Beacon Lite Road Improvements
Drainage Report

Prepared for:

El Paso County
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STATEMENTS

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. Said drainage report has been prepared according to the criteria established by the County for drainage reports and said report is in conformity with the 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.

Michael E. Butters, PE
Colorado License #32595

Date 09/09/2024

El Paso County:

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

Date

County Engineer / ECM Administrator Conditions:

Contents

List of Figures

List of Tables

List of Appendices

List of Exhibits

1 General Location and Description

1.1 Location

The Beacon Lite Road Improvements Project is located in northern El Paso County, Colorado with Douglas County to the north and the Town of Monument to the south; in Township 11S Range 67W of the 6th Principal Meridian. The project starts in NW Section 11 and ends in NW Section 2. The Project extends from Wakonda Way to County Line Road. Beacon Lite Road runs parallel to the I-25 corridor. The extent of the project limits is shown in Figure 1:

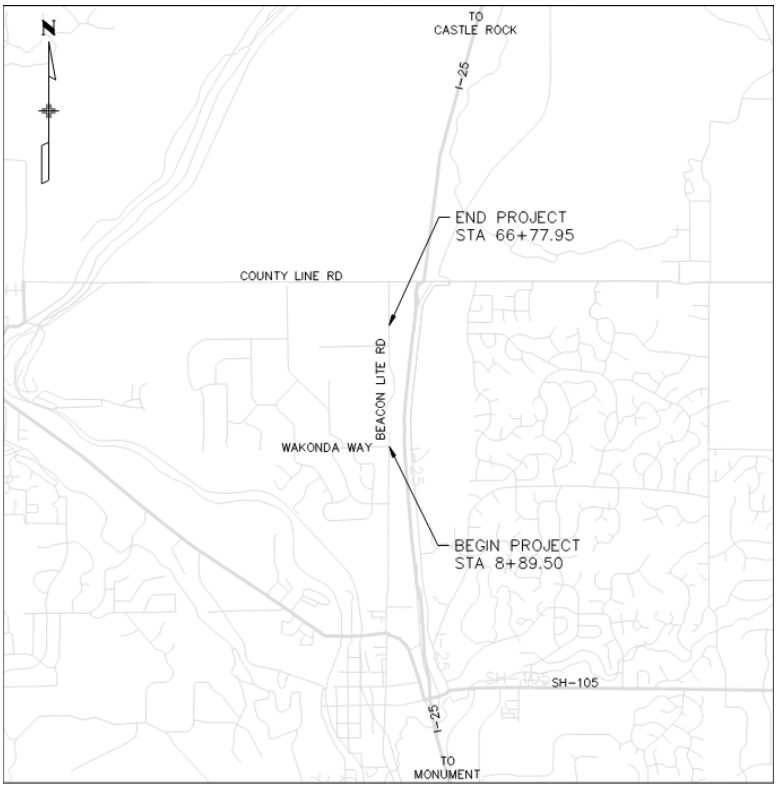


Figure 1 - Project Location

1.2 Description of Property

The existing one-mile gravel road operates as a rural collector and provides access to local residents. The area around the project is mostly rural with some residential and commercial properties. Existing vegetation is primarily native grasses, shrubs, evergreen, and deciduous forest. The topography varies with grades ranging from 0-50% in some of the upstream portions of the drainage basins.

The NRCS soil survey database was used to identify soil types and infiltration rates for the project. The dominant Hydrologic Soils Group (HSG) for the project is Group-B. See Appendix A.1 for soils map.

There are no known existing irrigation facilities within the Project limits.

There are no major drainageways crossings or existing stormwater facilities on the Project.

Utilities on the site include fiber optic lines owned by Lumen, Comcast, and Zayo, copper communications lines owned by Lumen, Town of Monument water and sewer services, Mountain View Electric overhead power lines, and Black Hills Energy gas lines. Due to large impacts created by the project, utility lines will be relocated prior to construction or during construction to accommodate the proposed roadway geometry and storm sewer improvements. Coordination during construction between the utility owners and the contractor will be required.

1.3 Description of Climate

This area of El Paso County can be described as the foothills, with total precipitation amounts typical of a semi-arid region. Winters are generally cold and dry, and summers relatively warm and dry. Precipitation ranges from 12 to 14 inches per year, with the majority of this moisture occurring in the spring and summer in the form of rainfall. Thunderstorms are common during the summer months.

2 Drainage Basins and Sub-Basins

2.1 Major Basin Descriptions

The project resides between two major drainage basins: Bald Mountain (PLPL0200), and Palmer Lake (FOMO5400). An existing water tower is located at approximate STA 24+00. North of the water tower, the project drains northeast to Bald Mountain Basin and south of the water tower, the project drains southwest to the Palmer Lake Basin. See Exhibit 1 - Major Basin map.

There are no Master Drainage Plans or Drainage Basin Planning Studies for the project to follow.

According to the Federal Emergency Management Agency (FEMA) Flood insurance Rate Map (FIRM) Panel #080059, effective 12/7/2018, the project site is within a designated Zone X area described as "areas determined to be outside 500-year floodplain". A firmette map is included in Appendix A.3.

2.2 Sub-basin Description

Existing basins were delineated to analyze existing conditions on the site. Hydrology calculations were completed using the Rational Method, discussed in Section 3.2. See Exhibit - 2 for Existing Basin Map.

The following sub-basins are within the Bald Mountain Basin:

Basin B (21.03 AC, Q10 = 16.61 cfs, Q100 = 33.85 cfs) is a large, mostly undeveloped, basin that includes the intersection of Beacon Lite Road and County Line Road. Proposed County Line Road improvements were assumed to be complete as part of the existing condition. This basin flows east to **DP 1** where flows are conveyed under the I-25 on-ramp in an existing 24-inch RCP culvert.

Basin A (0.06 AC, Q10 = 0.12 cfs, Q100 = 0.23 cfs) includes a gravel driveway and side ditch that flows south under the driveway through an 18-inch CMP into Basin C.

Basin C (3.84 AC, Q10 = 3.37 cfs, Q100 = 6.98 cfs) is mostly undeveloped with one residential property and driveway. The basin collects flows from the west of Beacon Lite Road in a roadside ditch where they are combined with flows from Basin A. The ditch drains south until it is conveyed east in an 18-inch RCP cross culvert under Beacon Lite Road where the basin outfalls into Basin D.

Basin H (5.60 AC, Q10 = 2.30 cfs, Q100 = 4.90 cfs) is mostly undeveloped with one residential property and gravel driveway. The basin collects flows from the west in a roadside ditch that flows north to the driveway where there is no apparent outlet. The flows overtop Beacon and flows east into Basin D.

Basin E (5.93 AC, Q10 = 4.67 cfs, Q100 = 9.25 cfs) is mostly undeveloped with a couple of residential properties on the upstream (west) end. The basin collects flows from the west of Beacon Lite Road in a roadside ditch that drains under a driveway and then through the same existing culvert as Basin C, outfalling into Basin D. Existing side drain is an 18-inch CMP.

A high point in Beacon Lite Road, separates Basins H and J. Basin J (0.41 AC, Q10 = 0.39 cfs, Q100 = 0.80 cfs) is undeveloped land that flows south into Basin L. Existing flow from Basin J to L is conveyed through an 18-inch CMP.

Basin L (6.98 AC, Q10 = 3.52 cfs, Q100 = 7.42 cfs) is heavily forested with a couple of residential properties and gravel driveways. The Basin collects flows from the west of Beacon Lite Road in a roadside ditch where they flow north and combine with flows from Basin J before being conveyed into Basin D via an existing 18-inch RCP cross-culvert.

Basin N (2.79 AC, Q10 = 2.62 cfs, Q100 = 5.33 cfs) is mostly undeveloped and collects flows from the west in a roadside ditch that flows north and then east through an existing 18-inch CMP cross-culvert into Basin D.

Basin D (34.11 AC, Q10 = 12.08 cfs, Q100 = 25.79 cfs) is a large, mostly undeveloped, basin on the east of Beacon Lite Road that collects flows from the west side of Beacon Lite Road from basins A, C, E, H, J, L, N. This basin flows east to **DP 2** where flows are conveyed under I-25 in an existing 42-inch RCP culvert.

The following sub-basins are within the Palmer Lake Basin:

Basin Q (0.60 AC, Q10 = 0.66 cfs, Q100 = 1.32 cfs) is heavily forested and collects flows from the west in a roadside ditch that flows south into Basin S.

Basin S (0.09 AC, Q10 = 0.27 cfs, Q100 = 0.49 cfs) includes the west side of Beacon Lite Road that is collected on the west in a roadside ditch that combines with Basin Q and flows south into Basin U.

Basin U (0.12 AC, Q10 = 0.34 cfs, Q100 = 0.62 cfs) includes the west side of Beacon Lite Road that is collected on the west in a roadside ditch that combines with Basins Q and S and flows south into Basin V.

Basin V (0.09 AC, Q10 = 0.23 cfs, Q100 = 0.43 cfs) includes the west side of Beacon Lite Road that is collected on the west in a roadside ditch that combines with Basins Q, S, and U and flows south into Basin X.

Basin X (0.24 AC, Q10 = 0.71 cfs, Q100 = 1.31 cfs) includes the west side of Beacon Lite Road that is collected on the west in a roadside ditch that combines with Basins Q, S, U and V and flows south into Basin Y.

Basin Y (0.25 AC, Q10 = 0.59 cfs, Q100 = 1.10 cfs) includes the west side of Beacon Lite Road that is collected on the west in a roadside ditch that combines with Basins Q, S, U, V and Y and flows south to **DP 3** where the flow goes offsite to the west.

Basin W (10.30 AC, Q10 = 5.32 cfs, Q100 = 10.98 cfs) is an offsite basin that collects drainage from I-25 and undeveloped, forested land to the west of I-25. The flows are conveyed into Basin T via an existing 48-inch culvert.

Basin R (2.31 AC, Q10 = 2.27 cfs, Q100 = 4.58 cfs) is a mostly undeveloped basin on the east of Beacon Lite Road that collects flows in a roadside ditch on the east of the road and flows south into Basin T.

Basin T (12.36 AC, Q10 = 7.61 cfs, Q100 = 16.10 cfs) is a heavily forested basin that collects flows in a roadside ditch on the east of Beacon Lite Road. The ditch also conveys flows from Basins W and R. The ditch flows south to **DP 4** before crossing under Beacon Lite Road and flowing west.

Basin Z (0.27 AC, Q10 = 0.91 cfs, Q100 = 1.70 cfs) includes Beacon Lite Road and sheet flows to the west.

Basin AA (0.20 AC, Q10 = 0.40 cfs, Q100 = 0.76 cfs) includes Beacon Lite Road and flows south in a roadside ditch on the west side of the road. Basin AA outfalls into Basin AC.

Basin AC (3.49 AC, Q10 = 2.80 cfs, Q100 = 5.73 cfs) consists of forested land and a residential property and

driveway. This basin collects flows from Basin AA and flows south to **DP 5** where they are conveyed under Wakonda Way to the south in an 18-inch CMP.

Basin AD (46.36 AC, Q10 = 32.53 cfs, Q100 = 63.47 cfs) is a large offsite basin to the east of Beacon Lite Road that consists of I-25, undeveloped areas, forested land, residential properties, and commercial properties. The basin flows southwest towards Beacon Lite Road where it is eventually collected in a roadside ditch and conveyed into Basin AF.

Basin AF (0.91 AC, Q10 = 0.85 cfs, Q100 = 1.73 cfs) consists of one residential property and driveway. Flows from this basin are combined with flows from Basin AD in a roadside ditch on the east of Beacon Lite before being conveyed into Basin AH.

Basin AH (5.83 AC, Q10 = 6.99 cfs, Q100 = 13.42 cfs) is a commercial property that flows northwest into a roadside ditch on the east side of Beacon Lite Road. The ditch flows north and is conveyed to the west of the road in an existing culvert that also carries flows from Basins AD and AF. The 18-inch CMP culvert outfalls into Basin AE.

Basin AE (0.42 AC, Q10 = 0.53 cfs, Q100 = 1.05 cfs) collects flows from the intersection of Wakonda Way and Beacon Lite Road. Basins AD, AF, and AH flow through Basin AE to **DP 6** where they are conveyed west in an existing 18-inch CMP driveway culvert.

Basin AG (5.88 AC, Q10 = 4.54 cfs, Q100 = 9.27 cfs) is comprised of residential properties and collects flows from **DP 5** and **DP 6**. The Basin flows west to **DP 7.**

Basin AJ (0.13 AC, Q10 = 0.33 cfs, Q100 = 0.62 cfs) consists of flows from Beacon Lite Road that are collected in a roadside ditch on the west side of the road. The ditch flows south to **DP 8**.

A high point in Beacon Lite Road separates Basins AH, AJ, AK and AL. Basin AK (0.17 AC, Q10 = 0.21 cfs, Q100 = 0.43 cfs) includes undeveloped area and the roadside ditch on the east of Beacon Lite Road that flows south to Basin AL.

Basin AL (0.10 AC, Q10 = 0.24 cfs, Q100 = 0.45 cfs) consists of flows from Beacon Lite Road that are collected in a roadside ditch on the east side of the road. The ditch also conveys flows from Basin AK and flows south to **DP 9**.

3 Drainage Design Criteria

3.1 Development Criteria Reference

The basis for design comes from the following sources but is not limited to:

- El Paso County *Engineering Criteria Manual* (ECM), adopted 12/23/2004, revised 12/13/2016, Revision 6
- ECM Revision July 2019 Implementation Directive 06.20.2019
- El Paso County Drainage Criteria Manual
- City of Colorado Springs Drainage Criteria Manual (DCM)
- Urban Storm Drainage Criteria Manual (USDCM) Volume 1 and Volume 1 Updated
- Urban Storm Drainage Criteria Manual (USDCM) Volume 2
- Urban Storm Drainage Criteria Manual (USDCM) Volume 3
- Colorado Department of Transportation (CDOT) Drainage Design Manual 2019
- CDOT M&S Standard Plans
- Beacon Lite Road Improvements Geotechnical Design Report (April 2022)

3.2 Hydrologic Criteria

The hydrologic analysis was conducted in conformance with the El Paso County Drainage Criteria Manual. The Rational Method is valid for drainage basins of 130 acres or less. All basins for this project are less than 130 acres in tributary area.

The rational method is as follows:

$$Q = CiA$$

Where:

Q = peak runoff rate in cubic feet per second (cfs);
C = Runoff coefficient representing a ratio of peak runoff rate to average rainfall intensity for a duration equal to the runoff time of concentration;
i = average rainfall intensity in inches per hour for a duration equal to the time of concentration, t_c; and
A = drainage area in acres

The runoff coefficients in Table 1 were used for the Project. These numbers represent a summary of Table 5-1 in the El Paso County DCM.

Table 1 - Runoff Coefficients

Land use or surface characteristics	**Percent Impervious**	**"C" Frequency**	
		10 Year	**100 Year**
Paved Street	100	0.90	0.95
Gravel Street	80	0.80	0.85
Roof	90	0.90	0.95
Undeveloped	2	0.15	0.20

For areas with varying land use and characteristics, a composite runoff coefficient was calculated using the relationship:

$$c = \frac{\sum_{i=1}^{n} c_i A_i}{A_t}$$

Where:

c_i = individual runoff coefficient corresponding to surface type;
A_i = area of surface type corresponding to c_i;
A_t = total drainage area for which composite runoff coefficient is applicable;
n = total number of surface types in drainage areas; and
c = the composite runoff coefficient.

Rainfall intensity is the average rate of rainfall for a storm of a given duration equal to the estimated runoff time of concentration. Rainfall depth-duration-frequency values were obtained from NOAA Atlas 14 for the Project site. See Appendix A.2 for NOAA Atlas 14 values.

The 1-hour point rainfall depth in inches was used in the following equation (Equation 5-1, USDCM Volume 1) to calculate rainfall intensity:

$$i = \frac{28.5P_1}{(10 + t_c)^{0.786}}$$

Where:

P_1 = 1-hour point rainfall depth (inches)
t_c = time of concentration (minimum 5 minutes), $t_c = t_i + t_t$
t_i = initial time in minutes
t_t = channelized travel time in minutes
$t_i = 0.395(1.1-C_{10})(L_i)^{0.5}/S_i^{0.33}$
$t_t = L_t/(60KS_t^{0.5})$
C_{10} = runoff coefficient for 10-year frequency
L_i = initial flow distance (maximum 300 ft)
S = average slope of the basin in percent
L_t = remaining length of basin in feet
K = conveyance factor from table 6-2 of the USDCM Volume 1 (summarized in Table 2 below).

Table 2 - NRCS Conveyance factors, K

Type of Land Surface	Conveyance Factor, K
Heavy meadow	2.5
Tillage/field	5
Short Pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

A 10-year initial (minor) storm event and 100-year major storm event were analyzed in the design of the drainage systems.

3.3 Hydraulic Criteria

Table 3 summarizes the criteria used for street capacity. Capacity of gutters was calculated based on the effective longitudinal gutter slope, averaging slopes at 0 feet, 25 feet and 50 feet upstream from the inlet.

Table 3 - Allowable Use of Roads and Streets

Street Classification	Use of Streets for Initial and Major Storms		Cross Flow in Streets for Initial and Major Storms	
	10-year Initial Storm	100-year Major Storm	10-year Initial Storm	100-year Major Storm
Type B (Collector or Minor Arterial)	No curb overtopping. Flow spread must be limited to a maximum 20 foot spread from each curb face.	Residential dwellings, public, commercial and industrial buildings shall not be inundated at the ground line. The depth of water at the gutter flow line shall not exceed 12 inches.	Where cross pans are allowed, depth of flow shall not exceed 6 inches at flow line	12 inches of depth at gutter flow line
Type B (Collector or Minor Arterial with Roadside Ditch)	Flow must not encroach upon street shoulder area.	Residential dwellings, public, commercial and industrial buildings shall not be inundated at the ground line. The depth of flow shall not exceed 6 inches at the shoulder	Requires culvert. Flow shall not encroach upon street shoulder.	Requires culvert. Depth of flow shall not exceed 6 inches at the street shoulder

Where gutter or street capacity as shown in Table 3 was exceeded, inlets were placed to intercept runoff. Inlets were also placed to reduce bypass across roadway intersections and into sag locations. A standard CDOT Type R curb opening inlet was used.

Minimum pipe size is 18 inches. Storm drains are designed to carry the initial storm without surcharging the storm system. The HGL from the major storm event shall be 1 foot below the final grade elevation. Storm drains were designed to have a minimum pipe velocity of 2.5 ft/s and maximum velocity of 18 ft/sec. Storm drains were placed horizontally 6 feet from roadway centerline where possible.

Minimum culvert pipe size is 18 inches. Cross culverts were designed to pass the 10-year and 100-year runoff in accordance with the following table.

Table 4 - Allowable Culvert Overtoppings*

Drainage Classification	10-year Minor Storm	100-year Major Storm
Types A & B (Local/Residential and Collector)	Headwater Depth Ratio (HW/D) is less than Pipe Height	12 inches of depth at the gutter flow line
Types A & B (Local/Residential and collector with roadside ditch	Headwater Depth Ratio (HW/D) is less than Pipe Height	6 inches of depth at the street
* A culvert is defined as any buried structure with both a clear opening less than 200 square feet, and span less than 20 feet and capacity less than 1500 cfs.		

Roadside ditches along the corridor were designed for the minor storm event. Hydraulic design criteria for rural roadside ditches are summarized in Table 5.

Table 5 - Hydraulic Design Criteria for Grass-Lined Constructed Ditches

Design Item	Criteria
Maximum velocity (slopes <5%)	5.0 fps
Maximum velocity (slopes 5-10%)	4.0 fps
Maximum velocity (slopes >10%)	3.0 fps
Maximum Froude number	0.9
Max side slope	4H:1V

Freeboard requirement was determined using the following formula from El Paso County DCM Section 10.5.5:

$$H = 1.0 + 0.025 * V * D^{0.33}$$

Where:

V = average channel flow velocity, in fps
D = Depth of flow, in ft

3.4 Water Quality Criteria

Detention storage is an effective means of reducing peak flow rates and mitigating negative downstream impacts including flooding and soil erosion. Detention is required where downstream conveyance facilities do not have adequate capacity to convey the increased runoff from the project.

Stormwater quality management is required for projects that fall within the existing Municipal Separate Storm Sewer System Permit (MS4) area as shown in Appendix D.1 – MS4 Existing Area Boundary. The Project does not fall within the limits. However, El Paso County has requested that water quality be provided per the MS4 requirements. When water quality management is required, proposed water quality Best Management Practice (BMP) selection shall follow the four-step process specified in the El Paso County DCM Volume 2:

- Step 1: Employ Runoff Reduction Practices. Reduce runoff peaks and volumes by routing impervious area to pervious area to slow down runoff and promote infiltration. Runoff reduction estimates are based on Mile High Flood District (MHFD) approved calculation methods to quantify the volume of reduction achieved.

- Step 2: Stabilize Drainageways. Use channel lining and outlet protection to protect natural drainageways.

- Step 3: Provide Water Quality Capture Volume (WQCV). All sites requiring stormwater detention must address stormwater quality by providing the WQCV using one of the following six approved BMPs.
    - Porous Pavement Detention
    - Porous Landscape Detention
    - Extended Detention Basin
    - Sand Filter Extended Detention Basin
    - Constructed Wetland Basin
    - Retention Pond

- Step 4: Consider need for Industrial and Commercial BMPs. Specialized BMPs must be considered if significant development is planned for an industrial or commercial site. The need for industrial and commercial BMPs was considered, however, the need for industrial and commercial BMPs are not applicable for this project.

4 Drainage Facility Design

4.1 General Concept

North of the water tower, the proposed roadway will be a paved rural roadway section with no curb and gutter. Stormwater runoff from the roadway on the west will be collected in roadside ditches where it will combine with offsite flows coming towards the roadway from the west. The ditches will be conveyed east in cross culverts to maintain existing flow conditions to the extent possible. Roadway runoff on the east will sheet flow following existing drainage patterns.

South of the water tower, the proposed roadway will have a typical urban roadway section with curb and gutter on both sides of the proposed road. In this area the offsite flows coming from the east will be collected in roadside ditches and conveyed to the west of Beacon Lite Road, maintaining existing flow patterns to the extent possible. Onsite flows will be collected in a closed storm sewer system and will outfall into one of the two proposed Extended Detention Basins on the east side before being conveyed to the west of Beacon Lite Road where they will combine with offsite flows.

4.2 Proposed Hydrology

Existing and proposed sub-basins were delineated using existing topography and proposed roadway grading. Existing and proposed basin maps are in Appendix A.1. Hydrology calculations were completed using the Rational Method for the 10-year and 100-year storm events. A 5-minute time of concentration was used for roadway basins. Calculations are in Appendix A.1.

The following sub-basins are within the Bald Mountain Basin:

Basin B (20.66 AC, Q10 = 19.74 cfs, Q100 = 40.28 cfs) is a large, mostly undeveloped, basin that includes the intersection of Beacon Lite Road and County Line Road. Minor improvements to Beacon Lite Road increase the flows to **DP 1** where flows are conveyed under the I-25 on-ramp in an existing 24" culvert.

Basin B_Rd (0.12 AC, Q10 = 0.25 cfs, Q100 = 0.48 cfs) consists of Beacon Lite Road and the roadside ditch on the east. This basin flows into Basin B to **DP 1**. Roadway runoff from this basin is treated via runoff reduction.

Basin A (0.39 AC, Q10 = 0.54 cfs, Q100 = 1.07 cfs) includes improvements to a gravel driveway and roadway improvements that flow into Basin B to **DP 1**. Roadway runoff from this basin is treated via runoff reduction.

Basin C (3.80 AC, Q10 = 2.73 cfs, Q100 = 5.65 cfs) is mostly undeveloped with one residential property and driveway. The basin collects flows from the west of Beacon Lite Road in a roadside ditch that drains south to IN-46. IN-46 oufalls into Basin D on the east of Beacon Lite Road. Roadway runoff from this basin is treated via runoff reduction.

Basin H (5.55 AC, Q10 = 2.36 cfs, Q100 = 5.00 cfs) is mostly undeveloped with one residential property and gravel driveway. The basin collects flows from the west in a roadside ditch that flows north through P-45 into Basin E. Roadway runoff from this basin is treated via runoff reduction.

Basin E (5.95 AC, Q10 = 5.15 cfs, Q100 = 10.09 cfs) is mostly undeveloped with a couple of residential properties on the upstream (west) end. The basin collects flows from the west of Beacon Lite Road in a roadside ditch that drains north to P-47 which outfalls to Basin D. Roadway runoff from this basin is treated via runoff reduction.

A high point in Beacon Lite Road separates Basins H and J. Basin J (0.46 AC, Q10 = 0.52 cfs, Q100 = 1.03 cfs) includes undeveloped land that flows south in a roadside ditch and through P-48 into Basin L. Roadway runoff from this basin is treated via runoff reduction.

Basin L (6.96 AC, Q10 = 3.70 cfs, Q100 = 7.75 cfs) is heavily forested with a couple of residential properties and gravel driveways. The Basin collects flows from the west of Beacon Lite Road in a roadside ditch where they flow north to IN-44. IN-44 collects flows from Basin L and Basin J and outfalls to the east into Basin D. Roadway runoff from this basin is treated via runoff reduction.

Basin N (2.50 AC, Q10 = 1.79 cfs, Q100 = 3.72 cfs) is mostly undeveloped and collects flows from the west in a roadside ditch that flows north and then east through P-43, outfalling into Basin D. Roadway runoff from this basin is treated via runoff reduction.

Basin N_Rd (0.23 AC, Q10 = 1.00 cfs, Q100 = 1.80 cfs) consists of new pavement. Flows are collected in the curb and gutter and flow north to IN-42 where they are conveyed to the east of Beacon Lite Road into Basin D.

Basin D_Rd (0.35 AC, Q10 = 0.75 cfs, Q100 = 1.42 cfs) consists of Beacon Lite Road and the roadside ditch on the east. Flows from this basin are treated via runoff reduction. This basin flows into Basin D.

Basin D (33.91 AC, Q10 = 11.19 cfs, Q100 = 24.51 cfs) is a large, mostly undeveloped, basin on the east of Beacon Lite Road that collects flows from the west side of Beacon Lite Road from basins C, E, H, J, L, N, N_Rd, and D_Rd. Runoff on the east side of Beacon Lite Road within this basin sheet flows to undeveloped area to the east and is treated via runoff reduction with a calculated 12-foot wide Received Pervious Area (RPA). This basin flows east to **DP 2** where flows are conveyed under I-25 in an existing 42" culvert.

The following sub-basins are within the Palmer Lake Basin:

Basin P_Rd (0.23 AC, Q10 = 1.02 cfs, Q100 = 1.83 cfs) is a paved roadway basin that collects runoff in the curb and gutter that flows south to curb inlet IN-38.

Basin R_Rd (0.22 AC, Q10 = 1.00 cfs, Q100 = 1.79 cfs) is a paved roadway basin that collects runoff in the curb and gutter that flows south to curb inlet IN-39.

Basin V (0.36 AC, Q10 = 1.61 cfs, Q100 = 2.88 cfs) is a paved roadway basin that collects runoff in the curb and gutter that flows south to curb inlet IN-36.

Basin V_Rd (0.37 AC, Q10 = 1.64 cfs, Q100 = 2.93 cfs) is a paved roadway basin that collects runoff in the curb and gutter that flows south to curb inlet IN-37.

Basin X (0.23 AC, Q10 = 1.03 cfs, Q100 = 1.85 cfs) is a paved roadway basin that collects runoff in the curb and gutter that flows south to curb inlet IN-33.

Basin X_Rd (0.24 AC, Q10 = 1.08 cfs, Q100 = 1.94 cfs) is a paved roadway basin that collects runoff in the curb and gutter that flows south to curb inlet IN-34.

Basin Y (0.27 AC, Q10 = 1.21 cfs, Q100 = 2.17 cfs) is a paved roadway basin that collects runoff in the curb and gutter that flows south to curb inlet IN-32.

Basin Y_Rd (0.27 AC, Q10 = 1.21 cfs, Q100 = 2.18 cfs) is a paved roadway basin that collects runoff in the curb and gutter that flows south to curb inlet IN-21. IN-21 outfalls into the North Pond through P-21 that also conveys the flows from Basins P_Rd, R_Rd, V, V_Rd, X, X_Rd, and Y into the North Pond.

Basin U (2.02 AC, Q10 = 1.05 cfs, Q100 = 2.39 cfs) consists of the north pond and the offsite area that drains directly into the pond.

Basin Q (0.62 AC, Q10 = 0.28 cfs, Q100 = 0.63 cfs) is heavily forested and collects flows from the west in a roadside ditch that flows south. Existing flows from this Basin continued south in a roadside ditch on the west of Beacon Lite Road. In the proposed condition, the roadside ditch on the west is eliminated as the roadway runoff is captured in curb and gutter. To keep flows from this basin from impacting properties on the west of Beacon Lite Road, they are collected in IN-41 and conveyed to the roadside ditch on the east and into Basin T.

Basin R (2.12 AC, Q10 = 1.94 cfs, Q100 = 4.03 cfs) is a mostly undeveloped basin on the east of Beacon Lite Road that collects flows in a roadside ditch on the east of the road and flows south into IN-40 and into Basin T.

Basin W (10.30 AC, Q10 = 5.32 cfs, Q100 = 10.98 cfs) is an offsite basin that collects drainage from I-25 and undeveloped, forested land to the west of I-25. The flows are conveyed into Basin T via an existing 48-inch culvert.

Basin T (10.48 AC, Q10 = 5.87 cfs, Q100 = 12.76 cfs) is a heavily forested basin that collects flows in a roadside ditch on the east of Beacon Lite Road. The ditch also conveys flows from Basins Q, R, and W. The ditch flows south to IN-19.

Detained and treated onsite flows from the North Pond and offsite flows from Basins U, Q, R, W, and T combine at **DP 4** before crossing under Beacon Lite Road and flowing west.

Basin AI (0.95 AC, Q10 = 0.61 cfs, Q100 = 1.37 cfs) consists of offsite area that drains into a roadside ditch on the east of Beacon Lite Road. The ditch flows south to IN-17 that oufalls into Basin AD.

Basin AD (44.50 AC, Q10 = 31.10 cfs, Q100 = 60.60 cfs) is a large offsite basin to the east of Beacon Lite Road that consists of I-25, undeveloped areas, forested land, residential properties, and commercial properties. The basin flows southwest towards Beacon Lite Road where it is eventually collected in a roadside ditch that flows south to IN-15 and IN-14.

Basin AF (0.97 AC, Q10 = 1.06 cfs, Q100 = 2.10 cfs) consists of one residential property and driveway. Flows from this basin are collected on the east of Beacon Lite Road in IN-35. Basin AF includes some roadway drainage from Beacon Lite Road, these flows are treated via runoff reduction.

Existing flows from Basins AI, AD, and AF were routed through DP 6. However, due to the small capacity of the existing driveway culverts at **DP 6**, these flows are routed along Wakonda Way and outfall to the west of the two properties to **DP 7**.

Basin AA (0.96 AC, Q10 = 1.05 cfs, Q100 = 2.11 cfs) includes the undeveloped area between the existing Beacon Lite Road and the proposed road. The flows from this basin are collected in a roadside ditch that flows south to IN-16 where they are combined with the onsite flow conveyance system. This is to prevent increasing flows into Basin AC and its properties. Flows from AA will be routed through the proposed South Pond.

Basin AA_Rd (0.39 AC, Q10 = 1.76 cfs, Q100 = 3.15 cfs) is a paved roadway basin that collects runoff in the curb and gutter that flows south to curb inlet IN-7.

Basin AB_Rd (0.39 AC, Q10 = 1.73 cfs, Q100 = 3.10 cfs) is a paved roadway basin that collects runoff in the curb and gutter that flows south to curb inlet IN-8.

Basin AC_Rd (0.26 AC, Q10 = 1.15 cfs, Q100 = 2.07 cfs) is a paved roadway basin that collects runoff in the curb and gutter that flows south to curb inlet IN-6.

Basin AD_Rd (0.29 AC, Q10 = 1.28 cfs, Q100 = 2.30 cfs) is a paved roadway basin that collects runoff in the curb and gutter that flows south to curb inlet IN-27.

Basin AH (6.26 AC, Q10 = 6.80 cfs, Q100 = 13.13 cfs) is a commercial property that flows northwest into a roadside ditch on the east side of Beacon Lite Road. The ditch flows north into the proposed south pond. A drainage report was found for the commercial property that showed a potential future development of this basin. The future development would have 60.7% imperviousness. This imperviousness was used for Basin AH when sizing the south pond to account for any future development on the property.

The south pond combines flows from basins AA, AA_Rd, AB_Rd, AC_Rd, AD_Rd, and AH. The outfall from the pond is routed along Wakonda Way and outfalls into **DP 7**. The existing flows were conveyed through design point 6, but were redirected in the proposed system to avoid any impacts to the properties on the corner of Beacon Lite Road and Wakonda Way.

Basin AE (0.42 AC, Q10 = 0.79 cfs, Q100 = 1.49 cfs) collects flows from the intersection of Wakonda Way and Beacon Lite Road at **DP 6.**

Basin AC (3.43 AC, Q10 = 2.86 cfs, Q100 = 5.73 cfs) is comprised of forested land and a residential property and driveway. Flows from this basin are conveyed into the proposed offsite drainage system in Wakonda Way via P-5 at **DP 5**.

Basin AG (4.20 AC, Q10 = 4.12 cfs, Q100 = 8.18 cfs) is comprised of residential properties and collects flows from **DP 6** and **DP 5**. The Basin flows west to **DP 7.** Roadway runoff from this basin is treated via runoff reduction.

A high point in Beacon Lite Road separates Basins AH and AG from Basins AJ and AL. Basin AJ (0.28 AC, Q10 = 0.59 cfs, Q100 = 1.10 cfs) includes Beacon Lite Road and ditch that flows south to **DP 8**. Roadway runoff from this basin is treated via runoff reduction.

Basin AL (0.50 AC, Q10 = 0.68 cfs, Q100 = 1.36 cfs) consists of flows from Beacon Lite Road and a gravel driveway that are collected in a roadside ditch on the east side of the road. The ditch also conveys flows south to **DP 9**.

Roadway runoff from this basin is treated via runoff reduction.

A summary of existing vs proposed flows at design points is listed in Table 6.

Table 6 - Existing vs Proposed Flows (100-YR)

Drainage Basin	Design Point	Existing Area (ac)	100-yr Existing Flow (cfs)	Proposed Area (ac)	100-yr Proposed Flow (cfs)
Bald Mountain	1	21.03	34.08	21.18	41.83
	2	59.74	60.68	58.12	58.09
Palmer Lake	3	1.39	5.28	NA	NA
	4	24.97	31.66	29.32	52.39* 32.55 (with detention)
	5	3.69	6.49	3.43	5.73
	6	53.52	79.66	0.42	1.49
	7	63.09	95.41	63.03	105.33* 90.58 (with detention)
	8	0.27	0.88	0.68	1.36
	9	0.13	0.62	0.28	1.10

*These flows do not include detention provided from the Extended Detention Basins. See Section 4.4 for summary of detained flows.

4.3 Hydraulic Analysis

Street and inlet capacity calculations were completed using the Mile High Flood District (MHFD) Street Capacity and Inlet Sizing spreadsheet to meet the criteria listed in Table 3. 100 percent of bypass flow was added to the downstream inlet. Calculations are in Appendix C.3.

Existing cross culverts convey stormwater through the Project site. The cross culverts will be removed and replaced with longer cross culverts to convey offsite and onsite drainage to match existing drainage patterns. Culverts were analyzed using the Federal Highway Administration HY-8 Culvert Hydraulic Analysis software. Calculations are included in Appendix C.4. Outlet protection for culverts were calculated using MHFD's equations for riprap aprons. Calculations are included in Appendix C.5.

For storm sewers, pipe capacity and velocity calculations were completed using AutoCAD Sanitary and Sewer Analysis (SSA). They were designed to meet the criteria listed in Section 3.3. See Appendix C.1 for calculations. Outlet protection for culverts and storm sewers was calculated using MHFD's equations for riprap aprons. Calculations are included in Appendix C.

Roadside ditches were analyzed using Bentley's FlowMaster. Ditches were designed to meet requirements in Section 3.2. Minimum longitudinal slope was used for depth calculations and maximum longitudinal slope was used for velocity and Froude number calculations. Riprap lining is required for ditches where steep slopes led to the exceedance of the Froude number criteria. FHWA Hydraulic Toolbox was used for ditches D-7 and D-11 as a design check for sizing the riprap lining due to the longitudinal slope being 13.00%. Ditch D-7 produced results of having a stable side slope with a D50 of 4.5 inches and a stable channel bottom with a D50 of 5 inches. Section 10.10 of the El Paso County Drainage Manual indicates that the minimum D50 is 6 inches, therefore ditch D-7 will be lined with 6-inch riprap. Ditch D-11 starts at approximately Station 145+14.00 and is restrained by right-of-way and has a depth of 6-inches until Station 144+24.64, where it ties into an existing ditch. Where right-of-way permits after Station 144+24.64, ditch D-11 becomes 2.5 feet deep. Basin R is tributary to ditch D-11 and the majority of flow is intercepted once the ditch is 2.5 feet deep. Calculations show that the max depth of ditch D-11 is 0.49 feet, and

overtopping is not observed in the 6-inch section and freeboard requirements are met once ditch D-11 transitions to 2.5 feet. From the high point at Station 145+80.00 to the driveway for the water tower, offsite runoff will sheet flow into the curb and gutter and be captured by IN-39. The area tributary is 0.02 acres and produces a flow of 0.01 cfs, therefore allowing the runoff to sheet flow onto the roadway eliminates the need for a side culvert beneath the water tower driveway for a minimal amount flow. Ditches D-1, D-2, D-3, D-4, and D-5 use drop structures to maintain a 1.5% slope to keep the flow subcritical and meet the Froude number requirement. Calculation results are summarized in Appendix C.2.

4.4 Water Quality and Detention

Though the Project does not fall within the MS4 boundary area, El Paso County has requested that water quality be provided in accordance with the MS4 requirements. The four-step process was used when analyzing water quality BMPs. Runoff reduction and Extended Detention Basins were used for the Project.

The BMP map in Exhibit 3 shows where and how each area is being detained and/or treated. Summary in Table 7.

Table 7 - BMP Summary

Design Point	Water Quality	Detention
1	Runoff Reduction	NA
2	Runoff Reduction	NA
3	NA	NA
4	North Pond	North Pond
5	NA	NA
6	Runoff Reduction	NA
7	South Pond	South Pond
8	Runoff Reduction	NA
9	Runoff Reduction	NA

Runoff reduction calculations for Design Points 1, 2, 8, and 9 are included in Appendix B.1. For these areas, the fore slope of the roadside ditches was used as the Receiving Pervious Area (RPA). In Basin D, the east side of Beacon Lite Road allows sheet flow from the roadway. A 12-foot-wide area is needed to account for the required runoff reduction. An easement will be needed for this width.

Runoff draining to Design Points 1 and 2 does not require detention required per Chapter 2, section 6.4.3 of the City of Colorado Springs DCM Volume 1 which states that on-site detention is not required if the downstream conveyance system has adequate capacity. Design Point 1 crosses the I-25 on-ramp through an existing 24-inch culvert with a capacity of 55.88 cfs. The existing pipe is adequate to convey the proposed 100-yr flow rate of 41.46 cfs. Design Point 2 crosses under I-25 in an existing 42-inch culvert with a capacity of 132 cfs which is greater than the proposed flow rate of 58 cfs. Downstream analysis calculations are in Appendix C.6.

The design of the two Extended Detention Basins (EBD) was based on the full spectrum design approach outlined in USDCM Volume 2. The MHFD-Detention spreadsheet was used for design. The first stage was designed for the water quality capture volume (WQCV), the second stage was designed for the Excess Urban Runoff Volume (EURV), and the third stage was designed for ½ WQCV + 100-year detention volume (described hereafter as the 100-year water surface elevation). Zones 1 and 2 are controlled by a vertical orifice plate designed to drain the WQCV within 40 hours.

The North Pond is a proposed EDB that will provide detention and water quality treatment for onsite, roadway runoff that is conveyed in the closed storm sewer system from Basins P_Rd, R_Rd, V, V_Rd, X, X_Rd, and Y. The

pond is located on the east side of Beacon Lite Road and cuts into the existing topography where it will intercept offsite flows from Basin U. Most offsite flows will bypass the pond in pipe P-19 that will run parallel to the pond on the east side of Beacon Lite Road. The North Pond has a tributary area of 4.48 acres with 55.85% imperviousness. The pond outlet was designed to match 80% of the predevelopment 100-year peak runoff rate (2.0 cfs). With detention, the proposed 100-year flow rate at Design Point 4 will be 32.53 cfs. The emergency overflow for the North Pond will consist of a Type D inlet slightly above at the 100-yr water surface elevation, with a grate elevation of 7247.50. The top of pond is at 7249 which provides adequate head above the grate to pass the 100-year flow. The overflow inlet is attached to the outfall pipe from the pond (P-20).

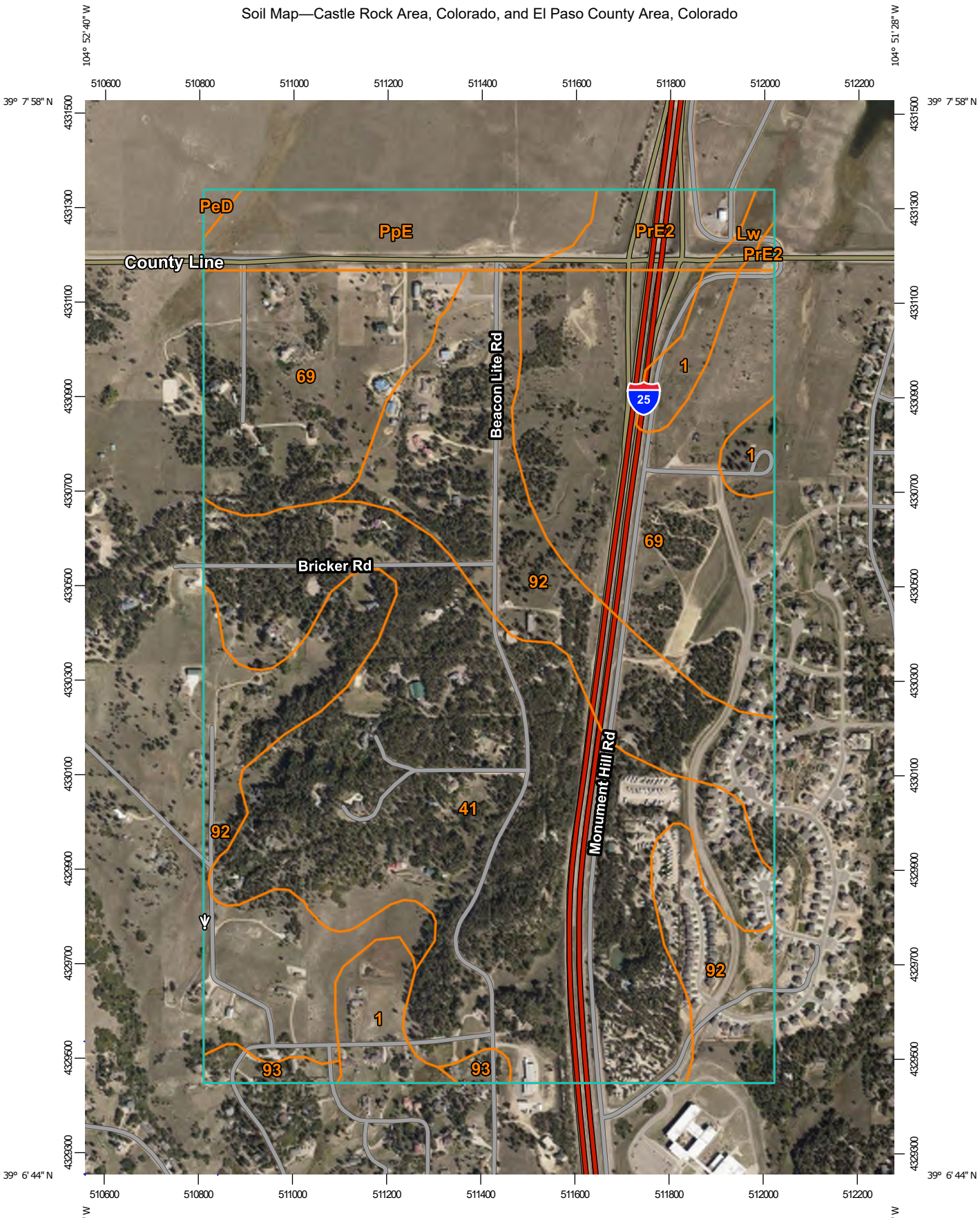
The South Pond is a proposed EDB that will provide detention and water quality treatment for onsite flows downstream of the North Pond to the low point just south of Wakonda Way (Basins AA, AA_Rd, AB_Rd, AC_Rd, AD_Rd, and AH). The South Pond is located on the east side of Beacon Lite Road on a commercial property. A proposed drainage report for the property showed a detention pond in this location, however, the property was not fully developed, and the proposed pond was not completed. This project will incorporate the anticipated proposed imperviousness from the commercial site that was shown in the drainage report. The south pond has a tributary area of 8.56 acres with 60.19% imperviousness. A wall is required to provide the required volume while minimizing impacts to the adjacent commercial property. The wall will retain the existing slope to the east. The pond outlet was designed to match the predevelopment 100-year peak runoff rate (11.0 cfs). With detention, the proposed 100-year flow rate will be 90.48 cfs at Design Point 7. The emergency overflow for the South Pond will consist of a Type D inlet at the 100-yr water surface elevation, with a grate elevation of 7196.97. The top of pond is at 7198.50 which provides adequate head above the grate to pass the 100-year flow. The overflow inlet is attached to the outfall pipe from the pond (P-10).

