PHASE III DRAINAGE REPORT

FOR

DAWSON TRAILS FILING NO. 2
TOWN OF CASTLE ROCK, COLORADO
PROJECT NO. CD23-0045

Prepared for:

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April 30, 2025

Engineer's Statement:

I affirm that this report and plan for the Phase III drainage design of Dawson Trails Filing No. 2 was prepared by me (or under my direct supervision) in accordance with the provisions of the Town of Castle Rock Drainage Design and Technical Criteria for the owners thereof. I understand that the Town of Castle Rock does not and will not assume liability for drainage facilities designed by others.

_____

David J. Ott, P.E.
Colorado Professional Engineer
License #38935

Developer's Statement:

ACM Dawson Trails JV LLC hereby certifies that the drainage facilities for Dawson Trails Filing No. 2 shall be constructed according to the design presented in this report. I understand that the Town of Castle Rock does not and will not assume liability for the drainage facilities designed and/or certified by my engineer and that the Town of Castle Rock reviews drainage plans pursuant to the Municipal Code; but cannot, on behalf of Dawson Trails Filing No. 2 , guarantee that final drainage design review will absolve ACM Dawson Trails JV LLC and/or their successors and/or assigns of future liability for improper design.

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Lawrence Jacobson
Owner/Developer

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I. GENERAL LOCATION AND DESCRIPTION

A. Site Location

This Phase III Drainage Report provides an analysis of the drainage patterns and facilities for the proposed Dawson Trails Filing No. 2 project located within the Dawson Trails Proposed Development Plan (PDP).

The Dawson Trails Filing No. 2 project is bounded by Burlington Northern Santa Fe (BNSF) Railway and Interstate 25 (I-25) to the east, Twin Oaks subdivision to the north, undeveloped Dawson Trails to the west and south. The Site is located in parts of Sections 21, 22, 27, and 28 of Township 8 South, Range 67 West of the Sixth Principal Meridian, Town of Castle Rock, County of Douglas, State of Colorado. A vicinity map is included in **Appendix A**.

The Dawson Trails Filing 2 project will construct roadway, drainage, and utility improvements to support development in the area southeast of the Crystal Valley Interchange (CVI), which is currently in design. Improvements to be constructed with this project include:

- The west half of Dawson Trails Blvd roughly from North Dawson Tributary north to Crystal Valley Pkwy (4,900 LF), including water main
- Gambel Ridge Blvd. roadway improvements (5,300 LF), including water, sanitary sewer and storm sewer
- Schroeder Drive roadway improvements (1,100 LF), including water sanitary sewer and storm sewer
- Blanca Peak Pkwy. roadway improvements (2,200 LF), including water, sanitary sewer and storm sewer
- Quandary Peak Drive roadway improvements (1,500 LF), including water, sanitary sewer and storm sewer
- Ike Street roadway improvements (2,200 LF), including water main and sanitary sewer
- North Dawson Tributary Major Drainageway Improvements
- In-line regional detention facility A1 on North Dawson Tributary
- Off-line regional detention facility B1, adjacent to Gambel Ridge Tributary
- Off-line water quality facilities D3, D4 and D5, adjacent to North Dawson Tributary
- Full-spectrum facility D1, modified from existing Dawson Trails Boulevard Pond B

The Dawson Trails Filing No. 2 Project coordinates with several other projects that facilitate development in the region:

Crystal Valley Interchange (by others) (preceding)
CIP22-0012 Dawson Trails Boulevard (preceding)
CD22-0054 Dawson Trail (Dawson Ridge Infrastructure) Demolition (preceding)
CD23-0015 Dawson Trails South Early Grading (preceding)
CD22-0056 Dawson Trails Early Grading North, Regions 1-4 (preceding)
CD23-0002 Dawson Trails Offsite Sanitary Sewer Main and Interceptor (preceding)
CD23-0034 Dawson Trails Filing No. 1 Infrastructure – South (concurrent)
CD23-0020 Dawson Trails Blvd Infrastructure North (concurrent)
SDP23-0020 Costco (Dawson Trails) (concurrent)

SDP23-0023 Dawson Trails Residential Neighborhood (PA B-1) (subsequent)

The proposed improvements succeed an early grading operation over all of the aforementioned roadway and drainage corridors, and portions of planning areas B1, D, E2, F3, and G1 of the Dawson Trails Preliminary Development Plan.

B. Description of Property

The Dawson Trails Filing No. 2 project covers approximately 445 acres. The project area is generally undeveloped. Abandoned roadway infrastructure in the northeast part of the site is programmed for demolition under a separate project (CD22-0054). Another preceding project (CD22-0012) will construct the eastern half of Dawson Trails Blvd between Crystal Valley Pkwy and the southern Dawson Trails (PD) boundary.

The project area is entirely contained within two major watersheds: North Dawson Tributary and Gambel Ridge Tributary.

North Dawson Tributary is analyzed in the Flood Hazard Area Delineation (FHAD) study: *North and South Dawson Master Plan and Flood Hazard Area Delineation.* Gambel Ridge Tributary is analyzed in the FHAD study: *Flood Hazard Area Delineation -- Gambel Ridge and Douglas Lane Tributary Watershed.* The project area is contained within FIRM map panel 08035C0284G. There are no FEMA Special Flood Hazard Areas (SFHAs) from either tributary within the site boundary.

The Town of Castle Rock recognizes floodplain areas along both the Gambel Ridge and North Dawson Tributaries in the following documents:

- Flood Hazard Area – Delineation Gambel Ridge and Douglas Lane Tributary Watersheds by Respec Consulting and Service, July 2014 [Reference F]
- Gambel Ridge and Douglas Lane Tributary Watersheds – Master Plan by Respec Consulting and Service, July 2014. [Reference G]
- North and South Dawson Watershed Master Plan Draft Preliminary Design Report, dated February 2011, CH2MHill (Reference K]

The floodplain areas are depicted on the drainage maps using boundary data obtained electronically from the Town of Castle Rock. Floodplain Modification Studies for adjoining projects are currently under review and will be referenced in this report once they are formally adopted.

According to the Natural Resources Conservation Service (NRCS) Web Soil Survey, soils on-site include Blakeland-Orsa association, 1 to 4 percent slopes (Bo), Bresser sandy loam, cool, 1 to 3 percent slopes (BrB), Bresser sandy loam, cool, 5 to 9 percent slopes (BrD), Bresser-Truckton sandy loams, 5 to 25 percent slopes (BtE), Bresser and Truckton soils, 3 to 12 percent slopes, eroded (BUD2), Crowfoot-Tomah sandy loams, 5 to 25 percent slopes (CrE), Englewood clay loam (En) Fondis-Kutch association (Fu), Pits, gravel (GP), Kutch sandy loam, 5 to 20 percent slopes (KtE), Kutch clay loam, 4 to 8 percent slopes (KuD), Loamy alluvial land (Lo), Loamy alluvial land, dark surface (Lu), Newlin gravelly sandy loam, 8 to 30 percent slopes (NeE), Peyton-Pring-Crowfoot sandy loams, 5

to 25 percent slopes (PpE), Peyton-Pring-Crowfoot complex, 3 to 15 percent slopes, eroded (PrE2), Razor clay, 3 to 25 percent slopes, Renohill-Buick complex, 5 to 25 percent slopes (RmE), Sampson loam (Sa), Sandy wet alluvial land (Se), Stapleton-Bresser association (St), and Water (W). The predominant hydrologic soil groups on the site are B/C soils, however the hydrologic calculations assumed all C/D soils for a more conservative analysis and to consider the potential for previous grading.

Soils are classified as Hydrologic Soil Group (HSG) A (having a high infiltration rate when thoroughly wet), HSG B (having a moderate infiltration rate when thoroughly wet), HSG C (having slow infiltration rates with high surface runoff), and HSG D (having a very slow infiltration rates and a very slow rate of water transmission). A HSG Map as part of the Web Soil Survey is included in **Appendix A**.

There are no irrigation canals within or near the project area.

There are no notable geologic features within or near the site.

A variety of land uses are programmed within the tributary area of the Filing 2 projects, per the approved Dawson Trails PDP. Allowable land uses are listed below. Drainage infrastructure constructed with the Filing 2 package is intended to serve as spine infrastructure and accommodate future development.

- SFD (Single Family Detached Residential)
- SFA (Single Family Attached Residential)
- MF (Multifamily Residential)
- Non-Res (Commercial, Retail, Industrial, Institutional)
- PL-1 (Parks, Educational, Community)
- PL-2 (Public open space)
- OSP (Private parks and open space)

Two planning areas adjacent to the Filing 2 improvements—P.A. B1 and P.A. D—have preliminary land plans for residential development underway. Other planning areas will be submitted for development at a future date. Road, drainage, and utility improvements in these areas are coordinated with those land plans.

II. DRAINAGE BASINS AND SUB-BASINS

A. Major Drainage Basins

Major Drainageways; [Existing Drainage Maps 1,2]
Two major drainageways cross through the site: Gambel Ridge Tributary and North Dawson Tributary. These are described as follows:

Gambel Ridge Tributary (Basin EX-8):
Consists of 607.63 acres comprised of existing single-family residential within the Twin Oaks subdivision and undeveloped land. Basin EX-8 is part of the Gambel Ridge Tributary. Flows within this basin generally flow east to existing triple 6' x 9' CMP culverts, located at existing design point 8, underneath the BNSF railroad and underneath Interstate 25 via a 6' x 10' RBC. The demolition activities of project CD22-0054 have taken place within this watershed.

North Dawson Tributary (Basin EX-11):
Consists of 237.19 acres comprised of undeveloped land. Basin EX-11 is part of the North Dawson Tributary. Flows within this basin generally flow east to an existing 7.5' x 28' bridge opening, located at existing design point 11, underneath the BNSF railroad and are conveyed via a 4' x 8' concrete box culvert underneath Interstate 25, approximately 600 feet south of mile marker 178.

Gambel Ridge Tributary and North Dawson Tributary both discharge to East Plum Creek approximately 1000 feet east of the Dawson Trails Planned Development boundary. East Plum Creek is the primary receiving drainageway for the Castle Rock region and ultimately flows to the South Platte River at Chatfield Reservoir. The East Plum Creek drainageway has a floodway that is mapped by FEMA and the Town of Castle Rock. No part of the East Plum Creek floodplain or floodway encroaches into the Dawson Trails Planned Development. Since East Plum Creek is part of the Chatfield Basin, the drainage design of Dawson Trails may subject to additional requirements under the Chatfield Reservoir Control Regulation No. 73.

Other Existing Drainage Basins and Outfalls: [Existing Drainage Maps 1,2]
Several smaller drainage basins exist in the eastern portion of the site. All of these areas drain eastward through the BNSF railroad and Interstate 25 rights-of-way, ultimately discharging to East Plum Creek:

Basin EX-9:
Consists of 136.84 acres comprised of an abandoned building and undeveloped land. Basin EX-9 is a part of the Gambel Ridge Tributary. Flows within this basin generally flow east to an existing dual 36" CMP culverts, located at existing design point 9, underneath the BNSF railroad and underneath Interstate 25 via an existing 48" RCP.

Basin EX-10:
Consists of 91.52 acres comprised of existing single-family residential area and undeveloped land. Flows within this basin generally flow east to an existing 6' CMP culvert, located at existing design point 10, underneath the BNSF railroad and underneath Interstate 25 via an existing 18" RCP.

Basin EX-12:
Consists of 38.33 acres comprised of open space. Basin EX-12 is a part of the North Dawson Tributary. Flows within this basin generally flow east to an existing 24" steel pipe, located at existing design point 12, underneath the BNSF railroad and underneath Interstate 25 via an existing 24" RCP.

Basin EX-13:
Consists of 25.80 acres comprised of undeveloped land. Basin EX-13 is not a part of any major tributary. Flows within this basin generally flow east to a low point at design point 13.

In the proposed condition, runoff will primarily be directed to either design point 12 (North Dawson Tributary at the BNSF railroad) and design point 8 (Gambel Ridge Tributary at the BNSF railroad).

B. Minor Drainage Basins

Upper Gambel Ridge Watershed (Watershed B)

The upper portion of Gambel Ridge Tributary watershed is designated as Major Basin B. Planning Area B1 forms a significant part of Gambel Ridge Tributary's upper watershed. This area is not on the main stem of the tributary. The upper basins of Gambel Ridge Tributary are modeled in this report with CUHP and SWMM. The areas of upper Gambel Ridge Tributary are designated as Major Basin B, with offsite areas of the upper watershed delineated into basin OS-1 and OS-2.

Upper Gambel Ridge Watershed: Onsite Major Basins used in CUHP/SWMM Analysis: [Proposed Overall SWMM Map 2, and see Overall Basin Map]

Basin H-1 *(46.4 acres | 8% Impervious | Q100 = 68.7 cfs)*
Major basin H-1 contains the uppermost areas of the Gambel Ridge Watershed. H-1 is ultimately reserved for open space, park facilities, and a school site. A future detention pond (Pond B2) is planned for attenuation of developed flows from Basin H-1. This pond will be required when development of Basin H-1 commences.

Basin H-2 *(76.0 acres | 28% Impervious | Q100 = 125 cfs)*
Major Basin H-2 contains the western half of Planning Area B1, which is designated for future residential development per the approved Dawson Trails Development Plan. Neither H-1 nor H-2 are part of the Filing 2 early grading effort. The current land plan for Planning Area B1 accounts for surface conveyance of runoff from Basins H-1 and H-2 through a drainage/open space tract to regional Pond B1.