The proposed drainage facilities require ongoing maintenance for the safety of the traveling public. Regular inspections are required with follow up repairs, if necessary, to assure ongoing establishment of a fully functional drainage, detention, and water quality treatment system that meets the requirements of El Paso County standards and specifications.

APPENDIX A

APPENDIX A.1

Hydrology Calculations



Map Scale: 1:11,100 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 150 300 600 900

Feet: 0 500 1000 2000 3000

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

El Paso County Area, Colorado

69—Peyton-Pring complex, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 369g
Elevation: 6,800 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

Peyton and similar soils: 40 percent
Pring and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Peyton

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Arkosic alluvium derived from sedimentary rock and/or arkosic residuum weathered from sedimentary rock

Typical profile

A - 0 to 12 inches: sandy loam
Bt - 12 to 25 inches: sandy clay loam
BC - 25 to 35 inches: sandy clay loam
C - 35 to 60 inches: sandy loam

Properties and qualities

Slope: 8 to 9 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.3 inches)

Interpretive groups

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

El Paso County Area, Colorado

92—Tomah-Crowfoot loamy sands, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 36b9
Elevation: 7,300 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

Tomah and similar soils: 50 percent
Crowfoot and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tomah

Setting

Landform: Hills, alluvial fans
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from arkose and/or residuum weathered from arkose

Typical profile

A - 0 to 10 inches: loamy sand
E - 10 to 22 inches: coarse sand
C - 48 to 60 inches: coarse sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 2.0 inches)

Interpretive groups

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

Description of Crowfoot

Setting

Landform: Alluvial fans, hills

El Paso County Beacon Lite - Existing Hydrology Calculations

BASIN DATA									INITIAL TIME				CHANNELIZED TIME					TIME OF CONCENTRATION (T_C)			
BASIN	AREA	TOTAL AREA	TYPE	C_{10}	C_{100}	C_{10w}	C_{100w}	FL_{total} LENGTH	FL_i LENGTH	HI EL [ft]	LO EL [ft]	SLOPE [ft/ft]	FL_t LENGTH [ft]	HI EL [ft]	LO EL [ft]	SLOPE [ft/ft]	Conveyance Coeff (K)	INITIAL T_i	CHANNEL T_t	COMPUTED T_C	T_C
	acre	acre						ft	ft	ft	ft	ft/ft	ft	ft	ft	ft/ft		min	min	min	min
A	0.02	0.06	PAVED	0.90	0.95	0.43	0.48	106	67	7,377.12	7,374.01	0.046	39	7,374.01	7,369.85	0.108	15	5.99	0.13	6.12	6.12
	0.01		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.04		UNDEVELOPED	0.15	0.20																
B	2.80	21.03	PAVED	0.90	0.95	0.25	0.30	1,469	143	7,376.47	7,365.21	0.078	1325	7,365.21	7,310.50	0.041	15	9.31	7.25	16.56	16.56
	0.00		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	18.23		UNDEVELOPED	0.15	0.20																
C	0.09	3.84	PAVED	0.90	0.95	0.23	0.28	512	121	7,377.16	7,368.74	0.070	391	7,368.74	7,350.70	0.046	15	9.10	2.02	11.12	11.12
	0.28		GRAVEL	0.80	0.85																
	0.09		ROOFS	0.90	0.95																
	3.39		UNDEVELOPED	0.15	0.20																
D	1.19	34.11	PAVED	0.90	0.95	0.19	0.24	1,885	300	7,387.90	7,372.71	0.051	1585	7,372.71	7,312.59	0.038	5	16.57	27.12	43.70	43.70
	0.86		GRAVEL	0.80	0.85																
	0.10		ROOFS	0.90	0.95																
	31.96		UNDEVELOPED	0.15	0.20																
E	0.02	5.93	PAVED	0.90	0.95	0.30	0.35	876	300	7,392.20	7,374.30	0.060	576	7,374.30	7,352.41	0.038	5	13.87	9.85	23.71	23.71
	1.03		GRAVEL	0.80	0.85																
	0.28		ROOFS	0.90	0.95																
	4.60		UNDEVELOPED	0.15	0.20																
H	0.02	5.60	PAVED	0.90	0.95	0.20	0.25	1,254	300	7,404.00	7,394.37	0.032	954	7,394.37	7,358.17	0.038	5	19.18	16.33	35.52	35.52
	0.35		GRAVEL	0.80	0.85																
	0.04		ROOFS	0.90	0.95																
	5.19		UNDEVELOPED	0.15	0.20																
J	0.00	0.41	PAVED	0.90	0.95	0.25	0.30	219	185	7,371.98	7,359.22	0.069	34	7,359.22	7,358.62	0.018	15	11.00	0.28	11.29	11.29
	0.07		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.35		UNDEVELOPED	0.15	0.20																
L	0.02	6.98	PAVED	0.90	0.95	0.21	0.26	947	300	7,398.10	7,382.49	0.052	647	7,382.49	7,357.13	0.039	5	16.20	10.89	27.08	27.08
	0.43		GRAVEL	0.80	0.85																
	0.14		ROOFS	0.90	0.95																
	6.39		UNDEVELOPED	0.15	0.20																
N	0.14	2.79	PAVED	0.90	0.95	0.25	0.30	432	188	7,398.00	7,381.93	0.085	244	7,381.93	7,373.18	0.036	15	10.33	1.43	11.76	11.76
	0.20		GRAVEL	0.80	0.85																
	0.08		ROOFS	0.90	0.95																
	2.38		UNDEVELOPED	0.15	0.20																
Q	0.00	0.60	PAVED	0.90	0.95	0.28	0.33	487	164	7,397.36	7,383.83	0.083	323	7,383.83	7,343.79	0.124	15	9.40	1.02	10.42	10.42
	0.12		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.48		UNDEVELOPED	0.15	0.20																
R	0.00	2.31	PAVED	0.90	0.95	0.27	0.32	464	197	7,388.26	7,374.92	0.068	267	7,374.92	7,343.20	0.119	15	11.21	0.86	12.07	12.07
	0.17		GRAVEL	0.80	0.85																
	0.22		ROOFS	0.90	0.95																
	1.92		UNDEVELOPED	0.15	0.20																

BASIN DATA									INITIAL TIME				CHANNELIZED TIME					TIME OF CONCENTRATION (T_C)			
BASIN	AREA acre	TOTAL AREA acre	TYPE	C_{10}	C_{100}	C_{10w}	C_{100w}	FL_{total} LENGTH ft	FL_i LENGTH	HI EL [ft] ft	LO EL [ft] ft	SLOPE [ft/ft] ft/ft	FL_t LENGTH [ft] ft	HI EL [ft] ft	LO EL [ft] ft	SLOPE [ft/ft] ft/ft	Conveyance Coeff (K)	INITIAL T_i min	CHANNEL T_t min	COMPUTED T_C min	T_C min
S	0.00	0.09	PAVED	0.90	0.95	0.55	0.60	210	31	7,346.00	7,343.35	0.085	179	7,343.35	7,325.97	0.097	15	2.71	0.64	3.35	5.00
	0.06		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.03		UNDEVELOPED	0.15	0.20																
T	0.00	12.36	PAVED	0.90	0.95	0.20	0.25	1,724	267	7,367.65	7,333.55	0.127	1456	7,333.55	7,246.56	0.060	15	11.43	6.62	18.05	18.05
	0.95		GRAVEL	0.80	0.85																
	0.05		ROOFS	0.90	0.95																
	11.36		UNDEVELOPED	0.15	0.20																
U	0.00	0.12	PAVED	0.90	0.95	0.57	0.62	289	90	7,330.00	7,322.12	0.088	200	7,322.12	7,306.62	0.078	15	4.44	0.80	5.24	5.24
	0.08		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.04		UNDEVELOPED	0.15	0.20																
V	0.00	0.09	PAVED	0.90	0.95	0.53	0.58	232	73	7,310.00	7,304.34	0.078	159	7,304.34	7,290.87	0.085	15	4.48	0.61	5.09	5.09
	0.05		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.04		UNDEVELOPED	0.15	0.20																
W	0.91	10.30	PAVED	0.90	0.95	0.23	0.28	1,622	300	7,390.00	7,367.97	0.073	1322	7,367.97	7,286.00	0.062	5	14.04	17.69	31.72	31.72
	0.18		GRAVEL	0.80	0.85																
	0.07		ROOFS	0.90	0.95																
	9.13		UNDEVELOPED	0.15	0.20																
X	0.00	0.24	PAVED	0.90	0.95	0.60	0.65	493	49	7,292.00	7,288.00	0.081	443	7,288.00	7,255.24	0.074	15	3.20	1.81	5.01	5.01
	0.17		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.08		UNDEVELOPED	0.15	0.20																
Y	0.00	0.25	PAVED	0.90	0.95	0.51	0.56	403	74	7,260.50	7,255.66	0.065	329	7,255.66	7,241.53	0.043	15	4.92	1.76	6.68	6.68
	0.14		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.11		UNDEVELOPED	0.15	0.20																
Z	0.00	0.27	PAVED	0.90	0.95	0.49	0.54	NA									5				5.00
	0.14		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.13		UNDEVELOPED	0.15	0.20																
AA	0.00	0.20	PAVED	0.90	0.95	0.48	0.53	408	52	7,252.45	7,251.75	0.013	356	7,251.75	7,217.30	0.097	15	7.28	1.27	8.55	8.55
	0.10		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.10		UNDEVELOPED	0.15	0.20																
AC	0.05	3.49	PAVED	0.90	0.95	0.25	0.30	603	300	7,251.56	7,201.83	0.166	303	7,201.83	7,188.98	0.042	5	10.57	4.91	15.48	15.48
	0.38		GRAVEL	0.80	0.85																
	0.07		ROOFS	0.90	0.95																
	2.99		UNDEVELOPED	0.15	0.20																
AD	4.76	46.36	PAVED	0.90	0.95	0.34	0.39	3,392	148	7,354.01	7,352.87	0.008	3244	7,352.87	7,202.83	0.046	15	18.28	16.76	35.05	35.05
	6.96		GRAVEL	0.80	0.85																
	0.72		ROOFS	0.90	0.95																
	33.92		UNDEVELOPED	0.15	0.20																

BASIN DATA									INITIAL TIME				CHANNELIZED TIME					TIME OF CONCENTRATION (T_C)			
BASIN	AREA acre	TOTAL AREA acre	TYPE	C_{10}	C_{100}	C_{10w}	C_{100w}	FL_{total} LENGTH ft	FL_i LENGTH	HI EL [ft] ft	LO EL [ft] ft	SLOPE [ft/ft] ft/ft	FL_t LENGTH [ft] ft	HI EL [ft] ft	LO EL [ft] ft	SLOPE [ft/ft] ft/ft	Conveyance Coeff (K)	INITIAL T_i min	CHANNEL T_t min	COMPUTED T_C min	T_C min
AE	0.09	0.42	PAVED	0.90	0.95	0.31	0.36	166	160	7,202.99	7,189.68	0.083	6	7,189.68	7,189.33	0.056	7	9.02	0.06	9.09	9.09
	0.00		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.34		UNDEVELOPED	0.15	0.20																
AF	0.00	0.91	PAVED	0.90	0.95	0.26	0.31	404	300	7,248.00	7,210.76	0.124	104	7,210.76	7,200.90	0.095	5	11.42	1.12	12.54	12.54
	0.12		GRAVEL	0.80	0.85																
	0.04		ROOFS	0.90	0.95																
	0.76		UNDEVELOPED	0.15	0.20																
AG	0.29	5.88	PAVED	0.90	0.95	0.25	0.30	654	300	7,204.52	7,181.07	0.078	354	7,181.07	7,159.97	0.060	7	13.53	3.45	16.98	16.98
	0.14		GRAVEL	0.80	0.85																
	0.36		ROOFS	0.90	0.95																
	5.10		UNDEVELOPED	0.15	0.20																
AH	0.66	5.83	PAVED	0.90	0.95	0.39	0.44	790	300	7,242.00	7,216.00	0.087	490	7,216.00	7,198.90	0.035	7	10.94	6.24	17.18	17.18
	0.89		GRAVEL	0.80	0.85																
	0.41		ROOFS	0.90	0.95																
	3.88		UNDEVELOPED	0.15	0.20																
AJ	0.07	0.13	PAVED	0.90	0.95	0.52	0.57	207	35	7,204.52	7,203.91	0.017	172	7,203.91	7,191.36	0.073	15	5.19	0.71	5.89	5.89
	0.00		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.07		UNDEVELOPED	0.15	0.20																
AK	0.02	0.17	PAVED	0.90	0.95	0.27	0.32	106	89	7,214.98	7,204.00	0.124	17	7,204.00	7,202.00	0.118	15	6.17	0.05	6.22	6.22
	0.00		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.14		UNDEVELOPED	0.15	0.20																
AL	0.03	0.10	PAVED	0.90	0.95	0.46	0.51	123	52	7,204.00	7,197.97	0.116	71	7,197.97	7,192.75	0.074	15	3.73	0.29	4.02	5.00
	0.01		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.06		UNDEVELOPED	0.15	0.20																

El Paso County Beacon Lite - Existing Hydrology Calculations

One-hour rainfall intensity:

10YR 1.46 in/hr

100YR 2.48 in/hr

Rainfall Intensity Duration Frequency Equation:

$I=28.5*P/(10+T_c)^{0.786}$ (Equation 5-1, USDCM Volume 1)

BASIN DATA					DIRECT RUNOFF					TOTAL RUNOFF			Notes
DESIGN POINT	AREA DESIGN	AREA (ac)	RUNOFF COEFF. (C10)	RUNOFF COEFF. (C100)	t_c	I_{10}	I_{100}	Q_{10}	Q_{100}	TOTAL AREA (ac)	Q_{10}	Q_{100}	
					min	in/hr	in/hr	cfs	cfs		cfs	cfs	
1	B	21.03	0.25	0.30	16.6	3.16	5.37	16.61	33.85	21.03	**16.73**	**34.08**	
	A	0.06	0.43	0.48	6.1	4.68	7.95	0.12	0.23				
	C	3.84	0.23	0.28	11.1	3.78	6.43	3.37	6.96				
	H	5.60	0.20	0.25	35.5	2.07	3.52	2.30	4.90				
	E	5.93	0.30	0.35	23.7	2.62	4.45	4.67	9.25				
	J	0.41	0.25	0.30	11.3	3.76	6.39	0.39	0.80				
	L	6.98	0.21	0.26	27.1	2.43	4.13	3.52	7.42				
	N	2.79	0.25	0.30	11.8	3.70	6.28	2.62	5.33				
2	D	34.11	0.19	0.24	43.7	1.82	3.09	12.08	25.79	59.74	**29.08**	**60.68**	
	Q	0.60	0.28	0.33	10.4	3.89	6.60	0.66	1.32				
	S	0.09	0.55	0.60	3.4	5.43	9.22	0.27	0.49				
	U	0.12	0.57	0.62	5.2	4.89	8.31	0.34	0.62				
	V	0.09	0.53	0.58	5.1	4.93	8.37	0.23	0.43				
	X	0.24	0.60	0.65	5.0	4.95	8.41	0.71	1.31				
3	Y	0.25	0.51	0.56	6.7	4.56	7.74	0.59	1.10	1.39	**2.80**	**5.28**	
	R	2.31	0.27	0.32	12.1	3.66	6.21	2.27	4.58				
	W	10.30	0.23	0.28	31.7	2.22	3.76	5.32	10.98				
4	T	12.36	0.20	0.25	18.1	3.03	5.14	7.61	16.10	24.97	**15.20**	**31.66**	
	Z	0.27	0.49	0.54	0.0	6.81	11.57	0.91	1.70				
	AA	0.20	0.48	0.53	8.6	4.19	7.12	0.40	0.76				
5	AC	3.49	0.25	0.30	15.5	3.27	5.55	2.80	5.73	3.69	**3.21**	**6.49**	
	AD	46.36	0.34	0.39	35.0	2.09	3.54	32.53	63.47				
	AF	0.91	0.26	0.31	12.5	3.60	6.11	0.85	1.73				
	AH	5.83	0.39	0.44	17.2	3.10	5.27	6.99	13.42				
6	AE	0.42	0.31	0.36	9.1	4.10	6.96	0.53	1.05	53.52	**40.90**	**79.66**	
7	AG	5.88	0.25	0.30	17.0	3.12	5.30	4.54	9.27	63.09	**48.65**	**95.41**	
	AK	0.17	0.27	0.32	6.2	4.66	7.91	0.21	0.43				
8	AL	0.10	0.46	0.51	4.0	5.22	8.87	0.24	0.45	0.27	**0.45**	**0.88**	
9	AJ	0.13	0.52	0.57	5.9	4.73	8.04	0.33	0.62	0.13	**0.33**	**0.62**	

El Paso County Beacon Lite - Proposed Hydrology Calculations

BASIN DATA									INITIAL TIME				CHANNELIZED TIME					TIME OF CONCENTRATION (T_C)			
BASIN	AREA	TOTAL AREA	TYPE	C_{10}	C_{100}	C_{10w}	C_{100w}	FL_{total} LENGTH	FL_i ACTUAL LENGTH	HI EL [ft]	LO EL [ft]	SLOPE [ft/ft]	FL_C LENGTH [ft]	HI EL [ft]	LO EL [ft]	SLOPE [ft/ft]	Conveyance Coeff (K)	INITIAL T_i	CHANNEL T_t	COMPUTED T_C	T_C
	acre	acre						ft	ft	ft	ft	ft/ft	ft	ft	ft	ft/ft		min	min	min	min
A	0.08	0.39	PAVED	0.90	0.95	0.30	0.35	174	90	7,376.86	7,363.00	0.153	83.13	7,363.00	7,362.65	0.004	15	5.56	1.42	6.98	6.98
	0.00		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.31		UNDEVELOPED	0.15	0.20																
B	2.71	20.66	PAVED	0.90	0.95	0.25	0.30	1257	59	7,374.57	7,361.71	0.219	1,197.91	7,361.71	7,310.50	0.043	15	4.26	6.44	10.69	10.69
	0.00		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	17.95		UNDEVELOPED	0.15	0.20																
B_Rd	0.04	0.12	PAVED	0.90	0.95	0.41	0.46	NA									20			5.00	5.00
	0.00		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.08		UNDEVELOPED	0.15	0.20																
C	0.32	3.80	PAVED	0.90	0.95	0.23	0.28	564	165	7,378.00	7,363.49	0.088	399.72	7,363.49	7,349.64	0.035	5	9.83	7.16	16.99	16.99
	0.00		GRAVEL	0.80	0.85																
	0.09		ROOFS	0.90	0.95																
	3.40		UNDEVELOPED	0.15	0.20																
D	0.94	33.91	PAVED	0.90	0.95	0.17	0.22	1769	300	7,390.00	7,363.17	0.089	1,469.43	7,363.17	7,312.59	0.034	5	14.07	26.40	40.47	40.47
	0.00		GRAVEL	0.80	0.85																
	0.10		ROOFS	0.90	0.95																
	32.87		UNDEVELOPED	0.15	0.20																
D_Rd	0.13	0.35	PAVED	0.90	0.95	0.43	0.48	NA									20			5.00	5.00
	0.00		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.22		UNDEVELOPED	0.15	0.20																
E	0.16	5.95	PAVED	0.90	0.95	0.33	0.38	848	300	7,392.00	7,374.30	0.059	548.33	7,374.30	7,354.38	0.036	5	13.49	9.59	23.08	23.08
	1.13		GRAVEL	0.80	0.85																
	0.25		ROOFS	0.90	0.95																
	4.41		UNDEVELOPED	0.15	0.20																
H	0.11	5.55	PAVED	0.90	0.95	0.20	0.25	1227	300	7,404.00	7,394.37	0.032	927.15	7,394.37	7,355.52	0.042	5	19.14	15.10	34.23	34.23
	0.26		GRAVEL	0.80	0.85																
	0.04		ROOFS	0.90	0.95																
	5.14		UNDEVELOPED	0.15	0.20																
J	0.08	0.46	PAVED	0.90	0.95	0.29	0.34	185	177	7,371.98	7,358.00	0.079	7.85	7,358.00	7,357.44	0.071	5	9.91	0.10	10.01	10.01
	0.00		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.38		UNDEVELOPED	0.15	0.20																
L	0.24	6.96	PAVED	0.90	0.95	0.21	0.26	906	300	7,398.10	7,382.49	0.052	605.88	7,382.49	7,356.66	0.043	5	16.10	9.78	25.88	25.88
	0.24		GRAVEL	0.80	0.85																
	0.14		ROOFS	0.90	0.95																
	6.34		UNDEVELOPED	0.15	0.20																
N	0.12	2.50	PAVED	0.90	0.95	0.22	0.27	458	221	7,397.27	7,379.35	0.081	236.23	7,379.35	7,371.54	0.033	5	11.81	4.33	16.14	16.14
	0.05		GRAVEL	0.80	0.85																
	0.08		ROOFS	0.90	0.95																
	2.25		UNDEVELOPED	0.15	0.20																
N_Rd	0.23	0.23	PAVED	0.90	0.95	0.90	0.95	NA									20			5.00	5.00
	0.00		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.00		UNDEVELOPED	0.15	0.20																

BASIN DATA									INITIAL TIME				CHANNELIZED TIME					TIME OF CONCENTRATION (T_C)			
BASIN	AREA	TOTAL AREA	TYPE	C_{10}	C_{100}	C_{10w}	C_{100w}	FL_{total} LENGTH	FL_i ACTUAL LENGTH	HI EL [ft]	LO EL [ft]	SLOPE [ft/ft]	FL_C LENGTH [ft]	HI EL [ft]	LO EL [ft]	SLOPE [ft/ft]	Conveyance Coeff (K)	INITIAL T_i	CHANNEL T_t	COMPUTED T_C	T_C
	acre	acre						ft	ft	ft	ft	ft/ft	ft	ft	ft	ft/ft		min	min	min	min
Q	0.00	0.62	PAVED	0.90	0.95	0.15	0.20	966	300	7,402.00	7,378.91	0.077	666.41	7,378.91	7,339.54	0.059	15	15.15	3.05	18.20	18.20
	0.00		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.62		UNDEVELOPED	0.15	0.20																
P_Rd	0.23	0.23	PAVED	0.90	0.95	0.90	0.95	NA									20			5.00	5.00
	0.00		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.00		UNDEVELOPED	0.15	0.20																
R	0.00	2.12	PAVED	0.90	0.95	0.23	0.28	454	173	7,388.26	7,362.60	0.148	280.86	7,362.60	7,340.00	0.080	15	8.50	1.10	9.60	9.60
	0.00		GRAVEL	0.80	0.85																
	0.22		ROOFS	0.90	0.95																
	1.90		UNDEVELOPED	0.15	0.20																
R_Rd	0.22	0.22	PAVED	0.90	0.95	0.90	0.95	NA									20			5.00	5.00
	0.00		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.00		UNDEVELOPED	0.15	0.20																
T	0.00	10.48	PAVED	0.90	0.95	0.18	0.23	1,564	249	7,367.65	7,333.85	0.136	1315	7,333.85	7,250.34	0.064	15	11.10	5.79	16.89	16.89
	0.41		GRAVEL	0.80	0.85																
	0.05		ROOFS	0.90	0.95																
	10.02		UNDEVELOPED	0.15	0.20																
U	0.00	2.02	PAVED	0.90	0.95	0.15	0.20	416	300	7,367.65	7,333.55	0.114	116	7,333.55	7,246.56	0.749	15	13.32	0.15	13.47	13.47
	0.00		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	2.02		UNDEVELOPED	0.15	0.20																
V	0.36	0.36	PAVED	0.90	0.95	0.90	0.95	NA									20			5.00	5.00
	0.00		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.00		UNDEVELOPED	0.15	0.20																
V_Rd	0.37	0.37	PAVED	0.90	0.95	0.90	0.95	NA									20			5.00	5.00
	0.00		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.00		UNDEVELOPED	0.15	0.20																
W	0.91	10.30	PAVED	0.90	0.95	0.23	0.28	1622	300	7,390.00	7,367.97	0.073	1,321.52	7,367.97	7,286.00	0.062	5	14.04	17.69	31.72	31.72
	0.18		GRAVEL	0.80	0.85																
	0.07		ROOFS	0.90	0.95																
	9.13		UNDEVELOPED	0.15	0.20																
X	0.23	0.23	PAVED	0.90	0.95	0.90	0.95	NA									20			5.00	5.00
	0.00		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.00		UNDEVELOPED	0.15	0.20																
X_Rd	0.24	0.24	PAVED	0.90	0.95	0.90	0.95	NA									20			5.00	5.00
	0.00		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.00		UNDEVELOPED	0.15	0.20																
Y	0.27	0.27	PAVED	0.90	0.95	0.90	0.95	NA									20			5.00	5.00
	0.00		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.00		UNDEVELOPED	0.15	0.20																

BASIN DATA									INITIAL TIME				CHANNELIZED TIME					TIME OF CONCENTRATION (T_C)			
BASIN	AREA	TOTAL AREA	TYPE	C_{10}	C_{100}	C_{10w}	C_{100w}	FL_{total} LENGTH	FL_i ACTUAL LENGTH	HI EL [ft]	LO EL [ft]	SLOPE [ft/ft]	FL_C LENGTH [ft]	HI EL [ft]	LO EL [ft]	SLOPE [ft/ft]	Conveyance Coeff (K)	INITIAL T_i	CHANNEL T_t	COMPUTED T_C	T_C
	acre	acre						ft	ft	ft	ft	ft/ft	ft	ft	ft	ft/ft		min	min	min	min
Y_Rd	0.27	0.27	PAVED	0.90	0.95	0.90	0.95	NA									20			5.00	5.00
	0.00		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.00		UNDEVELOPED	0.15	0.20																
AA	0.00	0.96	PAVED	0.90	0.95	0.28	0.33	580	82	7,249.04	7,245.01	0.049	497.67	7,245.01	7,223.37	0.043	15	7.90	2.65	10.55	10.55
	0.20		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.77		UNDEVELOPED	0.15	0.20																
AA_Rd	0.39	0.39	PAVED	0.90	0.95	0.90	0.95	NA									20			5.00	5.00
	0.00		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.00		UNDEVELOPED	0.15	0.20																
AB_Rd	0.39	0.39	PAVED	0.90	0.95	0.90	0.95	NA									20			5.00	5.00
	0.00		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.00		UNDEVELOPED	0.15	0.20																
AC	0.14	3.43	PAVED	0.90	0.95	0.28	0.33	776	300	7,252.45	7,227.70	0.083	476.36	7,227.70	7,186.46	0.087	5	12.83	5.40	18.23	18.23
	0.43		GRAVEL	0.80	0.85																
	0.07		ROOFS	0.90	0.95																
	2.79		UNDEVELOPED	0.15	0.20																
AC_Rd	0.26	0.26	PAVED	0.90	0.95	0.90	0.95	NA									20			5.00	5.00
	0.00		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.00		UNDEVELOPED	0.15	0.20																
AD	4.76	44.50	PAVED	0.90	0.95	0.34	0.39	3519	148	7,354.01	7,352.87	0.008	3,370.54	7,352.87	7,200.26	0.045	15	18.23	17.60	35.83	35.83
	6.65		GRAVEL	0.80	0.85																
	0.72		ROOFS	0.90	0.95																
	32.37		UNDEVELOPED	0.15	0.20																
AD1	*0.00*	*0.46*	*PAVED*	*0.90*	*0.95*	*0.15*	*0.20*	*444*	*300*	*7,292.01*	*7,221.00*	*0.237*	*144.00*	*7,221.00*	*7,210.54*	*0.073*	*15*	*10.46*	*0.59*	*11.05*	*11.05*
	0.00		*GRAVEL*	*0.80*	*0.85*																
	0.00		*ROOFS*	*0.90*	*0.95*																
	0.46		*UNDEVELOPED*	*0.15*	*0.20*																
AD_Rd	0.29	0.29	PAVED	0.90	0.95	0.90	0.95	NA									20			5.00	5.00
	0.00		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.00		UNDEVELOPED	0.15	0.20																
AE	0.15	0.42	PAVED	0.90	0.95	0.42	0.47	159	153	7,202.88	7,189.68	0.086	6.26	7,189.68	7,189.33	0.056	7	7.40	0.06	7.47	7.47
	0.00		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.27		UNDEVELOPED	0.15	0.20																
AF	0.06	0.97	PAVED	0.90	0.95	0.30	0.35	379	300	7,248.00	7,210.76	0.124	78.83	7,210.76	7,204.22	0.083	5	10.96	0.91	11.87	11.87
	0.10		GRAVEL	0.80	0.85																
	0.04		ROOFS	0.90	0.95																
	0.77		UNDEVELOPED	0.15	0.20																
AG	0.36	4.20	PAVED	0.90	0.95	0.30	0.35	610	256	7,201.84	7,181.07	0.081	353.95	7,181.07	7,159.97	0.060	7	11.63	3.45	15.08	15.08
	0.07		GRAVEL	0.80	0.85																
	0.41		ROOFS	0.90	0.95																
	3.37		UNDEVELOPED	0.15	0.20																
AH_off	0.11	2.98	PAVED	0.90	0.95	0.29	0.34	600	165	7,244.00	7,218.43	0.155	434.43	7,218.43	7,213.99	0.010	7	7.58	10.23	17.81	17.81
	0.34		GRAVEL	0.80	0.85																
	0.16		ROOFS	0.90	0.95																
	2.36		UNDEVELOPED	0.15	0.20																
AH	0.54	3.29	PAVED	0.90	0.95	0.44	0.49	993	342	7,239.95	7,218.12	0.064	650.25	7,218.12	7,192.99	0.039	7	12.03	7.88	19.91	19.91
	0.55		GRAVEL	0.80	0.85																
	0.24		ROOFS	0.90	0.95																
	1.96		UNDEVELOPED	0.15	0.20																

BASIN DATA									INITIAL TIME				CHANNELIZED TIME					TIME OF CONCENTRATION (T_C)			
BASIN	AREA	TOTAL AREA	TYPE	C_{10}	C_{100}	C_{10w}	C_{100w}	FL_{total} LENGTH	FL_i ACTUAL LENGTH	HI EL [ft]	LO EL [ft]	SLOPE [ft/ft]	FL_C LENGTH [ft]	HI EL [ft]	LO EL [ft]	SLOPE [ft/ft]	Conveyance Coeff (K)	INITIAL T_i	CHANNEL T_t	COMPUTED T_C	T_C
	acre	acre						ft	ft	ft	ft	ft/ft	ft	ft	ft	ft/ft		min	min	min	min
AI	0.00	0.95	PAVED	0.90	0.95	0.15	0.20	489	144	7,290.57	7,242.28	0.335	344.91	7,242.28	7,225.00	0.050	15	6.46	1.71	8.17	8.17
	0.00		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.95		UNDEVELOPED	0.15	0.20																
AJ	0.13	0.28	PAVED	0.90	0.95	0.49	0.54	305	70	7,201.94	7,200.47	0.021	235.50	7,200.47	7,191.36	0.039	15	7.16	1.33	8.49	8.49
	0.00		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.15		UNDEVELOPED	0.15	0.20																
AL	0.07	0.50	PAVED	0.90	0.95	0.30	0.35	305	63	7,218.63	7,212.00	0.106	242.67	7,212.00	7,193.03	0.078	15	5.28	0.96	6.24	6.24
	0.03		GRAVEL	0.80	0.85																
	0.00		ROOFS	0.90	0.95																
	0.40		UNDEVELOPED	0.15	0.20																

El Paso County Beacon Lite - Proposed Hydrology Calculations

One-hour rainfall intensity:

10YR 1.46 in/hr

100YR 2.48 in/hr

Rainfall Intensity Duration Frequency Equation:

$I=28.5*P/(10+T_c)^{0.786}$ (Equation 5-1, USDCM Volume 1)

BASIN DATA					DIRECT RUNOFF					TOTAL RUNOFF			
DESIGN POINT	AREA DESIGN	AREA (ac)	RUNOFF COEFF. (C10)	RUNOFF COEFF. (C100)	t_c	I_{10}	I_{100}	Q_{10}	Q_{100}	TOTAL AREA (ac)	Q_{10}	Q_{100}	Notes
					min	in/hr	in/hr	cfs	cfs		cfs	cfs	
	A	0.39	0.30	0.35	6.98	4.49	7.63	0.54	1.07	0.39	**0.54**	**1.07**	**P-53 (flows north)**
	B_Rd	0.12	0.41	0.46	5.00	4.95	8.41	0.25	0.48				
1	B	20.66	0.25	0.30	10.69	3.85	6.53	19.74	40.28	21.18	**20.53**	**41.83**	
	H	5.55	0.20	0.25	34.23	2.12	3.60	2.36	5.00		**2.36**	**5.00**	**P-45 (flows north)**
	E	5.95	0.33	0.38	23.08	2.66	4.52	5.15	10.09		**7.51**	**15.09**	**P-47 (flows north)**
	C	3.80	0.23	0.28	16.99	3.12	5.30	2.73	5.65		**2.73**	**5.65**	**IN-46 (flows east)**
	J	0.46	0.29	0.34	10.01	3.95	6.71	0.52	1.03		**0.52**	**1.03**	**P-48 (flows south)**
	L	6.96	0.21	0.26	25.88	2.50	4.24	3.70	7.75		**4.21**	**8.79**	**IN-44 (flows east)**
	N_Rd	0.23	0.90	0.95	5.00	4.95	8.41	1.00	1.80				**IN-42 (flows east)**
	N	2.50	0.22	0.27	16.14	3.20	5.44	1.79	3.72		**1.79**	**3.72**	**P-43 (flows east)**
	D_Rd	0.35	0.43	0.48	5.00	4.95	8.41	0.75	1.42				
2	D	33.91	0.17	0.22	40.47	1.91	3.24	11.19	24.51	59.70	**29.19**	**60.98**	
	P_Rd	0.23	0.90	0.95	5.00	4.95	8.41	1.02	1.83				
	R_Rd	0.22	0.90	0.95	5.00	4.95	8.41	1.00	1.79				
	V	0.36	0.90	0.95	5.00	4.95	8.41	1.61	2.88				
	V_Rd	0.37	0.90	0.95	5.00	4.95	8.41	1.64	2.93				
	X	0.23	0.90	0.95	5.00	4.95	8.41	1.03	1.85				
	X_Rd	0.24	0.90	0.95	5.00	4.95	8.41	1.08	1.94				
	Y	0.27	0.90	0.95	5.00	4.95	8.41	1.21	2.17				
	Y_Rd	0.27	0.90	0.95	5.00	4.95	8.41	1.21	2.18				
	U	2.02	0.15	0.20	13.47	3.48	5.92	1.05	2.39	4.21	**10.85**	**19.95**	**North Pond**
	Q	0.62	0.15	0.20	18.20	3.02	5.12	0.28	0.63		**0.28**	**0.63**	**IN-41 (flows east)**
	R	2.12	0.23	0.28	9.60	4.01	6.82	1.94	4.03		**1.94**	**4.03**	**IN-40 (flows south)**

BASIN DATA					DIRECT RUNOFF					TOTAL RUNOFF			Notes
DESIGN POINT	AREA DESIGN	AREA (ac)	RUNOFF COEFF. (C10)	RUNOFF COEFF. (C100)	t_c	I_{10}	I_{100}	Q_{10}	Q_{100}	TOTAL AREA (ac)	Q_{10}	Q_{100}	
					min	in/hr	in/hr	cfs	cfs		cfs	cfs	
	W	10.30	0.23	0.28	31.72	2.22	3.76	5.32	10.98				
	T	10.48	0.18	0.23	16.89	3.13	5.32	5.87	12.76		**13.42**	**28.40**	**IN-19 (flows south)**
4										27.73	**24.27**	**48.35**	
5	AC	3.43	0.28	0.33	18.23	3.01	5.12	2.86	5.73	3.43	**2.86**	**5.73**	**P-5 (flows south)**
	AI	0.95	0.15	0.20	8.17	4.26	7.24	0.61	1.37		**0.61**	**1.37**	**IN-17 (flows south)**
	AD	44.50	0.34	0.39	35.83	2.06	3.50	31.10	60.60		**31.70**	**61.97**	**IN-15, IN-14 (flows south)**
	AD1	*0.46*	*0.15*	*0.20*	*11.05*	*3.79*	*6.44*	*0.26*	*0.59*		*0.87*	*1.96*	*Used for ditch calculation only*
	AF	0.97	0.30	0.35	11.87	3.68	6.25	1.06	2.10		**1.06**	**2.10**	**IN-35 (flows west)**
	AH_off	2.98	0.29	0.34	17.81	3.05	5.18	2.67	5.31				
	AH	3.29	0.44	0.49	19.91	2.88	4.89	4.13	7.82				
	AA	0.96	0.28	0.33	10.55	3.87	6.57	1.05	2.11				**IN-16 (flows east)**
	AA_Rd	0.39	0.90	0.95	5.00	4.95	8.41	1.76	3.15				
	AB_Rd	0.39	0.90	0.95	5.00	4.95	8.41	1.73	3.10				
	AC_Rd	0.26	0.90	0.95	5.00	4.95	8.41	1.15	2.07				
	AD_Rd	0.29	0.90	0.95	5.00	4.95	8.41	1.28	2.30	8.56	**13.78**	**25.85**	**South Pond**
6	AE	0.42	0.42	0.47	7.47	4.39	7.46	0.79	1.49	0.42	**0.79**	**1.49**	
7	AG	4.20	0.30	0.35	15.08	3.31	5.62	4.12	8.18	63.03	**54.30**	**105.33**	
8	AL	0.50	0.30	0.35	6.24	4.65	7.90	0.68	1.36	0.50	**0.68**	**1.36**	
9	AJ	0.28	0.49	0.54	8.49	4.20	7.14	0.59	1.10	0.28	**0.59**	**1.10**	

APPENDIX A.2

Rainfall Data

NOAA Atlas 14, Volume 8, Version 2
Location name: Monument, Colorado, USA*
Latitude: 39.1169°, Longitude: -104.8687°
Elevation: 7255.18 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**2.95** (2.42-3.58)	**3.77** (3.08-4.58)	**5.15** (4.20-6.25)	**6.31** (5.12-7.70)	**7.96** (6.24-10.0)	**9.26** (7.08-11.7)	**10.6** (7.82-13.7)	**12.0** (8.47-15.8)	**13.9** (9.41-18.6)	**15.3** (10.1-20.8)
10-min	**2.16** (1.77-2.62)	**2.76** (2.26-3.35)	**3.76** (3.07-4.58)	**4.62** (3.75-5.64)	**5.83** (4.57-7.33)	**6.78** (5.18-8.60)	**7.76** (5.72-10.0)	**8.77** (6.20-11.6)	**10.1** (6.89-13.7)	**11.2** (7.40-15.2)
15-min	**1.76** (1.44-2.13)	**2.24** (1.84-2.72)	**3.06** (2.50-3.72)	**3.76** (3.05-4.58)	**4.74** (3.71-5.96)	**5.51** (4.22-6.99)	**6.31** (4.66-8.15)	**7.13** (5.04-9.40)	**8.25** (5.60-11.1)	**9.11** (6.02-12.4)
30-min	**1.15** (0.944-1.40)	**1.47** (1.21-1.79)	**2.01** (1.64-2.45)	**2.47** (2.01-3.02)	**3.12** (2.44-3.92)	**3.63** (2.77-4.60)	**4.15** (3.06-5.35)	**4.68** (3.31-6.17)	**5.41** (3.67-7.28)	**5.98** (3.95-8.12)
60-min	**0.726** (0.595-0.881)	**0.896** (0.734-1.09)	**1.19** (0.975-1.45)	**1.46** (1.18-1.78)	**1.85** (1.46-2.35)	**2.17** (1.67-2.77)	**2.51** (1.88-3.26)	**2.88** (2.04-3.81)	**3.39** (2.31-4.58)	**3.79** (2.51-5.16)
2-hr	**0.438** (0.362-0.527)	**0.528** (0.435-0.636)	**0.690** (0.568-0.834)	**0.841** (0.687-1.02)	**1.07** (0.854-1.36)	**1.27** (0.981-1.61)	**1.48** (1.10-1.91)	**1.71** (1.22-2.25)	**2.03** (1.40-2.74)	**2.30** (1.53-3.10)
3-hr	**0.328** (0.272-0.393)	**0.385** (0.318-0.461)	**0.493** (0.407-0.592)	**0.598** (0.490-0.720)	**0.764** (0.616-0.969)	**0.910** (0.711-1.16)	**1.07** (0.806-1.39)	**1.25** (0.899-1.65)	**1.51** (1.04-2.03)	**1.72** (1.15-2.32)
6-hr	**0.200** (0.167-0.237)	**0.232** (0.193-0.275)	**0.294** (0.244-0.349)	**0.355** (0.293-0.424)	**0.453** (0.368-0.572)	**0.541** (0.426-0.684)	**0.638** (0.484-0.821)	**0.746** (0.542-0.980)	**0.906** (0.630-1.21)	**1.04** (0.698-1.39)
12-hr	**0.121** (0.101-0.142)	**0.143** (0.119-0.168)	**0.183** (0.153-0.216)	**0.221** (0.184-0.262)	**0.280** (0.228-0.348)	**0.331** (0.261-0.413)	**0.386** (0.294-0.491)	**0.447** (0.325-0.580)	**0.534** (0.373-0.707)	**0.605** (0.409-0.803)
24-hr	**0.073** (0.062-0.085)	**0.087** (0.073-0.102)	**0.112** (0.094-0.131)	**0.134** (0.112-0.157)	**0.168** (0.137-0.205)	**0.196** (0.155-0.242)	**0.226** (0.173-0.284)	**0.259** (0.189-0.332)	**0.305** (0.214-0.400)	**0.342** (0.233-0.451)
2-day	**0.044** (0.037-0.050)	**0.051** (0.043-0.059)	**0.064** (0.054-0.074)	**0.076** (0.064-0.088)	**0.094** (0.077-0.114)	**0.109** (0.087-0.133)	**0.125** (0.096-0.155)	**0.142** (0.105-0.181)	**0.166** (0.118-0.217)	**0.186** (0.127-0.244)
3-day	**0.031** (0.027-0.036)	**0.037** (0.031-0.042)	**0.047** (0.039-0.054)	**0.055** (0.046-0.064)	**0.068** (0.056-0.081)	**0.078** (0.062-0.095)	**0.089** (0.069-0.110)	**0.101** (0.075-0.128)	**0.118** (0.083-0.152)	**0.131** (0.090-0.171)
4-day	**0.025** (0.021-0.029)	**0.029** (0.025-0.034)	**0.037** (0.032-0.043)	**0.044** (0.037-0.050)	**0.054** (0.044-0.064)	**0.062** (0.050-0.075)	**0.070** (0.054-0.087)	**0.079** (0.059-0.100)	**0.092** (0.065-0.119)	**0.102** (0.071-0.133)
7-day	**0.017** (0.014-0.019)	**0.019** (0.017-0.022)	**0.024** (0.020-0.027)	**0.028** (0.024-0.032)	**0.034** (0.028-0.040)	**0.039** (0.031-0.047)	**0.044** (0.034-0.054)	**0.050** (0.037-0.063)	**0.058** (0.041-0.074)	**0.064** (0.044-0.083)
10-day	**0.013** (0.011-0.015)	**0.015** (0.013-0.017)	**0.019** (0.016-0.021)	**0.022** (0.018-0.025)	**0.026** (0.022-0.031)	**0.030** (0.024-0.036)	**0.034** (0.026-0.041)	**0.038** (0.028-0.047)	**0.044** (0.031-0.056)	**0.048** (0.034-0.062)
20-day	**0.009** (0.008-0.010)	**0.010** (0.009-0.011)	**0.012** (0.010-0.014)	**0.014** (0.012-0.016)	**0.017** (0.014-0.019)	**0.019** (0.015-0.022)	**0.021** (0.016-0.025)	**0.023** (0.018-0.029)	**0.027** (0.019-0.034)	**0.029** (0.020-0.037)
30-day	**0.007** (0.006-0.008)	**0.008** (0.007-0.009)	**0.010** (0.008-0.011)	**0.011** (0.010-0.012)	**0.013** (0.011-0.015)	**0.015** (0.012-0.017)	**0.016** (0.013-0.019)	**0.018** (0.013-0.022)	**0.020** (0.015-0.025)	**0.022** (0.015-0.028)
45-day	**0.006** (0.005-0.006)	**0.006** (0.006-0.007)	**0.008** (0.007-0.009)	**0.009** (0.008-0.010)	**0.010** (0.009-0.012)	**0.012** (0.009-0.013)	**0.013** (0.010-0.015)	**0.014** (0.010-0.017)	**0.015** (0.011-0.019)	**0.016** (0.012-0.021)
60-day	**0.005** (0.004-0.005)	**0.006** (0.005-0.006)	**0.007** (0.006-0.007)	**0.008** (0.007-0.008)	**0.009** (0.007-0.010)	**0.010** (0.008-0.011)	**0.011** (0.008-0.012)	**0.011** (0.009-0.014)	**0.012** (0.009-0.015)	**0.013** (0.009-0.017)