Basin H-3 *(5.5 acres | 38.8% Impervious | Q100 = 12.3 cfs),*
Major Basin H-3 contains the central portion of Planning Area B1, which is designated for future residential development per the approved Dawson Trails Development Plan. The current land plan for Planning Area B1 accounts for surface conveyance of runoff from Basins H-1, H-2, and H-3 through a drainage/open space tract to regional Pond B1. This basin is tributary to the Regional Pond B1 and has been accounted for in its sizing.

Basin H-4 *(8.1 acres | 43.5% Impervious | Q100 = 18.0 cfs),*
Major Basin H-4 contains the central portion of Planning Area B1, which is designated for future residential development per the approved Dawson Trails Development Plan. The current land plan for Planning Area B1 accounts for surface conveyance of upstream runoff from Basins H-1, H-2, and H-3through a drainage/open space tract to regional Pond B1. H-4 generally covers the open space area that is programmed for that open channel and adjacent development areas the will surface flow to the channel. This basin is tributary to the Regional Pond B1 and has been accounted for in its sizing.

Basin H-5 *(39.4 acres | 67.2% Impervious | Q100 = 106 cfs)*
Major Basin H-5 contains the central and northern portion of Planning Area B1, which is designated for future residential development per the approved Dawson Trails Development Plan. The current land plan for Planning Area B1 accounts for surface conveyance of runoff from Basins H-1, H-2, H-3, H-4, and H-5 through a drainage/open space tract to regional Pond B1. This basin is tributary to the Regional Pond B1 and has been accounted for in its sizing.

Basin H-6 (B6 in Rational) *(25.3 acres | 42.1% Impervious | Q100 = 32.7 cfs)*
Major Basin H-6 contains Gambel Ridge Blvd. right-of-way and opens space land. Gambel Ridge Blvd. is a critical infrastructure component of this project and will drain south to north towards Pond B1 for treatment and detention before release. This basin is tributary to the Regional Pond B1 and has been accounted for in its sizing.

Basin H-7 *(6.5 acres |70.2% Impervious | Q100 = 18.9 cfs)*
Major Basin H-7 contains the northern portion of Planning Area B1, which is designated for future residential development and a regional detention facility. Per the approved Dawson Trails Development Plan. Basin H-7 will contain the Regional Detention Pond B1 and release flows offsite, into the existing Gambel Ridge Tributary.

Major Basins H-3, H-4, and H-5 contain the first planned phase of development in Planning Area B1 and includes open space areas. The H-3, H-4 and H-5 major basins are all anticipated to drain to an open channel that crosses through the residential development area in route to Pond B1. No drainage improvements are proposed in these major basins by the Filing 2 project; all internal drainage improvements will be in a separate Filing for Planning Area B1. The eastern half of Planning Area B1 will be overlot graded by the separate Filing 2 Early Grading project, prior to the formal infrastructure package proposed with this project. Temporary sediment basins to manage disturbed area runoff will be left in the interim, until commencement of the Planning Area B1 project.

Basin H-8 *(10.6 acres | 36.4% Impervious | Q100 = 9.70 cfs)*
Major Basin H-8 contains open space and a proposed swale to assist in storm water conveyance. Basin H-8 is part of a future construction phasing effort and flows generated from this basin are intended to be routed offsite and not impact the sizing of Pond B1.

Water quality treatment for Upper Gambel basins (Basins H-2 through H-8), are accommodated in proposed regional Pond B1 in the interim and final conditions.

Upper Gambel Ridge Watershed: Offsite (OS) Basins used in CUHP/SWMM Analysis: [Proposed Overall SWMM Map 2] and see Overall Basin Map

Basin OS-1 *(69.4 acres |8.7% Impervious | Q100 = 81.4 cfs)*
Basin OS-1 contains rural residential areas directly north of the project site that surface drain across the site's north boundary to an existing, poorly defined swale. The existing swale flows eastward, roughly paralleling the property boundary, to Gambel Ridge Tributary where it crosses into the site. Offsite flows will enter Basin H-8 where they will be captured by a proposed drainage swale which will convey flows east, where they will exit the site and re-enter Gambel Ridge Tributary. Hydrology of OS-1 is analyzed by CUHP method and results can be found in **Appendix B** of this report. These flows will not be treated in the Regional Detention Pond B1 and were not considered for its sizing. Basin OS-1 is outside of the Town limits and there are no planning documents that anticipate further development.

Basin OS-2 *(101 acres | 3.9% Impervious | Q100 = 108 cfs)*
Basin OS-2 contains rural residential areas in Gambel Ridge Tributary's main stem. Gambel Ridge Tributary crosses into the site near the northeast corner and exits back

across the north boundary about 500 feet further east. Drainage patterns from OS-2 will generally remain unchanged from historic conditions. Hydrology of OS-2 is analyzed by CUHP method and results can be found in **Appendix B** of this report. Basin OS-2 is outside of the Town limits and there are no planning documents that anticipate further development.

Basin OS-3 *(98.8 acres | 10.4% Impervious | Q100 = 153 cfs)*
Basin OS-3 contains rural residential areas in Gambel Ridge Tributary's main stem. Flows from Basin OS-3 will enter the Gamble Ridge Tributary just west of the project boundary and CVI project area. Drainage patterns from OS-3 will generally remain unchanged from historic conditions. Hydrology of OS-3 is analyzed by CUHP method and results can be found in **Appendix B** of this report. Basin OS-3 is outside of the Town limits and there are no planning documents that anticipate further development.

Basin OS-4 *(25.3 acres | 11.5% Impervious | Q100 = 39.8 cfs)*
Basin OS-4 contains rural residential areas in Gambel Ridge Tributary's main stem. Flows from Basin OS-4 will enter the Gamble Ridge Tributary just west of the project boundary and CVI project area. Drainage patterns from OS-4 will generally remain unchanged from historic conditions. Hydrology of OS-4 is analyzed by CUHP method and results can be found in **Appendix B** of this report. Basin OS-4 is outside of the Town limits and there are no planning documents that anticipate further development.

Lower Gambel Ridge Tributary Watershed (Watershed C)

The Lower Gambel Ridge Watershed includes all areas of the Dawson Trails Planned Development that drain to the Gambel Ridge Tributary downstream of the point where it re-enters the development boundary. These areas generally include road rights-of-way for Dawson Trails Boulevard and Crystal Valley Parkway, and Planning Areas E1, E2, F2 and F3. In the context of the Filing 2 project, Crystal Valley Parkway, the Gambel Ridge Channel, Planning Areas E1 and F2, and Regional Pond C1 are considered off-site improvements by separate plans. However, the separately proposed infrastructure of these off-site areas is integral to the drainage design for the northwest portion of Filing 2 and is analyzed in this report as appropriate. More details on specific drainage components of off-site projects are included in Section III.B of this report.

Lower Gambel Watershed: Onsite Basins used in CUHP/SWMM Analysis: [Proposed Overall SWMM Map 2; Proposed Detailed Drainage Maps 6-8, 11-12]

Basin C-1 *(36.0 acres | 70% Impervious | Q100 = 137 cfs)*
Major Basin C-1 is bounded by Dawson Trails Boulevard on the east, Arterial A on the west, and Quandary Peak Drive on the north. It is designated within Planning area E2 in the development plan. Non-residential and residential uses are permitted within the development parcel, with a specific anticipation of commercial oriented use. The area is assigned a build-out imperviousness of 70% for hydrologic analysis. This basin is tributary to the Regional Pond C1 and has been accounted for in its sizing.