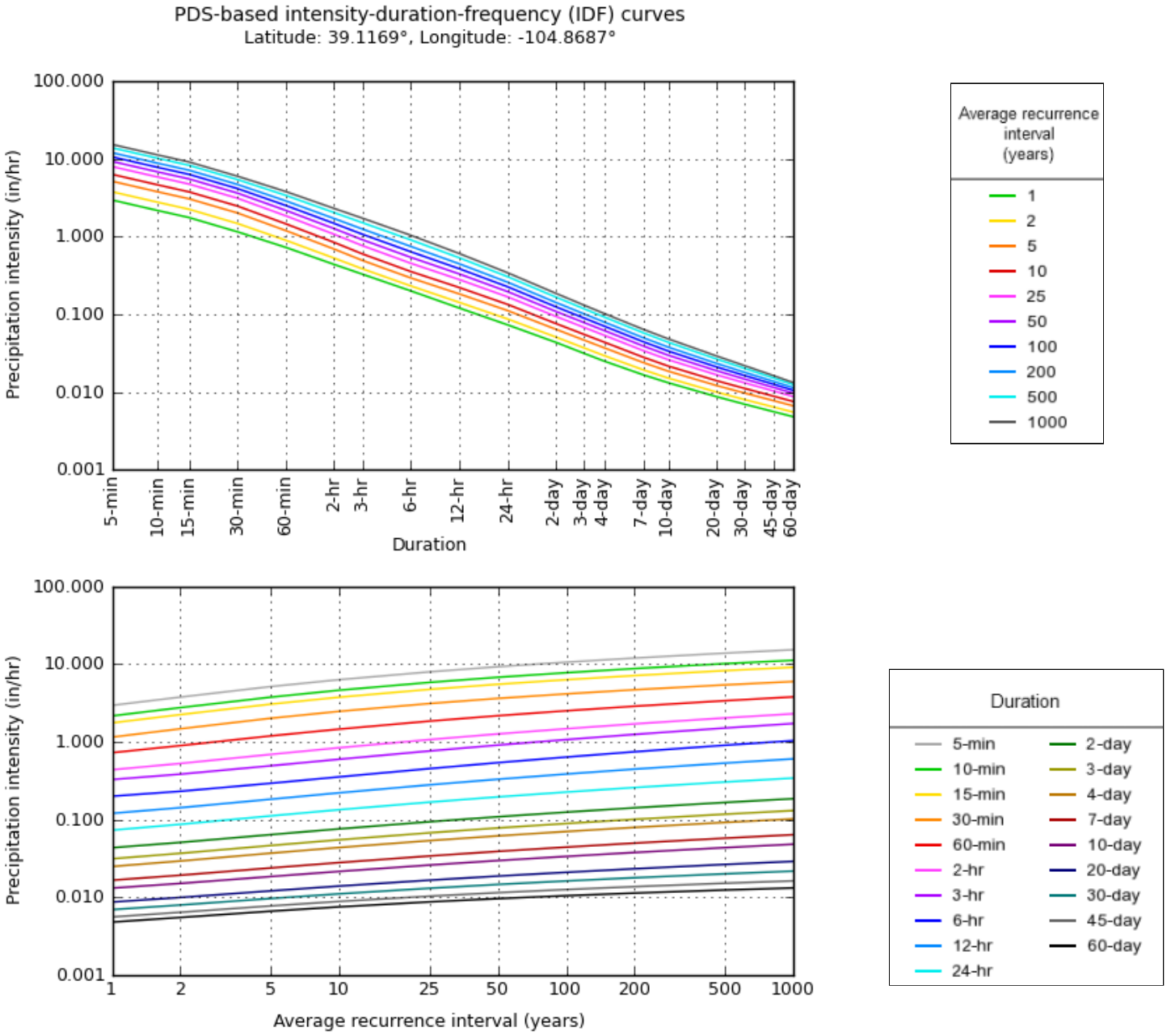
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical



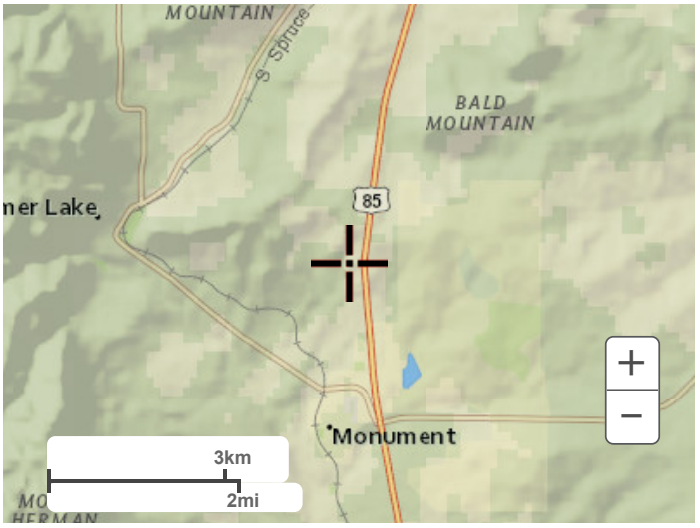
NOAA Atlas 14, Volume 8, Version 2

Created (GMT): Wed Dec 29 15:10:20 2021

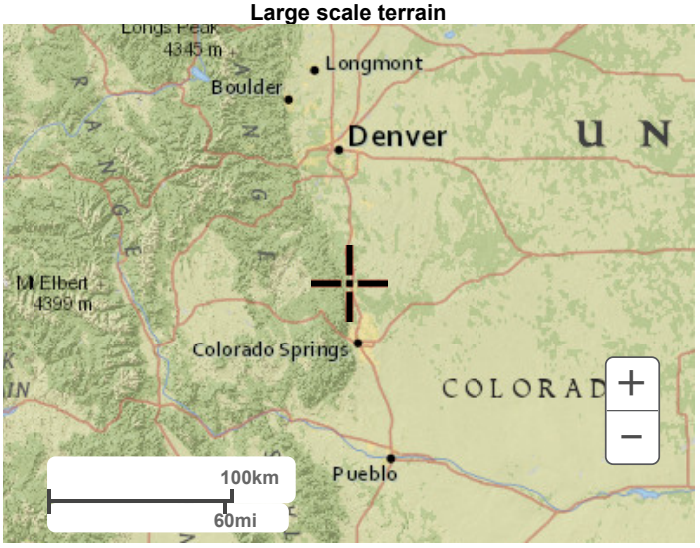
Back to Top

Maps & aerials

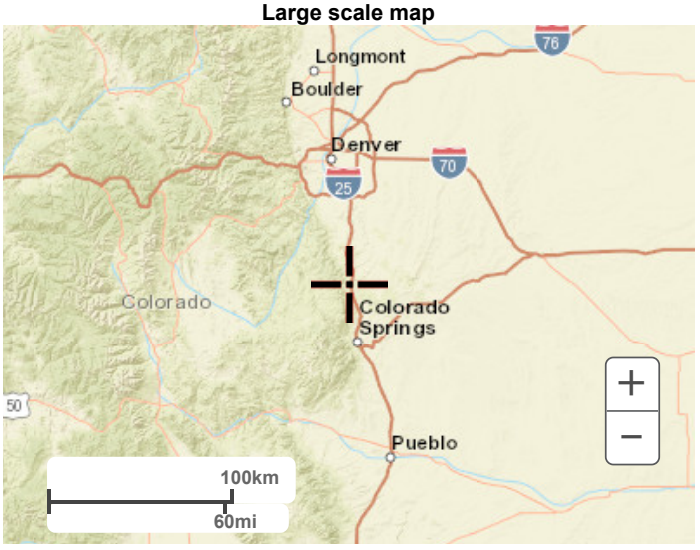
Small scale terrain



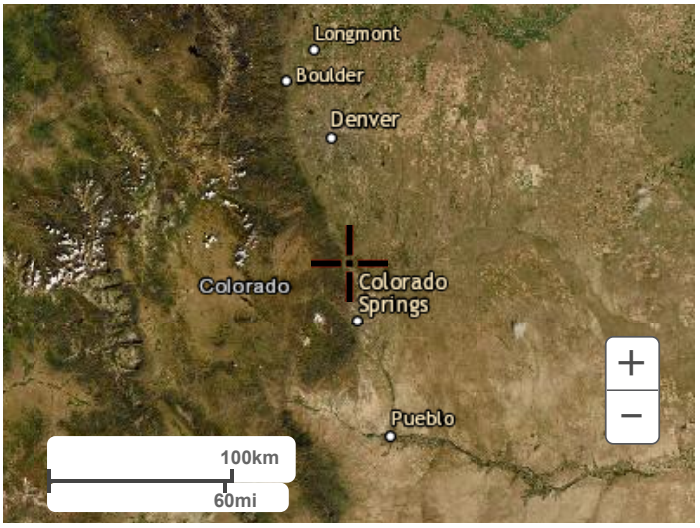
Large scale terrain



Large scale map



Large scale aerial



Back to Top

US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

APPENDIX A.3

FIRMETTE

National Flood Hazard Layer FIRMette

FEMA

104°52'23"W 39°7'41"N

104°51'46"W 39°7'13"N

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

1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

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

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

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

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

N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 2/1/2022 at 3:36 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

APPENDIX B

APPENDIX B.1

Runoff Reduction Calculations

Design Procedure Form: Runoff Reduction

UD-BMP (Version 3.07, March 2018) **Sheet 1 of 1**

Designer:	**Lucy East**
Company:	**Michael Baker Intl.**
Date:	**August 27, 2024**
Project:	**Beacon Lite Road**
Location:	**El Paso County**

SITE INFORMATION (User Input in Blue Cells)

WQCV Rainfall Depth = 0.60 inches

Depth of Average Runoff Producing Storm, d_6 = 0.43 inches (for Watersheds Outside of the Denver Region, Figure 3-1 in USDCM Vol. 3)

Area Type	UIA:RPA	UIA:RPA	UIA:RPA	UIA:RPA	UIA:RPA	UIA:RPA	UIA:RPA	UIA:RPA	UIA:RPA	UIA:RPA	UIA:RPA	UIA:RPA
Area ID	B_Rd	A1	B	C	E	H	J	L	D_Rd	D2	D3	D4
Downstream Design Point ID	1	1	1	2	2	2	2	2	2	2	2	2
Downstream BMP Type	None	None	None	None	None	None	None	None	None	None	None	None
DCIA (ft^2)	--	--	--	--	--	--	--	--	--	--	--	--
UIA (ft^2)	1,884	1,866	1,752	10,843	5,954	3,655	3,373	8,329	8,847	8,806	7,203	8,148
RPA (ft^2)	1,518	1,655	775	5,841	4,252	2,824	2,448	5,317	6,384	6,355	5,207	5,889
SPA (ft^2)	--	--	--	--	--	--	--	--	--	--	--	--
HSG A (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
HSG B (%)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
HSG C/D (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Average Slope of RPA (ft/ft)	0.250	0.250	0.330	0.250	0.250	0.250	0.250	0.250	0.100	0.100	0.100	0.100
UIA:RPA Interface Width (ft)	121.26	116.58	179.81	439.32	294.86	213.99	188.83	372.59	491.04	488.84	400.53	456.39

CALCULATED RUNOFF RESULTS

Area ID	B_Rd	A1	B	C	E	H	J	L	D_Rd	D2	D3	D4
UIA:RPA Area (ft^2)	3,402	3,520	2,527	16,684	10,205	6,479	5,821	13,645	15,231	15,161	12,410	14,037
L / W Ratio	0.23	0.26	0.08	0.09	0.12	0.14	0.16	0.10	0.06	0.06	0.08	0.07
UIA / Area	0.5537	0.5299	0.6932	0.6499	0.5834	0.5641	0.5795	0.6104	0.5809	0.5808	0.5804	0.5805
Runoff (in)	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Runoff (ft^3)	0	0	10	0	0	0	0	0	0	0	0	0
Runoff Reduction (ft^3)	78	78	63	452	248	152	141	347	369	367	300	340

CALCULATED WQCV RESULTS

Area ID	B_Rd	A1	B	C	E	H	J	L	D_Rd	D2	D3	D4
WQCV (ft^3)	78	78	73	452	248	152	141	347	369	367	300	340
WQCV Reduction (ft^3)	78	78	63	452	248	152	141	347	369	367	300	340
WQCV Reduction (%)	100%	100%	86%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Untreated WQCV (ft^3)	0	0	10	0	0	0	0	0	0	0	0	0

CALCULATED DESIGN POINT RESULTS (sums results from all columns with the same Downstream Design Point ID)

Downstream Design Point ID	1	1	1	2	2	2	2	2	2	2	2	2
DCIA (ft^2)	0	0	0	0	0	0	0	0	0	0	0	0
UIA (ft^2)	5,501	5,501	5,501	65,157	65,157	65,157	65,157	65,157	65,157	65,157	65,157	65,157
RPA (ft^2)	3,948	3,948	3,948	44,516	44,516	44,516	44,516	44,516	44,516	44,516	44,516	44,516
SPA (ft^2)	0	0	0	0	0	0	0	0	0	0	0	0
Total Area (ft^2)	9,449	9,449	9,449	109,673	109,673	109,673	109,673	109,673	109,673	109,673	109,673	109,673
Total Impervious Area (ft^2)	5,501	5,501	5,501	65,157	65,157	65,157	65,157	65,157	65,157	65,157	65,157	65,157
WQCV (ft^3)	229	229	229	2,715	2,715	2,715	2,715	2,715	2,715	2,715	2,715	2,715
WQCV Reduction (ft^3)	219	219	219	2,715	2,715	2,715	2,715	2,715	2,715	2,715	2,715	2,715
WQCV Reduction (%)	96%	96%	96%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Untreated WQCV (ft^3)	10	10	10	0	0	0	0	0	0	0	0	0

CALCULATED SITE RESULTS (sums results from all columns in worksheet)

Total Area (ft^2)	1,015,408
Total Impervious Area (ft^2)	602,920
WQCV (ft^3)	2,944
WQCV Reduction (ft^3)	2,934
WQCV Reduction (%)	100%
Untreated WQCV (ft^3)	10

Design Procedure Form: Runoff Reduction

UD-BMP (Version 3.07, March 2018) **Sheet 1 of 1**

Designer:	**Lucy East**
Company:	**Michael Baker Intl.**
Date:	**August 27, 2024**
Project:	**Beacon Lite Road**
Location:	**El Paso County**

SITE INFORMATION (User Input in Blue Cells)

WQCV Rainfall Depth = 0.60 inches

Depth of Average Runoff Producing Storm, d_6 = 0.43 inches (for Watersheds Outside of the Denver Region, Figure 3-1 in USDCM Vol. 3)

Area Type	UIA:RPA	UIA:RPA										
Area ID	D5	A2										
Downstream Design Point ID	1	1										
Downstream BMP Type	None	None										
DCIA (ft^2)	--	--										
UIA (ft^2)	2,790	1,661										
RPA (ft^2)	1,413	886										
SPA (ft^2)	--	--										
HSG A (%)	0%	0%										
HSG B (%)	100%	100%										
HSG C/D (%)	0%	0%										
Average Slope of RPA (ft/ft)	0.015	0.330										
UIA:RPA Interface Width (ft)	155.01	132.74										

CALCULATED RUNOFF RESULTS

Area ID	D5	A2										
UIA:RPA Area (ft^2)	4,202	2,547										
L / W Ratio	0.17	0.14										
UIA / Area	0.6638	0.6521										
Runoff (in)	0.00	0.00										
Runoff (ft^3)	0	0										
Runoff Reduction (ft^3)	116	69										

CALCULATED WQCV RESULTS

Area ID	D5	A2										
WQCV (ft^3)	116	69										
WQCV Reduction (ft^3)	116	69										
WQCV Reduction (%)	100%	100%										
Untreated WQCV (ft^3)	0	0										

CALCULATED DESIGN POINT RESULTS (sums results from all columns with the same Downstream Design Point ID)

Downstream Design Point ID	1	1										
DCIA (ft^2)	0	0										
UIA (ft^2)	4,450	4,450										
RPA (ft^2)	2,299	2,299										
SPA (ft^2)	0	0										
Total Area (ft^2)	6,749	6,749										
Total Impervious Area (ft^2)	4,450	4,450										
WQCV (ft^3)	185	185										
WQCV Reduction (ft^3)	185	185										
WQCV Reduction (%)	100%	100%										
Untreated WQCV (ft^3)	0	0										

CALCULATED SITE RESULTS (sums results from all columns in worksheet)

Total Area (ft^2)	13,498
Total Impervious Area (ft^2)	8,901
WQCV (ft^3)	185
WQCV Reduction (ft^3)	185
WQCV Reduction (%)	100%
Untreated WQCV (ft^3)	0

Design Procedure Form: Runoff Reduction

UD-BMP (Version 3.07, March 2018) **Sheet 1 of 1**

Designer:	**Lucy East**
Company:	**Michael Baker Intl.**
Date:	**March 3, 2022**
Project:	**Beacon Lite Road**
Location:	**El Paso County**

SITE INFORMATION (User Input in Blue Cells)

WQCV Rainfall Depth = 0.60 inches

Depth of Average Runoff Producing Storm, d_6 = 0.43 inches (for Watersheds Outside of the Denver Region, Figure 3-1 in USDCM Vol. 3)

Area Type	UIA:RPA	UIA:RPA	UIA:RPA	UIA:RPA	UIA:RPA							
Area ID	AJ	AL	AF	AE	AG							
Downstream Design Point ID	8	9	7	7	7							
Downstream BMP Type	None	None	None	None	None							
DCIA (ft^2)	--	--	--	--	--							
UIA (ft^2)	5,653	3,252	2,807	4,079	4,202							
RPA (ft^2)	4,266	1,666	994	2,245	3,808							
SPA (ft^2)	--	--	--	--	--							
HSG A (%)	0%	0%	0%	0%	0%							
HSG B (%)	100%	100%	100%	100%	100%							
HSG C/D (%)	0%	0%	0%	0%	0%							
Average Slope of RPA (ft/ft)	0.250	0.250	0.250	0.025	0.250							
UIA:RPA Interface Width (ft)	319.24	162.26	60.40	170.00	240.44							

CALCULATED RUNOFF RESULTS

Area ID	AJ	AL	AF	AE	AG							
UIA:RPA Area (ft^2)	9,919	4,919	3,801	6,324	8,010							
L / W Ratio	0.10	0.19	1.04	0.22	0.14							
UIA / Area	0.5699	0.6612	0.7385	0.6451	0.5246							
Runoff (in)	0.00	0.00	0.10	0.00	0.00							
Runoff (ft^3)	0	2	32	0	0							
Runoff Reduction (ft^3)	236	134	84	170	175							

CALCULATED WQCV RESULTS

Area ID	AJ	AL	AF	AE	AG							
WQCV (ft^3)	236	136	117	170	175							
WQCV Reduction (ft^3)	236	134	84	170	175							
WQCV Reduction (%)	100%	99%	72%	100%	100%							
Untreated WQCV (ft^3)	0	2	32	0	0							

CALCULATED DESIGN POINT RESULTS (sums results from all columns with the same Downstream Design Point ID)

Downstream Design Point ID	8	9	7	7	7							
DCIA (ft^2)	0	0	0	0	0							
UIA (ft^2)	5,653	3,252	11,088	11,088	11,088							
RPA (ft^2)	4,266	1,666	7,047	7,047	7,047							
SPA (ft^2)	0	0	0	0	0							
Total Area (ft^2)	9,919	4,919	18,135	18,135	18,135							
Total Impervious Area (ft^2)	5,653	3,252	11,088	11,088	11,088							
WQCV (ft^3)	236	136	462	462	462							
WQCV Reduction (ft^3)	236	134	430	430	430							
WQCV Reduction (%)	100%	99%	93%	93%	93%							
Untreated WQCV (ft^3)	0	2	32	32	32							

CALCULATED SITE RESULTS (sums results from all columns in worksheet)

Total Area (ft^2)	69,242
Total Impervious Area (ft^2)	42,171
WQCV (ft^3)	833
WQCV Reduction (ft^3)	799
WQCV Reduction (%)	96%
Untreated WQCV (ft^3)	34

APPENDIX B.2

Pond Calculations

El Paso County Beacon Lite - Proposed Pond Basin Data

North Pond			
Tributary Basins	Area (ac)	% Impervious	A*%I
P_Rd	0.37	100	37.00
R_Rd	0.34	100	34.36
V	0.36	100	36.07
V_Rd	0.37	100	36.69
X	0.23	100	23.20
X_Rd	0.24	100	24.25
Y	0.27	100	27.09
Y_Rd	0.27	100	27.24
U	2.02	2	4.03
TOTAL AREA =	**4.48**	**% Impervious =**	**55.85**

South Pond - Forebay East			
Tributary Basins	Area (ac)	% Impervious	
AH_OFF	2.98	60.7	

South Pond - Forebay South			
Tributary Basins	Area (ac)	% Impervious	A*%I
AH	6.26	60.7	380.28
AA_Rd	0.39	100	39.41
AB_Rd	0.39	100	38.75
AC_Rd	0.26	100	25.90
AD_Rd	0.29	100	28.77
AA	0.96	2	1.93
TOTAL AREA =	**8.56**	**% Impervious =**	**60.19**

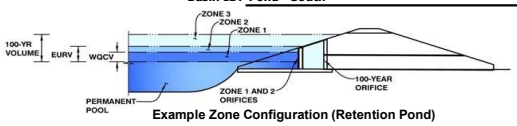
*Basin AH Impervious from Commercial Drainage Report				
	Area (ac)	Type	% Impervious	A*%I
A1	0.123	Paved	100.0	12.3
	0.319	Lanscape	2.0	0.6
A	1.729	Paved	100.0	172.9
	0.456	Lanscape	2.0	0.9
B1	0.124	Paved	100.0	12.4
	0.22	Lanscape	2.0	0.4
B	0.694	Paved	100.0	69.4
	0.652	Lanscape	2.0	1.3
C	0.907	Paved	100.0	90.7
	0.021	Lanscape	2.0	0.0
D	0.111	Paved	100.0	11.1
	0.161	Lanscape	2.0	0.3
E	0.026	Paved	100.0	2.6
	0.289	Lanscape	2.0	0.6
F	*0.187*	Paved	100.0	18.7
	0.499	Lanscape	2.0	1.0
Total =	**6.518**		**I (%) =**	**60.7**

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: Beacon Lite

Basin ID: Pond - South



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	8.56	acres
Watershed Length =	1,190	ft
Watershed Length to Centroid =	500	ft
Watershed Slope =	0.060	ft/ft
Watershed Imperviousness =	60.19%	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) =	0.169	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	0.559	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 0.9 in.) =	0.343	acre-feet	0.90 inches
5-yr Runoff Volume (P1 = 1.19 in.) =	0.492	acre-feet	1.19 inches
10-yr Runoff Volume (P1 = 1.46 in.) =	0.658	acre-feet	1.46 inches
25-yr Runoff Volume (P1 = 1.85 in.) =	0.955	acre-feet	1.85 inches
50-yr Runoff Volume (P1 = 2.17 in.) =	1.177	acre-feet	2.17 inches
100-yr Runoff Volume (P1 = 2.51 in.) =	1.440	acre-feet	2.51 inches
500-yr Runoff Volume (P1 = 3.39 in.) =	2.074	acre-feet	3.39 inches
Approximate 2-yr Detention Volume =	0.324	acre-feet	
Approximate 5-yr Detention Volume =	0.460	acre-feet	
Approximate 10-yr Detention Volume =	0.624	acre-feet	
Approximate 25-yr Detention Volume =	0.748	acre-feet	
Approximate 50-yr Detention Volume =	0.813	acre-feet	
Approximate 100-yr Detention Volume =	0.916	acre-feet	

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.169	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.390	acre-feet
Zone 3 (100yr + 1 / 2 WQCV - Zones 1 & 2) =	0.441	acre-feet
Total Detention Basin Volume =	1.000	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

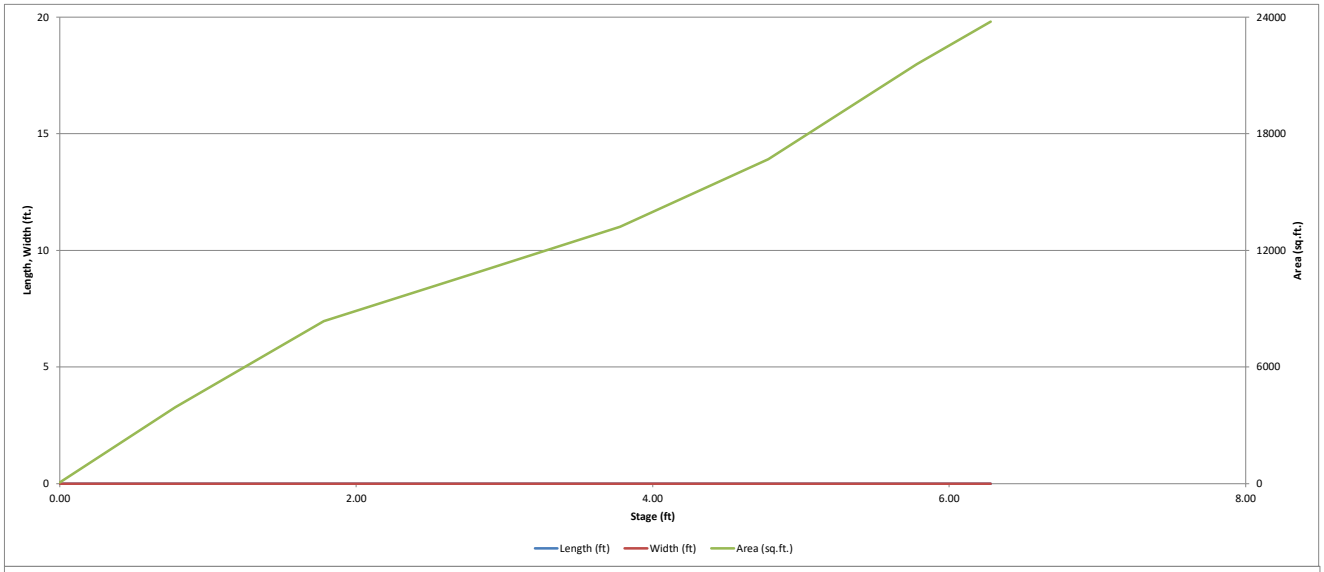
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

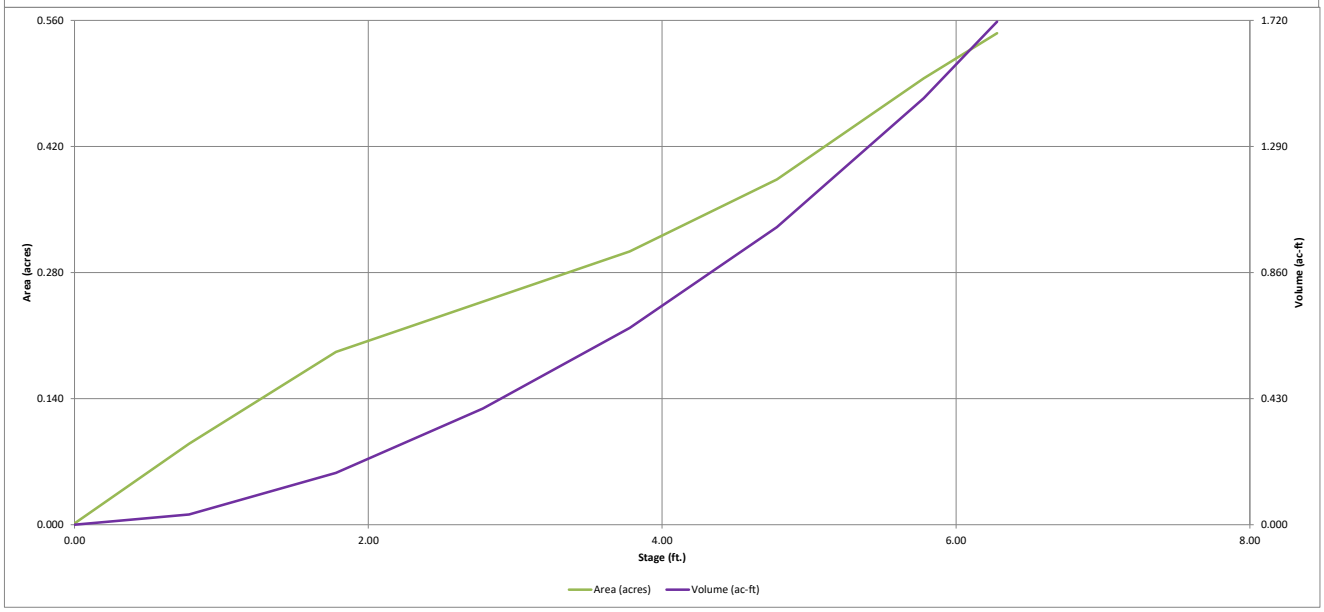
Depth Increment = 1.00 ft

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	--	--	--	60	0.001		
7193	--	0.78	--	--	--	3,923	0.090	1,553	0.036
7194	--	1.78	--	--	--	8,356	0.192	7,693	0.177
7195	--	2.78	--	--	--	10,787	0.248	17,264	0.396
7196	--	3.78	--	--	--	13,216	0.303	29,265	0.672
7197	--	4.78	--	--	--	16,699	0.383	44,223	1.015
7198	--	5.78	--	--	--	21,589	0.496	63,367	1.455
7198.5	--	6.28	--	--	--	23,777	0.546	74,709	1.715

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)



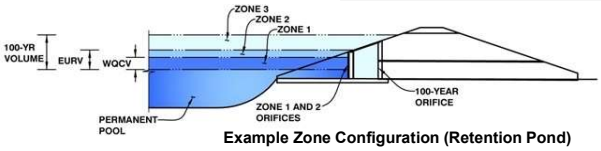


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: **Beacon Lite**

Basin ID: **Pond - South**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.74	0.169	Orifice Plate
Zone 2 (EURV)	3.40	0.390	Orifice Plate
Z3 (100+1/2WQCV)	4.75	0.441	Weir&Pipe (Restrict)
Total (all zones)		1.000	

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 =	9.028E-03	ft²
Depth at top of Zone using Orifice Plate =	3.40	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	13.60	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	1.30	sq. inches (diameter = 1-1/4 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	1.13	2.27					
Orifice Area (sq. inches)	1.30	1.30	1.30					

	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 =	3.40	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	4.03	N/A feet
Overflow Weir Front Edge Length =	6.00	N/A	feet	Overflow Weir Slope Length =	2.58	N/A feet
Overflow Weir Grate Slope =	4.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	6.92	N/A
Horiz. Length of Weir Sides =	2.50	N/A	feet	Overflow Grate Open Area w/o Debris =	12.23	N/A ft²
Overflow Grate Type =	Close Mesh Grate	N/A		Overflow Grate Open Area w/ Debris =	6.12	N/A ft²
Debris Clogging % =	50%	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 =	0.00	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	1.77	N/A ft²
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.75	N/A feet
Restrictor Plate Height Above Pipe Invert =	18.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	3.14	N/A radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	4.75	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	1.27	feet
Spillway Crest Length =	2.92	feet	Stage at Top of Freeboard =	7.02	feet
Spillway End Slopes =	3.00	H:V	Basin Area at Top of Freeboard =	0.55	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	1.72	acre-ft

Calculated Parameters for Spillway

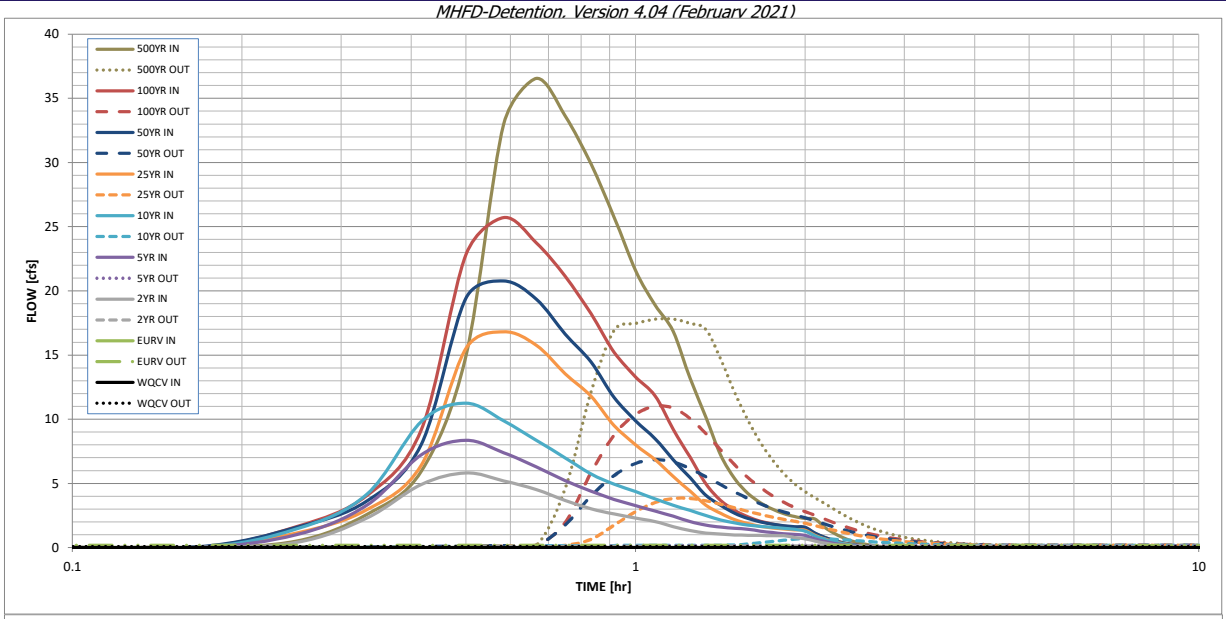
Routed Hydrograph Results

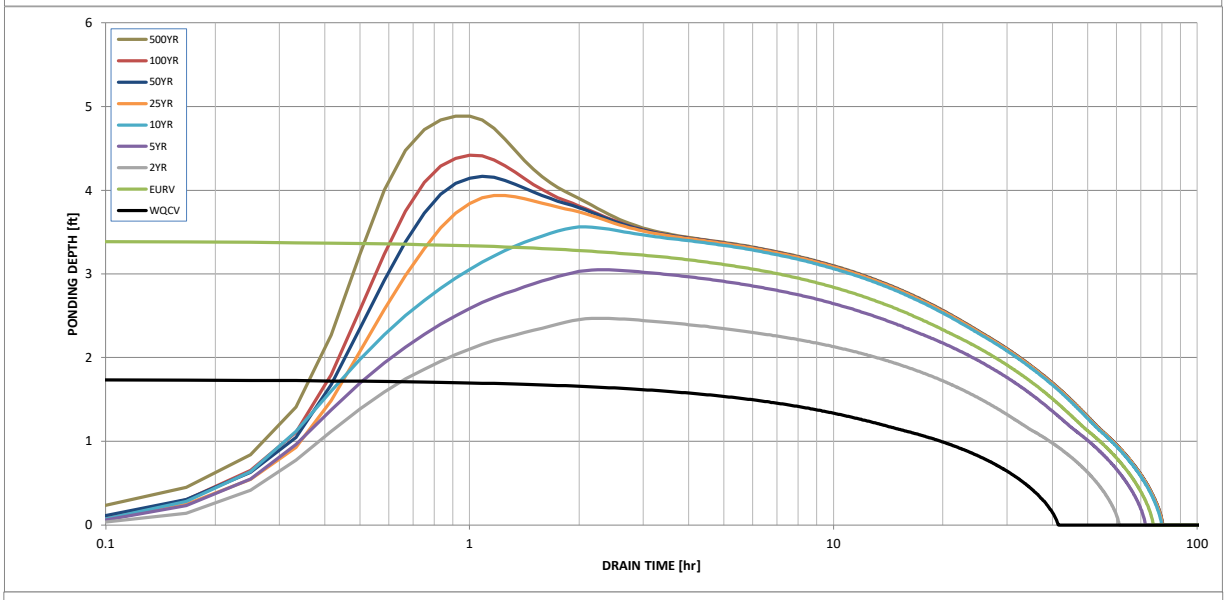
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

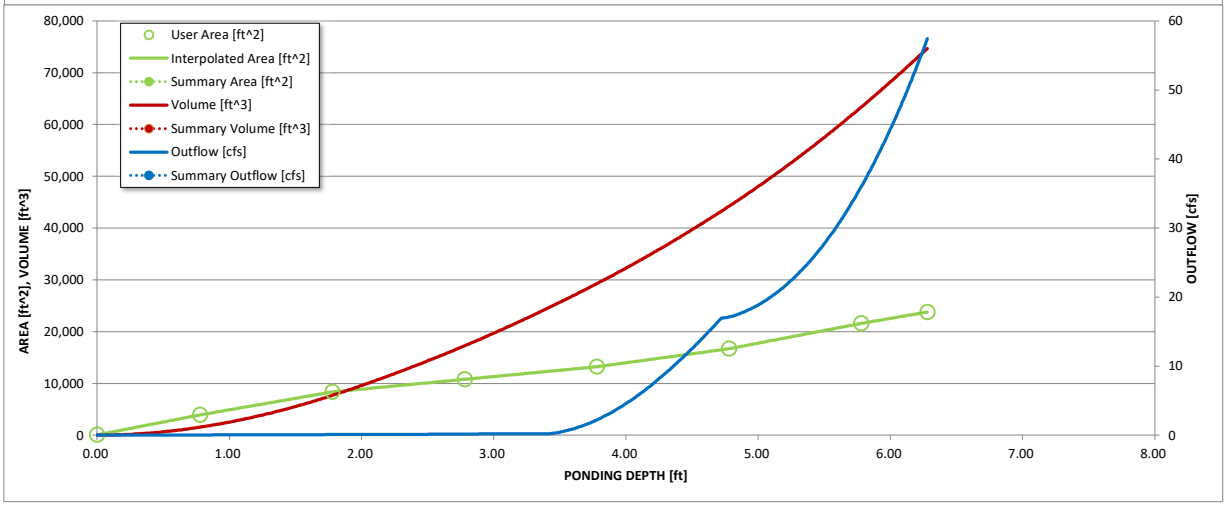
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.90	1.19	1.46	1.85	2.17	2.51	3.39
CUHP Runoff Volume (acre-ft) =	0.169	0.559	0.343	0.492	0.658	0.955	1.177	1.440	2.074
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.343	0.492	0.658	0.955	1.177	1.440	2.074
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	0.7	2.2	6.2	8.6	11.4	18.0
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.08	0.26	0.72	1.00	1.34	2.10
Peak Inflow Q (cfs) =	N/A	N/A	5.8	8.4	11.2	16.8	20.8	25.7	36.5
Peak Outflow Q (cfs) =	0.1	0.2	0.1	0.2	0.7	3.8	6.9	11.0	17.8
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.3	0.3	0.6	0.8	1.0	1.0
Structure Controlling Flow =	Plate	Overflow Weir 1	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.0	0.3	0.5	0.9	1.4
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	67	55	64	70	67	65	63	58
Time to Drain 99% of Inflow Volume (hours) =	**40**	72	58	69	76	75	74	73	70
Maximum Ponding Depth (ft) =	1.74	3.40	2.47	3.05	3.56	3.94	4.17	4.42	4.89
Area at Maximum Ponding Depth (acres) =	0.19	0.28	0.23	0.26	0.29	0.32	0.33	0.35	0.39
Maximum Volume Stored (acre-ft) =	0.169	0.561	0.322	0.465	0.606	0.718	0.793	0.879	1.054

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)







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

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Designer: Lucy East
Company: MBI
Date: April 26, 2022
Project: Beacon Lite Road - South Pond - Forebay East
Location: El Paso County

---

1. Basin Storage Volume

A) Effective Imperviousness of Tributary Area, I_a — I_a = 60.7 %

B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$) — i = 0.607

C) Contributing Watershed Area — Area = 2.980 ac

D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm — d_6 = 0.43 in

E) Design Concept (Select EURV when also designing for flood control)

Choose One
- ○ Water Quality Capture Volume (WQCV)
- ◉ Excess Urban Runoff Volume (EURV)

F) Design Volume (WQCV) Based on 40-hour Drain Time
($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area$)
V_{DESIGN} = ac-ft

G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume
($V_{WQCV\ OTHER} = (d_6 * (V_{DESIGN}/0.43))$)
$V_{DESIGN\ OTHER}$ = 0.059 ac-ft

H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)
$V_{DESIGN\ USER}$ = ac-ft

I) NRCS Hydrologic Soil Groups of Tributary Watershed
i) Percentage of Watershed consisting of Type A Soils — HSG_A = 0 %
ii) Percentage of Watershed consisting of Type B Soils — HSG_B = 100 %
iii) Percentage of Watershed consisting of Type C/D Soils — $HSG_{C/D}$ = 0 %

J) Excess Urban Runoff Volume (EURV) Design Volume
For HSG A: $EURV_A = 1.68 * i^{1.28}$
For HSG B: $EURV_B = 1.36 * i^{1.08}$
For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$
$EURV_{DESIGN}$ = 0.197 ac-f t

K) User Input of Excess Urban Runoff Volume (EURV) Design Volume (Only if a different EURV Design Volume is desired)
$EURV_{DESIGN\ USER}$ = ac-f t

---

2. Basin Shape: Length to Width Ratio
(A basin length to width ratio of at least 2:1 will improve TSS reduction.)
L : W = 2.0 : 1

---

3. Basin Side Slopes

A) Basin Maximum Side Slopes
(Horizontal distance per unit vertical, 4:1 or flatter preferred)
Z = 4.00 ft / ft

---

4. Inlet

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

---

5. Forebay

A) Minimum Forebay Volume
(V_{FMIN} = 1% of the WQCV)
V_{FMIN} = 0.001 ac-ft

B) Actual Forebay Volume
V_F = 0.003 ac-ft

C) Forebay Depth
(D_F = 12 inch maximum)
D_F = 12.0 in

D) Forebay Discharge

i) Undetained 100-year Peak Discharge
Q_{100} = 5.31 cfs

ii) Forebay Discharge Design Flow
($Q_F = 0.02 * Q_{100}$)
Q_F = 0.11 cfs

E) Forebay Discharge Design

Choose One
- ○ Berm With Pipe
- ◉ Wall with Rect. Notch
- ○ Wall with V-Notch Weir

Flow too small for berm w/ pipe

F) Discharge Pipe Size (minimum 8-inches)
Calculated D_F = in

G) Rectangular Notch Width
Calculated W_N = 2.8 in

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Designer: Lucy East
Company: MBI
Date: April 26, 2022
Project: Beacon Lite Road - South Pond - Forebay South
Location: El Paso County

---

1. Basin Storage Volume

A) Effective Imperviousness of Tributary Area, I_a — I_a = 59.9 %

B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$) — i = 0.599

C) Contributing Watershed Area — Area = 5.580 ac

D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm — d_6 = 0.43 in

E) Design Concept (Select EURV when also designing for flood control)

Choose One
- ○ Water Quality Capture Volume (WQCV)
- ◉ Excess Urban Runoff Volume (EURV)

F) Design Volume (WQCV) Based on 40-hour Drain Time
($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area$)
V_{DESIGN} = ac-ft

G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume
($V_{WQCV\ OTHER} = (d_6 * (V_{DESIGN}/0.43))$)
$V_{DESIGN\ OTHER}$ = 0.110 ac-ft

H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)
$V_{DESIGN\ USER}$ = ac-ft

I) NRCS Hydrologic Soil Groups of Tributary Watershed
i) Percentage of Watershed consisting of Type A Soils — HSG_A = 0 %
ii) Percentage of Watershed consisting of Type B Soils — HSG_B = 100 %
iii) Percentage of Watershed consisting of Type C/D Soils — $HSG_{C/D}$ = 0 %

J) Excess Urban Runoff Volume (EURV) Design Volume
For HSG A: $EURV_A = 1.68 * i^{1.28}$
For HSG B: $EURV_B = 1.36 * i^{1.08}$
For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$
$EURV_{DESIGN}$ = 0.364 ac-f t

K) User Input of Excess Urban Runoff Volume (EURV) Design Volume (Only if a different EURV Design Volume is desired)
$EURV_{DESIGN\ USER}$ = ac-f t

---

2. Basin Shape: Length to Width Ratio
(A basin length to width ratio of at least 2:1 will improve TSS reduction.)
L : W = 2.0 : 1

---

3. Basin Side Slopes

A) Basin Maximum Side Slopes
(Horizontal distance per unit vertical, 4:1 or flatter preferred)
Z = 4.00 ft / ft

---

4. Inlet

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

---

5. Forebay

A) Minimum Forebay Volume
(V_{FMIN} = 2% of the WQCV)
V_{FMIN} = 0.002 ac-ft

B) Actual Forebay Volume
V_F = 0.005 ac-ft

C) Forebay Depth
(D_F = 18 inch maximum)
D_F = 12.0 in

D) Forebay Discharge

i) Undetained 100-year Peak Discharge
Q_{100} = 20.54 cfs

ii) Forebay Discharge Design Flow
($Q_F = 0.02 * Q_{100}$)
Q_F = 0.41 cfs

E) Forebay Discharge Design

Choose One
- ○ Berm With Pipe
- ◉ Wall with Rect. Notch
- ○ Wall with V-Notch Weir

Flow too small for berm w/ pipe

F) Discharge Pipe Size (minimum 8-inches)
Calculated D_P = in

G) Rectangular Notch Width
Calculated W_N = 3.9 in

Design Procedure Form: Extended Detention Basin (EDB)

Designer: Lucy East
Company: MBI
Date: April 26, 2022
Project: Beacon Lite Road - South Pond - Forebay South
Location: El Paso County

6. Trickle Channel	
A) Type of Trickle Channel	Choose One: (•) Concrete ( ) Soft Bottom
F) Slope of Trickle Channel	S = 0.0050 ft / ft
7. Micropool and Outlet Structure	
A) Depth of Micropool (2.5-feet minimum)	D_M = 2.5 ft
B) Surface Area of Micropool (10 ft^2 minimum)	A_M = 60 sq ft
C) Outlet Type	Choose One: (•) Orifice Plate ( ) Other (Describe):
D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention)	$D_{orifice}$ = 1.25 inches
E) Total Outlet Area	A_{ot} = 3.90 square inches
8. Initial Surcharge Volume	
A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches)	D_{IS} = 4 in
B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV)	V_{IS} = cu ft
C) Initial Surcharge Provided Above Micropool	V_s = 20.0 cu ft
9. Trash Rack	
A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$	A_t = 133 square inches
B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open are to the total screen are for the material specified.)	*Aluminum Amico-Klemp SR Series with Cross Rods 2" O.C.*
Other (Y/N): N	
C) Ratio of Total Open Area to Total Area (only for type 'Other')	User Ratio =
D) Total Water Quality Screen Area (based on screen type)	A_{total} = 188 sq. in.
E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E)	H= 3.4 feet
F) Height of Water Quality Screen (H_{TR})	H_{TR}= 68.8 inches
G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended)	$W_{opening}$ = 12.0 inches **VALUE LESS THAN RECOMMENDED MIN. WIDTH. WIDTH HAS BEEN SET TO 12 INCHES.**

Design Procedure Form: Extended Detention Basin (EDB)

Designer: Lucy East
Company: MBI
Date: April 26, 2022
Project: Beacon Lite Road - South Pond - Forebay South
Location: El Paso County

10. Overflow Embankment	
A) Describe embankment protection for 100-year and greater overtopping:	Overflow structure - Type D with grate
B) Slope of Overflow Embankment (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Ze = 4.00 ft / ft
11. Vegetation	Choose One: ○ Irrigated ◉ Not Irrigated
12. Access	
A) Describe Sediment Removal Procedures	Annual local maintenance with skid steer. Winter months recommended to ensure pond bottom is solid surface.

Notes:

Design Procedure Form: Extended Detention Basin (EDB)

Designer: Lucy East
Company: MBI
Date: April 26, 2022
Project: Beacon Lite Road - South Pond - Forebay East
Location: El Paso County

6. Trickle Channel	
A) Type of Trickle Channel	Choose One: (•) Concrete ( ) Soft Bottom
F) Slope of Trickle Channel	S = 0.0050 ft / ft
7. Micropool and Outlet Structure	
A) Depth of Micropool (2.5-feet minimum)	D_M = 2.5 ft
B) Surface Area of Micropool (10 ft^2 minimum)	A_M = 60 sq ft
C) Outlet Type	Choose One: (•) Orifice Plate ( ) Other (Describe):
D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention)	$D_{orifice}$ = 1.25 inches
E) Total Outlet Area	A_{ot} = 3.90 square inches
8. Initial Surcharge Volume	
A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches)	D_{IS} = 4 in
B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV)	V_{IS} = cu ft
C) Initial Surcharge Provided Above Micropool	V_s = 20.0 cu ft
9. Trash Rack	
A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$	A_t = 133 square inches
B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open are to the total screen are for the material specified.)	*Aluminum Amico-Klemp SR Series with Cross Rods 2" O.C.*
Other (Y/N): N	
C) Ratio of Total Open Area to Total Area (only for type 'Other')	User Ratio =
D) Total Water Quality Screen Area (based on screen type)	A_{total} = 188 sq. in.
E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E)	H= 3.4 feet
F) Height of Water Quality Screen (H_{TR})	H_{TR}= 68.8 inches
G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended)	$W_{opening}$ = 12.0 inches **VALUE LESS THAN RECOMMENDED MIN. WIDTH. WIDTH HAS BEEN SET TO 12 INCHES.**

Design Procedure Form: Extended Detention Basin (EDB)

Designer: Lucy East
Company: MBI
Date: April 26, 2022
Project: Beacon Lite Road - South Pond - Forebay East
Location: El Paso County

10. Overflow Embankment	
A) Describe embankment protection for 100-year and greater overtopping:	Overflow structure - Type D with grate
B) Slope of Overflow Embankment (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Ze = 4.00 ft / ft
11. Vegetation	Choose One: ○ Irrigated ◉ Not Irrigated
12. Access	
A) Describe Sediment Removal Procedures	Annual local maintenance with skid steer. Winter months recommended to ensure pond bottom is solid surface.

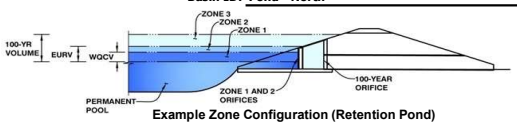
Notes:

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: Beacon Lite

Basin ID: Pond - North



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB		**Note: L / W Ratio > 8**
Watershed Area =	4.48	acres	**L / W Ratio = 27.11**
Watershed Length =	2,300	ft	
Watershed Length to Centroid =	1,100	ft	
Watershed Slope =	0.060	ft/ft	
Watershed Imperviousness =	55.85%	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) =	0.083	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.270	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.9 in.) =	0.172	acre-feet	0.90	inches
5-yr Runoff Volume (P1 = 1.19 in.) =	0.249	acre-feet	1.19	inches
10-yr Runoff Volume (P1 = 1.46 in.) =	0.338	acre-feet	1.46	inches
25-yr Runoff Volume (P1 = 1.85 in.) =	0.501	acre-feet	1.85	inches
50-yr Runoff Volume (P1 = 2.17 in.) =	0.621	acre-feet	2.17	inches
100-yr Runoff Volume (P1 = 2.51 in.) =	0.766	acre-feet	2.51	inches
500-yr Runoff Volume (P1 = 3.39 in.) =	1.111	acre-feet	3.39	inches
Approximate 2-yr Detention Volume =	0.155	acre-feet		
Approximate 5-yr Detention Volume =	0.222	acre-feet		
Approximate 10-yr Detention Volume =	0.304	acre-feet		
Approximate 25-yr Detention Volume =	0.366	acre-feet		
Approximate 50-yr Detention Volume =	0.398	acre-feet		
Approximate 100-yr Detention Volume =	0.453	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.083	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.187	acre-feet
Zone 3 (100yr + 1 / 2 WQCV - Zones 1 & 2) =	0.225	acre-feet
Total Detention Basin Volume =	0.494	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

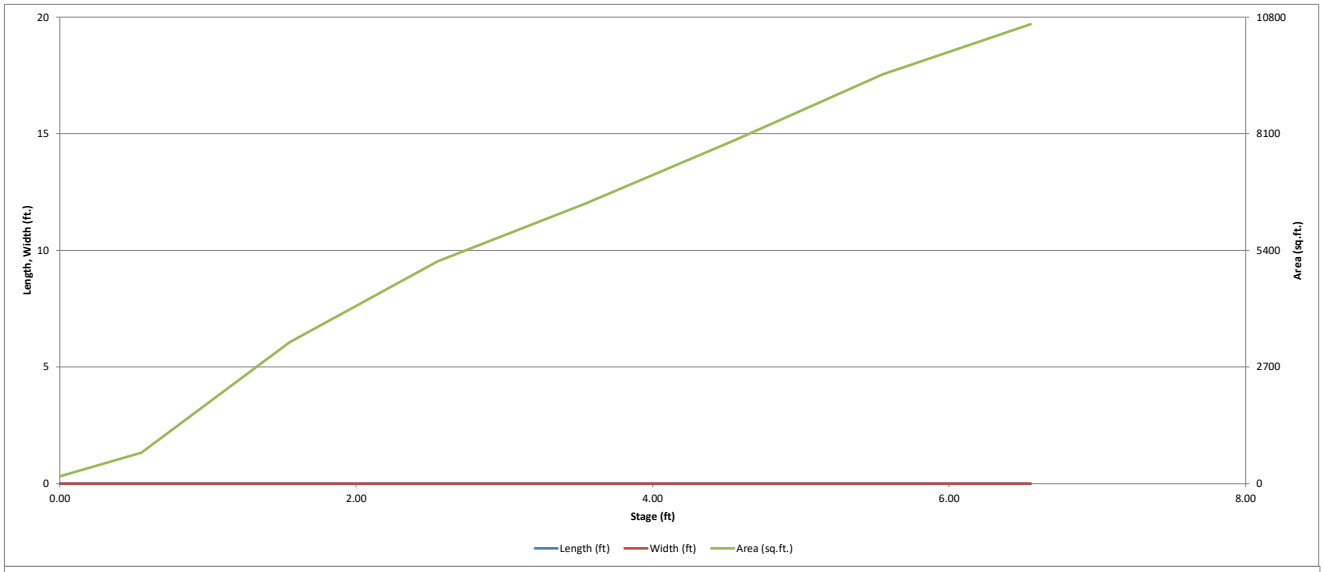
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

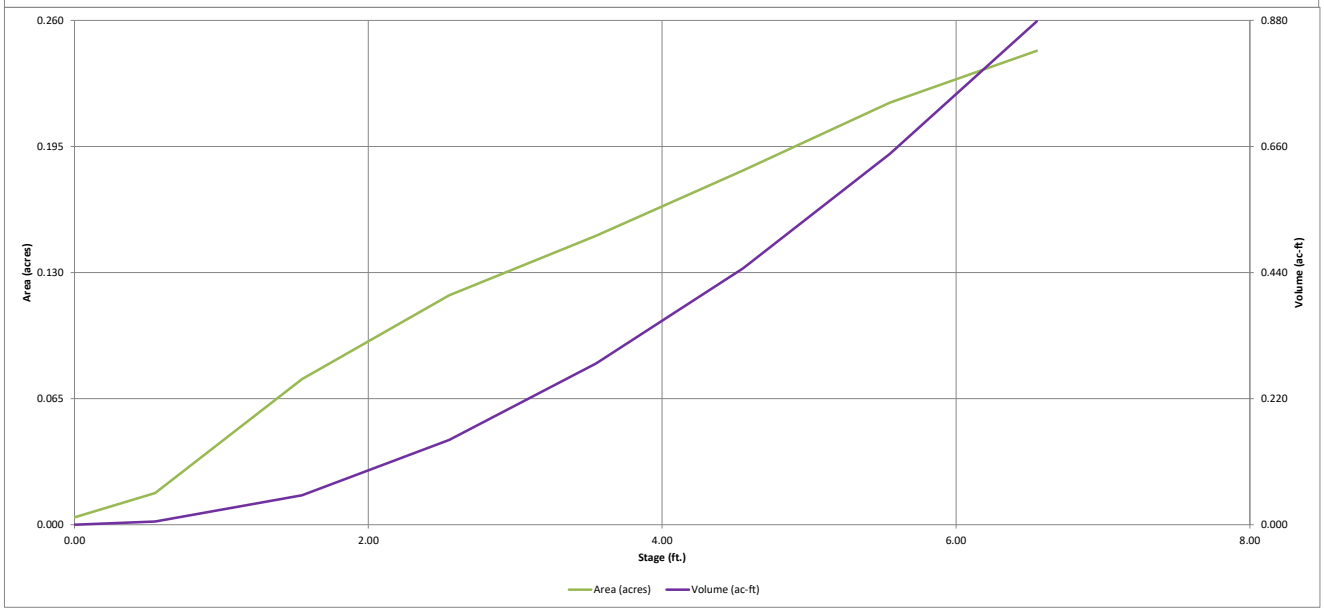
Depth Increment = 1.00 ft

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	--	--	--	166	0.004		
7243	--	0.55	--	--	--	712	0.016	242	0.006
7244	--	1.55	--	--	--	3,273	0.075	2,234	0.051
7245	--	2.55	--	--	--	5,151	0.118	6,446	0.148
7246	--	3.55	--	--	--	6,490	0.149	12,266	0.282
7247	--	4.55	--	--	--	7,950	0.183	19,487	0.447
7248	--	5.55	--	--	--	9,476	0.218	28,200	0.647
7249	--	6.55	--	--	--	10,642	0.244	38,259	0.878

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)



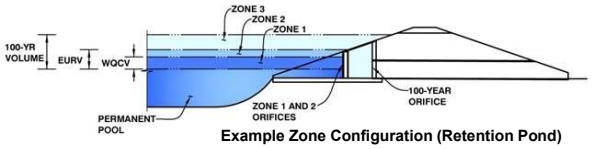


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: **Beacon Lite**

Basin ID: **Pond - North**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.94	0.083	Orifice Plate
Zone 2 (EURV)	3.48	0.187	Orifice Plate
Z3 (100+1/2WQCV)	4.81	0.225	Weir&Pipe (Restrict)
Total (all zones)		0.494	

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

			Calculated Parameters for Underdrain		
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

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

			Calculated Parameters for Plate		
Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	3.819E-03	ft^2
Depth at top of Zone using Orifice Plate =	3.48	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	13.90	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.55	sq. inches (diameter = 13/16 inch)	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	1.16	2.32					
Orifice Area (sq. inches)	0.55	0.55	0.55					

	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		Calculated Parameters for Vertical Orifice	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				

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		Calculated Parameters for Overflow Weir	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	4.50	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	5.13	N/A	feet
Overflow Weir Front Edge Length =	6.00	N/A	feet	Overflow Weir Slope Length =	2.58	N/A	feet
Overflow Weir Grate Slope =	4.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	6.92	N/A	
Horiz. Length of Weir Sides =	2.50	N/A	feet	Overflow Grate Open Area w/o Debris =	12.23	N/A	ft^2
Overflow Grate Type =	Close Mesh Grate	N/A		Overflow Grate Open Area w/ Debris =	6.12	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

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

	Zone 3 Restrictor	Not Selected		Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate	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 =	1.77	N/A	ft^2
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.75	N/A	feet
Restrictor Plate Height Above Pipe Invert =	18.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	3.14	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

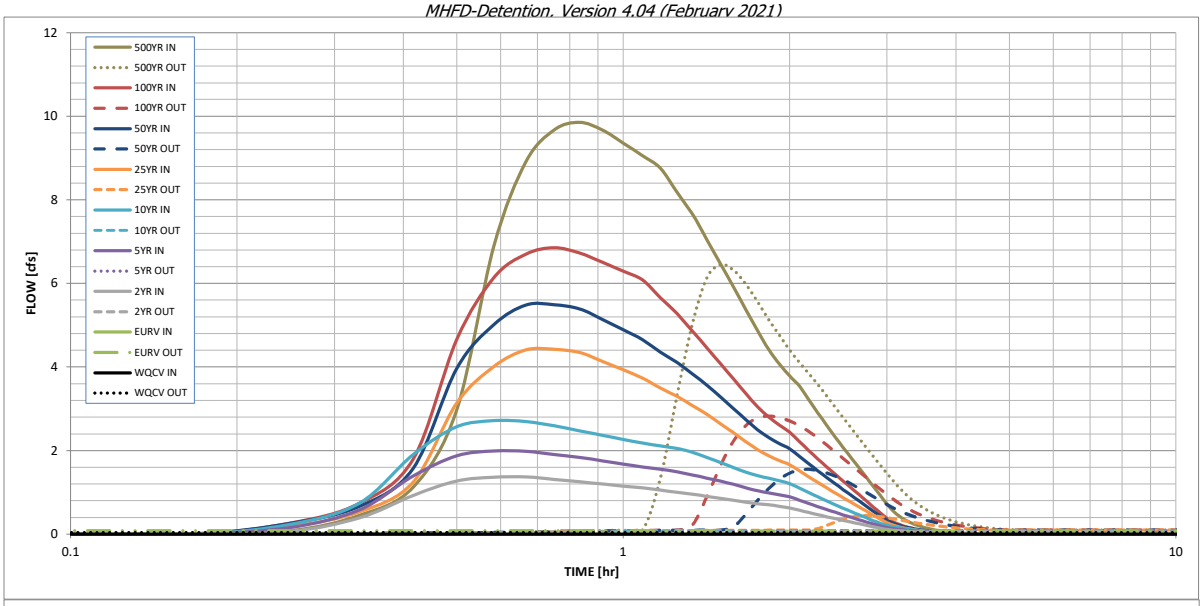
			Calculated Parameters for Spillway		
Spillway Invert Stage=	5.05	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.64	feet
Spillway Crest Length =	2.92	feet	Stage at Top of Freeboard =	6.69	feet
Spillway End Slopes =	3.00	H:V	Basin Area at Top of Freeboard =	0.24	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	0.88	acre-ft

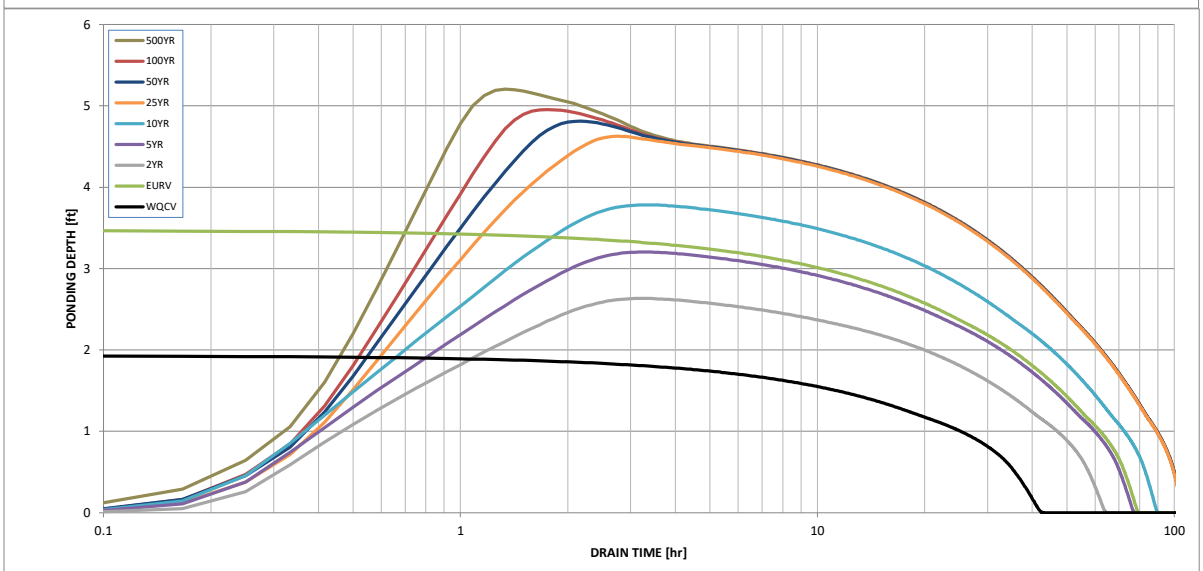
Routed Hydrograph Results — *The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).*

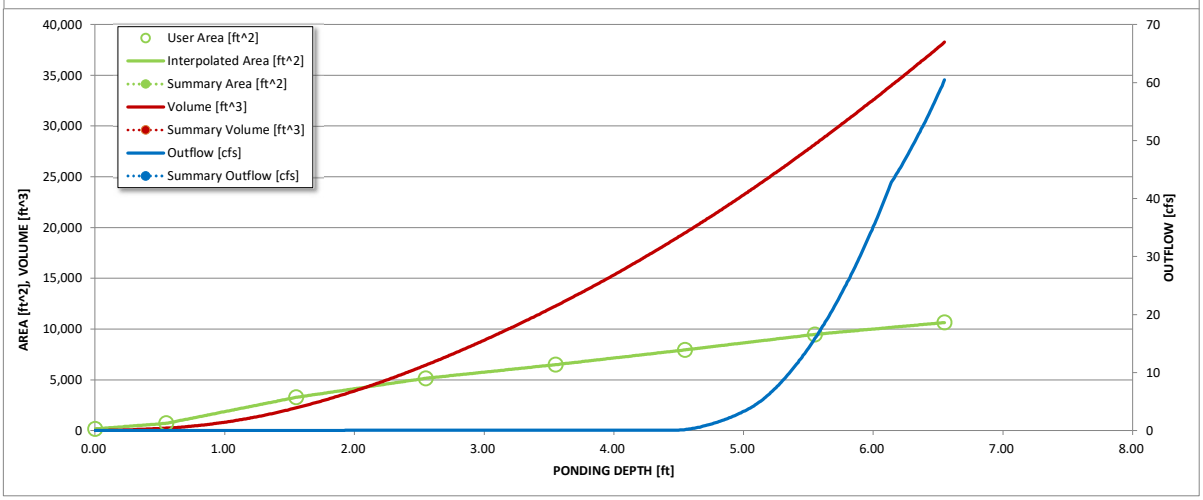
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.90	1.19	1.46	1.85	2.17	2.51	3.39
CUHP Runoff Volume (acre-ft) =	0.083	0.270	0.172	0.249	0.338	0.501	0.621	0.766	1.111
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.172	0.249	0.338	0.501	0.621	0.766	1.111
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.0	0.1	0.5	1.4	2.0	2.8	4.6
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.00	0.03	0.10	0.32	0.45	0.64	1.02
Peak Inflow Q (cfs) =	N/A	N/A	1.4	2.0	2.7	4.4	5.5	6.9	9.9
Peak Outflow Q (cfs) =	0.0	0.1	0.1	0.1	0.1	0.4	1.6	2.8	6.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.6	0.2	0.3	0.8	1.0	1.4
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.0	0.1	0.2	0.5
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	70	57	68	79	92	90	87	81
Time to Drain 99% of Inflow Volume (hours) =	**40**	75	61	73	84	99	99	97	95
Maximum Ponding Depth (ft) =	1.94	3.48	2.63	3.20	3.78	4.63	4.81	4.96	5.20
Area at Maximum Ponding Depth (acres) =	0.09	0.15	0.12	0.14	0.16	0.18	0.19	0.20	0.21
Maximum Volume Stored (acre-ft) =	0.084	0.271	0.158	0.231	0.317	0.460	0.496	0.523	0.573

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)







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

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Designer: Lucy East
Company: MBI
Date: April 26, 2022
Project: Beacon Lite Road - North Pond
Location: El Paso County

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1. Basin Storage Volume

A) Effective Imperviousness of Tributary Area, I_a — I_a = 55.9 %

B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$) — i = 0.559

C) Contributing Watershed Area — Area = 4.480 ac

D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm — d_6 = 0.43 in

E) Design Concept (Select EURV when also designing for flood control)

Choose One
- ○ Water Quality Capture Volume (WQCV)
- ◉ Excess Urban Runoff Volume (EURV)

F) Design Volume (WQCV) Based on 40-hour Drain Time
($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area$) — V_{DESIGN} = ac-ft

G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume
($V_{WQCV\ OTHER} = (d_6 * (V_{DESIGN} / 0.43))$) — $V_{DESIGN\ OTHER}$ = 0.083 ac-ft

H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired) — $V_{DESIGN\ USER}$ = ac-ft

I) NRCS Hydrologic Soil Groups of Tributary Watershed
- i) Percentage of Watershed consisting of Type A Soils — HSG $_A$ = 0 %
- ii) Percentage of Watershed consisting of Type B Soils — HSG $_B$ = 100 %
- iii) Percentage of Watershed consisting of Type C/D Soils — HSG $_{C/D}$ = 0 %

J) Excess Urban Runoff Volume (EURV) Design Volume
For HSG A: $EURV_A = 1.68 * i^{1.28}$
For HSG B: $EURV_B = 1.36 * i^{1.08}$
For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$
— $EURV_{DESIGN}$ = 0.271 ac-ft

K) User Input of Excess Urban Runoff Volume (EURV) Design Volume (Only if a different EURV Design Volume is desired) — $EURV_{DESIGN\ USER}$ = ac-ft

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2. Basin Shape: Length to Width Ratio
(A basin length to width ratio of at least 2:1 will improve TSS reduction.) — L : W = 2.0 : 1

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3. Basin Side Slopes

A) Basin Maximum Side Slopes
(Horizontal distance per unit vertical, 4:1 or flatter preferred) — Z = 4.00 ft / ft

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4. Inlet

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

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5. Forebay

A) Minimum Forebay Volume
(V_{FMIN} = 2% of the WQCV) — V_{FMIN} = 0.002 ac-ft

B) Actual Forebay Volume — V_F = 0.004 ac-ft

C) Forebay Depth
(D_F = 18 inch maximum) — D_F = 12.0 in

D) Forebay Discharge

i) Undetained 100-year Peak Discharge — Q_{100} = 22.04 cfs

ii) Forebay Discharge Design Flow
($Q_F = 0.02 * Q_{100}$) — Q_F = 0.44 cfs

E) Forebay Discharge Design

Choose One
- ○ Berm With Pipe
- ◉ Wall with Rect. Notch
- ○ Wall with V-Notch Weir

Flow too small for berm w/ pipe

F) Discharge Pipe Size (minimum 8-inches) — Calculated D_P = in

G) Rectangular Notch Width — Calculated W_N = 4.0 in

Design Procedure Form: Extended Detention Basin (EDB)

Designer: Lucy East
Company: MBI
Date: April 26, 2022
Project: Beacon Lite Road - North Pond
Location: El Paso County

6. Trickle Channel	
A) Type of Trickle Channel	Choose One: (●) Concrete ( ) Soft Bottom
F) Slope of Trickle Channel	S = 0.0050 ft / ft
7. Micropool and Outlet Structure	
A) Depth of Micropool (2.5-feet minimum)	D_M = 2.5 ft
B) Surface Area of Micropool (10 ft^2 minimum)	A_M = 60 sq ft
C) Outlet Type	Choose One: (●) Orifice Plate ( ) Other (Describe):
D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention)	$D_{orifice}$ = 0.81 inches
E) Total Outlet Area	A_{ot} = 1.65 square inches
8. Initial Surcharge Volume	
A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches)	D_{IS} = 4 in
B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV)	V_{IS} = cu ft
C) Initial Surcharge Provided Above Micropool	V_s = 20.0 cu ft
9. Trash Rack	
A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$	A_t = 59 square inches
B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open are to the total screen are for the material specified.)	*S.S. Well Screen with 60% Open Area*
Other (Y/N): N	
C) Ratio of Total Open Area to Total Area (only for type 'Other')	User Ratio =
D) Total Water Quality Screen Area (based on screen type)	A_{total} = 98 sq. in.
E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E)	H= 3.48 feet
F) Height of Water Quality Screen (H_{TR})	H_{TR}= 69.76 inches
G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended)	$W_{opening}$ = 12.0 inches **VALUE LESS THAN RECOMMENDED MIN. WIDTH. WIDTH HAS BEEN SET TO 12 INCHES.**

Design Procedure Form: Extended Detention Basin (EDB)

Designer: Lucy East
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Date: April 26, 2022
Project: Beacon Lite Road - North Pond
Location: El Paso County

10. Overflow Embankment	
A) Describe embankment protection for 100-year and greater overtopping:	Overflow structure - Type D inlet with grate
B) Slope of Overflow Embankment (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Ze = 4.00 ft / ft
11. Vegetation	Choose One: ○ Irrigated ◉ Not Irrigated
12. Access	
A) Describe Sediment Removal Procedures	Annual local maintenance with skid steer. Winter months recommended to ensure pond bottom is solid surface.

Notes:

APPENDIX C

APPENDIX C.1

Storm Sewer Calculations

10-Year Storm Event. Pipe Analysis (Sanitary and Sewer Analysis Output)

Element ID	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Inlet Invert Offset	Outlet Invert Elevation	Total Drop	Average Slope	Pipe Shape	Pipe Diameter or Height	Pipe Width	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow	Peak Flow	Time of Peak Flow Occurrence	Max Flow Velocity	Travel Time	Design Flow Capacity	Max Flow / Design Flow Ratio	Max Flow Depth / Total Depth Ratio	Total Time Surcharged	Max Flow Depth	Reported Condition
			(ft)	(ft)	(ft)	(ft)	(ft)	(%)		(inches)	(inches)					(cfs)	(cfs)	(days hh:mm)	(ft/sec)	(min)	(cfs)			(min)	(ft)	
P-1	MH-1	FES-1	57.00	7193.90	0.30	7193.03	0.87	1.5300	Horizontal Ellipse	24.000	38.04	0.0120	0.5000	0.5000	0.0000	0.00	7.65	0 00:06	7.68	0.12	56.00	0.14	0.27	0.00	0.54	Calculated
P-10	IN-10	IN-35	98.00	7190.62	0.00	7190.13	0.49	0.5000	CIRCULAR	30.000	30.00	0.0120	0.5000	0.5000	0.0000	0.00	8.73	0 00:20	5.67	0.29	31.42	0.28	0.36	0.00	0.90	Calculated
P-11	MH-12	FES-11	72.00	7187.15	0.00	7185.80	1.35	1.8700	CIRCULAR	36.000	36.00	0.0120	0.5000	0.5000	0.0000	0.00	34.56	0 00:36	12.75	0.09	98.94	0.35	0.41	0.00	1.22	Calculated
P-13	MH-13	MH-12	228.00	7189.40	0.00	7187.15	2.25	0.9900	CIRCULAR	36.000	36.00	0.0120	0.5000	0.5000	0.0000	0.00	34.50	0 00:36	10.08	0.38	71.78	0.48	0.49	0.00	1.46	Calculated
P-14	IN-14	MH-13	63.00	7191.20	0.05	7189.90	1.30	2.0600	CIRCULAR	30.000	30.00	0.0120	0.5000	0.5000	0.0000	0.00	32.64	0 00:36	13.08	0.08	63.83	0.51	0.51	0.00	1.27	Calculated
P-15	IN-15	IN-14	11.00	7191.43	0.00	7191.20	0.23	2.0900	CIRCULAR	30.000	30.00	0.0120	0.5000	0.5000	0.0000	0.00	32.66	0 00:36	13.14	0.01	64.25	0.51	0.50	0.00	1.26	Calculated
P-16	IN-16	IN-7	14.00	7219.76	0.00	7219.57	0.19	1.3600	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	1.21	0 00:10	4.68	0.05	13.26	0.09	0.20	0.00	0.31	Calculated
P-17	IN-17	FES-17	45.00	7220.96	-0.23	7220.74	0.22	0.4900	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	0.72	0 00:08	3.33	0.23	7.59	0.09	0.21	0.00	0.31	Calculated
P-18	MH-18	FES-18	97.00	7238.75	0.00	7237.52	1.23	1.2700	CIRCULAR	30.000	30.00	0.0120	0.5000	0.5000	0.0000	0.00	11.43	0 00:17	9.98	0.16	50.04	0.23	0.32	0.00	0.81	Calculated
P-19	IN-19	MH-18	160.00	7240.55	0.00	7239.50	1.05	0.6600	CIRCULAR	30.000	30.00	0.0120	0.5000	0.5000	0.0000	0.00	11.43	0 00:17	6.52	0.41	36.00	0.32	0.39	0.00	0.97	Calculated
P-2	MH-2	MH-1	279.00	7195.29	0.00	7193.90	1.39	0.5000	Horizontal Ellipse	24.000	38.04	0.0120	0.5000	0.5000	0.0000	0.00	7.66	0 00:06	5.27	0.88	31.99	0.24	0.35	0.00	0.71	Calculated
P-20	IN-20	MH-18	33.00	7239.42	0.00	7239.25	0.17	0.5200	CIRCULAR	24.000	24.00	0.0120	0.5000	0.5000	0.0000	7.70	12.08	0 00:00	14.92	0.04	17.59	0.69	0.30	0.00	0.15	Calculated
P-21	IN-21	FES-21	25.00	7245.50	0.00	7243.50	2.00	8.0000	CIRCULAR	24.000	24.00	0.0120	0.5000	0.5000	0.0000	0.00	12.61	0 00:05	14.49	0.03	56.53	0.22	0.32	0.00	0.64	Calculated
P-22	MH-22	IN-21	16.00	7245.86	0.00	7245.00	0.86	5.3700	CIRCULAR	24.000	24.00	0.0120	0.5000	0.5000	0.0000	0.00	11.33	0 00:06	10.30	0.03	36.76	0.31	0.38	0.00	0.76	Calculated
P-23	MH-23	MH-22	219.00	7252.54	0.00	7246.51	6.03	2.7500	CIRCULAR	24.000	24.00	0.0120	0.5000	0.5000	0.0000	0.00	10.05	0 00:06	10.80	0.34	40.67	0.25	0.34	0.00	0.68	Calculated
P-24	MH-24	MH-23	220.00	7263.76	0.00	7252.74	11.02	5.0100	CIRCULAR	24.000	24.00	0.0120	0.5000	0.5000	0.0000	0.00	10.08	0 00:05	13.36	0.27	54.85	0.18	0.29	0.00	0.58	Calculated
P-25	MH-25	MH-24	158.00	7273.91	0.00	7263.81	10.10	6.3900	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	7.70	0 00:05	13.85	0.19	28.77	0.27	0.35	0.00	0.53	Calculated
P-26	MH-26	MH-25	114.00	7282.48	0.00	7274.41	8.07	7.0800	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	7.70	0 00:05	14.35	0.13	30.28	0.25	0.34	0.00	0.52	Calculated
P-27	IN-27	MH-2	39.00	7198.53	0.00	7197.03	1.50	3.8500	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	1.64	0 00:05	7.91	0.08	22.32	0.07	0.18	0.00	0.27	Calculated
P-28	MH-28	MH-26	107.00	7290.08	0.00	7282.68	7.40	6.9200	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	7.70	0 00:05	14.23	0.13	29.93	0.26	0.35	0.00	0.52	Calculated
P-29	MH-29	MH-28	292.00	7312.09	0.00	7290.28	21.81	7.4700	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	3.93	0 00:05	12.15	0.40	31.10	0.13	0.24	0.00	0.36	Calculated
P-3	MH-3	MH-2	280.00	7213.23	0.00	7196.76	16.47	5.8800	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	4.89	0 00:05	11.89	0.39	27.60	0.18	0.28	0.00	0.43	Calculated
P-30	MH-30	MH-29	140.00	7324.39	0.00	7313.94	10.45	7.4600	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	3.96	0 00:05	12.14	0.19	31.09	0.13	0.24	0.00	0.36	Calculated
P-31	MH-31	MH-30	179.00	7334.58	0.00	7325.15	9.43	5.2700	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	3.98	0 00:05	10.78	0.28	26.12	0.15	0.26	0.00	0.39	Calculated
P-32	IN-32	MH-22	28.00	7246.90	0.00	7246.76	0.14	0.5000	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	1.52	0 00:05	4.10	0.11	8.05	0.19	0.29	0.00	0.44	Calculated
P-33	IN-33	MH-24	29.00	7264.32	0.00	7264.18	0.14	0.4800	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	1.29	0 00:05	3.95	0.12	7.91	0.16	0.27	0.00	0.41	Calculated
P-34	IN-34	MH-24	16.00	7264.30	0.00	7264.20	0.10	0.6300	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	1.36	0 00:05	3.73	0.07	9.00	0.15	0.26	0.00	0.39	Calculated
P-35	IN-35	MH-13	45.00	7190.13	0.00	7189.90	0.23	0.5100	CIRCULAR	30.000	30.00	0.0120	0.5000	0.5000	0.0000	0.00	9.10	0 00:20	5.59	0.13	31.77	0.29	0.37	0.00	0.92	Calculated
P-36	IN-36	MH-28	28.00	7290.70	0.00	7290.47	0.23	0.8200	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	2.03	0 00:05	5.01	0.09	10.31	0.20	0.30	0.00	0.45	Calculated
P-37	IN-37	MH-28	16.00	7290.71	0.00	7290.56	0.15	0.9400	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	2.10	0 00:05	4.81	0.06	11.02	0.19	0.30	0.00	0.44	Calculated
P-38	IN-38	MH-31	28.00	7339.06	0.00	7338.65	0.41	1.4600	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	2.09	0 00:05	5.90	0.08	13.77	0.15	0.26	0.00	0.39	Calculated
P-39	IN-39	MH-31	16.00	7339.20	0.00	7338.92	0.28	1.7500	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	1.93	0 00:05	5.87	0.05	15.05	0.13	0.24	0.00	0.36	Calculated
P-4	MH-4	MH-3	130.00	7219.18	0.00	7213.43	5.75	4.4200	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	4.95	0 00:05	10.72	0.20	23.93	0.21	0.31	0.00	0.46	Calculated
P-40	IN-40	FES-40	41.00	7336.60	0.00	7336.39	0.21	0.5100	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	3.02	0 00:09	4.27	0.16	8.14	0.37	0.42	0.00	0.63	Calculated
P-41	IN-41	IN-40	69.00	7337.08	0.00	7336.74	0.34	0.4900	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	1.32	0 00:17	3.66	0.31	7.99	0.17	0.28	0.00	0.41	Calculated
P-42	IN-42	FES-42	66.00	7371.10	0.00	7369.84	1.26	1.9100	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	1.21	0 00:14	5.29	0.21	15.72	0.08	0.19	0.00	0.28	Calculated
P-43	FES-43	IN-42	9.00	7372.43	0.00	7372.15	0.28	3.1100	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	1.22	0 00:14	6.26	0.02	20.07	0.06	0.17	0.00	0.25	Calculated
P-44	IN-44	FES-44	82.00	7354.15	0.00	7351.08	3.07	3.7400	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	3.94	0 00:26	9.42	0.15	22.02	0.18	0.29	0.00	0.43	Calculated
P-46	IN-46	FES-46	83.00	7346.94	0.00	7345.66	1.28	1.5400	CIRCULAR	24.000	24.00	0.0120	0.5000	0.5000	0.0000	0.00	9.31	0 00:23	8.52	0.16	30.43	0.31	0.38	0.00	0.76	Calculated
P-47	FES-47	IN-46	53.00	7350.95	0.00	7347.14	3.81	7.1900	CIRCULAR	24.000	24.00	0.0120	0.5000	0.5000	0.0000	0.00	7.35	0 00:23	13.81	0.06	65.71	0.11	0.23	0.00	0.45	Calculated
P-5	FES-5	MH-12	16.00	7188.42	0.00	7188.21	0.21	1.3100	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	3.21	0 00:18	6.10	0.04	13.04	0.25	0.34	0.00	0.51	Calculated
P-51	MH-51	FES-51	48.00	7193.70	0.88	7192.58	1.12	2.3300	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	8.75	0 00:20	9.86	0.08	17.38	0.50	0.50	0.00	0.75	Calculated
P-52	IN-52	MH-51	85.00	7209.50	0.00	7204.00	5.50	6.4700	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	8.75	0 00:20	14.36	0.10	28.95	0.30	0.38	0.00	0.57	Calculated
P-6	IN-6	MH-2	16.00	7198.37	0.00	7198.03	0.34	2.1300	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	1.47	0 00:05	5.81	0.05	16.59	0.09	0.20	0.00	0.30	Calculated
P-7	IN-7	MH-4	16.00	7219.44	0.00	7219.22	0.22	1.3700	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	2.78	0 00:05	5.97	0.04	13.34	0.21	0.31	0.00	0.46	Calculated
P-8	IN-8	MH-4	28.00	7221.14	0.00	7220.80	0.34	1.2100	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	2.21	0 00:05	5.67	0.08	12.54	0.18	0.28	0.00	0.43	Calculated

10-Year Storm Event. Structure Analysis (Sanitary and Sewer Analysis Output)