Basin C-2 *(59.9 acres | 71.4% Impervious | Q100 = 184 cfs)*
Major Basin C-2 is bounded by Dawson Trails Boulevard on the west, the BNSF rail right-of-way on the east, and Quandary Peak Drive on the north. It is designated within Planning area F-1, F-2, F-3 and G-1 in the development plan. Non-residential and residential uses are permitted within the development parcel, with a specific anticipation of commercial

oriented use. The area is assigned a build-out imperviousness of 71.4% for hydrologic analysis. This basin is tributary to the Regional Pond C1 and has been accounted for in its sizing. Release rates from Pond C1 have been coordinated with the design of the Gambel Ridge Tributary as to release at acceptable rates. This avoids any capacity issues in crossing the railroad in following historic drainage patterns. No impacts to wetlands or water rights are anticipated as a result of this inter-watershed transfer. Interim discharge from this basin continues east to culverts under I-25 and the railroad via sheet flow.

Basin C-3 *(19.6 acres | 70% Impervious | Q100 = 57.9 cfs)*
Major Basin C-3 is bounded by Dawson Trails Boulevard on the west, Crystal Valley Parkway on the north, Ike Street on the east, and Quandary Peak Drive on the South. It is designated within Planning area F3 in the development plan. Non-residential and residential uses are permitted within the development parcel, with a specific anticipation of commercial oriented use. The area is assigned a build-out imperviousness of 70% for hydrologic analysis. This basin is tributary to the Regional Pond C1 and has been accounted for in its sizing.

Basin C-4 *(20.6 acres | 75% Impervious | Q100 = 43.8 cfs)*
Major Basin C-4 is bounded by Dawson Trails Boulevard on the east, Arterial A on the north and west, and Quandary Peak Drive on the south. It is designated within Planning area E2 in the development plan. Non-residential and residential uses are permitted within the development parcel, with a specific anticipation of commercial oriented use. The area is assigned a build-out imperviousness of 75% for hydrologic analysis. This basin is tributary to the Regional Pond C1 and has been accounted for in its sizing.

Basin C-5 *(24.2 acres | 80% Impervious |Q100 = 50 cfs)*
Major Basin C-5 includes the road rights-of-way for Arterial A, Dawson Trails Boulevard, Crystal Valley Parkway and the western segment of Quandary Peak Drive. Specific sub-areas of Basin C-5 are further detailed in Section II.B of this report, along with the proposed drainage improvements for the included roadways. The area is assigned a build-out imperviousness of 80% for hydrologic analysis. This basin is tributary to the Regional Pond C1 and has been accounted for in its sizing.

Basin C-6 *(8.4 acres | 80% Impervious | Q100 = 15 cfs)*
Major Basin C-6 includes the road rights-of-way for Ike Street and the eastern segment of Quandary Peak Drive. Specific sub-areas of Basin C6 are further detailed in Section II.B of this report, along with the proposed drainage improvements for the included roadways. The area is assigned a build-out imperviousness of 80% for hydrologic analysis. This basin is tributary to the Regional Pond C1 and has been accounted for in its sizing.

North Dawson Tributary Watershed: On-site Basins used in CUHP/SWMM Analysis:
[Proposed Overall SWMM Map 1]

Basin A-1 *(13.4 acre | 12% Impervious| Q100 = 27.0 cfs)*
Major Basin A-1 is bounded by development parcels to the north, Dawson Trails Boulevard to the west, The CORE Electric substation to the south, and the BNSF Railraod to the east. Major Basin A-1 contains the Regional Flood Control Pond A1 and associated open space. Basin A-1 is located within the planning area OSP-4 in the development plan. This area has an anticipated use of open space and landscape features. The area is assigned a build out imperviousness of 12% for hydrologic analysis. Flows from this basin

will be detained to historic flowrates before exiting the project site via existing storm conveyance elements beneath the BNSF Railroad and eventually drain to East Plum Creek.

Basin A-2 *(23.4 acre | 48% Impervious | Q100 = 35.5 cfs)*
Major Basin A-2 is bounded by development parcels to the north, the future Regional Flood Control Pond E1 to the west, future development parcels to the south, and Dawson Trails Boulevard to the east. Major Basin A-2 contains the North Dawson Tributary drainageway and associated open space. Basin A-2 is located within the planning area OSP-3 in the development plan. This area has an anticipated use of open space and landscape features. The area is assigned a build out imperviousness of 48% for hydrologic analysis. Flows from this basin will exit to the east and drain to the proposed Regional Flood Control Pond A1.

Basin A-3 *(47.0 acre | 87% Impervious | Q100 = 179 cfs)*
Major Basin A-3 is bounded by development parcels to the north, future development parcels to the west, the Regional Flood Control Pond A1 to the south and the BNSF railroad to the east. Major Basin A-3 contains roadway right-of-way, future single family, multifamily, and commercial land use. Basin A-3 is located within the planning area D and G-1 in the development plan. The area is assigned a build out imperviousness of 87% for hydrologic analysis. Flows from this basin will be treated in a private Water Quality (WQ) and Excess Urban Runoff Volume (EURV) pond before discharging into the Regional Flood Control Pond A1.

Basin A-4 *(89.1 acre | 68% Impervious | Q100 = 326 cfs)*
Major Basin A-4 is bounded by development parcels to the north, future development parcels to the west, the North Dawson Tributary drainageway to the south and Dawson Trails Boulevard to the east. Major Basin A-4 contains roadway right-of-way, future single family, and multifamily land use. Basin A-4 is located within the planning area D in the development plan. The area is assigned a build out imperviousness of 68% for hydrologic analysis. Flows from this basin will be treated in a private Water Quality (WQ) and Excess Urban Runoff Volume (EURV) pond before discharging into the North Dawson Tributary immediately south.

Basin A-5 *(28.2 acre | 60% Impervious | Q100 = 90.3 cfs)*
Major Basin A-5 is bounded by development parcels to the north, future development parcels to the west, the North Dawson Tributary drainageway to the south and future development parcels to the east. Major Basin A-5 contains roadway right-of-way, future single family, and multifamily land use. Basin A-5 is located within the planning area D and C-2 in the development plan. The area is assigned a build out imperviousness of 60% for hydrologic analysis. Flows from this basin will be treated in a private Water Quality (WQ) and Excess Urban Runoff Volume (EURV) pond before discharging into the North Dawson Tributary immediately south.

Basin A-6 *(8.36 acre | 60% Impervious | Q100 = 30.3 cfs)*
Major Basin A-6 is bounded by development parcels to the north, future development parcels to the west, the North Dawson Tributary drainageway to the south and future development parcels to the east. Major Basin A-6 contains roadway right-of-way, future single family, and multifamily land use. Basin A-6 is located within the planning area C-1 and C-2 in the development plan. The area is assigned a build out imperviousness of 60% for hydrologic analysis. Flows from this basin will be treated in a private Water Quality

(WQ) and Excess Urban Runoff Volume (EURV) pond before discharging into the North Dawson Tributary immediately south.

Basin A-7 *(33.1 acre | 60% Impervious | Q100 = 93.3 cfs)*
Major Basin A-7 is bounded by the North Dawson Tributary drainageway to the north, future development parcels to the west, future development parcels to the south and Dawson Trails Boulevard to the east. Major Basin A-7 contains roadway right-of-way, future single family, and multifamily land use. Basin A-7 is located within the planning area C-1 and C-2 in the development plan. The area is assigned a build out imperviousness of 60% for hydrologic analysis. Flows from this basin will be treated in a private Water Quality (WQ) and Excess Urban Runoff Volume (EURV) pond before discharging into the North Dawson Tributary immediately north.

Basin A-8 *(34.8 acre | 60% Impervious | Q100 = 116 cfs)*
Major Basin A-8 is bounded by the North Dawson Tributary drainageway to the north, future development parcels to the west, future development parcels to the south and future development parcels to the east. Major Basin A-8 contains roadway right-of-way, future single family, and multifamily land use. Basin A-8 is located within the planning area C-1 and C-2 in the development plan. The area is assigned a build out imperviousness of 60% for hydrologic analysis. Flows from this basin will be treated in a private Water Quality (WQ) and Excess Urban Runoff Volume (EURV) pond before discharging into the North Dawson Tributary immediately north.

Basin E-1 *(49.8 acre | 12% Impervious | Q100 = 71.2 cfs)*
Major Basin E-1 is bounded by future development parcels to the north, undeveloped land to the west, future development parcels to the south, and the North Dawson Tributary drainageway to the east. Major Basin E-1 contains the Regional Flood Control Pond E1 and associated open space. Basin E-1 is located within the planning area OSP-1 in the development plan. This area has an anticipated use of open space and landscape features. The area is assigned a build out imperviousness of 12% for hydrologic analysis. Flows from this basin will be detained before existing to the North Dawson Tributary drainageway to the east.

Basin E-2 *(39.7 acre | 45% Impervious | Q100 = 97.6 cfs)*
Major Basin E-2 is bounded by future development parcels to the north, undeveloped land to the west, Regional Flood Control Pond E1 to the south and future development parcels to the east. Major Basin E-2 contains roadway right-of-way, and future single family land use. Basin E-2 is located within the planning area C-1 in the development plan. The area is assigned a build out imperviousness of 45% for hydrologic analysis. Flows from this basin will be treated in a private Water Quality (WQ) and Excess Urban Runoff Volume (EURV) pond before discharging into Regional Flood Control Pond E1 immediately south.

Basin E-3 *(44.3 acre | 45% Impervious | Q100 = 117 cfs)*
Major Basin E-3 is bounded by the Regional Flood Control Pond E1 to the north, undeveloped land to the west, future development parcels to the south and future development parcels to the east. Major Basin E-3 contains roadway right-of-way, and future single family land use. Basin E-3 is located within the planning area C-1 in the development plan. The area is assigned a build out imperviousness of 45% for hydrologic analysis. Flows from this basin will be treated in a private Water Quality (WQ) and Excess

Urban Runoff Volume (EURV) pond before discharging into Regional Flood Control Pond E1 immediately north.

Basin FZ-1
Major Basin E-1 is bounded by the Regional Flood Control Pond A1 to the north, Dawson Trails Boulevard to the east, future development parcels to the south, and the BNSF railroad to the west. Major Basin FZ-1 is anticipated to contain the future CORE Electric substation and accompanying infrastructure. Basin FZ-1 is located within the planning area G-1 and G-2 in the develop plan. This area was not analyzed as part of the Filing 2 development and will be responsible for their own storm water treatment and detention. Flows from this basin were not considered in the sizing of Pond A1. Release rates from Pond A1 have been coordinated with the design of the North Dawson Tributary as to release at acceptable rates. This avoids any capacity issues in crossing the railroad in following historic drainage patterns. No impacts to wetlands or water rights are anticipated as a result of this inter-watershed transfer.

Basin FZ-2 *(25.6 acres | 96% Impervious | Q100 = 92.8 cfs)*
Major Basin FZ-2 is bounded by the future CORE Electric substation to the north, Dawson Trails Boulevard to the west, future development parcels to the south, and the BNSF railroad to the east. Major Basin FZ-2 contains roadway right-of-way and commercial land use. Basin FZ-2 is located within the planning area G-1 and G-2 in the development plan. The area is assigned a build out imperviousness of 96% for hydrologic analysis. Flows from this basin will be treated in a private Extended Detention Basin (EDB) before being released at historic levels in coordination with the CORE Electric substation to not create adverse drainage conditions at existing downstream stormwater conveyance elements.

The CUHP calculations and SWMM routing for the above major basins are included in **Appendix B**.

Some of the basin areas described in the above section are further divided into sub-basins where street infrastructure is proposed. The sub-basin areas are generally much smaller than their parent basins and use rational method to calculate peak runoff.

Basin B6 sub-basins (Rational method analysis): [Proposed Detailed Drainage Maps 8-11]

Basin B6 is defined as the area along Gambel Ridge Blvd. between the road's high point and regional Pond B1. Basin B6 includes road right-of-way and the hillside that falls toward the roadway from the south. The hillside is designated as Planning Area PL-2.02 open space in the approved development plan. B6 is assigned an imperviousness of 32.6% and is broken out into 10 sub-basins.

B6.11 *(0.72 acres | 90% Impervious | Q100 = 5.3 cfs)* and
B6.12 *(0.85 acres | 90% Impervious | Q100 = 6.1 cfs)*
Sub-basins B6.11 and B6.12 contain the south and north halves of Gambel Ridge Blvd., respectively, between the high point at 27+14 and road station 34+75. The areas surface drain via curb/gutter to a pair of on-grade curb inlets on Gambel Ridge Blvd. at 34+75.

B6.10 *(1.89 acres | 2% Impervious | Q100 = 6.6 cfs)*
Sub-basin B6.10 includes the hillside south of sub-basin B6.11. Runoff from the slope is collected in a swale and captured in area inlet B6.10

B6.21 *(8.15 acres | 90% Impervious | Q100 = 9.8 cfs)* and
B6.22 *(1.20 acres | 90% Impervious | Q100 = 9.3 cfs)*
Sub-basins B6.21 and B6.22 contain the south and north halves of Gambel Ridge Blvd., respectively, between road stations 34+75 and 47+25. The areas surface drain via curb/gutter to a pair of on-grade curb inlets on Gambel Ridge Blvd. at 47+25. B6.21 and B6.22 accept bypass flows from B6.11 and B6.12, respectively. B6.22 is designed for full capture of major and minor storm gutter flows upstream of the planned intersection.