Element ID	Invert Elevation	Ground/Rim (Max) Elevation	Ground/Rim (Max) Offset	Initial Water Elevation	Initial Water Depth	Surcharge Elevation	Surcharge Depth	Ponded Area	Minimum Pipe Cover	Peak Inflow	Peak Lateral Inflow	Maximum HGL Elevation Attained	Maximum HGL Depth Attained	Maximum Surcharge Depth Attained	Minimum Freeboard Attained	Average HGL Elevation Attained	Average HGL Depth Attained	Time of Maximum HGL Occurrence	Time of Peak Flooding Occurrence	Total Flooded Volume	Total Time Flooded
	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft^2)	(inches)	(cfs)	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(days hh:mm)	(days hh:mm)	(ac-inches)	(minutes)
FES-43	7372.43	7375.00	2.57	0.00	-7372.43	7375.00	0.00	0.00	12.84	1.22	1.22	7372.68	0.25	0.00	2.32	7372.51	0.08	0 00:14	0 00:00	0.00	0.00
FES-47	7350.95	7354.75	3.80	0.00	-7350.95	7354.75	0.00	0.00	21.60	7.36	7.36	7351.40	0.45	0.00	3.35	7351.25	0.30	0 00:23	0 00:00	0.00	0.00
FES-5	7188.42	7190.13	1.71	0.00	-7188.42	7190.13	0.00	0.00	2.52	3.21	3.21	7188.93	0.51	0.00	1.20	7188.62	0.20	0 00:18	0 00:00	0.00	0.00
IN-10	7190.62	7196.97	6.35	0.00	-7190.62	7196.97	0.00	0.00	46.20	8.76	8.76	7191.52	0.90	0.00	5.45	7191.02	0.40	0 00:20	0 00:00	0.00	0.00
IN-14	7191.15	7200.02	8.87	0.00	-7191.15	7200.02	0.00	0.00	75.84	32.66	0.00	7192.47	1.32	0.00	7.55	7192.09	0.94	0 00:36	0 00:00	0.00	0.00
IN-15	7191.43	7200.04	8.61	0.00	-7191.43	7200.04	0.00	0.00	73.32	32.66	32.66	7192.69	1.26	0.00	7.35	7192.32	0.89	0 00:36	0 00:00	0.00	0.00
IN-16	7219.76	7223.15	3.39	0.00	-7219.76	7223.15	0.00	0.00	22.68	1.21	1.21	7220.07	0.31	0.00	3.08	7219.83	0.07	0 00:10	0 00:00	0.00	0.00
IN-17	7221.19	7223.68	2.49	0.00	-7221.19	7223.68	0.00	0.00	14.64	0.72	0.72	7221.50	0.31	0.00	2.18	7221.25	0.06	0 00:08	0 00:00	0.00	0.00
IN-19	7240.55	7249.83	9.28	0.00	-7240.55	7249.83	0.00	0.00	81.36	11.47	11.47	7241.52	0.97	0.00	8.31	7241.18	0.63	0 00:17	0 00:00	0.00	0.00
IN-20	7239.42	7247.50	8.08	0.00	-7239.42	7244.39	-3.11	0.00	72.96	0.00	0.00	7239.42	0.00	0.00	8.08	7239.42	0.00	0 00:00	0 00:00	0.00	0.00
IN-21	7245.50	7250.62	5.12	0.00	-7245.50	7250.62	0.00	0.00	37.44	12.62	1.53	7246.26	0.76	0.00	4.36	7245.61	0.11	0 00:06	0 00:00	0.00	0.00
IN-27	7198.53	7201.97	3.44	0.00	-7198.53	7201.97	0.00	0.00	23.28	1.65	1.65	7198.81	0.28	0.00	3.16	7198.56	0.03	0 00:05	0 00:00	0.00	0.00
IN-32	7246.90	7250.64	3.74	0.00	-7246.90	7250.64	0.00	0.00	26.88	1.53	1.53	7247.34	0.44	0.00	3.30	7246.95	0.05	0 00:05	0 00:00	0.00	0.00
IN-33	7264.32	7268.06	3.74	0.00	-7264.32	7268.06	0.00	0.00	26.88	1.31	1.31	7264.73	0.41	0.00	3.33	7264.37	0.05	0 00:05	0 00:00	0.00	0.00
IN-34	7264.30	7268.05	3.75	0.00	-7264.30	7268.05	0.00	0.00	27.00	1.36	1.36	7264.69	0.39	0.00	3.36	7264.34	0.04	0 00:05	0 00:00	0.00	0.00
IN-35	7190.13	7197.14	7.01	0.00	-7190.13	7197.14	0.00	0.00	54.12	9.11	1.19	7191.05	0.92	0.00	6.09	7190.54	0.41	0 00:20	0 00:00	0.00	0.00
IN-36	7290.70	7294.39	3.69	0.00	-7290.70	7294.39	0.00	0.00	26.28	2.04	2.04	7291.15	0.45	0.00	3.24	7290.75	0.05	0 00:05	0 00:00	0.00	0.00
IN-37	7290.71	7294.40	3.69	0.00	-7290.71	7294.40	0.00	0.00	26.28	2.10	2.10	7291.15	0.44	0.00	3.25	7290.76	0.05	0 00:05	0 00:00	0.00	0.00
IN-38	7339.06	7342.87	3.81	0.00	-7339.06	7342.87	0.00	0.00	27.72	2.10	2.10	7339.46	0.40	0.00	3.41	7339.10	0.04	0 00:05	0 00:00	0.00	0.00
IN-39	7339.20	7342.88	3.68	0.00	-7339.20	7342.88	0.00	0.00	26.16	1.93	1.93	7339.56	0.36	0.00	3.32	7339.24	0.04	0 00:05	0 00:00	0.00	0.00
IN-40	7336.60	7340.94	4.34	0.00	-7336.60	7340.94	0.00	0.00	32.40	3.03	2.32	7337.23	0.63	0.00	3.71	7336.92	0.32	0 00:09	0 00:00	0.00	0.00
IN-41	7337.08	7339.96	2.88	0.00	-7337.08	7339.85	-0.11	0.00	16.56	1.33	1.33	7337.49	0.41	0.00	2.47	7337.24	0.16	0 00:17	0 00:00	0.00	0.00
IN-42	7371.10	7374.81	3.71	0.00	-7371.10	7374.81	0.00	0.00	13.92	1.22	0.62	7372.40	1.30	0.00	2.41	7372.23	1.13	0 00:14	0 00:00	0.00	0.00
IN-44	7354.15	7357.29	3.14	0.00	-7354.15	7357.29	0.00	0.00	19.68	3.95	3.95	7354.58	0.43	0.00	2.71	7354.41	0.26	0 00:26	0 00:00	0.00	0.00
IN-46	7346.94	7350.63	3.69	0.00	-7346.94	7350.63	0.00	0.00	17.88	9.32	3.05	7347.70	0.76	0.00	2.93	7347.47	0.53	0 00:23	0 00:00	0.00	0.00
IN-52	7209.50	7213.99	4.49	0.00	-7209.50	7213.99	0.00	0.00	35.88	8.76	8.76	7210.07	0.57	0.00	3.92	7209.75	0.25	0 00:20	0 00:00	0.00	0.00
IN-6	7198.37	7202.21	3.84	0.00	-7198.37	7202.21	0.00	0.00	28.08	1.48	1.48	7198.67	0.30	0.00	3.54	7198.40	0.03	0 00:05	0 00:00	0.00	0.00
IN-7	7219.44	7224.86	5.42	0.00	-7219.44	7224.86	0.00	0.00	45.48	2.79	2.21	7219.91	0.47	0.00	4.95	7219.65	0.21	0 00:05	0 00:00	0.00	0.00
IN-8	7221.14	7224.84	3.70	0.00	-7221.14	7224.85	0.01	0.00	26.40	2.21	2.21	7221.57	0.43	0.00	3.27	7221.19	0.05	0 00:05	0 00:00	0.00	0.00
MH-1	7193.60	7198.96	5.36	0.00	-7193.60	7198.96	0.00	0.00	36.72	7.66	0.00	7194.61	1.01	0.00	4.35	7194.03	0.43	0 00:06	0 00:00	0.00	0.00
MH-12	7187.15	7192.00	4.85	0.00	-7187.15	7192.00	0.00	0.00	22.20	34.57	0.00	7188.72	1.57	0.00	3.28	7188.48	1.33	0 00:18	0 00:00	0.00	0.00
MH-13	7189.40	7201.02	11.62	0.00	-7189.40	7201.02	0.00	0.00	103.44	34.53	0.00	7191.17	1.77	0.00	9.85	7190.80	1.40	0 00:36	0 00:00	0.00	0.00
MH-18	7238.75	7248.44	9.69	0.00	-7238.75	7248.44	0.00	0.00	77.28	12.08	0.00	7248.44	9.69	0.00	0.00	7240.13	1.38	0 00:00	0 00:00	0.00	0.00
MH-2	7195.29	7202.61	7.32	0.00	-7195.29	7202.61	0.00	0.00	36.96	7.81	0.00	7198.33	3.04	0.00	4.28	7198.06	2.77	0 00:05	0 00:00	0.00	0.00
MH-22	7245.86	7251.05	5.19	0.00	-7245.86	7251.05	0.00	0.00	30.48	11.33	0.00	7247.20	1.34	0.00	3.85	7246.81	0.95	0 00:05	0 00:00	0.00	0.00
MH-23	7252.54	7257.93	5.39	0.00	-7252.54	7257.93	0.00	0.00	38.28	10.08	0.00	7253.32	0.78	0.00	4.61	7252.82	0.28	0 00:05	0 00:00	0.00	0.00
MH-24	7263.76	7268.46	4.70	0.00	-7263.76	7268.46	0.00	0.00	32.40	10.10	0.00	7264.59	0.83	0.00	3.87	7264.24	0.48	0 00:05	0 00:00	0.00	0.00
MH-25	7273.91	7278.25	4.34	0.00	-7273.91	7278.25	0.00	0.00	28.08	7.70	0.00	7274.93	1.02	0.00	3.32	7274.48	0.57	0 00:05	0 00:00	0.00	0.00
MH-26	7282.48	7286.43	3.95	0.00	-7282.48	7286.43	0.00	0.00	27.00	7.70	0.00	7283.20	0.72	0.00	3.23	7282.75	0.27	0 00:05	0 00:00	0.00	0.00
MH-28	7290.08	7294.81	4.73	0.00	-7290.08	7294.81	0.00	0.00	33.00	7.71	0.00	7291.00	0.92	0.00	3.81	7290.61	0.53	0 00:05	0 00:00	0.00	0.00
MH-29	7312.09	7318.00	5.91	0.00	-7312.09	7318.00	0.00	0.00	30.72	3.96	0.00	7314.30	2.21	0.00	3.70	7313.98	1.89	0 00:05	0 00:00	0.00	0.00
MH-3	7213.23	7217.38	4.15	0.00	-7213.23	7217.38	0.00	0.00	29.40	4.95	0.00	7213.89	0.66	0.00	3.49	7213.52	0.29	0 00:05	0 00:00	0.00	0.00
MH-30	7324.39	7329.00	4.61	0.00	-7324.39	7329.00	0.00	0.00	28.20	3.98	0.00	7325.55	1.16	0.00	3.45	7325.20	0.81	0 00:05	0 00:00	0.00	0.00
MH-31	7334.58	7343.45	8.87	0.00	-7334.58	7343.45	0.00	0.00	36.36	4.02	0.00	7339.28	4.70	0.00	4.17	7338.96	4.38	0 00:05	0 00:00	0.00	0.00
MH-4	7219.18	7225.35	6.17	0.00	-7219.18	7225.35	0.00	0.00	36.60	4.98	0.00	7221.23	2.05	0.00	4.12	7220.85	1.67	0 00:05	0 00:00	0.00	0.00
MH-51	7192.82	7215.15	22.33	0.00	-7192.82	7215.15	0.00	0.00	115.80	8.75	0.00	7204.57	11.75	0.00	10.58	7204.25	11.43	0 00:20	0 00:00	0.00	0.00

10-Year Storm Event. Basin Analysis (Sanitary and Sewer Analysis Output)

Element ID	Area	Drainage Node ID	Weighted Runoff Coefficient	Accumulated Precipitation	Total Runoff	Peak Runoff	Rainfall Intensity	Time of Concentration
	(acres)			(inches)	(inches)	(cfs)	(inches/hr)	(days hh:mm:ss)
AA	0.96	IN-16	0.2800	0.79	0.22	1.21	4.496	0 00:10:33
AA_Rd	0.39	IN-7	0.9000	0.53	0.47	2.22	6.310	0 00:05:00
AB_Rd	0.39	IN-8	0.9000	0.53	0.47	2.22	6.310	0 00:05:00
AC	3.43	FES-5	0.2800	1.01	0.28	3.21	3.341	0 00:18:13
AC_Rd	0.26	IN-6	0.9000	0.53	0.47	1.48	6.310	0 00:05:00
AD	44.50	IN-15	0.3400	1.29	0.44	32.66	2.159	0 00:35:49
AD_Rd	0.29	IN-27	0.9000	0.53	0.47	1.65	6.310	0 00:05:00
AF	0.94	IN-35	0.3000	0.84	0.25	1.19	4.235	0 00:11:52
AH	6.29	IN-52	0.4400	1.05	0.46	8.77	3.167	0 00:19:54
AH_	6.29	IN-10	0.4400	1.05	0.46	8.77	3.167	0 00:19:54
AI	0.95	IN-17	0.1500	0.69	0.10	0.72	5.060	0 00:08:10
AI_	0.95	IN-15	0.1500	0.69	0.10	0.72	5.060	0 00:08:10
C	3.80	IN-46	0.2300	0.99	0.23	3.05	3.487	0 00:16:59
E	5.95	FES-47	0.3300	1.11	0.37	5.69	2.896	0 00:23:04
H	5.55	FES-47	0.2000	1.27	0.26	2.48	2.235	0 00:34:13
J	0.46	IN-44	0.2900	0.77	0.22	0.62	4.618	0 00:10:00
L	6.96	IN-44	0.2100	1.16	0.24	3.95	2.701	0 00:25:52
N	1.24	FES-43	0.2500	0.91	0.23	1.22	3.928	0 00:13:45
N_Rd	0.11	IN-42	0.9000	0.53	0.47	0.63	6.310	0 00:05:00
P_Rd	0.37	IN-38	0.9000	0.53	0.47	2.10	6.310	0 00:05:00
Q	1.93	IN-41	0.2000	1.00	0.20	1.33	3.445	0 00:17:19
Q_	1.93	IN-19	0.2000	1.00	0.20	1.33	3.445	0 00:17:19
R	2.14	IN-40	0.2300	0.76	0.17	2.32	4.703	0 00:09:36
R_	2.14	IN-19	0.2300	0.76	0.17	2.32	4.703	0 00:09:36
R_Rd	0.34	IN-39	0.9000	0.53	0.47	1.93	6.310	0 00:05:00
T	10.48	IN-19	0.1800	0.98	0.18	6.60	3.499	0 00:16:53
V	0.36	IN-36	0.9000	0.53	0.47	2.04	6.310	0 00:05:00
V_Rd	0.37	IN-37	0.9000	0.53	0.47	2.10	6.310	0 00:05:00
W	10.30	IN-19	0.2300	1.25	0.29	5.61	2.368	0 00:31:43
X	0.23	IN-33	0.9000	0.53	0.47	1.31	6.310	0 00:05:00
X_Rd	0.24	IN-34	0.9000	0.53	0.47	1.36	6.310	0 00:05:00
Y	0.27	IN-32	0.9000	0.53	0.47	1.53	6.310	0 00:05:00
Y_Rd	0.27	IN-21	0.9000	0.53	0.47	1.53	6.310	0 00:05:00

100-Year Storm Event. Pipe Analysis (Sanitary and Sewer Analysis Output)

Element ID	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Inlet Invert Offset	Outlet Invert Elevation	Total Drop	Average Slope	Pipe Shape	Pipe Diameter or Height	Pipe Width	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow	Peak Flow	Time of Peak Flow Occurrence	Max Flow Velocity	Travel Time	Design Flow Capacity	Max Flow / Design Flow Ratio	Max Flow Depth / Total Depth Ratio	Total Time Surcharged	Max Flow Depth	Reported Condition
			(ft)	(ft)	(ft)	(ft)	(ft)	(%)		(inches)	(inches)					(cfs)	(cfs)	(days hh:mm)	(ft/sec)	(min)	(cfs)			(min)	(ft)	
P-1	MH-1	FES-1	57.00	7193.90	0.30	7193.03	0.87	1.5300	Horizontal Ellipse	24.000	38.04	0.0120	0.5000	0.5000	0.0000	0.00	13.67	0 00:06	9.04	0.11	56.00	0.24	0.36	0.00	0.72	Calculated
P-10	IN-10	IN-35	98.00	7190.62	0.00	7190.13	0.49	0.5000	CIRCULAR	30.000	30.00	0.0120	0.5000	0.5000	0.0000	0.00	20.57	0 00:10	6.83	0.24	31.42	0.65	0.59	0.00	1.48	Calculated
P-11	MH-12	FES-11	72.00	7187.15	0.00	7185.80	1.35	1.8700	CIRCULAR	36.000	36.00	0.0120	0.5000	0.5000	0.0000	0.00	66.79	0 00:36	15.02	0.08	98.94	0.68	0.60	0.00	1.81	Calculated
P-13	MH-13	MH-12	228.00	7189.40	0.00	7187.15	2.25	0.9900	CIRCULAR	36.000	36.00	0.0120	0.5000	0.5000	0.0000	0.00	66.67	0 00:36	11.57	0.33	71.78	0.93	0.76	0.00	2.29	Calculated
P-14	IN-14	MH-13	63.00	7191.20	0.05	7189.90	1.30	2.0600	CIRCULAR	30.000	30.00	0.0120	0.5000	0.5000	0.0000	0.00	63.27	0 00:36	14.83	0.07	63.83	0.99	0.81	0.00	2.03	Calculated
P-15	IN-15	IN-14	11.00	7191.43	0.00	7191.20	0.23	2.0900	CIRCULAR	30.000	30.00	0.0120	0.5000	0.5000	0.0000	0.00	63.31	0 00:36	14.92	0.01	64.25	0.99	0.81	0.00	2.02	Calculated
P-16	IN-16	IN-7	14.00	7219.76	0.00	7219.57	0.19	1.3600	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	2.39	0 00:10	5.68	0.04	13.26	0.18	0.29	0.00	0.43	Calculated
P-17	IN-17	FES-17	45.00	7220.96	-0.23	7220.74	0.22	0.4900	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	1.60	0 00:08	4.02	0.19	7.59	0.21	0.31	0.00	0.47	Calculated
P-18	MH-18	FES-18	97.00	7238.75	0.00	7237.52	1.23	1.2700	CIRCULAR	30.000	30.00	0.0120	0.5000	0.5000	0.0000	0.00	31.88	0 00:17	10.80	0.15	50.04	0.64	0.58	0.00	1.45	Calculated
P-19	IN-19	MH-18	160.00	7240.55	0.00	7239.50	1.05	0.6600	CIRCULAR	30.000	30.00	0.0120	0.5000	0.5000	0.0000	0.00	24.19	0 00:17	7.88	0.34	36.00	0.67	0.60	0.00	1.50	Calculated
P-2	MH-2	MH-1	279.00	7195.29	0.00	7193.90	1.39	0.5000	Horizontal Ellipse	24.000	38.04	0.0120	0.5000	0.5000	0.0000	0.00	13.68	0 00:05	6.21	0.75	31.99	0.43	0.46	0.00	0.91	Calculated
P-20	IN-20	MH-18	33.00	7239.42	0.00	7239.25	0.17	0.5200	CIRCULAR	24.000	24.00	0.0120	0.5000	0.5000	0.0000	7.70	12.08	0 00:00	14.92	0.04	17.59	0.69	0.46	0.00	0.93	Calculated
P-21	IN-21	FES-21	25.00	7245.50	0.00	7243.50	2.00	8.0000	CIRCULAR	24.000	24.00	0.0120	0.5000	0.5000	0.0000	0.00	22.49	0 00:06	16.97	0.02	56.53	0.40	0.44	0.00	0.88	Calculated
P-22	MH-22	IN-21	16.00	7245.86	0.00	7245.00	0.86	5.3700	CIRCULAR	24.000	24.00	0.0120	0.5000	0.5000	0.0000	0.00	20.24	0 00:06	11.98	0.02	36.76	0.55	0.53	0.00	1.06	Calculated
P-23	MH-23	MH-22	219.00	7252.54	0.00	7246.51	6.03	2.7500	CIRCULAR	24.000	24.00	0.0120	0.5000	0.5000	0.0000	0.00	17.94	0 00:06	12.68	0.29	40.67	0.44	0.46	0.00	0.93	Calculated
P-24	MH-24	MH-23	220.00	7263.76	0.00	7252.74	11.02	5.0100	CIRCULAR	24.000	24.00	0.0120	0.5000	0.5000	0.0000	0.00	18.01	0 00:05	15.71	0.23	54.85	0.33	0.39	0.00	0.79	Calculated
P-25	MH-25	MH-24	158.00	7273.91	0.00	7263.81	10.10	6.3900	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	13.75	0 00:05	16.17	0.16	28.77	0.48	0.49	0.00	0.73	Calculated
P-26	MH-26	MH-25	114.00	7282.48	0.00	7274.41	8.07	7.0800	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	13.76	0 00:05	16.75	0.11	30.28	0.45	0.47	0.00	0.71	Calculated
P-27	IN-27	MH-2	39.00	7198.53	0.00	7197.03	1.50	3.8500	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	2.91	0 00:05	8.93	0.07	22.32	0.13	0.24	0.00	0.37	Calculated
P-28	MH-28	MH-26	107.00	7290.08	0.00	7282.68	7.40	6.9200	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	13.76	0 00:05	16.60	0.11	29.93	0.46	0.48	0.00	0.71	Calculated
P-29	MH-29	MH-28	292.00	7312.09	0.00	7290.28	21.81	7.4700	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	6.97	0 00:05	14.34	0.34	31.10	0.22	0.32	0.00	0.48	Calculated
P-3	MH-3	MH-2	280.00	7213.23	0.00	7196.76	16.47	5.8800	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	8.77	0 00:05	13.98	0.33	27.60	0.32	0.39	0.00	0.58	Calculated
P-30	MH-30	MH-29	140.00	7324.39	0.00	7313.94	10.45	7.4600	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	7.03	0 00:05	14.28	0.16	31.09	0.23	0.32	0.00	0.48	Calculated
P-31	MH-31	MH-30	179.00	7334.58	0.00	7325.15	9.43	5.2700	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	7.05	0 00:05	12.65	0.24	26.12	0.27	0.35	0.00	0.53	Calculated
P-32	IN-32	MH-22	28.00	7246.90	0.00	7246.76	0.14	0.5000	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	2.70	0 00:05	4.62	0.10	8.05	0.34	0.40	0.00	0.60	Calculated
P-33	IN-33	MH-24	29.00	7264.32	0.00	7264.18	0.14	0.4800	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	2.30	0 00:05	4.42	0.11	7.91	0.29	0.37	0.00	0.55	Calculated
P-34	IN-34	MH-24	16.00	7264.30	0.00	7264.20	0.10	0.6300	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	2.41	0 00:05	4.32	0.06	9.00	0.27	0.35	0.00	0.53	Calculated
P-35	IN-35	MH-13	45.00	7190.13	0.00	7189.90	0.23	0.5100	CIRCULAR	30.000	30.00	0.0120	0.5000	0.5000	0.0000	0.00	22.72	0 00:11	7.03	0.11	31.77	0.72	0.63	0.00	1.56	Calculated
P-36	IN-36	MH-28	28.00	7290.70	0.00	7290.47	0.23	0.8200	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	3.60	0 00:05	5.69	0.08	10.31	0.35	0.41	0.00	0.61	Calculated
P-37	IN-37	MH-28	16.00	7290.71	0.00	7290.56	0.15	0.9400	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	3.71	0 00:05	5.63	0.05	11.02	0.34	0.40	0.00	0.60	Calculated
P-38	IN-38	MH-31	28.00	7339.06	0.00	7338.65	0.41	1.4600	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	3.71	0 00:05	6.70	0.07	13.77	0.27	0.35	0.00	0.53	Calculated
P-39	IN-39	MH-31	16.00	7339.20	0.00	7338.92	0.28	1.7500	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	3.42	0 00:05	6.90	0.04	15.05	0.23	0.32	0.00	0.49	Calculated
P-4	MH-4	MH-3	130.00	7219.18	0.00	7213.43	5.75	4.4200	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	8.89	0 00:05	12.58	0.17	23.93	0.37	0.42	0.00	0.63	Calculated
P-40	IN-40	FES-40	41.00	7336.60	0.00	7336.39	0.21	0.5100	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	6.24	0 00:09	5.09	0.13	8.14	0.77	0.66	0.00	0.98	Calculated
P-41	IN-41	IN-40	69.00	7337.08	0.00	7336.74	0.34	0.4900	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	2.79	0 00:17	4.35	0.26	7.99	0.35	0.41	0.00	0.61	Calculated
P-42	IN-42	FES-42	66.00	7371.10	0.00	7369.84	1.26	1.9100	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	2.05	0 00:14	6.16	0.18	15.72	0.13	0.24	0.00	0.36	Calculated
P-43	FES-43	IN-42	9.00	7372.43	0.00	7372.15	0.28	3.1100	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	2.05	0 00:14	7.31	0.02	20.07	0.10	0.22	0.00	0.32	Calculated
P-44	IN-44	FES-44	82.00	7354.15	0.00	7351.08	3.07	3.7400	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	9.47	0 00:26	12.00	0.11	22.02	0.43	0.46	0.00	0.69	Calculated
P-46	IN-46	FES-46	83.00	7346.94	0.00	7345.66	1.28	1.5400	CIRCULAR	24.000	24.00	0.0120	0.5000	0.5000	0.0000	0.00	18.56	0 00:23	10.17	0.14	30.43	0.61	0.56	0.00	1.13	Calculated
P-47	FES-47	IN-46	53.00	7350.95	0.00	7347.14	3.81	7.1900	CIRCULAR	24.000	24.00	0.0120	0.5000	0.5000	0.0000	0.00	14.53	0 00:23	16.80	0.05	65.71	0.22	0.32	0.00	0.64	Calculated
P-5	FES-5	MH-12	16.00	7188.42	0.00	7188.21	0.21	1.3100	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	6.37	0 00:18	7.33	0.04	13.04	0.49	0.49	0.00	0.74	Calculated
P-51	MH-51	FES-51	48.00	7193.70	0.88	7192.58	1.12	2.3300	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	16.41	0 00:20	11.19	0.07	17.38	0.94	0.77	0.00	1.16	Calculated
P-52	IN-52	MH-51	85.00	7209.50	0.00	7204.00	5.50	6.4700	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	16.42	0 00:20	16.90	0.08	28.95	0.57	0.54	0.00	0.81	Calculated
P-6	IN-6	MH-2	16.00	7198.37	0.00	7198.03	0.34	2.1300	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	2.61	0 00:05	6.85	0.04	16.59	0.16	0.27	0.00	0.40	Calculated
P-7	IN-7	MH-4	16.00	7219.44	0.00	7219.22	0.22	1.3700	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	5.04	0 00:05	7.02	0.04	13.34	0.38	0.43	0.00	0.64	Calculated
P-8	IN-8	MH-4	28.00	7221.14	0.00	7220.80	0.34	1.2100	CIRCULAR	18.000	18.00	0.0120	0.5000	0.5000	0.0000	0.00	3.91	0 00:05	6.46	0.07	12.54	0.31	0.38	0.00	0.58	Calculated

100-Year Storm Event. Structure Analysis (Sanitary and Sewer Analysis Output)

Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft^2)	Minimum Pipe Cover (inches)	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Maximum HGL Elevation Attained (ft)	Maximum HGL Depth Attained (ft)	Maximum Surcharge Depth Attained (ft)	Minimum Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Maximum HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-inches)	Total Time Flooded (minutes)
FES-43	7372.43	7375.00	2.57	0.00	-7372.43	7375.00	0.00	0.00	12.84	2.05	2.05	7372.75	0.32	0.00	2.25	7372.53	0.10	0 00:14	0 00:00	0.00	0.00
FES-47	7350.95	7354.75	3.80	0.00	-7350.95	7354.75	0.00	0.00	21.60	14.54	14.54	7351.59	0.64	0.00	3.16	7351.37	0.42	0 00:23	0 00:00	0.00	0.00
FES-5	7188.42	7190.13	1.71	0.00	-7188.42	7190.13	0.00	0.00	2.52	6.37	6.37	7189.16	0.74	0.00	0.97	7188.71	0.29	0 00:18	0 00:00	0.00	0.00
IN-10	7190.62	7196.97	6.35	0.00	-7190.62	7196.97	0.00	0.00	46.20	20.64	20.64	7192.10	1.48	0.00	4.87	7191.28	0.66	0 00:10	0 00:00	0.00	0.00
IN-14	7191.15	7200.02	8.87	0.00	-7191.15	7200.02	0.00	0.00	75.84	63.31	0.00	7193.23	2.08	0.00	6.79	7192.53	1.38	0 00:36	0 00:00	0.00	0.00
IN-15	7191.43	7200.04	8.61	0.00	-7191.43	7200.04	0.00	0.00	73.32	63.32	63.32	7193.45	2.02	0.00	6.59	7192.75	1.32	0 00:36	0 00:00	0.00	0.00
IN-16	7219.76	7223.15	3.39	0.00	-7219.76	7223.15	0.00	0.00	22.68	2.39	2.39	7220.19	0.43	0.00	2.96	7219.86	0.10	0 00:10	0 00:00	0.00	0.00
IN-17	7221.19	7223.68	2.49	0.00	-7221.19	7223.68	0.00	0.00	14.64	1.61	1.61	7221.66	0.47	0.00	2.02	7221.28	0.09	0 00:08	0 00:00	0.00	0.00
IN-19	7240.55	7249.83	9.28	0.00	-7240.55	7249.83	0.00	0.00	81.36	24.27	24.27	7242.05	1.50	0.00	7.78	7241.49	0.94	0 00:17	0 00:00	0.00	0.00
IN-20	7239.42	7247.50	8.08	0.00	-7239.42	7244.39	-3.11	0.00	72.96	18.24	18.24	7247.50	8.08	0.00	0.00	7241.64	2.22	0 00:05	0 00:13	1.36	16.00
IN-21	7245.50	7250.62	5.12	0.00	-7245.50	7250.62	0.00	0.00	37.44	22.49	2.72	7246.56	1.06	0.00	4.06	7245.64	0.14	0 00:06	0 00:00	0.00	0.00
IN-27	7198.53	7201.97	3.44	0.00	-7198.53	7201.97	0.00	0.00	23.28	2.92	2.92	7198.90	0.37	0.00	3.07	7198.57	0.04	0 00:05	0 00:00	0.00	0.00
IN-32	7246.90	7250.64	3.74	0.00	-7246.90	7250.64	0.00	0.00	26.88	2.72	2.72	7247.50	0.60	0.00	3.14	7246.97	0.07	0 00:05	0 00:00	0.00	0.00
IN-33	7264.32	7268.06	3.74	0.00	-7264.32	7268.06	0.00	0.00	26.88	2.32	2.32	7264.88	0.56	0.00	3.18	7264.38	0.06	0 00:05	0 00:00	0.00	0.00
IN-34	7264.30	7268.05	3.75	0.00	-7264.30	7268.05	0.00	0.00	27.00	2.42	2.42	7264.83	0.53	0.00	3.22	7264.36	0.06	0 00:05	0 00:00	0.00	0.00
IN-35	7190.13	7197.14	7.01	0.00	-7190.13	7197.14	0.00	0.00	54.12	22.72	2.34	7191.69	1.56	0.00	5.45	7190.81	0.68	0 00:11	0 00:00	0.00	0.00
IN-36	7290.70	7294.39	3.69	0.00	-7290.70	7294.39	0.00	0.00	26.28	3.63	3.63	7291.31	0.61	0.00	3.08	7290.77	0.07	0 00:05	0 00:00	0.00	0.00
IN-37	7290.71	7294.40	3.69	0.00	-7290.71	7294.40	0.00	0.00	26.28	3.73	3.73	7291.31	0.60	0.00	3.09	7290.78	0.07	0 00:05	0 00:00	0.00	0.00
IN-38	7339.06	7342.87	3.81	0.00	-7339.06	7342.87	0.00	0.00	27.72	3.73	3.73	7339.59	0.53	0.00	3.28	7339.12	0.06	0 00:05	0 00:00	0.00	0.00
IN-39	7339.20	7342.88	3.68	0.00	-7339.20	7342.88	0.00	0.00	26.16	3.42	3.42	7339.69	0.49	0.00	3.19	7339.25	0.05	0 00:05	0 00:00	0.00	0.00
IN-40	7336.60	7340.94	4.34	0.00	-7336.60	7340.94	0.00	0.00	32.40	6.26	4.73	7337.59	0.99	0.00	3.35	7337.03	0.43	0 00:09	0 00:00	0.00	0.00
IN-41	7337.08	7339.96	2.88	0.00	-7337.08	7339.85	-0.11	0.00	16.56	2.80	2.80	7337.69	0.61	0.00	2.27	7337.31	0.23	0 00:17	0 00:00	0.00	0.00
IN-42	7371.10	7374.81	3.71	0.00	-7371.10	7374.81	0.00	0.00	13.92	2.05	1.11	7372.47	1.37	0.00	2.34	7372.25	1.15	0 00:14	0 00:00	0.00	0.00
IN-44	7354.15	7357.29	3.14	0.00	-7354.15	7357.29	0.00	0.00	19.68	9.48	9.48	7354.84	0.69	0.00	2.45	7354.55	0.40	0 00:26	0 00:00	0.00	0.00
IN-46	7346.94	7350.63	3.69	0.00	-7346.94	7350.63	0.00	0.00	17.88	18.57	6.25	7348.07	1.13	0.00	2.56	7347.67	0.73	0 00:23	0 00:00	0.00	0.00
IN-52	7209.50	7213.99	4.49	0.00	-7209.50	7213.99	0.00	0.00	35.88	16.43	16.43	7210.31	0.81	0.00	3.68	7209.85	0.35	0 00:20	0 00:00	0.00	0.00
IN-6	7198.37	7202.21	3.84	0.00	-7198.37	7202.21	0.00	0.00	28.08	2.62	2.62	7198.77	0.40	0.00	3.44	7198.41	0.04	0 00:05	0 00:00	0.00	0.00
IN-7	7219.44	7224.86	5.42	0.00	-7219.44	7224.86	0.00	0.00	45.48	5.06	3.93	7220.08	0.64	0.00	4.78	7219.68	0.24	0 00:05	0 00:00	0.00	0.00
IN-8	7221.14	7224.84	3.70	0.00	-7221.14	7224.85	0.01	0.00	26.40	3.93	3.93	7221.72	0.58	0.00	3.12	7221.20	0.06	0 00:05	0 00:00	0.00	0.00
MH-1	7193.60	7198.96	5.36	0.00	-7193.60	7198.96	0.00	0.00	36.72	13.68	0.00	7194.82	1.22	0.00	4.14	7194.08	0.48	0 00:05	0 00:00	0.00	0.00
MH-12	7187.15	7192.00	4.85	0.00	-7187.15	7192.00	0.00	0.00	22.20	66.80	0.00	7189.44	2.29	0.00	2.56	7188.90	1.75	0 00:36	0 00:00	0.00	0.00
MH-13	7189.40	7201.02	11.62	0.00	-7189.40	7201.02	0.00	0.00	103.44	66.74	0.00	7191.93	2.53	0.00	9.09	7191.34	1.94	0 00:36	0 00:00	0.00	0.00
MH-18	7238.75	7248.44	9.69	0.00	-7238.75	7248.44	0.00	0.00	77.28	31.89	0.00	7248.44	9.69	0.00	0.00	7240.44	1.69	0 00:00	0 00:00	0.00	0.00
MH-2	7195.29	7202.61	7.32	0.00	-7195.29	7202.61	0.00	0.00	36.96	13.94	0.00	7198.43	3.14	0.00	4.18	7198.08	2.79	0 00:05	0 00:00	0.00	0.00
MH-22	7245.86	7251.05	5.19	0.00	-7245.86	7251.05	0.00	0.00	30.48	20.24	0.00	7247.44	1.58	0.00	3.61	7246.83	0.97	0 00:06	0 00:00	0.00	0.00
MH-23	7252.54	7257.93	5.39	0.00	-7252.54	7257.93	0.00	0.00	38.28	18.01	0.00	7253.53	0.99	0.00	4.40	7252.84	0.30	0 00:05	0 00:00	0.00	0.00
MH-24	7263.76	7268.46	4.70	0.00	-7263.76	7268.46	0.00	0.00	32.40	18.04	0.00	7264.73	0.97	0.00	3.73	7264.26	0.50	0 00:05	0 00:00	0.00	0.00
MH-25	7273.91	7278.25	4.34	0.00	-7273.91	7278.25	0.00	0.00	28.08	13.76	0.00	7275.12	1.21	0.00	3.13	7274.50	0.59	0 00:05	0 00:00	0.00	0.00
MH-26	7282.48	7286.43	3.95	0.00	-7282.48	7286.43	0.00	0.00	27.00	13.76	0.00	7283.39	0.91	0.00	3.04	7282.77	0.29	0 00:05	0 00:00	0.00	0.00
MH-28	7290.08	7294.81	4.73	0.00	-7290.08	7294.81	0.00	0.00	33.00	13.76	0.00	7291.16	1.08	0.00	3.65	7290.63	0.55	0 00:05	0 00:00	0.00	0.00
MH-29	7312.09	7318.00	5.91	0.00	-7312.09	7318.00	0.00	0.00	30.72	7.03	0.00	7314.42	2.33	0.00	3.58	7314.00	1.91	0 00:05	0 00:00	0.00	0.00
MH-3	7213.23	7217.38	4.15	0.00	-7213.23	7217.38	0.00	0.00	29.40	8.89	0.00	7214.06	0.83	0.00	3.32	7213.55	0.32	0 00:05	0 00:00	0.00	0.00
MH-30	7324.39	7329.00	4.61	0.00	-7324.39	7329.00	0.00	0.00	28.20	7.05	0.00	7325.68	1.29	0.00	3.32	7325.21	0.82	0 00:05	0 00:00	0.00	0.00
MH-31	7334.58	7343.45	8.87	0.00	-7334.58	7343.45	0.00	0.00	36.36	7.13	0.00	7339.41	4.83	0.00	4.04	7338.97	4.39	0 00:05	0 00:00	0.00	0.00
MH-4	7219.18	7225.35	6.17	0.00	-7219.18	7225.35	0.00	0.00	36.60	8.95	0.00	7221.38	2.20	0.00	3.97	7220.86	1.68	0 00:05	0 00:00	0.00	0.00
MH-51	7192.82	7215.15	22.33	0.00	-7192.82	7215.15	0.00	0.00	115.80	16.42	0.00	7204.81	11.99	0.00	10.34	7204.35	11.53	0 00:20	0 00:00	0.00	0.00

100-Year Storm Event. Basin Analysis (Sanitary and Sewer Analysis Output)

Element ID	Area (acres)	Drainage Node ID	Weighted Runoff Coefficient	Accumulated Precipitation (inches)	Total Runoff (inches)	Peak Runoff (cfs)	Rainfall Intensity (inches/hr)	Time of Concentration (days hh:mm:ss)
AA	0.96	IN-16	0.3300	1.32	0.44	2.39	7.556	0 00:10:33
AA_Rd	0.39	IN-7	0.9500	0.88	0.84	3.93	10.600	0 00:05:00
AB_Rd	0.39	IN-8	0.9500	0.88	0.84	3.93	10.600	0 00:05:00
AC	3.43	FES-5	0.3300	1.70	0.56	6.37	5.627	0 00:18:13
AC_Rd	0.26	IN-6	0.9500	0.88	0.84	2.62	10.600	0 00:05:00
AD	44.50	IN-15	0.3900	2.18	0.85	63.32	3.648	0 00:35:49
AD_Rd	0.29	IN-27	0.9500	0.88	0.84	2.92	10.600	0 00:05:00
AF	0.94	IN-35	0.3500	1.41	0.49	2.34	7.124	0 00:11:52
AH	6.29	IN-52	0.4900	1.76	0.86	16.43	5.332	0 00:19:54
AH_	6.29	IN-10	0.4900	1.76	0.86	16.43	5.332	0 00:19:54
AI	0.95	IN-17	0.2000	1.16	0.23	1.62	8.499	0 00:08:10
AI_	0.95	IN-15	0.2000	1.16	0.23	1.62	8.499	0 00:08:10
C	3.80	IN-46	0.2800	1.67	0.47	6.25	5.875	0 00:16:59
E	5.95	FES-47	0.3800	1.87	0.71	11.02	4.872	0 00:23:04
H	5.55	FES-47	0.2500	2.15	0.54	5.23	3.771	0 00:34:13
J	0.46	IN-44	0.3400	1.29	0.44	1.21	7.756	0 00:10:00
L	6.96	IN-44	0.3000	1.96	0.59	9.48	4.542	0 00:25:52
N	1.24	FES-43	0.2500	1.53	0.38	2.05	6.619	0 00:13:45
N_Rd	0.11	IN-42	0.9500	0.88	0.84	1.11	10.600	0 00:05:00
NORTH_POND_BYPASS	4.47	IN-20	0.6100	1.51	0.92	18.24	6.689	0 00:13:28
P_Rd	0.37	IN-38	0.9500	0.88	0.84	3.73	10.600	0 00:05:00
Q	1.93	IN-41	0.2500	1.68	0.42	2.80	5.804	0 00:17:19
Q_	1.93	IN-19	0.2500	1.68	0.42	2.80	5.804	0 00:17:19
R	2.14	IN-40	0.2800	1.27	0.36	4.73	7.900	0 00:09:36
R_	2.14	IN-19	0.2800	1.27	0.36	4.73	7.900	0 00:09:36
R_Rd	0.34	IN-39	0.9500	0.88	0.84	3.42	10.600	0 00:05:00
SOUTH_POND_BYPASS	2.29	IN-10	0.6900	1.32	0.91	11.94	7.556	0 00:10:33
T	10.48	IN-19	0.2300	1.65	0.38	14.21	5.896	0 00:16:53
V	0.36	IN-36	0.9500	0.88	0.84	3.63	10.600	0 00:05:00
V_Rd	0.37	IN-37	0.9500	0.88	0.84	3.73	10.600	0 00:05:00
W	10.30	IN-19	0.2800	2.10	0.59	11.49	3.986	0 00:31:43
X	0.23	IN-33	0.9500	0.88	0.84	2.32	10.600	0 00:05:00
X_Rd	0.24	IN-34	0.9500	0.88	0.84	2.42	10.600	0 00:05:00
Y	0.27	IN-32	0.9500	0.88	0.84	2.72	10.600	0 00:05:00
Y_Rd	0.27	IN-21	0.9500	0.88	0.84	2.72	10.600	0 00:05:00

APPENDIX C.2

Ditch Calculations

El Paso County Beacon Lite - Proposed Ditch Calculations

Drainage Criteria					
Slope Range (%)		Max Vel fps	Side Slopes (H:V)	Max Depth (ft)	Max froude number
0.00	5.00	5	4	5	0.9
5.00	10.00	4	4	5	0.9
10.00	20.00	3	4	5	0.9

	Ditch Flow									Channel Geometry					Bentley FlowMaster Results			Ditch Geometry				Criteria Check			Notes
Ditch ID	Tributary Basins 1		Tributary Basins 2		Tributary Basins 3		Tributary Basins 4		Ditch Flow	Long Slope MIN	Long Slope MAX	Manning's n	LT Side Slope	RT Side Slope	Normal-Depth	Velocity	Froude number	Freeboard	Required Depth	LT Width	RT Width	Max Velocity	Velocity	Froude number	
	ID	cfs	ID	cfs	ID	cfs	ID	cfs	cfs	%	%		H:V	H:V	in	fps		ft	ft	ft	ft	fps	X/✓	X/✓	
D-1	C	2.73		0		0		0	2.73	1.50	1.50	0.030	3	5	6.3	2.4	0.8	1.05	1.57	1.58	2.63	5	✓	✓	Drop structures to keep 1.5% slope
D-2	E	5.15	H	2.36		0		0	7.51	1.10	1.40	0.030	3	6	9.4	3.0	0.8	1.07	1.85	2.35	4.70	5	✓	✓	Drop structures to keep 1.5% slope
D-3	H	2.36		0		0		0	2.36	1.50	1.50	0.030	3	4	6.3	2.4	0.8	1.05	1.57	1.58	2.10	5	✓	✓	Drop structures to keep 1.5% slope
D-4	J	0.52		0		0		0	0.52	1.50	1.50	0.030	3	4	3.6	1.7	0.8	1.03	1.33	0.90	1.20	5	✓	✓	Drop structures to keep 1.5% slope
D-5	L	3.70		0		0		0	3.70	0.50	1.50	0.030	3	5	8.7	2.6	0.9	1.06	1.78	2.18	3.63	5	✓	✓	Drop structures to keep 1.5% slope
D-6	N	1.79		0		0		0	1.79	5.00	5.00	0.076	3	3	6.9	1.8	0.6	1.04	1.61	1.73	1.73	FALSE	✓	✓	Riprap Lining required, Velocity OK - non-erodible
D-7	Q	0.28		0		0		0	0.28	13.00	13.00	0.070	3	3	2.8	1.8	0.9	1.03	1.26	0.70	0.70	3	✓	✓	Riprap Lining required
D-8	AA	1.05		0		0		0	1.05	1.90	6.10	0.069	3	3	6.5	1.9	0.7	1.04	1.58	1.63	1.63	4	✓	✓	Riprap Lining required
D-9	AC	2.86		0		0		0	2.86	4.50	8.60	0.069	11	5	6.0	2.3	0.9	1.05	1.55	5.50	2.50	4	✓	✓	Riprap Lining required
D-10	AJ	0.59		0		0		0	0.59	3.60	5.80	0.069	4	4	4.1	1.5	0.7	1.03	1.37	1.37	1.37	4	✓	✓	Riprap Lining required
D-11	R	1.94		0		0		0	1.94	13.00	13.00	0.076	3	3	5.9	2.7	0.9	1.05	1.54	1.48	1.48	3	✓	X	Riprap Lining required, Froude number OK - close to criteria
D-12	T	5.87	R	1.94	W	5.32	Q	0.28	13.42	3.00	8.00	0.075	3	3	16.4	3.7	0.9	1.10	2.47	4.10	4.10	4	✓	✓	Riprap Lining required
D-13	AI	0.61		0		0		0	0.61	1.60	6.00	0.069	3	3	5.4	1.6	0.7	1.03	1.48	1.35	1.35	4	✓	✓	Riprap Lining required
D-14	AD	31.10	AI	0.61	AA	1.05		0	32.76	1.30	6.00	0.075	3	3	25.8	4.0	0.8	1.13	3.28	6.45	6.45	4	✓	✓	Riprap Lining required
D-14.1	AD1	0.26	AI	0.61	AA	1.05		0	1.92	18.30	18.30	0.075	3	3	4.1	2.5	1.1	1.04	1.39	1.03	1.03	3	✓	X	Riprap Lining required, Froude number OK - close to criteria
D-15	AH	4.13		0		0		0	4.13	0.50	0.90	0.030	4	3	12.1	2.6	0.7	1.07	2.07	4.03	3.03	5	✓	✓	
D-15A	AH	4.13		0		0		0	4.13	0.01	0.01	0.069	4	4	12.1	2.6	0.7	1.07	2.07	4.03	4.03	5	✓	✓	Riprap Lining required
D-16	AL	0.68		0		0		0	0.68	5.30	11.20	0.069	4	3	4.3	2.0	0.9	1.04	1.39	1.43	1.08	3	✓	✓	Riprap Lining required
D-17	D_Rd	0.75		0		0		0	0.75	1.50	1.50	0.030	4	3	4.1	1.8	0.8	1.03	1.37	1.37	1.03	5	✓	✓	

Hydraulic Analysis Report

Project Data

Project Title: Beacon Lite

Designer:

Project Date: Tuesday, August 20, 2024

Project Units: U.S. Customary Units

Notes:

Channel Analysis: D-6

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 3.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.0500 ft/ft

Manning's n: 0.0761

Flow 1.7900 cfs

Result Parameters

Depth 0.5712 ft

Area of Flow 0.9790 ft^2

Wetted Perimeter 3.6129 ft

Hydraulic Radius 0.2710 ft

Average Velocity 1.8285 ft/s

Top Width 3.4275 ft

Froude Number: 0.6029

Critical Depth 0.4666 ft

Critical Velocity 2.7408 ft/s

Critical Slope: 0.1471 ft/ft

Critical Top Width 2.80 ft

Calculated Max Shear Stress 1.7823 lb/ft^2

Calculated Avg Shear Stress 0.8454 lb/ft^2

Channel Lining Analysis: D-6

Notes:

Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 150.00 mm

Riprap Specific Weight: 165 lb/ft^3

Water Specific Weight: 62.4 lb/ft^3

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.00016

Lining Results

Angle of Repose: 41.15 degrees

Relative Flow Depth: 0.580787 ft

Manning's n method: Bathurst

Manning's n: 0.0760988

Channel Bottom Shear Results

V*: 0.959345

Reynold's Number: 38793.6

Shield's Parameter: 0.047

Shear stress on channel bottom: 1.78352 lb/ft^2

Permissible shear stress for channel bottom: 2.1827 lb/ft^2

Channel bottom is stable

Stable D50: 122.587 mm

Channel Side Shear Results

K1: 0.868

K2: 1

Kb: 0

Shear stress on side of channel: 1.78352 lb/ft^2

Permissible shear stress for side of channel: 2.1827 lb/ft^2

Stable Side D50: 0.349099 lb/ft^2

Side of channel is stable

Channel Lining Stability Results 2

The channel is stable

Channel Summary

Name of Selected Channel: D-6

Channel Analysis: D-7

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 3.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.1300 ft/ft

Manning's n: 0.0700

Flow 0.2800 cfs

Result Parameters

Depth 0.2308 ft

Area of Flow 0.1598 ft^2

Wetted Perimeter 1.4596 ft

Hydraulic Radius 0.1095 ft

Average Velocity 1.7525 ft/s

Top Width 1.3847 ft

Froude Number: 0.9092

Critical Depth 0.2222 ft

Critical Velocity 1.8912 ft/s

Critical Slope: 0.1593 ft/ft

Critical Top Width 1.33 ft

Calculated Max Shear Stress 1.8721 lb/ft^2

Calculated Avg Shear Stress 0.8880 lb/ft^2

Channel Lining Analysis: D-7

Notes:

Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 116.00 mm

Riprap Specific Weight: 165 lb/ft^3

Water Specific Weight: 62.4 lb/ft^3

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.00016

Lining Results

Angle of Repose: 41.15 degrees

Relative Flow Depth: 0.303195 ft

Manning's n method: Bathurst

Manning's n: 0.0699625

Channel Bottom Shear Results

V*: 0.982871

Reynold's Number: 30736.1

Shield's Parameter: 0.047

Shear stress on channel bottom: 1.87207 lb/ft^2

Permissible shear stress for channel bottom: 1.63587 lb/ft^2

Channel bottom is NOT stable

Stable D50: 132.769 mm

Will use D50 = 6" (150 mm) to provide a stable channel

Channel Side Shear Results

K1: 0.868

K2: 1

Kb: 0

Shear stress on side of channel: 1.87207 lb/ft^2

Permissible shear stress for side of channel: 1.63587 lb/ft^2

Stable Side D50: 0.378096 lb/ft^2

Side of channel is stable

Channel Lining Stability Results 2

The channel is NOT stable

Channel Summary

Name of Selected Channel: D-7

Channel Analysis: D-11

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 3.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.1300 ft/ft

Manning's n: 0.0759

Flow 1.9400 cfs

Result Parameters

Depth 0.4916 ft

Area of Flow 0.7251 ft^2

Wetted Perimeter 3.1094 ft

Hydraulic Radius 0.2332 ft

Average Velocity 2.6755 ft/s

Top Width 2.9498 ft

Froude Number: 0.9510

Critical Depth 0.4818 ft

Critical Velocity 2.7853 ft/s

Critical Slope: 0.1447 ft/ft

Critical Top Width 2.89 ft

Calculated Max Shear Stress 3.9881 lb/ft^2

Calculated Avg Shear Stress 1.8917 lb/ft^2

Channel Lining Analysis: D-11

Notes:

Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 230.00 mm

Riprap Specific Weight: 165 lb/ft^3

Water Specific Weight: 62.4 lb/ft^3

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.15312

Lining Results

Angle of Repose: 41.7 degrees

Relative Flow Depth: 0.325759 ft

Manning's n method: Bathurst

Manning's n: 0.075871

Channel Bottom Shear Results

V*: 1.43456

Reynold's Number: 88949.1

Shield's Parameter: 0.078511

Shear stress on channel bottom: 3.98811 lb/ft^2

Permissible shear stress for channel bottom: 5.1274 lb/ft^2

Channel bottom is stable

Stable D50: 206.287 mm

Channel Side Shear Results

K1: 0.868

K2: 1

Kb: 0

Shear stress on side of channel: 3.98811 lb/ft^2

Permissible shear stress for side of channel: 5.1274 lb/ft^2

Stable Side D50: 0.587459 lb/ft^2

Side of channel is stable

Channel Lining Stability Results 2

The channel is stable

Channel Summary

Name of Selected Channel: D-11

APPENDIX C.3

Inlet Calculations

MHFD-Inlet, Version 5.01 (April 2021)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	IN-40	IN-19	IN-41
Site Type (Urban or Rural)	URBAN	URBAN	URBAN
Inlet Application (Street or Area)	AREA	AREA	AREA
Hydraulic Condition	Swale	Swale	Swale
Inlet Type	CDOT Type C	CDOT TYPE D (Parallel)	CDOT Type C

USER-DEFINED INPUT

User-Defined Design Flows

Minor Q_{Known} (cfs)	2.0	14.4	0.3
Major Q_{Known} (cfs)	4.0	30.4	0.6

Bypass (Carry-Over) Flow from Upstream

Receive Bypass Flow from:	IN-41	No Bypass Flow Received	No Bypass Flow Received
Minor Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.0
Major Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.0

Watershed Characteristics

Subcatchment Area (acres)			
Percent Impervious			
NRCS Soil Type			

Watershed Profile

Overland Slope (ft/ft)			
Overland Length (ft)			
Channel Slope (ft/ft)			
Channel Length (ft)			

Minor Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

Major Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

CALCULATED OUTPUT

Minor Total Design Peak Flow, Q (cfs)	**2.0**	**14.4**	**0.3**
Major Total Design Peak Flow, Q (cfs)	**4.0**	**30.4**	**0.6**
Minor Flow Bypassed Downstream, Q_b (cfs)	0.0	0.0	0.0
Major Flow Bypassed Downstream, Q_b (cfs)	0.0	0.0	0.0

MHFD-Inlet, Version 5.01 (April 2021)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	IN-35	IN-15	IN-14
Site Type (Urban or Rural)	URBAN	URBAN	URBAN
Inlet Application (Street or Area)	AREA	AREA	AREA
Hydraulic Condition	Swale	Swale	Swale
Inlet Type	CDOT TYPE D (Parallel)	CDOT Type D (In Series)	CDOT Type D (In Series)

USER-DEFINED INPUT

User-Defined Design Flows

Minor Q_{Known} (cfs)	1.0	31.7	0.0
Major Q_{Known} (cfs)	2.1	62.0	0.0

Bypass (Carry-Over) Flow from Upstream

Receive Bypass Flow from:	No Bypass Flow Received	No Bypass Flow Received	IN-15
Minor Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.0
Major Bypass Flow Received, Q_b (cfs)	0.0	0.0	16.5

Watershed Characteristics

Subcatchment Area (acres)			
Percent Impervious			
NRCS Soil Type			

Watershed Profile

Overland Slope (ft/ft)			
Overland Length (ft)			
Channel Slope (ft/ft)			
Channel Length (ft)			

Minor Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

Major Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

CALCULATED OUTPUT

Minor Total Design Peak Flow, Q (cfs)	**1.0**	**31.7**	**0.0**
Major Total Design Peak Flow, Q (cfs)	**2.1**	**62.0**	**16.5**
Minor Flow Bypassed Downstream, Q_b (cfs)	0.0	0.0	0.0
Major Flow Bypassed Downstream, Q_b (cfs)	0.0	16.5	0.0

MHFD-Inlet, Version 5.01 (April 2021)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	IN-16	IN-17	IN-46
Site Type (Urban or Rural)	URBAN	URBAN	URBAN
Inlet Application (Street or Area)	AREA	AREA	AREA
Hydraulic Condition	Swale	Swale	Swale
Inlet Type	CDOT Type C	CDOT Type C	CDOT Type C

USER-DEFINED INPUT

User-Defined Design Flows

Minor Q_{Known} (cfs)	1.1	0.6	2.7
Major Q_{Known} (cfs)	2.1	1.4	5.7

Bypass (Carry-Over) Flow from Upstream

Receive Bypass Flow from:	No Bypass Flow Received	No Bypass Flow Received	No Bypass Flow Received
Minor Bypass Flow Received, Q_b (cfs)		0.0	0.0
Major Bypass Flow Received, Q_b (cfs)		0.0	0.0

Watershed Characteristics

Subcatchment Area (acres)			
Percent Impervious			
NRCS Soil Type			

Watershed Profile

Overland Slope (ft/ft)			
Overland Length (ft)			
Channel Slope (ft/ft)			
Channel Length (ft)			

Minor Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

Major Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

CALCULATED OUTPUT

Minor Total Design Peak Flow, Q (cfs)	**1.1**	**0.6**	**2.7**
Major Total Design Peak Flow, Q (cfs)	**2.1**	**1.4**	**5.7**
Minor Flow Bypassed Downstream, Q_b (cfs)	0.0	0.0	0.0
Major Flow Bypassed Downstream, Q_b (cfs)	0.0	0.0	0.0

MHFD-Inlet, Version 5.01 (April 2021)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	IN-44	IN-52
Site Type (Urban or Rural)	URBAN	URBAN
Inlet Application (Street or Area)	AREA	AREA
Hydraulic Condition	Swale	Swale
Inlet Type	CDOT Type C	CDOT Type C

USER-DEFINED INPUT

User-Defined Design Flows

Minor Q_{Known} (cfs)	4.2	8.2
Major Q_{Known} (cfs)	8.8	15.6

Bypass (Carry-Over) Flow from Upstream

Receive Bypass Flow from:	No Bypass Flow Received	No Bypass Flow Received
Minor Bypass Flow Received, Q_b (cfs)	0.0	0.0
Major Bypass Flow Received, Q_b (cfs)	0.0	0.0

Watershed Characteristics

Subcatchment Area (acres)		
Percent Impervious		
NRCS Soil Type		

Watershed Profile

Overland Slope (ft/ft)		
Overland Length (ft)		
Channel Slope (ft/ft)		
Channel Length (ft)		

Minor Storm Rainfall Input

Design Storm Return Period, T_r (years)		
One-Hour Precipitation, P_1 (inches)		

Major Storm Rainfall Input

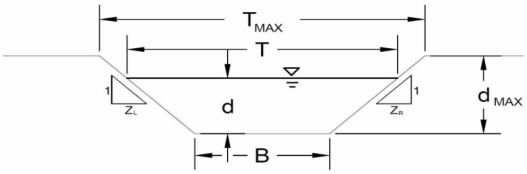
Design Storm Return Period, T_r (years)		
One-Hour Precipitation, P_1 (inches)		

CALCULATED OUTPUT

Minor Total Design Peak Flow, Q (cfs)	**4.2**	**8.2**
Major Total Design Peak Flow, Q (cfs)	**8.8**	**15.6**
Minor Flow Bypassed Downstream, Q_b (cfs)	0.0	0.0
Major Flow Bypassed Downstream, Q_b (cfs)	0.0	0.0

AREA INLET IN A SWALE

IN-40



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

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using SCS Method

NRCS Vegetal Retardance (A, B, C, D, or E)	A, B, C, D, or E =	B	
Manning's n (Leave cell D16 blank to manually enter an n value)	n =	see details below	
Channel Invert Slope	S_O =	0.0800	ft/ft
Bottom Width	B =	0.00	ft
Left Side Slope	Z1 =	4.00	ft/ft
Right Side Sloe	Z2 =	4.00	ft/ft

Check one of the following soil types:

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

Choose One:
- Non-Cohesive
- Cohesive
- Paved

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

Allowable Channel Capacity Based On Channel Geometry

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**125.1**	**125.1**	cfs
MAJOR STORM Allowable Capacity is based on Depth Criterion	d_{allow} =	**2.00**	**2.00**	ft

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow	Q_o =	**1.9**	**4.0**	cfs
Water Depth	d =	**0.82**	**0.99**	ft

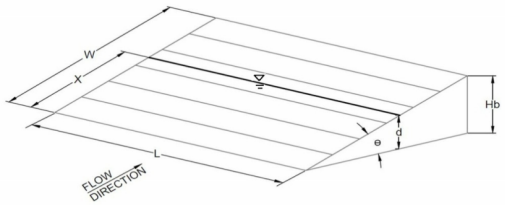
Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

AREA INLET IN A SWALE

IN-40

Inlet Design Information (Input)

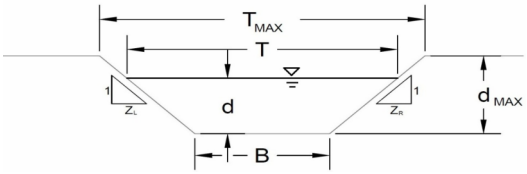
Type of Inlet	CDOT Type C	Inlet Type =	CDOT Type C	
Angle of Inclined Grate (must be <= 30 degrees)		θ =	0.00	degrees
Width of Grate		W =	3.00	ft
Length of Grate		L =	3.00	ft
Open Area Ratio		A_{RATIO} =	0.70	
Height of Inclined Grate		H_B =	0.00	ft
Clogging Factor		C_f =	0.50	
Grate Discharge Coefficient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



		MINOR	MAJOR	
Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)	d =	0.82	0.99	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**13.8**	**16.1**	**cfs**
Bypassed Flow	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Qa/Qo	**C% =**	**100**	**100**	**%**

AREA INLET IN A SWALE

IN-19



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

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using SCS Method

NRCS Vegetal Retardance (A, B, C, D, or E)	A, B, C, D, or E =	B	
Manning's n (Leave cell D16 blank to manually enter an n value)	n =	see details below	
Channel Invert Slope	S_O =	0.0800	ft/ft
Bottom Width	B =	0.00	ft
Left Side Slope	Z1 =	4.00	ft/ft
Right Side Sloe	Z2 =	4.00	ft/ft

Check one of the following soil types:

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

Choose One:
- Non-Cohesive
- Cohesive
- Paved

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

Allowable Channel Capacity Based On Channel Geometry

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**125.1**	**125.1**	**cfs**
MAJOR STORM Allowable Capacity is based on Depth Criterion	d_{allow} =	**2.00**	**2.00**	**ft**

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow	Q_o =	**14.4**	**30.4**	**cfs**
Water Depth	d =	**1.23**	**1.41**	**ft**

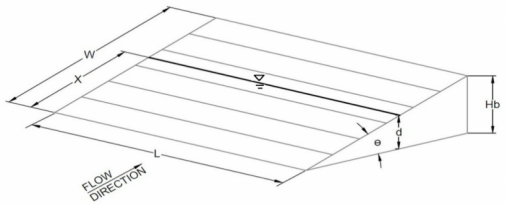
Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

AREA INLET IN A SWALE

IN-19

Inlet Design Information (Input)

Type of Inlet	CDOT TYPE D (Parallel)	Inlet Type =	CDOT TYPE D (Parallel)	
Angle of Inclined Grate (must be <= 30 degrees)		θ =	0.00	degrees
Width of Grate		W =	6.00	ft
Length of Grate		L =	3.00	ft
Open Area Ratio		A_{RATIO} =	0.70	
Height of Inclined Grate		H_B =	0.00	ft
Clogging Factor		C_f =	0.38	
Grate Discharge Coefficient		C_d =	0.76	
Orifice Coefficient		C_o =	0.50	
Weir Coefficient		C_w =	1.62	

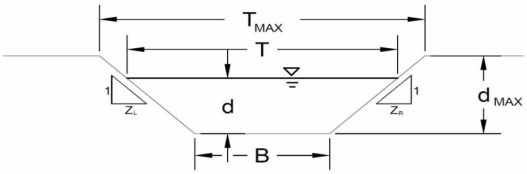


		MINOR	MAJOR	
Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)	d =	1.23	1.41	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**35.1**	**37.9**	**cfs**
Bypassed Flow	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Qa/Qo	**C% =**	**100**	**100**	**%**

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

AREA INLET IN A SWALE

IN-41



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

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using SCS Method

NRCS Vegetal Retardance (A, B, C, D, or E)	A, B, C, D, or E =	B	
Manning's n (Leave cell D16 blank to manually enter an n value)	n =	see details below	
Channel Invert Slope	S_O =	0.0800	ft/ft
Bottom Width	B =	0.00	ft
Left Side Slope	Z1 =	4.00	ft/ft
Right Side Sloe	Z2 =	4.00	ft/ft

Check one of the following soil types:

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

Choose One:
- Non-Cohesive
- Cohesive
- Paved

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

Allowable Channel Capacity Based On Channel Geometry

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**125.1**	**125.1**	cfs
MAJOR STORM Allowable Capacity is based on Depth Criterion	d_{allow} =	**2.00**	**2.00**	ft

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow	Q_o =	**0.3**	**0.6**	cfs
Water Depth	d =	**0.40**	**0.54**	ft

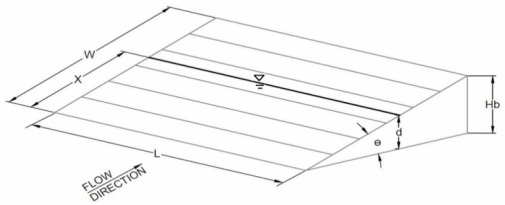
Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

AREA INLET IN A SWALE

IN-41

Inlet Design Information (Input)

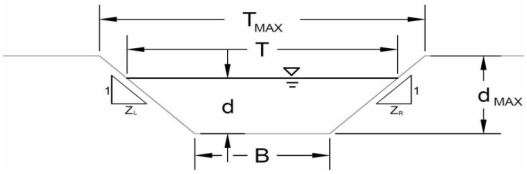
Type of Inlet	CDOT Type C	Inlet Type =	CDOT Type C	
Angle of Inclined Grate (must be <= 30 degrees)		θ =	0.00	degrees
Width of Grate		W =	3.00	ft
Length of Grate		L =	3.00	ft
Open Area Ratio		A_{RATIO} =	0.70	
Height of Inclined Grate		H_B =	0.00	ft
Clogging Factor		C_f =	0.50	
Grate Discharge Coefficient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



		MINOR	MAJOR	
Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)	d =	0.40	0.54	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**4.6**	**7.4**	**cfs**
Bypassed Flow	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Qa/Qo	**C% =**	**100**	**100**	**%**

AREA INLET IN A SWALE

IN-35



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

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using SCS Method

NRCS Vegetal Retardance (A, B, C, D, or E)	A, B, C, D, or E =	B	
Manning's n (Leave cell D16 blank to manually enter an n value)	n =	see details below	
Channel Invert Slope	S_O =	0.0934	ft/ft
Bottom Width	B =	0.00	ft
Left Side Slope	Z1 =	4.00	ft/ft
Right Side Sloe	Z2 =	4.00	ft/ft

Check one of the following soil types:

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

Choose One:
- Non-Cohesive
- Cohesive
- Paved

		Minor Storm	Major Storm	
Maximum Allowable Top Width of Channel for Minor & Major Storm	T_{MAX} =	**24.00**	**24.00**	**ft**
Maximum Allowable Water Depth in Channel for Minor & Major Storm	d_{MAX} =	**2.00**	**2.50**	**ft**

Allowable Channel Capacity Based On Channel Geometry

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**139.9**	**297.0**	**cfs**
MAJOR STORM Allowable Capacity is based on Depth Criterion	d_{allow} =	**2.00**	**2.50**	**ft**

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow	Q_o =	**1.0**	**2.1**	**cfs**
Water Depth	d =	**0.64**	**0.81**	**ft**

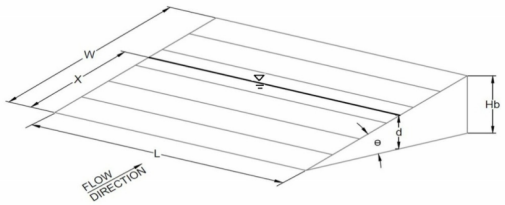
Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

AREA INLET IN A SWALE

IN-35

Inlet Design Information (Input)

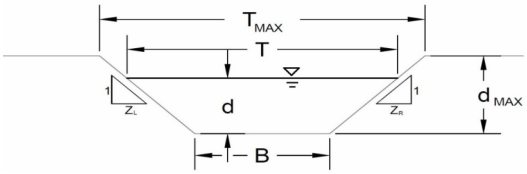
Type of Inlet	CDOT TYPE D (Parallel)	Inlet Type =	CDOT TYPE D (Parallel)	
Angle of Inclined Grate (must be <= 30 degrees)		θ =	0.00	degrees
Width of Grate		W =	6.00	ft
Length of Grate		L =	3.00	ft
Open Area Ratio		A_{RATIO} =	0.70	
Height of Inclined Grate		H_B =	0.00	ft
Clogging Factor		C_f =	0.38	
Grate Discharge Coefficient		C_d =	0.76	
Orifice Coefficient		C_o =	0.50	
Weir Coefficient		C_w =	1.62	



		MINOR	MAJOR	
Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)	d =	0.64	0.81	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**13.1**	**18.9**	**cfs**
Bypassed Flow	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Qa/Qo	**C% =**	**100**	**100**	**%**

AREA INLET IN A SWALE

IN-15



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

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using SCS Method

NRCS Vegetal Retardance (A, B, C, D, or E)	A, B, C, D, or E =	B	
Manning's n (Leave cell D16 blank to manually enter an n value)	n =	see details below	
Channel Invert Slope	S_O =	0.0430	ft/ft
Bottom Width	B =	0.00	ft
Left Side Slope	Z1 =	4.00	ft/ft
Right Side Sloe	Z2 =	4.00	ft/ft

Check one of the following soil types:

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

Choose One:
- Non-Cohesive
- Cohesive
- Paved

		Minor Storm	Major Storm	
Maximum Allowable Top Width of Channel for Minor & Major Storm	T_{MAX} =	**24.00**	**24.00**	**ft**
Maximum Allowable Water Depth in Channel for Minor & Major Storm	d_{MAX} =	**2.00**	**2.50**	**ft**

Allowable Channel Capacity Based On Channel Geometry

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**74.8**	**170.8**	**cfs**
MAJOR STORM Allowable Capacity is based on Depth Criterion	d_{allow} =	**2.00**	**2.50**	**ft**

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow	Q_o =	**31.7**	**62.0**	**cfs**
Water Depth	d =	**1.66**	**1.92**	**ft**

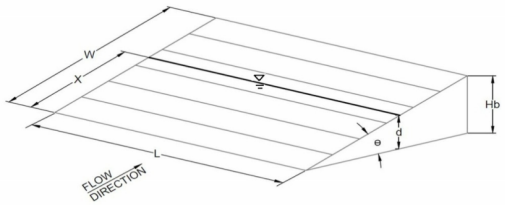
Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

AREA INLET IN A SWALE

IN-15

Inlet Design Information (Input)

Type of Inlet	CDOT Type D (In Series)	Inlet Type =	CDOT Type D (In Series)	
Angle of Inclined Grade (must be <= 30 degrees)		θ =	0.00	degrees
Width of Grade		W =	3.00	ft
Length of Grade		L =	6.00	ft
Open Area Ratio		A_{RATIO} =	0.70	
Height of Inclined Grade		H_B =	0.00	ft
Clogging Factor		C_f =	0.38	
Grade Discharge Coefficient		C_d =	0.78	
Orifice Coefficient		C_o =	0.52	
Weir Coefficient		C_w =	1.67	

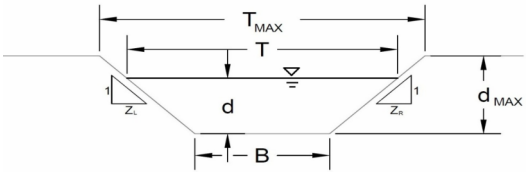


		MINOR	MAJOR	
Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)	d =	1.66	1.92	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**42.3**	**45.5**	**cfs**
Bypassed Flow	**Q_b =**	**0.0**	**16.5**	**cfs**
Capture Percentage = Qa/Qo	**C% =**	**100**	**73**	**%**

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

AREA INLET IN A SWALE

IN-14



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

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using SCS Method

NRCS Vegetal Retardance (A, B, C, D, or E)	A, B, C, D, or E =	B	
Manning's n (Leave cell D16 blank to manually enter an n value)	n =	see details below	
Channel Invert Slope	S_O =	0.0430	ft/ft
Bottom Width	B =	0.00	ft
Left Side Slope	Z1 =	4.00	ft/ft
Right Side Sloe	Z2 =	4.00	ft/ft

Check one of the following soil types:

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

Choose One:
- ☐ **Non-Cohesive**
- ☐ **Cohesive**
- ☐ **Paved**

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

Allowable Channel Capacity Based On Channel Geometry

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**74.8**	**74.8**	**cfs**
MAJOR STORM Allowable Capacity is based on Depth Criterion	d_{allow} =	**2.00**	**2.00**	**ft**

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow	Q_o =	**0.0**	**16.5**	**cfs**
Water Depth	**d** =	**0.02**	**1.47**	**ft**

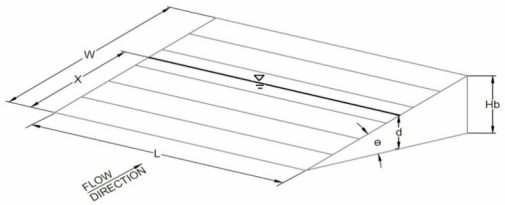
Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

AREA INLET IN A SWALE

IN-14

Inlet Design Information (Input)

Type of Inlet: CDOT Type D (In Series) — Inlet Type = CDOT Type D (In Series)

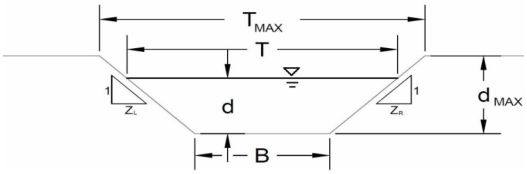


Angle of Inclined Grate (must be <= 30 degrees)	θ =	0.00	degrees
Width of Grate	W =	3.00	ft
Length of Grate	L =	6.00	ft
Open Area Ratio	A_{RATIO} =	0.70	
Height of Inclined Grate	H_B =	0.00	ft
Clogging Factor	C_f =	0.38	
Grate Discharge Coefficient	C_d =	0.78	
Orifice Coefficient	C_o =	0.52	
Weir Coefficient	C_w =	1.67	

		MINOR	MAJOR	
Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)	d =	0.02	1.47	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**0.1**	**39.9**	**cfs**
Bypassed Flow	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Qa/Qo	**C% =**	**100**	**100**	**%**

AREA INLET IN A SWALE

IN-16



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

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using SCS Method

NRCS Vegetal Retardance (A, B, C, D, or E)	A, B, C, D, or E =	B	
Manning's n (Leave cell D16 blank to manually enter an n value)	n =	see details below	
Channel Invert Slope	S_O =	0.0613	ft/ft
Bottom Width	B =	0.00	ft
Left Side Slope	Z1 =	4.00	ft/ft
Right Side Sloe	Z2 =	4.00	ft/ft

Check one of the following soil types:

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

Choose One:
- Non-Cohesive
- Cohesive
- Paved

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

Allowable Channel Capacity Based On Channel Geometry

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**102.2**	**102.2**	**cfs**
MAJOR STORM Allowable Capacity is based on Depth Criterion	d_{allow} =	**2.00**	**2.00**	**ft**

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow	Q_o =	**1.0**	**2.1**	**cfs**
Water Depth	d =	**0.69**	**0.89**	**ft**

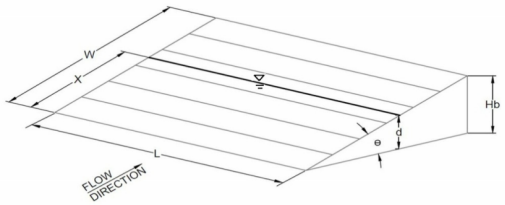
Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

AREA INLET IN A SWALE

IN-16

Inlet Design Information (Input)

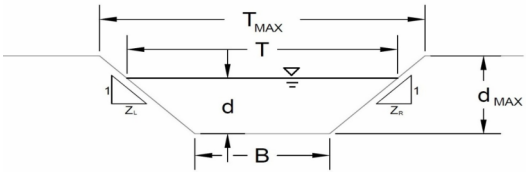
Type of Inlet	CDOT Type C	Inlet Type =	CDOT Type C	
Angle of Inclined Grate (must be <= 30 degrees)		θ =	0.00	degrees
Width of Grate		W =	3.00	ft
Length of Grate		L =	3.00	ft
Open Area Ratio		A_{RATIO} =	0.70	
Height of Inclined Grate		H_B =	0.00	ft
Clogging Factor		C_f =	0.50	
Grate Discharge Coefficient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



		MINOR	MAJOR	
Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)	d =	0.69	0.89	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**10.6**	**15.3**	**cfs**
Bypassed Flow	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Qa/Qo	**C% =**	**100**	**100**	**%**

AREA INLET IN A SWALE

IN-17



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

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using SCS Method

NRCS Vegetal Retardance (A, B, C, D, or E)	A, B, C, D, or E =	B	
Manning's n (Leave cell D16 blank to manually enter an n value)	n =	see details below	
Channel Invert Slope	S_O =	0.0566	ft/ft
Bottom Width	B =	0.00	ft
Left Side Slope	Z1 =	4.00	ft/ft
Right Side Sloe	Z2 =	4.00	ft/ft

Check one of the following soil types:

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

Choose One:
- Non-Cohesive
- Cohesive
- Paved

		Minor Storm	Major Storm	
Maximum Allowable Top Width of Channel for Minor & Major Storm	T_{MAX} =	24.00	24.00	ft
Maximum Allowable Water Depth in Channel for Minor & Major Storm	d_{MAX} =	2.00	2.00	ft

Allowable Channel Capacity Based On Channel Geometry

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	95.3	95.3	cfs
MAJOR STORM Allowable Capacity is based on Depth Criterion	d_{allow} =	2.00	2.00	ft

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow	Q_o =	0.6	1.4	cfs
Water Depth	d =	0.57	0.77	ft

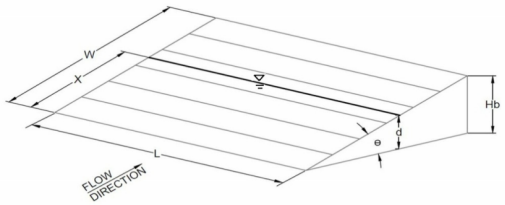
Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

AREA INLET IN A SWALE

IN-17

Inlet Design Information (Input)

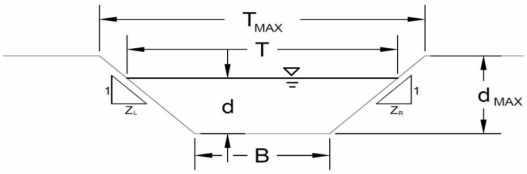
Type of Inlet	CDOT Type C	Inlet Type =	CDOT Type C	
Angle of Inclined Grate (must be <= 30 degrees)		θ =	0.00	degrees
Width of Grate		W =	3.00	ft
Length of Grate		L =	3.00	ft
Open Area Ratio		A_{RATIO} =	0.70	
Height of Inclined Grate		H_B =	0.00	ft
Clogging Factor		C_f =	0.50	
Grate Discharge Coefficient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



		MINOR	MAJOR	
Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)	d =	0.57	0.77	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**8.0**	**12.6**	**cfs**
Bypassed Flow	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Qa/Qo	**C% =**	**100**	**100**	**%**

AREA INLET IN A SWALE

IN-46



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

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using SCS Method

NRCS Vegetal Retardance (A, B, C, D, or E)	A, B, C, D, or E =	B	
Manning's n (Leave cell D16 blank to manually enter an n value)	n =	see details below	
Channel Invert Slope	S_O =	0.0067	ft/ft
Bottom Width	B =	0.00	ft
Left Side Slope	Z1 =	4.00	ft/ft
Right Side Sloe	Z2 =	4.00	ft/ft

Check one of the following soil types:

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

Choose One:
- Non-Cohesive
- Cohesive
- Paved

		Minor Storm	Major Storm	
Maximum Allowable Top Width of Channel for Minor & Major Storm	T_{MAX} =	**32.00**	**32.00**	**ft**
Maximum Allowable Water Depth in Channel for Minor & Major Storm	d_{MAX} =	**4.00**	**4.00**	**ft**

Allowable Channel Capacity Based On Channel Geometry

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**219.0**	**219.0**	**cfs**
MAJOR STORM Allowable Capacity is based on Depth Criterion	d_{allow} =	**4.00**	**4.00**	**ft**

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow	Q_o =	**2.7**	**5.6**	**cfs**
Water Depth	d =	**1.49**	**1.90**	**ft**

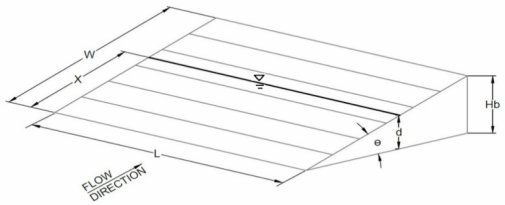
Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

AREA INLET IN A SWALE

IN-46

Inlet Design Information (Input)

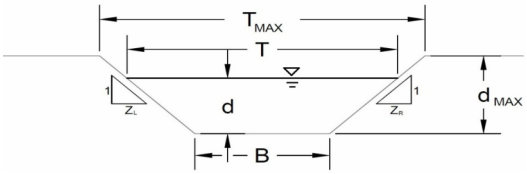
Type of Inlet	CDOT Type C	Inlet Type =	CDOT Type C	
Angle of Inclined Grate (must be <= 30 degrees)		θ =	0.00	degrees
Width of Grate		W =	3.00	ft
Length of Grate		L =	3.00	ft
Open Area Ratio		A_{RATIO} =	0.70	
Height of Inclined Grate		H_B =	0.00	ft
Clogging Factor		C_f =	0.50	
Grate Discharge Coefficient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



		MINOR	MAJOR	
Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)	d =	1.49	1.90	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**19.8**	**22.3**	**cfs**
Bypassed Flow	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Qa/Qo	**C% =**	**100**	**100**	**%**

AREA INLET IN A SWALE

IN-44



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

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using SCS Method

NRCS Vegetal Retardance (A, B, C, D, or E)	A, B, C, D, or E =	B	
Manning's n (Leave cell D16 blank to manually enter an n value)	n =	see details below	
Channel Invert Slope	S_O =	0.0150	ft/ft
Bottom Width	B =	0.00	ft
Left Side Slope	Z1 =	4.00	ft/ft
Right Side Sloe	Z2 =	4.00	ft/ft

Check one of the following soil types:

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

Choose One:
- Non-Cohesive
- Cohesive
- Paved

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

Allowable Channel Capacity Based On Channel Geometry

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**21.4**	**21.4**	cfs
MAJOR STORM Allowable Capacity is based on Depth Criterion	d_{allow} =	**2.00**	**2.00**	ft

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow	Q_o =	**4.2**	**8.8**	cfs
Water Depth	d =	**1.47**	**1.72**	ft

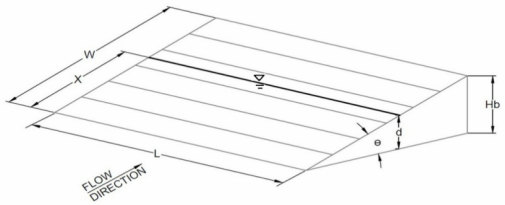
Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

AREA INLET IN A SWALE

IN-44

Inlet Design Information (Input)

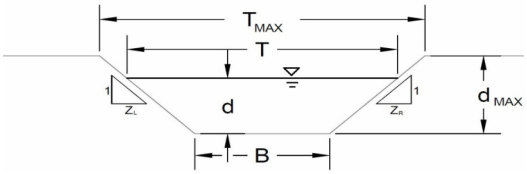
Type of Inlet	CDOT Type C	Inlet Type =	CDOT Type C	
Angle of Inclined Grate (must be <= 30 degrees)		θ =	0.00	degrees
Width of Grate		W =	3.00	ft
Length of Grate		L =	3.00	ft
Open Area Ratio		A_{RATIO} =	0.70	
Height of Inclined Grate		H_B =	0.00	ft
Clogging Factor		C_f =	0.50	
Grate Discharge Coefficient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



		MINOR	MAJOR	
Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)	d =	1.47	1.72	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**19.6**	**21.2**	**cfs**
Bypassed Flow	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Qa/Qo	**C% =**	**100**	**100**	**%**

AREA INLET IN A SWALE

IN-52



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

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using SCS Method

NRCS Vegetal Retardance (A, B, C, D, or E)	A, B, C, D, or E =	B	
Manning's n (Leave cell D16 blank to manually enter an n value)	n =	see details below	
Channel Invert Slope	S_O =	0.0200	ft/ft
Bottom Width	B =	0.00	ft
Left Side Slope	Z1 =	7.00	ft/ft
Right Side Sloe	Z2 =	7.00	ft/ft

Check one of the following soil types:

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

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

		Minor Storm	Major Storm	
Maximum Allowable Top Width of Channel for Minor & Major Storm	T_{MAX} =	24.00	24.00	ft
Maximum Allowable Water Depth in Channel for Minor & Major Storm	d_{MAX} =	2.00	2.00	ft

Allowable Channel Capacity Based On Channel Geometry

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Top Width Criterion	Q_{allow} =	26.1	26.1	cfs
MAJOR STORM Allowable Capacity is based on Top Width Criterion	d_{allow} =	1.71	1.71	ft

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow	Q_o =	8.2	15.6	cfs
Water Depth	d =	1.41	1.56	ft

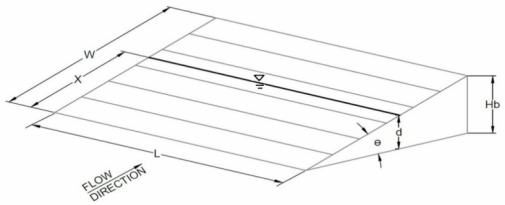
Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

AREA INLET IN A SWALE

IN-52

Inlet Design Information (Input)

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



		MINOR	MAJOR	
Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)	d =	1.41	1.56	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**19.2**	**20.2**	**cfs**
Bypassed Flow	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Qa/Qo	**C% =**	**100**	**100**	**%**

MHFD-Inlet, Version 5.01 (April 2021)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	IN-38	IN-36	IN-33
Site Type (Urban or Rural)	URBAN	URBAN	URBAN
Inlet Application (Street or Area)	STREET	STREET	STREET
Hydraulic Condition	On Grade	On Grade	On Grade
Inlet Type	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening

USER-DEFINED INPUT

User-Defined Design Flows

Minor Q_{Known} (cfs)	1.0	1.6	1.0
Major Q_{Known} (cfs)	1.8	2.9	1.9

Bypass (Carry-Over) Flow from Upstream

Receive Bypass Flow from:	No Bypass Flow Received	IN-38	IN-36
Minor Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.2
Major Bypass Flow Received, Q_b (cfs)	0.0	0.3	1.0

Watershed Characteristics

Subcatchment Area (acres)			
Percent Impervious			
NRCS Soil Type			

Watershed Profile

Overland Slope (ft/ft)			
Overland Length (ft)			
Channel Slope (ft/ft)			
Channel Length (ft)			