B6.20 *(6.69 acres | 2% Impervious | Q100 = 14.7 cfs)*
Sub-basin B6.20 includes the hillside south of sub-basin B6.21. Runoff from the slope is collected in a swale and captured in area inlet B6.20

B6.31 *(4.87 acres | 90% Impervious | Q100 = 8.8 cfs)* and
B6.32 *(0.83 acres | 90% Impervious | Q100 = 6.5 cfs)*
Sub-basins B6.31 and B6.32 contain the south and north halves of Gambel Ridge Blvd., respectively, between road stations 47+25 and 56+00. The areas surface drain via curb/gutter to a pair of on-grade curb inlets on Gambel Ridge Blvd. at 56+00.

B6.30 *(3.65 acres | 2% Impervious | Q100 = 9.1 cfs)*
Sub-basin B6.30 includes the hillside south of sub-basin B6.31. Runoff from the slope is collected in a swale and captured in area inlet B6.30

B6.41 *(1.63 acres | 90% Impervious | Q100 = 5.7 cfs)* and
B6.42 *(0.49 acres | 90% Impervious | Q100 = 4.4 cfs)*
Sub-basins B6.41 and B6.42 contain the south and north halves of Gambel Ridge Blvd., respectively, between road stations 56+00 and 61+00. The areas surface drain via curb/gutter to a pair of on-grade curb inlets on Gambel Ridge Blvd. at 61+00. B6.41 and B6.42 accept bypass flows from B6.31 and B6.32, respectively. B6.42 is designed for full capture of major and minor storm gutter flows upstream of a planned intersection.

B6.40 *(0.87 acres | 2% Impervious | Q100 = 2.7 cfs)*
Sub-basin B6.40 includes the hillside south of sub-basin B6.41. Runoff from the slope is collected in a swale and captured in area inlet B6.40

B6.51 *(0.66 acres | 90% Impervious | Q100 = 4.9 cfs)* and
B6.52 *(0.63 acres | 90% Impervious | Q100 = 4.8 cfs)*
Sub-basins B6.09 and B6.10 contain the south and north halves of Gambel Ridge Blvd., respectively, between road stations 61+00 and 65+50. The areas surface drain via curb/gutter to a pair of on-grade curb inlets on Gambel Ridge Blvd. at 65+50. B6.52 also includes the adjacent hillside and accepts bypass flows from B6.41. B6.51 and B6.52 are designed for full capture of major and minor storm gutter flows before routing to Pond B1.

Basin C5 sub-basins (Rational Method Analysis): [Proposed Detailed Drainage Maps 6-7, 12]

Basin C5 is defined as the areas of road-right-of way, including Dawson Trails Boulevards and roadways west, that are tributary to regional Pond C1.

C5.01 *(2.61 acres | 90% Impervious | Q100 = 9.6 cfs)* and
C5.02 *(2.11 acres | 90% Impervious | Q100 = 9.6 cfs)*

Sub-basins C5.01 and C5.02 contain the north and south halves of Arterial A, respectively, between road stations 65+50 and 81+50. The areas surface drain via curb/gutter to a pair of on-grade curb inlets on Arterial A at 81+50. C5.01 is designed for full capture of major and minor storm gutter flows upstream of the intersection with Twin Oaks Drive

C5.03 *(1.36 acres | 90% Impervious | Q100 = 10.1 cfs)* and
C5.04 *(1.22 acres | 90% Impervious | Q100 = 9.0 cfs)*
Sub-basins C5.03 and C5.04 contain the north and south halves of Arterial A, respectively, between road stations 81+50 and 88+45. The areas surface drain via curb/gutter to a pair of on-grade curb inlets on Arterial A at 88+45. C5.03 and C5.04 accept bypass flows from C5.01 and C5.02, respectively. Both inlets are designed for full capture of major and minor storm gutter flows upstream of the intersection with Dawson Trails Boulevard

C5.11 *(1.56 acres | 90% Impervious | Q100 = 9.6 cfs)* and
C5.12 *(1.56 acres | 90% Impervious | Q100 = 9.6 cfs)*
Sub-basins C5.11 and C5.12 contain the west and east halves of Dawson Trails Boulevard, respectively, between the high point at road stations 148+33 and road station 160+00. The areas surface drain via curb/gutter to a pair of on-grade curb inlets just south of the Dawson Trails Boulevard/Quandary Peak Drive roundabout. Inlet C5.12 is previously constructed with the Dawson Trails Boulevard project (CIP22-0012). Inlet C5.11 is proposed with this project but its flows are accounted for by the Dawson Trails storm sewer design.

C5.13 *(1.80 acres | 90% Impervious | Q100 = 13.6 cfs)* and
C5.14 *(0.76 acres | 90% Impervious | Q100 = 5.7 cfs)*
Sub-basins C5.13 and C5.14 contain the north and south halves of Quandary Peak Drive, respectively, between Arterial A and Dawson Trails Boulevard. C5.13 also receives bypass flow from C5.14. The areas surface drain via curb/gutter to a pair of sump inlets just west of the Dawson Trails Boulevard/Quandary Peak Drive roundabout.

C5.15 *(1.81 acres | 90% Impervious | Q100 = 11.3 cfs)* and
C5.16 *(1.65 acres | 90% Impervious | Q100 = 8.3 cfs)*
Sub-basins C5.15 and C5.16 contain the west and east halves of Dawson Trails Boulevard, respectively, between the Quandary Peak Drive roundabout and road station 174+75. The areas surface drain via curb/gutter to a pair of existing on-grade curb inlets at174+75. Inlets C5.15 and C5.16 mark the northern limits of Dawson Trails Boulevard construction with the Filing 2 project, and are designed to fully capture roadway runoff before leaving the project limits.

Basin C6 sub-basins (Rational Method analysis): [Proposed Detailed Drainage Map 7]

Basin C6 is defined as the areas of road-right-of way east of Dawson Trails Boulevards that are tributary to regional Pond C1.

C6.01 *(1.89 acres | 90% Impervious | Q100 = 13.3 cfs)* and
C6.02 *(1.13 acres | 90% Impervious | Q100 = 8.3 cfs)*
Sub-basins C6.01 and C6.02 contain the north and south halves of Quandary Peak Drive, respectively, between Dawson Trails Boulevard and Ike Street. The areas surface drain

via curb/gutter to a pair of inlets on the west side of Quandary Peak Drive/Ike Street roundabout. Inlet C6.01 is a sump inlet. Inlet C6.02 is an on-grade inlet.

C6.03 *(1.27 acres | 90% Impervous | Q100 = 6.7 cfs)* and
C6.04 *(1.22 acres | 90% Impervious | Q100 = 6.6 cfs)*
Sub-basins C6.03 and C6.04 contain the east and west halves of Ike Street, respectively, between road stations 10+10 and 25+60. The areas surface drain via curb/gutter to a pair of on-grade curb inlets at 25+60. Inlets C6.03 and C6.04 mark the northern limits of Ike Street construction by the Filing 2 project, and are designed to fully capture roadway runoff before leaving the project limits.