Minor Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

Major Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

CALCULATED OUTPUT

Minor Total Design Peak Flow, Q (cfs)	**1.0**	**1.6**	**1.2**
Major Total Design Peak Flow, Q (cfs)	**1.8**	**3.2**	**2.9**
Minor Flow Bypassed Downstream, Q_b (cfs)	0.0	0.2	0.1
Major Flow Bypassed Downstream, Q_b (cfs)	0.3	1.0	0.9

MHFD-Inlet, Version 5.01 (April 2021)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	IN-32	IN-7	IN-6
Site Type (Urban or Rural)	URBAN	URBAN	URBAN
Inlet Application (Street or Area)	STREET	STREET	STREET
Hydraulic Condition	On Grade	On Grade	On Grade
Inlet Type	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening

USER-DEFINED INPUT

User-Defined Design Flows

Minor Q_{Known} (cfs)	1.2	1.8	1.2
Major Q_{Known} (cfs)	2.2	3.2	2.0

Bypass (Carry-Over) Flow from Upstream

Receive Bypass Flow from:	IN-33	IN-32	IN-7
Minor Bypass Flow Received, Q_b (cfs)	0.1	0.1	0.3
Major Bypass Flow Received, Q_b (cfs)	0.9	1.0	1.7

Watershed Characteristics

Subcatchment Area (acres)			
Percent Impervious			
NRCS Soil Type			

Watershed Profile

Overland Slope (ft/ft)			
Overland Length (ft)			
Channel Slope (ft/ft)			
Channel Length (ft)			

Minor Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

Major Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

CALCULATED OUTPUT

Minor Total Design Peak Flow, Q (cfs)	**1.3**	**1.8**	**1.4**
Major Total Design Peak Flow, Q (cfs)	**3.0**	**4.1**	**3.6**
Minor Flow Bypassed Downstream, Q_b (cfs)	0.1	0.3	0.1
Major Flow Bypassed Downstream, Q_b (cfs)	1.0	1.7	1.3

MHFD-Inlet, Version 5.01 (April 2021)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	IN-42
Site Type (Urban or Rural)	URBAN
Inlet Application (Street or Area)	STREET
Hydraulic Condition	On Grade
Inlet Type	CDOT Type R Curb Opening

USER-DEFINED INPUT

User-Defined Design Flows

Minor Q_{Known} (cfs)	1.0
Major Q_{Known} (cfs)	1.8

Bypass (Carry-Over) Flow from Upstream

Receive Bypass Flow from:	No Bypass Flow Received
Minor Bypass Flow Received, Q_b (cfs)	0.0
Major Bypass Flow Received, Q_b (cfs)	0.0

Watershed Characteristics

Subcatchment Area (acres)	
Percent Impervious	
NRCS Soil Type	

Watershed Profile

Overland Slope (ft/ft)	
Overland Length (ft)	
Channel Slope (ft/ft)	
Channel Length (ft)	

Minor Storm Rainfall Input

Design Storm Return Period, T_r (years)	
One-Hour Precipitation, P_1 (inches)	

Major Storm Rainfall Input

Design Storm Return Period, T_r (years)	
One-Hour Precipitation, P_1 (inches)	

CALCULATED OUTPUT

Minor Total Design Peak Flow, Q (cfs)	**1.0**
Major Total Design Peak Flow, Q (cfs)	**1.8**
Minor Flow Bypassed Downstream, Q_b (cfs)	0.0
Major Flow Bypassed Downstream, Q_b (cfs)	0.3

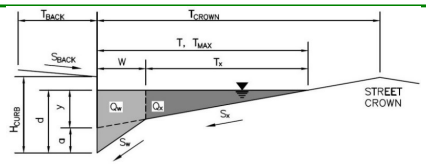
MHFD-Inlet, Version 5.01 (April 2021)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

Inlet ID: **IN-38**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	5.5	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.015	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.012	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	20.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.080	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.012	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	20.0	20.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

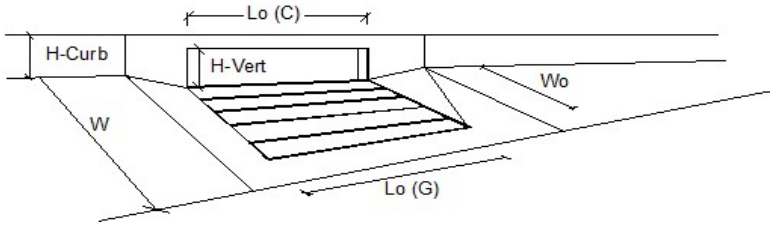
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**17.6**	**17.6**	**cfs**

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

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

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	

Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.0**	**1.5**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.3**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**97**	**84**	**%**

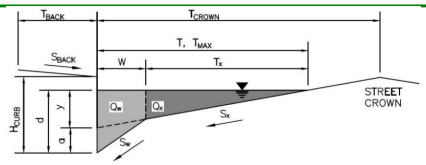
MHFD-Inlet, Version 5.01 (April 2021)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

Inlet ID: **IN-36**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	5.5	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.015	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.012	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	20.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.082	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.012	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	20.0	20.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

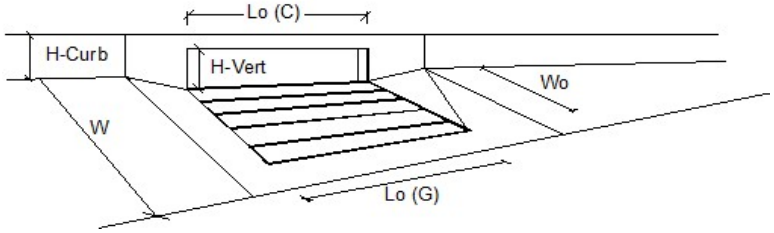
	Minor Storm	Major Storm	
Q_{allow} =	**17.5**	**17.5**	**cfs**

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

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

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	
Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.4**	**2.1**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.2**	**1.0**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**87**	**67**	**%**

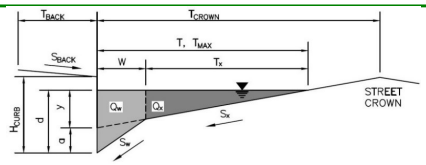
MHFD-Inlet, Version 5.01 (April 2021)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

Inlet ID: **IN-33**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	5.5	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.015	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.012	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	20.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.058	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.012	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	20.0	20.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

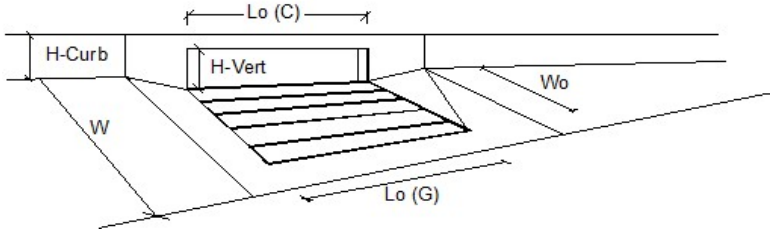
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**19.4**	**19.4**	**cfs**

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

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

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	

Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.2**	**2.0**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.1**	**0.9**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**94**	**70**	**%**

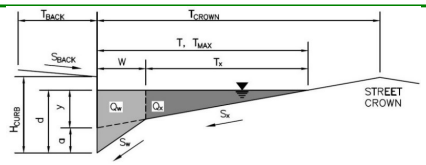
MHFD-Inlet, Version 5.01 (April 2021)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

Inlet ID: **IN-32**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	5.5	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.015	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.012	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	20.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.025	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.012	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	20.0	20.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

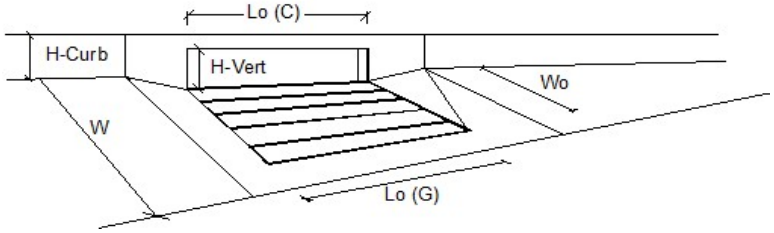
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**25.0**	**25.0**	**cfs**

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

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

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	
Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.2**	**2.1**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.1**	**1.0**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**95**	**69**	**%**

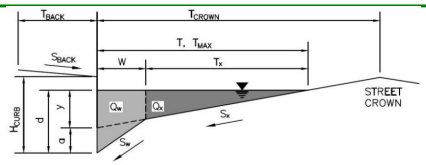
MHFD-Inlet, Version 5.01 (April 2021)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

Inlet ID: **IN-7**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	5.5	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.015	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.012	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	20.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.061	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.012	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	20.0	20.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

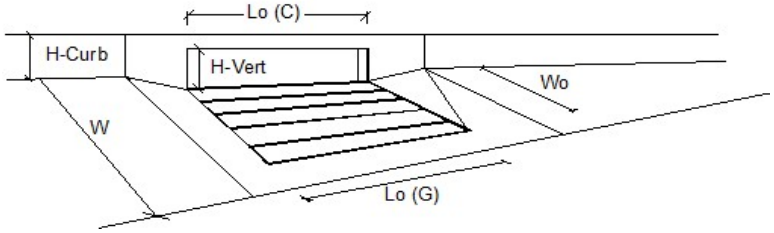
	Minor Storm	Major Storm	
Q_{allow} =	**19.1**	**19.1**	**cfs**

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

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

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	

Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.5**	**2.4**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.3**	**1.7**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**85**	**59**	**%**

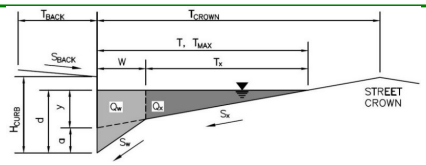
MHFD-Inlet, Version 5.01 (April 2021)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

Inlet ID: **IN-6**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	5.5	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.015	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.012	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	20.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.040	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.012	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	20.0	20.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

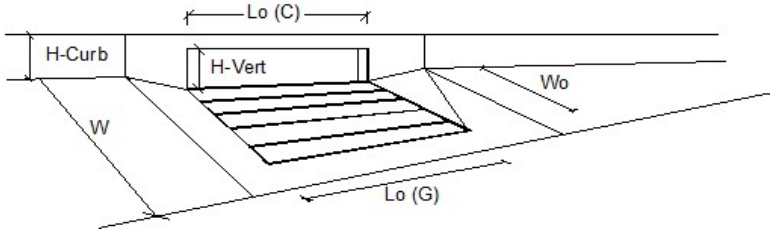
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**21.7**	**21.7**	**cfs**

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

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

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



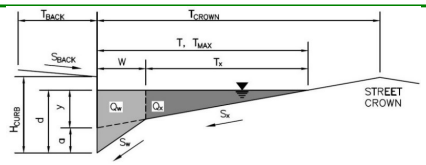
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	

Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.3**	**2.3**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.1**	**1.3**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**91**	**63**	**%**

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:
Inlet ID: **IN-42**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	5.5	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.015	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.012	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	20.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.040	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.012	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	20.0	20.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

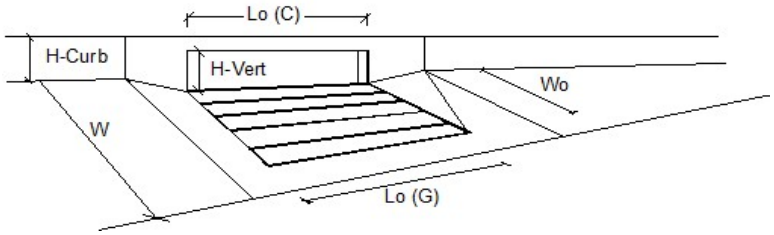
MINOR STORM Allowable Capacity is based on Depth Criterion
MAJOR STORM Allowable Capacity is based on Depth Criterion

	Minor Storm	Major Storm	
Q_{allow} =	**21.7**	**21.7**	**cfs**

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

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	

Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.0**	**1.5**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.3**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**98**	**85**	**%**

MHFD-Inlet, Version 5.01 (April 2021)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	IN-39	IN-37	IN-34
Site Type (Urban or Rural)	URBAN	URBAN	URBAN
Inlet Application (Street or Area)	STREET	STREET	STREET
Hydraulic Condition	On Grade	On Grade	On Grade
Inlet Type	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening

USER-DEFINED INPUT

User-Defined Design Flows

Minor Q_{Known} (cfs)	1.0	1.6	1.1
Major Q_{Known} (cfs)	1.8	2.9	1.9

Bypass (Carry-Over) Flow from Upstream

Receive Bypass Flow from:	No Bypass Flow Received	IN-39	IN-37
Minor Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.2
Major Bypass Flow Received, Q_b (cfs)	0.0	0.3	1.1

Watershed Characteristics

Subcatchment Area (acres)			
Percent Impervious			
NRCS Soil Type			

Watershed Profile

Overland Slope (ft/ft)			
Overland Length (ft)			
Channel Slope (ft/ft)			
Channel Length (ft)			

Minor Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

Major Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

CALCULATED OUTPUT

Minor Total Design Peak Flow, Q (cfs)	**1.0**	**1.6**	**1.3**
Major Total Design Peak Flow, Q (cfs)	**1.8**	**3.2**	**3.0**
Minor Flow Bypassed Downstream, Q_b (cfs)	0.0	0.2	0.1
Major Flow Bypassed Downstream, Q_b (cfs)	0.3	1.1	0.9

MHFD-Inlet, Version 5.01 (April 2021)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	IN-21	IN-8	IN-27
Site Type (Urban or Rural)	URBAN	URBAN	URBAN
Inlet Application (Street or Area)	STREET	STREET	STREET
Hydraulic Condition	On Grade	On Grade	On Grade
Inlet Type	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening

USER-DEFINED INPUT

User-Defined Design Flows

Minor Q_{Known} (cfs)	1.2	1.7	1.3
Major Q_{Known} (cfs)	2.2	3.1	2.3

Bypass (Carry-Over) Flow from Upstream

Receive Bypass Flow from:	IN-34	IN-21	IN-8
Minor Bypass Flow Received, Q_b (cfs)	0.1	0.1	0.2
Major Bypass Flow Received, Q_b (cfs)	0.9	1.0	1.7

Watershed Characteristics

Subcatchment Area (acres)			
Percent Impervious			
NRCS Soil Type			

Watershed Profile

Overland Slope (ft/ft)			
Overland Length (ft)			
Channel Slope (ft/ft)			
Channel Length (ft)			

Minor Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

Major Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

CALCULATED OUTPUT

Minor Total Design Peak Flow, Q (cfs)	**1.3**	**1.7**	**1.5**
Major Total Design Peak Flow, Q (cfs)	**3.1**	**4.1**	**4.0**
Minor Flow Bypassed Downstream, Q_b (cfs)	0.1	0.2	0.2
Major Flow Bypassed Downstream, Q_b (cfs)	1.0	1.7	1.6

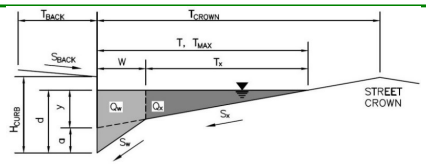
MHFD-Inlet, Version 5.01 (April 2021)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

Inlet ID: **IN-39**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	5.5	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.015	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.012	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	20.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.080	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.012	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	20.0	20.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

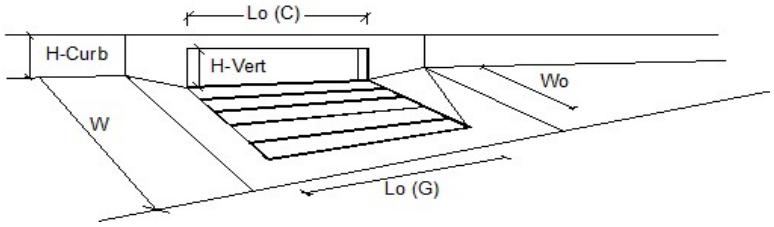
	Minor Storm	Major Storm	
Q_{allow} =	**17.6**	**17.6**	**cfs**

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

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

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	

Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.0**	**1.5**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.3**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**97**	**85**	**%**

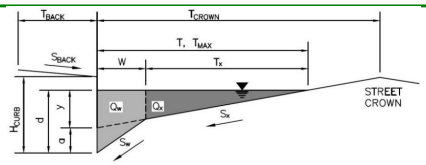
MHFD-Inlet, Version 5.01 (April 2021)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

Inlet ID: **IN-37**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	5.5	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.015	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.012	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	20.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.077	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.012	

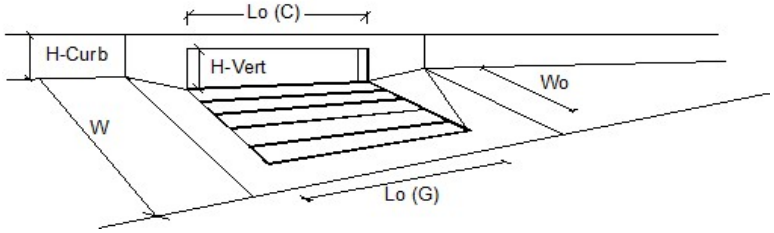
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	20.0	20.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion		Minor Storm	Major Storm	
	Q_{allow} =	**17.8**	**17.8**	**cfs**

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

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

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	

Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.4**	**2.1**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.2**	**1.1**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**87**	**67**	**%**

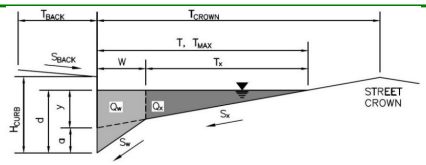
MHFD-Inlet, Version 5.01 (April 2021)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

Inlet ID: **IN-34**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	5.5	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.015	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.012	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	20.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.058	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.012	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	20.0	20.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

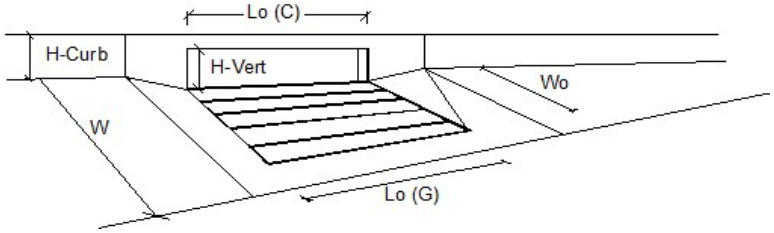
	Minor Storm	Major Storm	
Q_{allow} =	**19.4**	**19.4**	**cfs**

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

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

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	

Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.2**	**2.1**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.1**	**0.9**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**93**	**69**	**%**

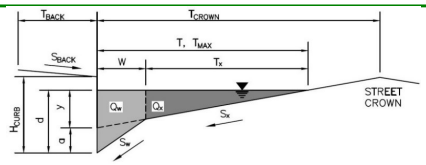
MHFD-Inlet, Version 5.01 (April 2021)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

Inlet ID: **IN-21**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	5.5	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.015	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.012	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	20.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.025	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.012	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	20.0	20.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

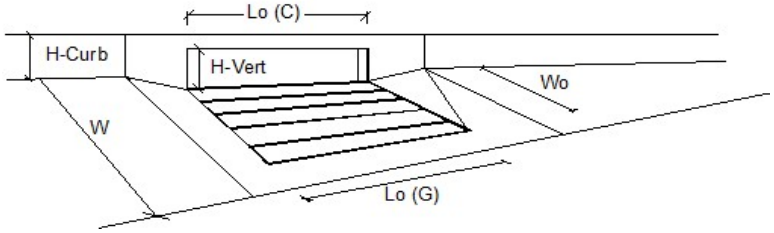
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**25.0**	**25.0**	**cfs**

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

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

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	

Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.2**	**2.1**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.1**	**1.0**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**95**	**68**	**%**

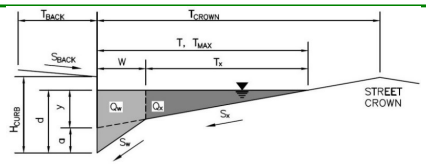
MHFD-Inlet, Version 5.01 (April 2021)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

Inlet ID: **IN-8**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	5.5	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.015	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.012	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	20.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.059	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.012	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	20.0	20.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

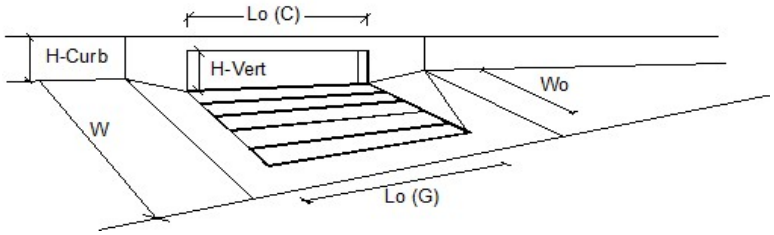
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**19.3**	**19.3**	**cfs**

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

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

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



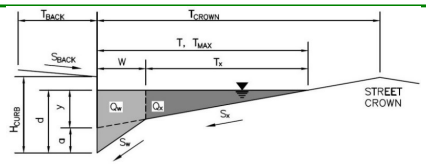
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	

Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.5**	**2.4**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.2**	**1.7**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**86**	**59**	**%**

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:
Inlet ID: **IN-27**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	5.5	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.015	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.012	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	20.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.042	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.012	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	20.0	20.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

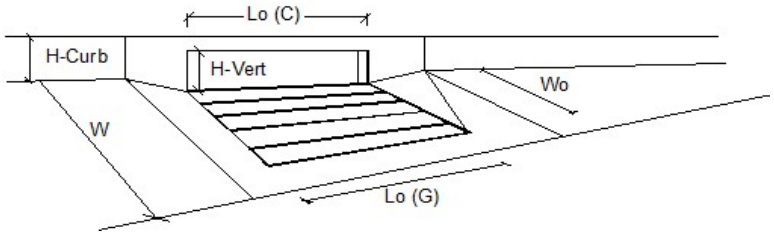
MINOR STORM Allowable Capacity is based on Depth Criterion
MAJOR STORM Allowable Capacity is based on Depth Criterion

	Minor Storm	Major Storm	
Q_{allow} =	**21.5**	**21.5**	**cfs**

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

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	

Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.4**	**2.4**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.2**	**1.6**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**90**	**60**	**%**

APPENDIX C.4

Culvert Calculations

Culvert Summary							
ID	Size	Invert	10yr HW	HW/D	100-yr HW	Crest EL	Freeboard
	ft	ft	ft		ft	ft	ft
P-5	1.50	7188.42	7189.44	0.68	7189.94	7192.11	2.17
P-43	1.50	7372.43	7373.00	0.38	7373.27	7375.31	2.04
P-45	2.00	7355.31	7356.08	0.38	7356.47	7359.43	2.96
P-47	2.00	7350.95	7352.49	0.77	7353.43	7354.75	1.32
P-48	1.50	7357.67	7358.05	0.25	7358.21	7361.12	2.91
P-53	1.50	7362.63	7363.02	0.26	7363.18	7364.83	1.65

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 0.52 cfs
Design Flow: 0.52 cfs
Maximum Flow: 1.03 cfs

Table 1 - Summary of Culvert Flows at Crossing: P-48

Headwater Elevatio	Total Discharge (c	P-48 Discharge (c	Roadway Dischar (cfs)	Iterations
7358.05	0.52	0.52	0.00	1
7358.07	0.57	0.57	0.00	1
7358.09	0.62	0.62	0.00	1
7358.10	0.67	0.67	0.00	1
7358.12	0.72	0.72	0.00	1
7358.14	0.78	0.78	0.00	1
7358.15	0.83	0.83	0.00	1
7358.17	0.88	0.88	0.00	1
7358.18	0.93	0.93	0.00	1
7358.20	0.98	0.98	0.00	1
7358.21	1.03	1.03	0.00	1
7361.12	12.50	12.50	0.00	Overtopping

Table 2 - Culvert Summary Table: P-48

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwater Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.52	0.52	7358.05	0.379	0.127	1-JS1	0.249	0.267	0.324	0.324	1.852	1.240
0.57	0.57	7358.07	0.397	0.139	1-JS1	0.261	0.280	0.335	0.335	1.935	1.270
0.62	0.62	7358.09	0.415	0.151	1-JS1	0.273	0.292	0.346	0.346	2.015	1.297
0.67	0.67	7358.10	0.433	0.162	1-JS1	0.283	0.304	0.357	0.357	2.090	1.323
0.72	0.72	7358.12	0.449	0.172	1-JS1	0.293	0.316	0.367	0.367	2.163	1.347
0.78	0.78	7358.14	0.465	0.183	1-JS1	0.304	0.327	0.376	0.376	2.234	1.370
0.83	0.83	7358.15	0.481	0.193	1-JS1	0.313	0.338	0.385	0.385	2.303	1.392
0.88	0.88	7358.17	0.497	0.202	1-S2r	0.323	0.349	0.323	0.394	3.139	1.413
0.93	0.93	7358.18	0.511	0.212	1-S2r	0.332	0.359	0.332	0.402	3.191	1.434
0.98	0.98	7358.20	0.526	0.221	1-S2r	0.341	0.369	0.341	0.410	3.239	1.453
1.03	1.03	7358.21	0.540	0.230	1-S2r	0.350	0.379	0.350	0.418	3.286	1.471

****

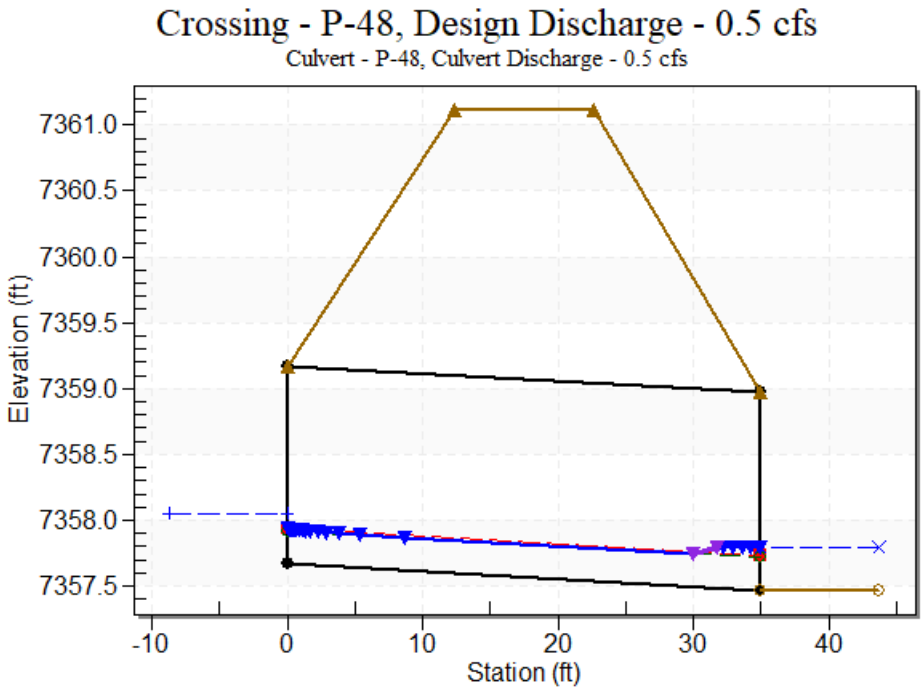
Straight Culvert

Inlet Elevation (invert): 7357.67 ft, Outlet Elevation (invert): 7357.47 ft

Culvert Length: 35.00 ft, Culvert Slope: 0.0057

****

Water Surface Profile Plot for Culvert: P-48



Site Data - P-48

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 7357.67 ft
Outlet Station: 35.00 ft
Outlet Elevation: 7357.47 ft
Number of Barrels: 1

Culvert Data Summary - P-48

Barrel Shape: Circular
Barrel Diameter: 1.50 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: P-48)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
0.52	7357.79	0.32	1.24	0.15	0.54
0.57	7357.81	0.34	1.27	0.15	0.55
0.62	7357.82	0.35	1.30	0.16	0.55
0.67	7357.83	0.36	1.32	0.16	0.55
0.72	7357.84	0.37	1.35	0.17	0.55
0.78	7357.85	0.38	1.37	0.17	0.56
0.83	7357.86	0.39	1.39	0.18	0.56
0.88	7357.86	0.39	1.41	0.18	0.56
0.93	7357.87	0.40	1.43	0.19	0.56
0.98	7357.88	0.41	1.45	0.19	0.57
1.03	7357.89	0.42	1.47	0.19	0.57

Tailwater Channel Data - P-48

Tailwater Channel Option: Triangular Channel
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0074
Channel Manning's n: 0.0300
Channel Invert Elevation: 7357.47 ft

Roadway Data for Crossing: P-48

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 24.00 ft
Crest Elevation: 7361.12 ft
Roadway Surface: Gravel
Roadway Top Width: 10.19 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 2.36 cfs
Design Flow: 2.36 cfs
Maximum Flow: 5 cfs

Table 4 - Summary of Culvert Flows at Crossing: P-45

Headwater Elevatio	Total Discharge (c	P-45 Discharge (c	Roadway Dischar (cfs)	Iterations
7356.08	2.36	2.36	0.00	1
7356.12	2.62	2.62	0.00	1
7356.16	2.89	2.89	0.00	1
7356.21	3.15	3.15	0.00	1
7356.24	3.42	3.42	0.00	1
7356.28	3.68	3.68	0.00	1
7356.32	3.94	3.94	0.00	1
7356.36	4.21	4.21	0.00	1
7356.39	4.47	4.47	0.00	1
7356.43	4.74	4.74	0.00	1
7356.47	5.00	5.00	0.00	1
7359.43	23.70	23.70	0.00	Overtopping

Table 5 - Culvert Summary Table: P-45

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwater Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
2.36	2.36	7356.08	0.768	0.212	1-S2n	0.415	0.534	0.423	0.366	4.873	2.514
2.62	2.62	7356.12	0.812	0.246	1-S2n	0.438	0.564	0.446	0.381	5.016	2.581
2.89	2.89	7356.16	0.854	0.279	1-S2n	0.460	0.593	0.469	0.395	5.145	2.644
3.15	3.15	7356.21	0.895	0.312	1-S2n	0.480	0.620	0.491	0.408	5.261	2.702
3.42	3.42	7356.24	0.935	0.344	1-S2n	0.500	0.646	0.512	0.421	5.373	2.757
3.68	3.68	7356.28	0.973	0.375	1-S2n	0.519	0.672	0.533	0.433	5.471	2.809
3.94	3.94	7356.32	1.010	0.406	1-S2n	0.537	0.696	0.553	0.444	5.569	2.858
4.21	4.21	7356.36	1.048	0.437	1-S2n	0.556	0.720	0.573	0.455	5.659	2.905
4.47	4.47	7356.39	1.085	0.468	1-S2n	0.573	0.743	0.592	0.465	5.746	2.949
4.74	4.74	7356.43	1.121	0.498	1-S2n	0.590	0.766	0.610	0.476	5.832	2.992
5.00	5.00	7356.47	1.155	0.528	1-S2n	0.607	0.788	0.629	0.485	5.910	3.033

****

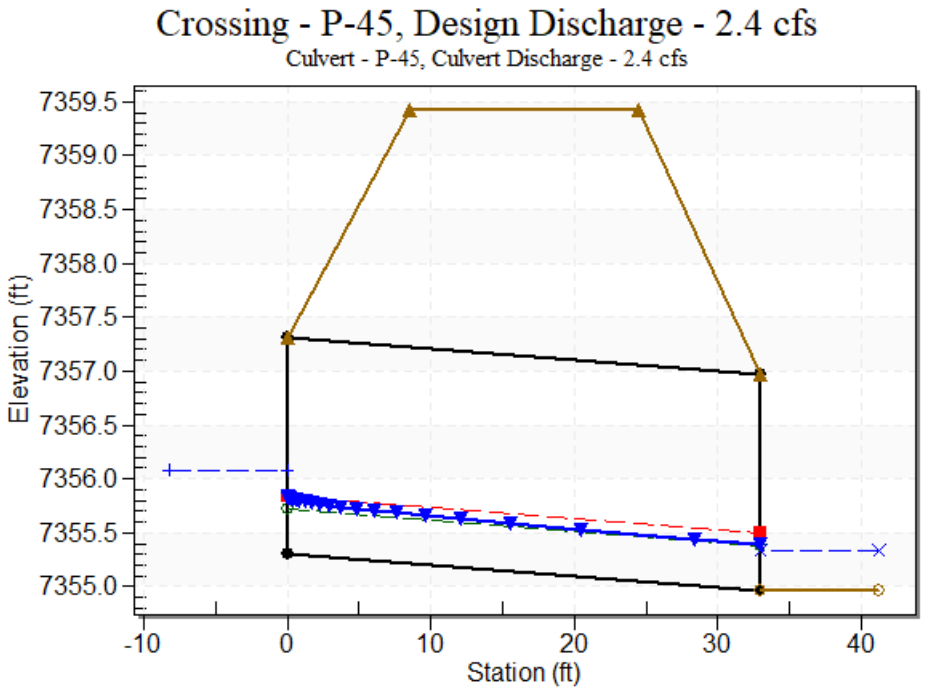
Straight Culvert

Inlet Elevation (invert): 7355.31 ft, Outlet Elevation (invert): 7354.97 ft

Culvert Length: 33.00 ft, Culvert Slope: 0.0103

****

Water Surface Profile Plot for Culvert: P-45



Site Data - P-45

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 7355.31 ft
Outlet Station: 33.00 ft
Outlet Elevation: 7354.97 ft
Number of Barrels: 1

Culvert Data Summary - P-45

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 6 - Downstream Channel Rating Curve (Crossing: P-45)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
2.36	7355.34	0.37	2.51	0.57	1.04
2.62	7355.35	0.38	2.58	0.60	1.04
2.89	7355.37	0.40	2.64	0.62	1.05
3.15	7355.38	0.41	2.70	0.64	1.05
3.42	7355.39	0.42	2.76	0.66	1.06
3.68	7355.40	0.43	2.81	0.68	1.06
3.94	7355.41	0.44	2.86	0.70	1.07
4.21	7355.42	0.45	2.90	0.71	1.07
4.47	7355.44	0.47	2.95	0.73	1.08
4.74	7355.45	0.48	2.99	0.74	1.08
5.00	7355.46	0.49	3.03	0.76	1.08

Tailwater Channel Data - P-45

Tailwater Channel Option: Triangular Channel
Side Slope (H:V): 7.00 (_:1)
Channel Slope: 0.0251
Channel Manning's n: 0.0300
Channel Invert Elevation: 7354.97 ft

Roadway Data for Crossing: P-45

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 7359.43 ft
Roadway Surface: Gravel
Roadway Top Width: 16.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 7.51 cfs
Design Flow: 7.51 cfs
Maximum Flow: 15.09 cfs

Table 7 - Summary of Culvert Flows at Crossing: P-47

Headwater Elevatio	Total Discharge (c	P-47 Discharge (c	Roadway Dischar (cfs)	Iterations
7352.49	7.51	7.51	0.00	1
7352.57	8.27	8.27	0.00	1
7352.65	9.03	9.03	0.00	1
7352.74	9.78	9.78	0.00	1
7352.82	10.54	10.54	0.00	1
7352.91	11.30	11.30	0.00	1
7353.01	12.06	12.06	0.00	1
7353.10	12.82	12.82	0.00	1
7353.21	13.57	13.57	0.00	1
7353.31	14.33	14.33	0.00	1
7353.43	15.09	15.09	0.00	1
7354.75	21.97	21.97	0.00	Overtopping

Table 8 - Culvert Summary Table: P-47

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwater Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
7.51	7.51	7352.49	1.537	0.0*	1-S2n	0.456	0.974	0.480	0.560	12.947	0.000
8.27	8.27	7352.57	1.620	0.0*	1-S2n	0.478	1.024	0.515	0.560	12.903	0.000
9.03	9.03	7352.65	1.703	0.0*	1-S2n	0.500	1.072	0.535	0.560	13.362	0.000
9.78	9.78	7352.74	1.787	0.0*	1-S2n	0.521	1.119	0.563	0.560	13.493	0.000
10.54	10.54	7352.82	1.873	0.0*	1-S2n	0.541	1.163	0.587	0.560	13.706	0.000
11.30	11.30	7352.91	1.962	0.0*	1-S2n	0.561	1.206	0.605	0.560	14.082	0.000
12.06	12.06	7353.01	2.055	0.0*	5-S2n	0.579	1.247	0.634	0.560	14.083	0.000
12.82	12.82	7353.10	2.153	0.0*	5-S2n	0.598	1.288	0.655	0.560	14.312	0.000
13.57	13.57	7353.21	2.256	0.0*	5-S2n	0.616	1.326	0.675	0.560	14.566	0.000
14.33	14.33	7353.31	2.364	0.0*	5-S2n	0.633	1.364	0.701	0.560	14.600	0.000
15.09	15.09	7353.43	2.479	0.0*	5-S2n	0.651	1.400	0.722	0.560	14.760	0.000

* Full Flow Headwater elevation is below inlet invert.

****

Straight Culvert

Inlet Elevation (invert): 7350.95 ft, Outlet Elevation (invert): 7347.14 ft

Culvert Length: 53.14 ft, Culvert Slope: 0.0719

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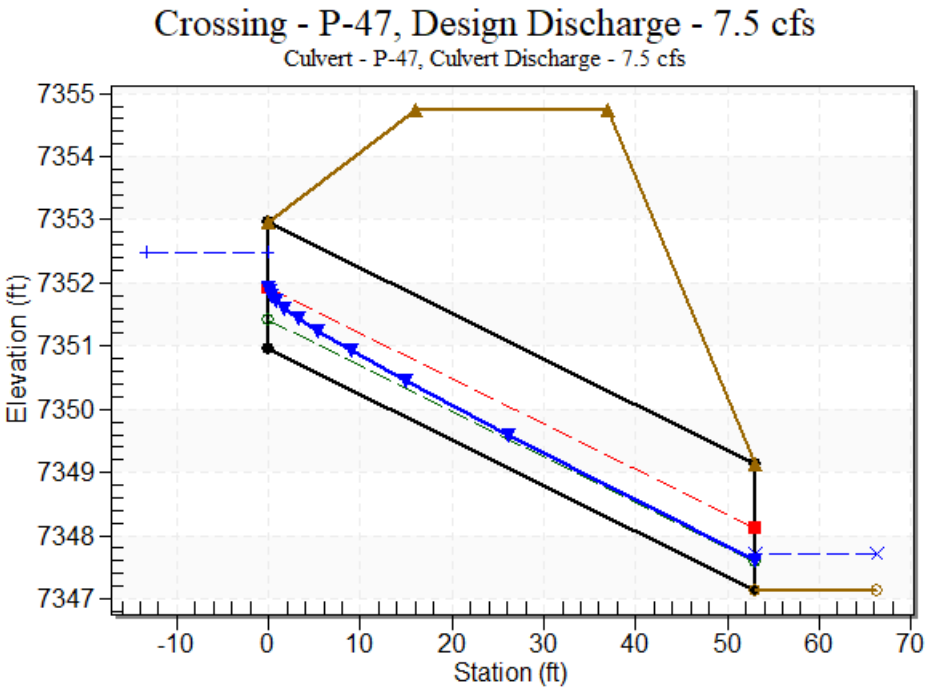
Water Surface Profile Plot for Culvert: P-47



Site Data - P-47

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 7350.95 ft
Outlet Station: 53.00 ft
Outlet Elevation: 7347.14 ft
Number of Barrels: 1

Culvert Data Summary - P-47

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 9 - Downstream Channel Rating Curve (Crossing: P-47)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
7.51	7347.70	0.56
8.27	7347.70	0.56
9.03	7347.70	0.56
9.78	7347.70	0.56
10.54	7347.70	0.56
11.30	7347.70	0.56
12.06	7347.70	0.56
12.82	7347.70	0.56
13.57	7347.70	0.56
14.33	7347.70	0.56
15.09	7347.70	0.56

Tailwater Channel Data - P-47

Tailwater Channel Option: Enter Constant Tailwater Elevation
Constant Tailwater Elevation: 7347.70 ft

Roadway Data for Crossing: P-47

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 7354.75 ft
Roadway Surface: Gravel
Roadway Top Width: 21.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 2.86 cfs
Design Flow: 2.86 cfs
Maximum Flow: 5.73 cfs

Table 10 - Summary of Culvert Flows at Crossing: P-5

Headwater Elevatio	Total Discharge (c	P-5 Discharge (cf	Roadway Dischar (cfs)	Iterations
7189.44	2.86	2.86	0.00	1
7189.49	3.15	3.15	0.00	1
7189.54	3.43	3.43	0.00	1
7189.59	3.72	3.72	0.00	1
7189.64	4.01	4.01	0.00	1
7189.69	4.29	4.29	0.00	1
7189.74	4.58	4.58	0.00	1
7189.79	4.87	4.87	0.00	1
7189.84	5.16	5.16	0.00	1
7189.89	5.44	5.44	0.00	1
7189.94	5.73	5.73	0.00	1
7192.11	12.91	12.91	0.00	Overtopping

Table 11 - Culvert Summary Table: P-5

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwater Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
2.86	2.86	7189.44	1.020	0.655	1-JS1	0.302	0.642	1.500	0.000	1.618	0.000
3.15	3.15	7189.49	1.072	0.672	1-JS1	0.317	0.675	1.500	0.000	1.781	0.000
3.43	3.43	7189.54	1.122	0.690	1-JS1	0.331	0.707	1.500	0.000	1.943	0.000
3.72	3.72	7189.59	1.171	0.710	1-JS1	0.345	0.737	1.500	0.000	2.106	0.000
4.01	4.01	7189.64	1.219	0.732	1-JS1	0.357	0.766	1.500	0.000	2.268	0.000
4.29	4.29	7189.69	1.268	0.755	1-JS1	0.370	0.794	1.500	0.000	2.430	0.000
4.58	4.58	7189.74	1.316	0.779	1-S2r	0.383	0.822	0.458	0.000	10.035	0.000
4.87	4.87	7189.79	1.366	0.806	1-S2r	0.394	0.848	0.475	0.000	10.134	0.000
5.16	5.16	7189.84	1.416	0.833	1-S2r	0.406	0.874	0.492	0.000	10.227	0.000
5.44	5.44	7189.89	1.468	0.863	1-S2r	0.418	0.899	0.508	0.000	10.315	0.000
5.73	5.73	7189.94	1.522	0.894	5-S2r	0.429	0.924	0.525	0.000	10.401	0.000

****

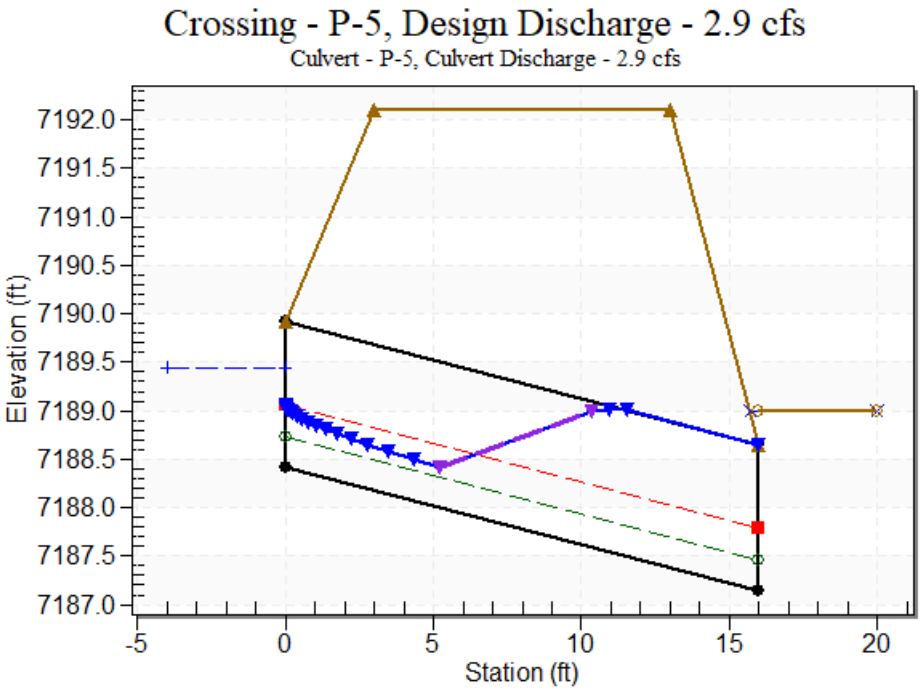
Straight Culvert

Inlet Elevation (invert): 7188.42 ft, Outlet Elevation (invert): 7187.15 ft

Culvert Length: 16.05 ft, Culvert Slope: 0.0794

****

Water Surface Profile Plot for Culvert: P-5



Site Data - P-5

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 7188.42 ft
Outlet Station: 16.00 ft
Outlet Elevation: 7187.15 ft
Number of Barrels: 1

Culvert Data Summary - P-5

Barrel Shape: Circular
Barrel Diameter: 1.50 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 12 - Downstream Channel Rating Curve (Crossing: P-5)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
2.86	7189.00	0.00
3.15	7189.00	0.00
3.43	7189.00	0.00
3.72	7189.00	0.00
4.01	7189.00	0.00
4.29	7189.00	0.00
4.58	7189.00	0.00
4.87	7189.00	0.00
5.16	7189.00	0.00
5.44	7189.00	0.00
5.73	7189.00	0.00

Tailwater Channel Data - P-5

Tailwater Channel Option: Enter Constant Tailwater Elevation
Constant Tailwater Elevation: 7189.00 ft

Roadway Data for Crossing: P-5

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 7192.11 ft
Roadway Surface: Paved
Roadway Top Width: 10.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 1.08 cfs
Design Flow: 1.08 cfs
Maximum Flow: 2.19 cfs

Table 13 - Summary of Culvert Flows at Crossing: P-43

Headwater Elevatio	Total Discharge (c	P-43 Discharge (c	Roadway Dischar (cfs)	Iterations
7373.00	1.08	1.08	0.00	1
7373.03	1.19	1.19	0.00	1
7373.06	1.30	1.30	0.00	1
7373.09	1.41	1.41	0.00	1
7373.12	1.52	1.52	0.00	1
7373.14	1.64	1.64	0.00	1
7373.17	1.75	1.75	0.00	1
7373.19	1.86	1.86	0.00	1
7373.22	1.97	1.97	0.00	1
7373.24	2.08	2.08	0.00	1
7373.27	2.19	2.19	0.00	1
7375.31	10.91	10.91	0.00	Overtopping

Table 14 - Culvert Summary Table: P-43

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwater Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1.08	1.08	7373.0(	0.573	0.119	1-S2r	0.236	0.388	0.263	0.000	5.169	0.000
1.19	1.19	7373.0:	0.603	0.141	1-S2r	0.247	0.408	0.278	0.000	5.268	0.000
1.30	1.30	7373.0(	0.632	0.163	1-S2r	0.258	0.427	0.292	0.000	5.362	0.000
1.41	1.41	7373.0(	0.660	0.184	1-S2r	0.269	0.445	0.306	0.000	5.450	0.000
1.52	1.52	7373.1:	0.688	0.204	1-S2r	0.279	0.463	0.320	0.000	5.531	0.000
1.64	1.64	7373.1-	0.714	0.225	1-S2r	0.289	0.480	0.333	0.000	5.602	0.000
1.75	1.75	7373.1:	0.740	0.245	1-S2r	0.298	0.497	0.345	0.000	5.678	0.000
1.86	1.86	7373.1(	0.765	0.265	1-S2r	0.308	0.513	0.358	0.000	5.746	0.000
1.97	1.97	7373.2:	0.790	0.284	1-S2r	0.317	0.529	0.370	0.000	5.810	0.000
2.08	2.08	7373.2-	0.814	0.303	1-S2r	0.325	0.544	0.381	0.000	5.873	0.000
2.19	2.19	7373.2:	0.838	0.323	1-S2r	0.334	0.559	0.393	0.000	5.931	0.000

****

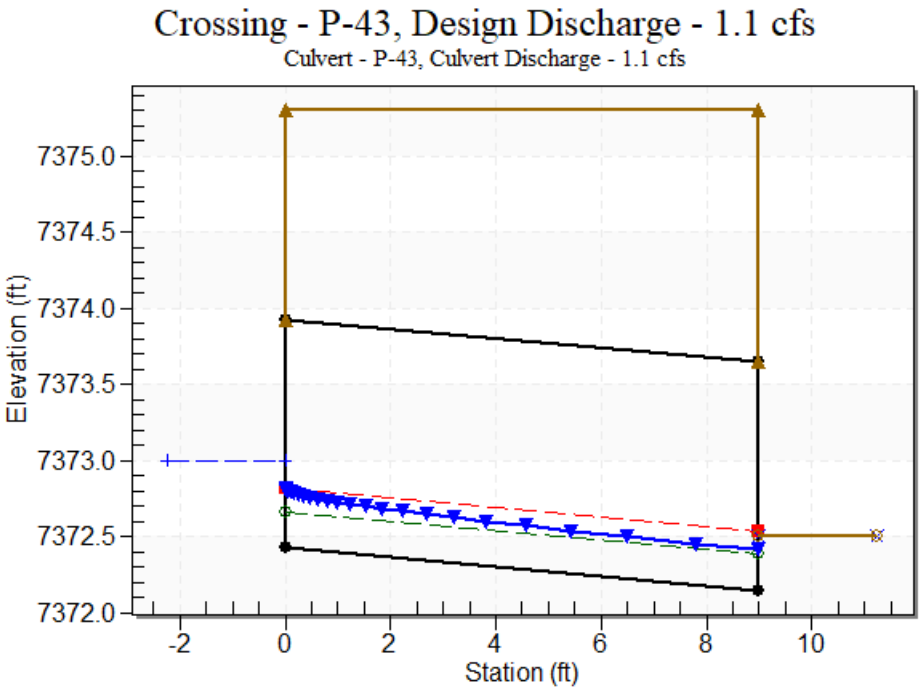
Straight Culvert

Inlet Elevation (invert): 7372.43 ft, Outlet Elevation (invert): 7372.15 ft

Culvert Length: 9.00 ft, Culvert Slope: 0.0311

****

Water Surface Profile Plot for Culvert: P-43



Site Data - P-43

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 7372.43 ft
Outlet Station: 9.00 ft
Outlet Elevation: 7372.15 ft
Number of Barrels: 1

Culvert Data Summary - P-43

Barrel Shape: Circular
Barrel Diameter: 1.50 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 15 - Downstream Channel Rating Curve (Crossing: P-43)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
1.08	7372.50	0.00
1.19	7372.50	0.00
1.30	7372.50	0.00
1.41	7372.50	0.00
1.52	7372.50	0.00
1.64	7372.50	0.00
1.75	7372.50	0.00
1.86	7372.50	0.00
1.97	7372.50	0.00
2.08	7372.50	0.00
2.19	7372.50	0.00

Tailwater Channel Data - P-43

Tailwater Channel Option: Enter Constant Tailwater Elevation
Constant Tailwater Elevation: 7372.50 ft

Roadway Data for Crossing: P-43

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 7375.31 ft
Roadway Surface: Paved
Roadway Top Width: 9.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 0.54 cfs
Design Flow: 0.54 cfs
Maximum Flow: 1.07 cfs

Table 16 - Summary of Culvert Flows at Crossing: P-53

Headwater Elevatio	Total Discharge (c	P-53 Discharge (c	Roadway Dischar (cfs)	Iterations
7363.02	0.54	0.54	0.00	1
7363.03	0.59	0.59	0.00	1
7363.05	0.65	0.65	0.00	1
7363.07	0.70	0.70	0.00	1
7363.09	0.75	0.75	0.00	1
7363.10	0.81	0.81	0.00	1
7363.12	0.86	0.86	0.00	1
7363.14	0.91	0.91	0.00	1
7363.15	0.96	0.96	0.00	1
7363.17	1.02	1.02	0.00	1
7363.18	1.07	1.07	0.00	1
7364.83	8.90	8.90	0.00	Overtopping

Table 17 - Culvert Summary Table: P-53

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwater Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.54	0.54	7363.02	0.386	0.209	1-JS1	0.263	0.272	0.436	0.436	1.266	0.948
0.59	0.59	7363.03	0.405	0.225	1-S2r	0.275	0.285	0.275	0.451	2.669	0.971
0.65	0.65	7363.05	0.423	0.241	1-JS1	0.287	0.298	0.466	0.466	1.380	0.992
0.70	0.70	7363.07	0.441	0.256	1-JS1	0.298	0.310	0.480	0.480	1.434	1.012
0.75	0.75	7363.09	0.458	0.270	1-JS1	0.309	0.322	0.493	0.493	1.485	1.030
0.81	0.81	7363.10	0.474	0.284	1-JS1	0.320	0.334	0.506	0.506	1.536	1.048
0.86	0.86	7363.12	0.491	0.297	1-JS1	0.330	0.345	0.518	0.518	1.584	1.065
0.91	0.91	7363.14	0.506	0.310	1-JS1	0.340	0.355	0.530	0.530	1.631	1.081
0.96	0.96	7363.15	0.521	0.323	1-JS1	0.350	0.366	0.541	0.541	1.677	1.096
1.02	1.02	7363.17	0.536	0.335	1-JS1	0.359	0.376	0.552	0.552	1.722	1.111
1.07	1.07	7363.18	0.551	0.347	1-JS1	0.369	0.386	0.563	0.563	1.765	1.125

****

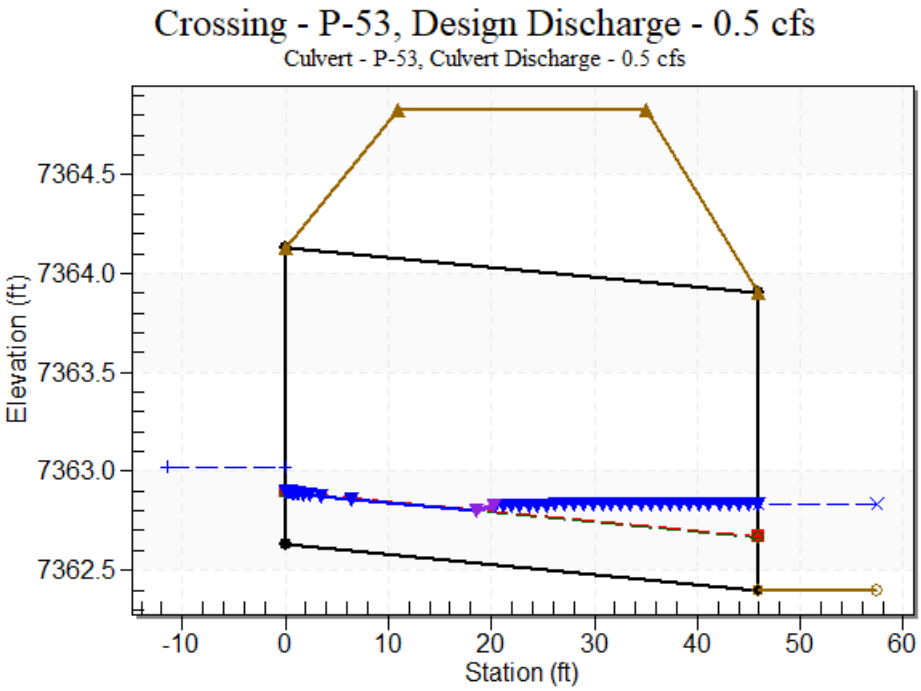
Straight Culvert

Inlet Elevation (invert): 7362.63 ft, Outlet Elevation (invert): 7362.40 ft

Culvert Length: 46.00 ft, Culvert Slope: 0.0050

****

Water Surface Profile Plot for Culvert: P-53



Site Data - P-53

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 7362.63 ft
Outlet Station: 46.00 ft
Outlet Elevation: 7362.40 ft
Number of Barrels: 1

Culvert Data Summary - P-53

Barrel Shape: Circular
Barrel Diameter: 1.50 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 18 - Downstream Channel Rating Curve (Crossing: P-53)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
0.54	7362.84	0.44	0.95	0.08	0.36
0.59	7362.85	0.45	0.97	0.08	0.36
0.65	7362.87	0.47	0.99	0.09	0.36
0.70	7362.88	0.48	1.01	0.09	0.36
0.75	7362.89	0.49	1.03	0.09	0.37
0.81	7362.91	0.51	1.05	0.09	0.37
0.86	7362.92	0.52	1.06	0.10	0.37
0.91	7362.93	0.53	1.08	0.10	0.37
0.96	7362.94	0.54	1.10	0.10	0.37
1.02	7362.95	0.55	1.11	0.10	0.37
1.07	7362.96	0.56	1.13	0.11	0.37

Tailwater Channel Data - P-53

Tailwater Channel Option: Triangular Channel
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0030
Channel Manning's n: 0.0300
Channel Invert Elevation: 7362.40 ft

Roadway Data for Crossing: P-53

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 7364.83 ft
Roadway Surface: Gravel
Roadway Top Width: 24.00 ft

APPENDIX C.5

Outlet Paving Calculations

El Paso County Beacon Lite - Outlet Paving Calculations

Pipe Name	Type of outlet protection	Q_{10} (cfs)	D_c (ft)	Y_t (ft)	$Q/D^{1.5}$ (1)	Y_t/D (1)*	Minimum Riprap Type (1)	$Q/D_c^{2.5}$ (2)	Expansion Factor $1/(2\tan\theta)$ (2)	V (3) (fps)	A_t (ft^2)	L_p (ft)	Min L (ft)	Calculated D_{50} (inches)
P-11	Low Tailwater Basin	34.60	3.00	1.45	6.66	0.48	Type L	2.22	NA	5.00	6.92	NA	NA	4.40
P-17	Riprap lined ditch	0.72	1.50	0.32	0.39	0.21	Type L	0.26	6.50	5.00	0.14	7.00	4.50	0.69
P-18	Low Tailwater Basin	11.42	2.50	0.85	2.89	0.34	Type L	1.16	NA	5.00	2.28	NA	NA	2.91
P-40	Riprap lined ditch	3.02	1.50	0.63	1.64	0.42	Type L	1.10	6.50	5.00	0.60	4.00	4.50	1.28
P-42	Low Tailwater Basin	1.21	1.50	0.28	0.66	0.19	Type L	0.44	NA	5.00	0.24	NA	NA	1.36
P-44	Low Tailwater Basin	3.94	1.50	0.43	2.14	0.29	Type L	1.43	NA	5.00	0.79	NA	NA	2.65
P-45	Riprap Apron	2.36	2.00	0.42	0.83	0.21	Type L	0.42	6.50	5.00	0.47	6.00	6.00	1.50
P-46	Low Tailwater Basin	9.31	2.00	0.76	3.29	0.38	Type L	1.65	NA	5.00	1.86	NA	NA	2.90
P-48	Riprap Apron	0.52	1.50	0.26	0.28	0.17	Type L	0.19	6.50	5.00	0.10	8.00	4.50	0.64
P-53	Riprap Apron	0.54	1.50	0.43	0.29	0.29	Type L	0.20	6.50	5.00	0.11	9.00	4.50	0.36

Riprap Outlet Paving is sized for the 10 Year Storm Frequency CDOT DDM Chapter 7 Table 7.2

Equations:

$D_a = (D_c + Y_N)/2$ Urban Drainage and Flood Control District Manual V.2 Chapter 9 Equation 9-18

$D_{50} = (0.023Q)/Y_t^{1.2}D_c^{0.3}$, inches Urban Drainage and Flood Control District Manual V.2 Chapter 9 Equation 9-16

$A_t = Q_{10}/V$ Urban Drainage and Flood Control District Manual V.2 Chapter 9 Equation 9-12

Thickness$= 2*D_{50}$ Urban Drainage and Flood Control District Manual V.2 Chapter 9 Equation 9-15

$Lp = (1/2\tan\Theta)(A_t/Y_t - W)$ Urban Drainage and Flood Control District Manual V.2 Chapter 9 Equation 9-11

Variables:

- Q= Design Disharge, cfs
- Y_t= Tailwater depth, ft (assumption: used flow depth)
- D_c= Diameter of circular conduit / rise for elliptical culvert, ft
- Y_n= Normal depth of supercritical flow, ft
- D_a= Parameter to use in place of D when flow is supercritical, ft
- θ= Expansion angle of culvert flow
- A_t= Required area of flow at allowable velocity, ft^2.
- V= The allowable non-eroding velocity in the downstream channel, ft/sec
- L= Length of protection, ft
- W= width of the conduit (ft, use diameter for circular conduits)
- D50= Riprap size, inches

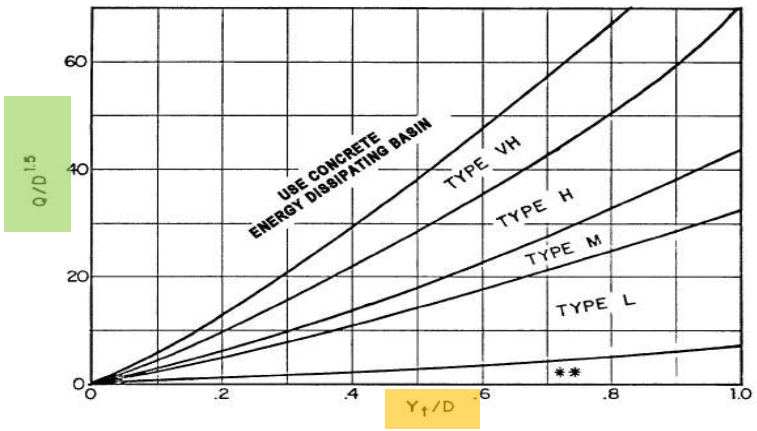
References:

(1) Figure 9-38 Riprap Erosion Protection at Circular Conduit Outlet from Urban Drainage and Flood Control District Manual V.2 Chapter 9

(2) Figure 9-35 Expansion Factor for Circular Conduits from Urban Drainage and Flood Control District Manual V.2 Chapter 9

(3) Assumed acceptable velocity of 5 fps for Non-Cohesive soils or Poor Vegetation per Table 8-1 from Urban Drainage and Flood Control District Manual V.1 Chapter 8

(4) Check Lp, Lp should not be less than 3*D, nor greater than 10*D per Urban Drainage and Flood Control District Manual V.2 Chapter 9



Use D_a instead of D whenever flow is supercritical in the barrel.
** Use Type L for a distance of 3D downstream.

Figure 9-38. Riprap erosion protection at circular conduit outlet (valid for Q/D2.5 ≤ 6.0)

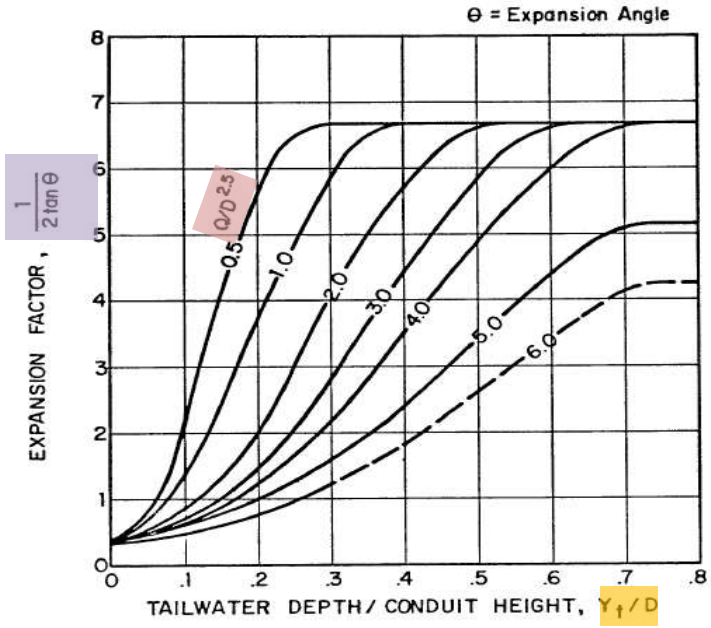


Figure 9-35. Expansion factor for circular conduits

Table 1: Riprap Gradation

Riprap Designation	% Smaller Than Given Size By Weight	Intermediate Rock Dimension (inches)	d_{50}* (inches)
Type VL	70 - 100 50 - 70 35 - 50 2 - 10	12 9 6 2	6**
Type L	70 - 100 50 - 70 35 - 50 2 - 10	15 12 9 3	9**
Type M	70 - 100 50 - 70 35 - 50 2 - 10	21 18 12 4	12**
Type H	70 - 100 50 - 70 35 - 50 2 - 10	30 24 18 6	18
Type VH	70 - 100 50 - 70 35 - 50 2 - 10	41 33 24 9	24

*d_{50} = Mean Particle Size

**Mix VL, L and M riprap with 35% topsoil (by volume) and bury it with 4 to 6 inches of topsoil, all vibration compacted, and revegetate.

Low Tailwater Basin Dimensions

PIPE SIZE OR BOX HEIGHT	D	W*	L
18" – 24"	1'–0"	4'	15'
30" – 36"	1'–6"	6'	20'
42" – 48"	2'–0"	7'	24'
54" – 60"	2'–6"	8'	28'
66" – 72"	3'–0"	9'	32'

* IF OUTLET PIPE IS A BOX CULVERT WITH A WIDTH GREATER THAN W, THEN W = CULVERT WIDTH

APPENDIX C.6

Downstream Analysis

Worksheet for I-25_24"

Project Description	
Friction Method	Manning Formula
Solve For	Full Flow Capacity

Input Data		
Roughness Coefficient	0.012	
Channel Slope	0.052	ft/ft
Normal Depth	24.0	in
Diameter	24.0	in
Discharge	55.88	cfs

Results		
Discharge	55.88	cfs
Normal Depth	24.0	in
Flow Area	3.1	ft²
Wetted Perimeter	6.3	ft
Hydraulic Radius	6.0	in
Top Width	0.00	ft
Critical Depth	23.8	in
Percent Full	100.0	%
Critical Slope	0.049	ft/ft
Velocity	17.79	ft/s
Velocity Head	4.92	ft
Specific Energy	6.92	ft
Froude Number	(N/A)	
Maximum Discharge	60.11	cfs
Discharge Full	55.88	cfs
Slope Full	0.052	ft/ft
Flow Type	Undefined	

GVF Input Data		
Downstream Depth	0.0	in
Length	0.0	ft
Number Of Steps	0	

GVF Output Data		
Upstream Depth	0.0	in
Profile Description	N/A	
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.0	%
Normal Depth Over Rise	100.0	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	24.0	in
Critical Depth	23.8	in
Channel Slope	0.052	ft/ft
Critical Slope	0.049	ft/ft

Worksheet for I-25_24"

Messages	
Notes	Design Point 1

Worksheet for I-25_42"

Project Description	
Friction Method	Manning Formula
Solve For	Full Flow Capacity

Input Data	
Roughness Coefficient	0.012
Channel Slope	0.052 ft/ft
Normal Depth	24.0 in
Diameter	24.0 in
Discharge	55.88 cfs

Results	
Discharge	55.88 cfs
Normal Depth	24.0 in
Flow Area	3.1 ft²
Wetted Perimeter	6.3 ft
Hydraulic Radius	6.0 in
Top Width	0.00 ft
Critical Depth	23.8 in
Percent Full	100.0 %
Critical Slope	0.049 ft/ft
Velocity	17.79 ft/s
Velocity Head	4.92 ft
Specific Energy	6.92 ft
Froude Number	(N/A)
Maximum Discharge	60.11 cfs
Discharge Full	55.88 cfs
Slope Full	0.052 ft/ft
Flow Type	Undefined

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	100.0 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	24.0 in
Critical Depth	23.8 in
Channel Slope	0.052 ft/ft
Critical Slope	0.049 ft/ft

Worksheet for I-25_42"

Messages	
Notes	Design Point 2

EXHIBITS

EXHIBIT 1

Major Basin Map

Drainage Basins

El Paso County
Colorado

Legend

- Drainage Basins Source: Muller Engineering Company (1988)
- US Interstate Highways
- US Highways
- Colorado State Highways
- Major Roadways
- Local Streets & Roads

Creeks

- Perennial
- Intermittent
- Lakes & Reservoirs
- Summits
- Unincorporated Urban Areas
- Incorporated Cities
- Military
- Forest
- County Lines

N W E S

Miles

0 0.5 1 2 3 4 5

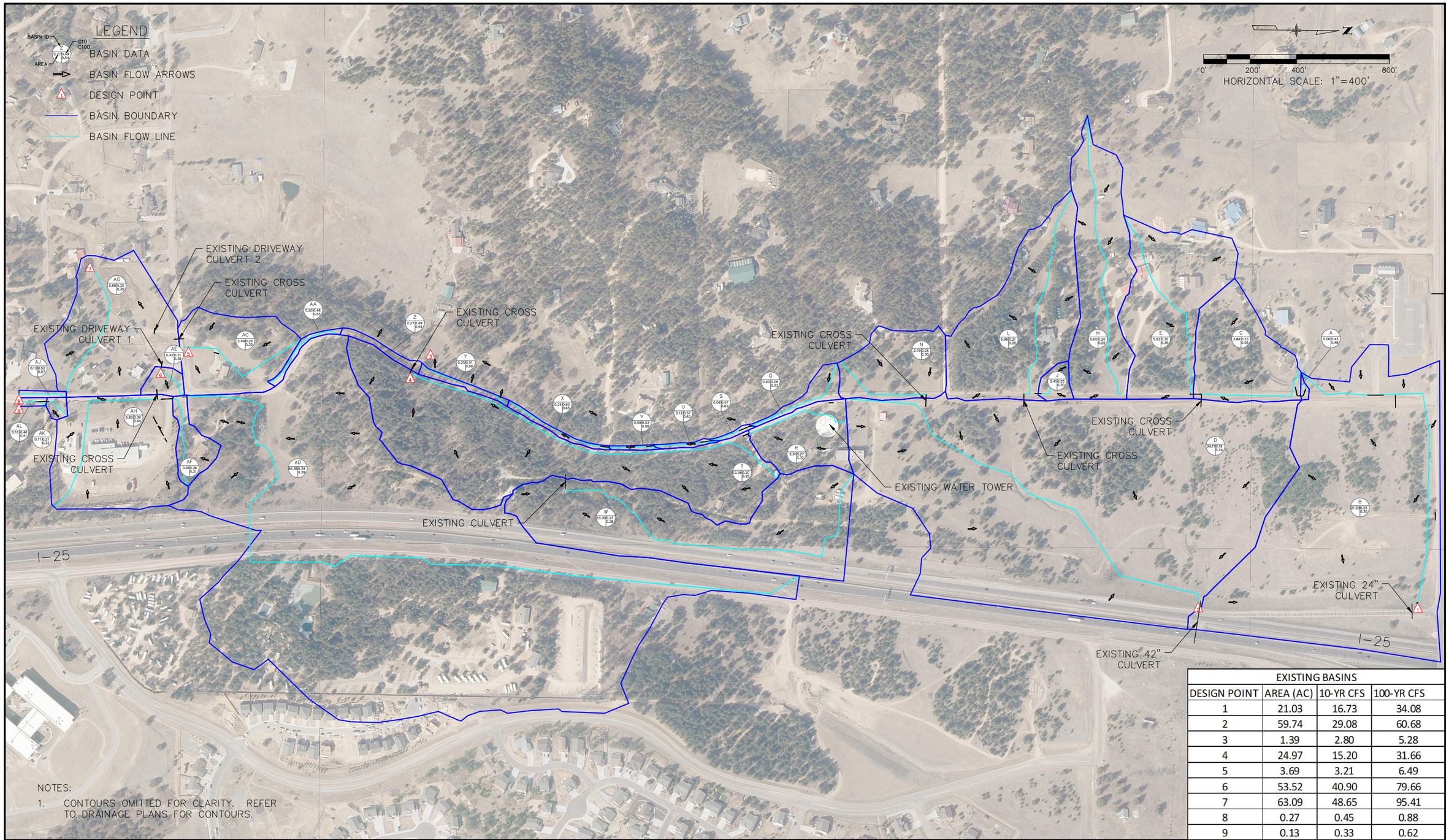
Douglas County
Elbert County
Teller County
Lincoln County
Fremont County
Pueblo County

Upper Monument Creek FOMO5800
Monument Rock FOMO5000
Monument Jackson FOMO4400
Dirty Woman Creek FOMO5200
West Cherry Creek CYCY0400
East Cherry Creek CYCY0200
West Kiowa Creek KIKI0200
East Kiowa Creek KIKI0400
Bijou Creek BIBI0200
Upper Big Sandy Creek BGBG1400
Antelope Creek BGBG0800
Lenard BGBG1200
Simla BGBG0400
Ramah BGBG0600
Mustang Creek BGBG0200
Calhan BGBG1000
Beaver Creek FOMO4600
Black Forest FOMO4200
Monument Branch FOMO3800
Black Squirrel Creek FOMO3600
Upper Black Squirrel CHBS2000
Upper Bracket Creek CHBR0600
North Fork HOHO0400
Pike National Forest
Air Force Academy FOMO3200
USAF Academy
Kettle Creek FOMO3000
Bennett Ranch CHWS1200
Geick Ranch CHMS0400
La Vega Ranch CHBR0400
Horse Creek HOHO0600
Pine Creek FOMO2800
South Pine Creek FOMO2600
Dry Creek FOMO2400
Cottonwood Creek FOMO2200
Falcon CHWS1400
Hook And Line Ranch CHBS1800
Baggett CHBR0200
Little Horse Creek HOHO0200
Steels Fork HOPO1000
Upper Fountain FOFO7600
Cheyenne Canon FOFO5800
Douglas Creek FOMO1000
Templeton Gap FOMO1200
Solbers Ranch CHWS0800
Haegler Ranch CHMS0200
West Big Springs Creek CHBG0200
Upper Big Springs Creek CHBG0400
Williams Canyon FOFO7200
Curtis Ranch CHWS1000
Sand Creek FOFO4000
Manitou Reservoir FOFO7400
Shooks Run FOFO5400
Rush HOPO0800
Livestock Company CHWS0400
Ellicott CHBS1600
Lower Big Springs Creek CHBS1400
Telephone Exchange CHWS0200
Ellicott Consolidated CHBS1200
Upper Pond Creek HOPO0600
Lower Pond Creek HOPO0400
Ruxton Creek FOFO7000
Sutherland Creek FOFO6400
Upper Beaver Creek BEBE0400
Bear Creek FOFO4800
Peterson Field FOFO3400
Jimmy Camp Creek FOFO2000
Upper East Chico CHEC0400
Schriever AFB
Crows Roost CHBS1000
Drennan CHBS0400
Middle East Chico CHEC0200
Southwest Area FOFO4600
Fishers Canyon FOFO3600
Windmill Gulch FOFO3000
Big Johnson FOFO2600
Upper Williams Creek FOWI0600
Upper Chico Creek CHCH1600
Upper Dry Squirrel CHDS0200
Haynes Creek HAHA0600
St.lukes HOPO0200
Fort Carson FOFO2200
Upper Williams Tributary FOWI0400
West Chico Tributary CHCH1200
Lower Black Squirrel CHBS0600
Little Fountain Creek FOFO1800
Chico Creek CHCH1400
Squirrel Creek CHBS0200
Calhan Reservoir FOFO1400
Lower Williams Creek FOFO1000
Lower Williams Tributary FOWI0200
Lower Dry Squirrel CHBS0400
East Kramer KRKR0600
Fort Carson
Sand Canyon FOFO1600
Lower East Chico CHCH0800
Kramer Creek KRKR0400
Turkey Creek TUTU0200
East Haynes HAHA0400
Hammer Ranch CHCH0600
Finch Ranch CHCH0400
Windmill CHCH0200
Sand Creek FOFO0600
Williams Ranch FOFO0400
Midway Ranch FOFO0800
West Haynes HAHA0200
West Kramer KRKR0200
Red Creek BEBE0200
West Chico Creek CHCH0600
Young Hollow FOFO0200

Cripple Creek
Victor
Woodland Park
Manitou Springs
Colorado Springs
Peterson AFB
Schriever AFB
Fountain
Falcon
Peyton
Calhan
Ramah
Ellicott
Yoder
Rush
Truckton
Cascade
Crystola
Chipita Park

EXHIBIT 2

Basin Maps



NOTES:

1. CONTOURS OMITTED FOR CLARITY. REFER TO DRAINAGE PLANS FOR CONTOURS.

EXISTING BASINS			
DESIGN POINT	AREA (AC)	10-YR CFS	100-YR CFS
1	21.03	16.73	34.08
2	59.74	29.08	60.68
3	1.39	2.80	5.28
4	24.97	15.20	31.66
5	3.69	3.21	6.49
6	53.52	40.90	79.66
7	63.09	48.65	95.41
8	0.27	0.45	0.88
9	0.13	0.33	0.62

Print Date: 03/04/2022
File Name: 175644_HYD_Basin Maps.dwg
Horiz. Scale: 1"=400' Vert. Scale: N/A
Unit Information Unit Leader Initials

Michael Baker INTERNATIONAL
MICHAEL BAKER INTERNATIONAL, INC.
165 S. UNION BLVD., STE. 1000
LAKEWOOD, CO 80228
720.514.1100

Sheet Revisions		
Date:	Comments	Init.

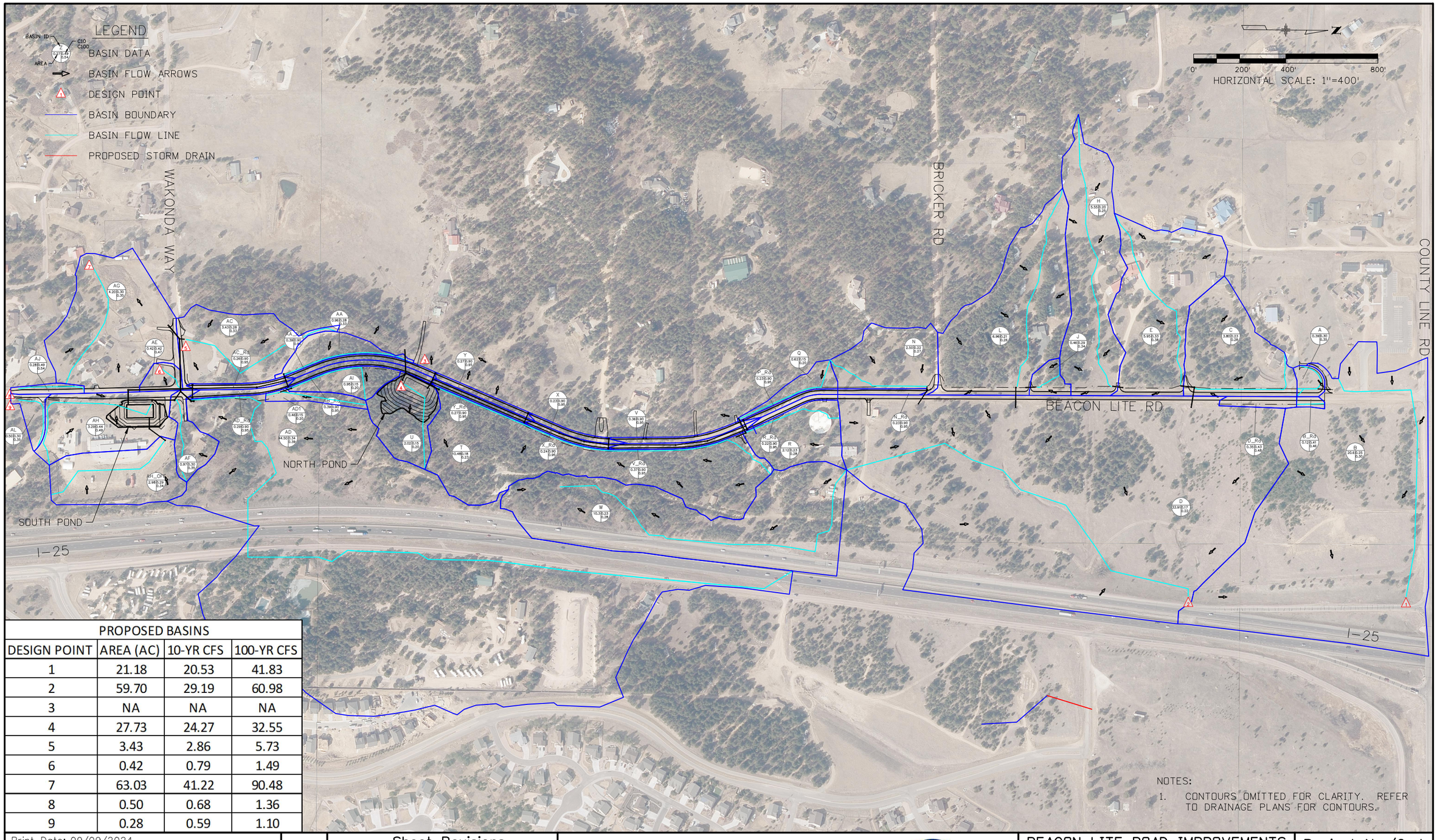
EL PASO COUNTY COLORADO

PIKES PEAK RURAL TRANSPORTATION AUTHORITY PPRTA

BEACON LITE ROAD IMPROVEMENTS DRAINAGE BASIN MAP EXISTING

Project No./Code: 128558

Designer: NED
Detailer: RBR
Sheet Subset: BASIN MAPS
Structure Numbers:
Subset Sheets: 1 OF 4
Sheet Number



PROPOSED BASINS			
DESIGN POINT	AREA (AC)	10-YR CFS	100-YR CFS
1	21.18	20.53	41.83
2	59.70	29.19	60.98
3	NA	NA	NA
4	27.73	24.27	32.55
5	3.43	2.86	5.73
6	0.42	0.79	1.49
7	63.03	41.22	90.48
8	0.50	0.68	1.36
9	0.28	0.59	1.10

NOTES:
1. CONTOURS OMITTED FOR CLARITY. REFER TO DRAINAGE PLANS FOR CONTOURS.

Print Date: 09/09/2024
File Name: 175644_HYD_Basin Maps Prop.dwg
Horiz. Scale: 1"=400' Vert. Scale: N/A
Unit Information Unit Leader Initials

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Sheet Revisions

Date:	Comments	Init.

EL PASO COUNTY
COLORADO

PPRTA

BEACON LITE ROAD IMPROVEMENTS DRAINAGE BASIN MAP PROPOSED

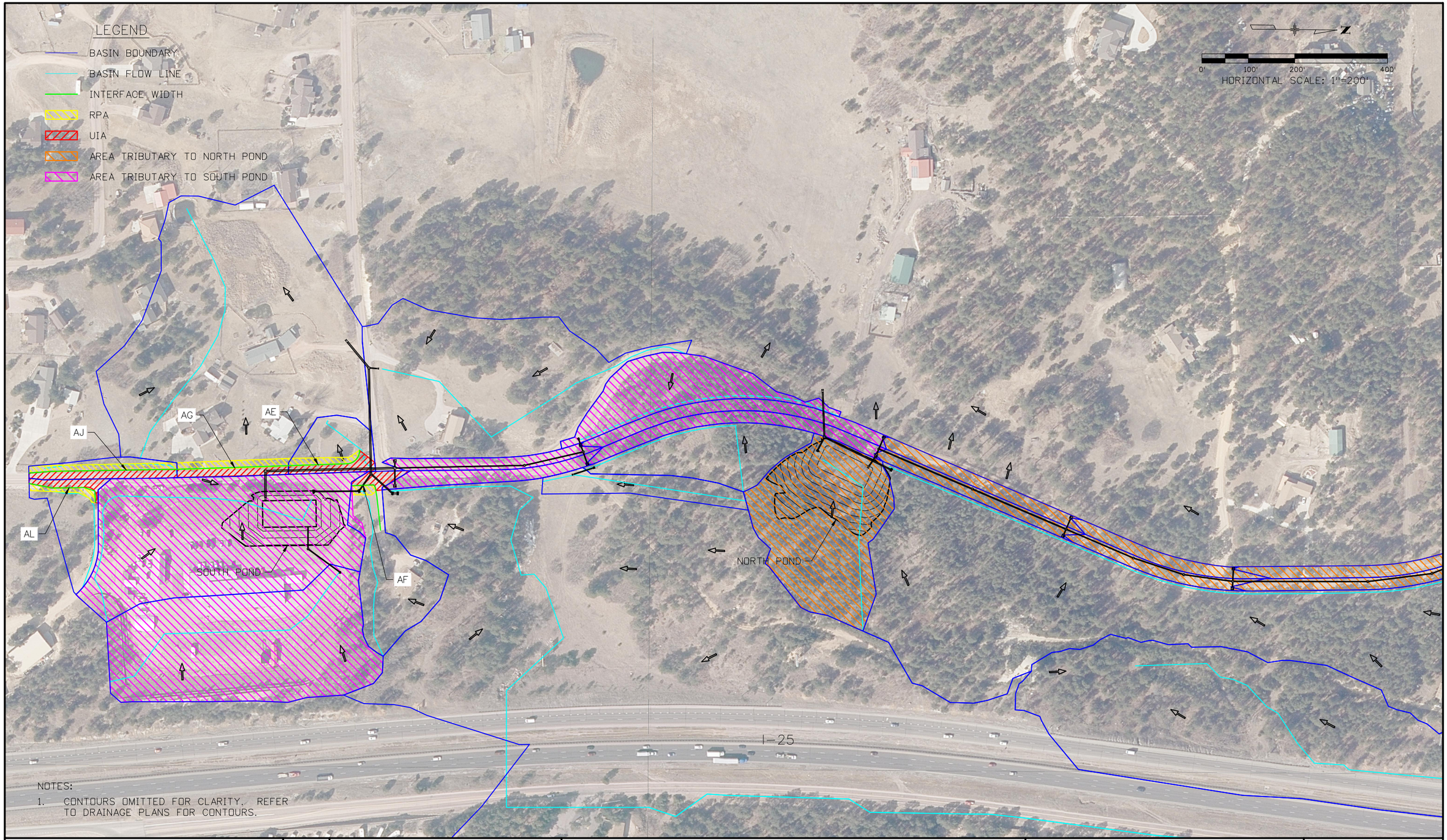
Designer:	NED	Structure Numbers	
Detailer:	RBR		
Sheet Subset:	BASIN MAPS	Subset Sheets:	2 OF 4

Project No./Code: 128558

Sheet Number

EXHIBIT 2

BMPs



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Horiz. Scale: 1"=200' Vert. Scale: N/A
Unit Information Unit Leader Initials

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Sheet Revisions		
Date:	Comments	Init.

EL PASO COUNTY
COLORADO

PPRTA

BEACON LITE ROAD IMPROVEMENTS DRAINAGE BASIN MAP BMP'S

Designer:	NED	Structure Numbers	
Detailer:	RBR		
Sheet Subset:	BASIN MAPS	Subset Sheets:	3 OF 4

Project No./Code
128558

Sheet Number

LEGEND

- BASIN BOUNDARY
- BASIN FLOW LINE
- INTERFACE WIDTH
- RPA
- UIA
- AREA TRIBUTARY TO NORTH POND
- AREA TRIBUTARY TO SOUTH POND

N

0' 100' 200' 400'

HORIZONTAL SCALE: 1"=200'

A2 A1 L J H E C D5 D4 D3 D2 D_Rd B_Rd B

NOTES:

1. CONTOURS OMITTED FOR CLARITY. REFER TO DRAINAGE PLANS FOR CONTOURS.

Print Date: 09/09/2024
File Name: 175644_HYD_Basin Maps Prop.dwg
Horiz. Scale: 1"=200' Vert. Scale: N/A
Unit Information Unit Leader Initials

Michael Baker INTERNATIONAL
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Sheet Revisions

Date:	Comments	Init.

EL PASO COUNTY COLORADO

PPRTA PIKES PEAK RURAL TRANSPORTATION AUTHORITY

BEACON LITE ROAD IMPROVEMENTS DRAINAGE BASIN MAP BMP'S

Project No./Code: 128558

Designer: NED
Detailer: RBR
Sheet Subset: BASIN MAPS
Structure Numbers:
Subset Sheets: 4 OF 4
Sheet Number