Basin D1 sub-basins (Rational Method analysis): [Proposed Detailed Drainage Maps 11-13]

Basin D1 includes the areas between Dawson Trails Boulevard and the BNSF railway that are within the North Dawson watershed. D1 also includes the Dawson Trails Boulevard right-of-way and an approximately 400-foot swath of future development area on the west side of Dawson Trails Boulevard. Much of the D1 drainage area on the west side of Dawson Trails Boulevard is too low in elevation to ensure practical conveyance to Pond D3. Therefore, the water quality treatment for Basin D1 is provided in a separate, lower elevation Pond on the east side of Dawson Trails Boulevard.

D1.0 *(6.94 acres | 2% Impervious | Q100 = 22.4 cfs)*
Sub-basin D1.0 contains future development area in the northwest quadrant of the Dawson Trail Boulevard / Blanca Peak Pkwy. intersection. It is designated within Planning area E2 in the development plan. Non-residential and residential uses are permitted within the development parcel, with a specific anticipation of pedestrian-oriented areas. The basin is assigned an interim imperviousness of 2% and a build-out imperviousness of 75% for sizing of receiving storm sewer. The area drains southwestward toward the Dawson Trails Boulevard / Blanca Peak Pkwy. intersection, and its anticipated developed flows are accommodated in the Dawson Trails Boulevard storm drain.

D1.08 *(0.52 acres | 100% Impervious | Q100 = 3.81 cfs)*
Sub-basin D1.08 contains the Dawson Plaza right-of-way, north of Blanca Peak Parkway. The roadway cross-slope transition on the north approach to the intersection directs all runoff to the east side curb. D1.08 surface drains to sub-basin D1.10 at the intersection, with flow intercepted by inlet D1.10.

D1.10 *(1.36 acres | 82.4% Impervious | Q100 = 8.57 cfs)* and
D1.11 *(0.73 acres | 81.6% Impervious | Q100 = 5.26 cfs)*
Sub-basins D1.10 and D1.11 contain the north and south halves of Blanca Peak Pkwy., respectively, between road station 32+00 and Dawson Trails Boulevard. D1.10 contains 450 LF of the west half of Dawson Trails Boulevard between the Blanca Peak Pkwy. roundabout and the high point at 14+33. The areas surface drain via curb/gutter to a pair of sump inlets just west of the Dawson Trails Boulevard/Blanca Peak Pkwy. roundabout.

D1.12 *(1.17 acres | 79.6% Impervious | Q100 = 6.86 cfs)* and
D1.13 *(0.41 acres | 82.5% Impervious | Q100 = 2.65 cfs)*
Sub-basins D1.12 and D1.13 contain the north and south halves of Blanca Peak Pkwy., respectively, east of the Dawson Trails Boulevard roundabout. D1.12 contains 450 LF of

the west half of Dawson Trails Boulevard between the Blanca Peak Pkwy. roundabout and the high point at 14+33. The areas surface drain via curb/gutter to a pair of sump inlets just east of the Dawson Trails Boulevard/Blanca Peak Pkwy. Roundabout, at the roadway construction limits.

D1.30 *(1.42 acres | 76.6% Impervious | Q100 = 8.74 cfs)* and
D1.32 *(1.43 acres | 76.2% Impervious | Q100 = 9.72 cfs)*
Sub-basins D1.30 and D1.32 contain the west and east halves of Dawson Trails Boulevard, respectively, between the low point at road station 134+90 and the Blanca Peak Pkwy. roundabout. The areas surface drain via curb/gutter to a pair of sump inlets at the station 134+90 low point.

D1.31 *(0.54 acres | 70.6% Impervious | Q100 = 3.15 cfs)* and
D1.33 *(0.55 acres | 68.8% Impervious | Q100 = 3.51 cfs)*
Sub-basins D1.31 and D1.33 contain the west and east halves of Dawson Trails Boulevard, respectively, between the high point at road station 129+55 and the low point at station 134+90. The areas surface drain via curb/gutter to a pair of sump inlets at the station 134+90 low point.

D1.5 *(0.85 acres | 53.8% Impervious | Q100 = 5.29 cfs)*
Sub-basin D1.5 includes proposed water quality Pond D1 and adjacent areas. The entire sub-basin surface drains to Pond D1. A 100% imperviousness is applied to the100-year water surface area.

A3.1 *(17.34 acres | 95.0% Impervious | Q100 = 116 cfs)*
Sub-basin A3.1 contains future development on the east side of Dawson Trails Boulevard between Blanca Peak Pkwy. and the North Dawson Tributary. It is designated within Planning area G-1 in the development plan, which only permits non-residential uses. The area is assigned a build-out imperviousness of 95% for hydrologic analysis. The area drains uniformly eastward, with the anticipation that its ultimate site layout will convey stormwater to the North Dawson Tributary. 100-year detention volume for Sub-basin A3.1 is accounted for in regional pond A1. WQCV and EURV for any development parcel within the basins will need to be provided separately at the time of improvement. Alternatively, if a future development plan elects to utilize existing Culvert 9 as at outfall, WQCV, EURV and 100-year detention would need to be provided for the portion of the basin routed to that outfall.

A1.0 *(13.42 acres | 85.3% Impervious | Q100 = 98.6 cfs)*
Sub-basin A1.0 includes proposed regional Pond A1 and adjacent areas. The entire basin surface drains to Pond A1. A 100% imperviousness is applied to the100-year water surface area.

Basin D3 sub-basins (Rational Method analysis): [Proposed Detailed Drainage Maps 11-14]

Basin D3 includes early phase development areas of Planning Area D, Blanca Peak Pkwy., and various surrounding areas. Most of the development area within Basin D3 has a land plan that is at least in a preliminary stage. Consequently, the drainage design for Basin D3 has a greater level of detail than most other areas within the North Dawson watershed. A significant part of the Filing 2 infrastructure investment will support development with Basin D3.

D3.0 *(12.31 acres | 2.0% Impervious | Q100 = 25.8 cfs)*
Sub-basin D3.0 contains areas west of Collector C that drain to a low point at station 17+00. The basin overlaps with Planning Area PL-1.05 (designated for open space) and Planning area C2 (programmed for single family residential development).

Drainage patterns within basin C3.0 are defined by existing topography. Runoff from the basins funnels into gully that drains southeast toward Collector C. An area inlet is proposed to intercept flows from the existing gully immediately west of Collector C

D3.1 *(2.41 acres | 2.0% Impervious | Q100 = 7.5 cfs)*
Sub-basin D3.1 a slope area west of Blanca Peak Pkwy. thats drain toward the roadway. A roadside swale is proposed to collect the runoff with flow interception by area inlet D3.1 The basin overlaps with Planning Area PL-1.05 (designated for open space).

D3.2 *(28.1 acres | 2.0% Impervious | Q100 = 57.2 cfs)*
Sub-basin D3.2 contains areas a significant area of runoff north of Blanca Peak Pkwy. that will be directed toward the roadway by early grading topography. The basin overlaps with Planning Area PL-1.05 (designated for open space) and Planning area D (initially planned for residential development). Runoff from sub-basin D3.2 is collected by a roadside swale and captured in area inlet D3.2 northwest of the Blanca Peak Parkway / Dawson Plaza Intersection.

D3.10 *(0.67 acres | 62.1% Impervious | Q100 = 4.3 cfs)* and
D3.11 *(0.64 acres | 64.5% Impervious | Q100 = 4.2 cfs)*
Sub-basins D3.10 and D3.11 contain the north and south halves of Blanca Peak Pkwy., respectively, between road stations 13+36 and 17+00. The areas surface drain via curb/gutter to a pair of on-grade curb inlets at station 17+00. The location of the inlets anticipates full capture of flows immediately upstream of a conceptually planned intersection per the Dawson Trails Development Plan.

D3.12 *(0.61 acres | 67.7% Impervious | Q100 = 3.7 cfs)* and
D3.13 *(0.90 acres | 45.8% Impervious | Q100 = 4.6 cfs)*
Sub-basins D3.12 and D3.13 contain the north and south halves of Blanca Peak Pkwy., respectively, between road stations 17+00 and 24+20. D3.12 additionally includes a cut slope that drains toward Blanca Peak Pkwy., that is designated as open space in the Dawson Trails development plan. The areas surface drain via curb/gutter to a pair of on-grade curb inlets at station 24+20. The location of the inlets anticipates full capture of flows immediately upstream of a planned access point to Planning Area D1.

D3.15 *(0.31 acres | 67.7% Impervious | Q100 = 1.9 cfs)* and
D3.16 *(1.14 acres | 51.4% Impervious | Q100 = 4.2 cfs)*
Sub-basins D3.15 and D3.16 contain the north and south halves of Blanca Peak Pkwy., respectively, between road stations 24+20 and 28+00. D3.16 includes a strip of adjacent land that is overlot graded to drain toward Blanca Peak Pkwy. The areas surface drain via curb/gutter to a pair of on-grade curb inlets at station 28+00. The location of the inlets anticipates full capture of flows immediately upstream of a planned access point to Planning Area D1.

D3.18 *(0.33 acres | 67.9% Impervious | Q100 = 2.2 cfs)* and
D3.19 *(1.12 acres | 21.2% Impervious | Q100 = 4.1 cfs)*

Sub-basins D3.18 and D3.19 contain the north and south halves of Blanca Peak Pkwy., respectively, between road stations 28+00 and 32+20. D3.19 includes a strip of adjacent land that is overlot graded to drain toward Blanca Peak Pkwy. The areas surface drain via curb/gutter to a pair of on-grade curb inlets at station 32+20. The location of the inlets anticipates full capture of flows immediately upstream of a planned access point to Planning Area D1.

D3.20 *(0.47 acres | 69.1% Impervious | Q100 = 2.9 cfs)*
Sub-basin D3.20 contains the Dawson Plaza right-of-way, between Blanca Peak Parkway and the roadway high point 220 feet to the south. The roadway cross-slope transition on the south approach to the intersection directs all runoff to the east side curb. Flow from the sub-basin is intercepted by on-grade inlet D3.20, just south of the Blanca Peak Parkway / Dawson Plaza intersection.

D3.21 *(0.55 acres | 47.1% Impervious | Q100 = 2.8 cfs)* and
D3.22 *(0.25 acres | 100% Impervious | Q100 = 2.0 cfs)*
Sub-basins D3.12 and D3.13 contain the west and east halves of Dawson Plaza, respectively, south of the high point at 12+55 and the south limits of construction. The areas surface drain via curb/gutter to a pair of sump inlets at station 11+10.

D3.3 *(34.71 acres | 2% Impervious | Q100 = 124 cfs)*
Sub-basin D3.0 contains the portion of Planning Area D that is south of Blanca Peak Pkwy. and north of the North Dawson drainageway. The current land plan within sub-basin D3.3 delineates 18 acres of detached single-family residential, with and assigned imperviousness of 45%, and 17 acres of attached single-family residential, with an assigned imperviousness of 75%. The internal drainage system within sub-basin D3.3 will be designed with Planning Area D development. Runoff from the area is accounted for in the D3 storm main at the planned eastern entrance into Planning Area D. The sub-basin's area and imperviousness are also accounted for in water quality Pond D3.

D3.4 *(2.90 acres | 2% Impervious | Q100 = 9.2 cfs)*
Sub-basin D3.4 includes the southeastern fringe of residential lots within Planning area D, just west of Ponds D2 and D3. The D3.4 basin areas surface drain to Pond D3.

D3.5 *(9.02 acres | 2% Impervious | Q100 = 19.9 cfs)*
Sub-basin D1.2 contains future development along the western frontage of Dawson Trails Boulevard between Blanca Peak Pkwy. and the North Dawson Tributary. It is designated within Planning area D in the development plan. Single-family and multifamily residential uses are permitted within the development parcel. The area is assigned a build-out imperviousness of 75% for hydrologic analysis. The area drains eastward toward the adjacent low point in Dawson Trails Boulevard, and its anticipated developed flows are accommodated in the Dawson Trails Boulevard storm drain. The sub-basin's area and assumed imperviousness are also accounted for in water quality Pond D1.

D3.6 *(5.31 acres | 28.7% Impervious | Q100 = 22.6 cfs)*
Sub-basin D3.6 includes proposed water quality Pond D3 and adjacent areas. The entire sub-basin surface drains to Pond D3. A 100% imperviousness is applied to the100-year water surface area.

Basin D4 sub-basins (Rational Method analysis): [Proposed Detailed Drainage Maps 14-15]

D4.0 *(0.27 acres | 34.3% Impervious | Q100 = 1.50 cfs)*
Sub-basin D4.0 contains water quality Pond D4. A 100% imperviousness is applied to the100-year water surface area.

D4.1 *(1.22 acres | 66.0% Impervious | Q100 = 8.09 cfs) and*
D4.2 *(1.29 acres | 66.2% Impervious | Q100 = 8.56 cfs)*
Sub-basins D4.1 and D4.2 contain the north and south halves of Schroeder Drive, respectively. The areas surface drain via curb/gutter to a pair of sump curb inlets on Schroeder Drive just west of the roundabout intersection with Blanca Peak Pkwy.. Intercepted flows rout immediately south to water quality Pond D4.

Basin D5 sub-basins (Rational Method analysis): [Proposed Detailed Drainage Maps 10, 14-15]

D5.0 *(0.28 acres | 43.3% Impervious | Q100 = 1.66 cfs)*
Sub-basin D5.0 contains water quality Pond D5. A 100% imperviousness is applied to the100-year water surface area.

D5.1 *(1.92 acres | 41.9% Impervious | Q100 = 11.1 cfs) and*
D5.2 *(2.03 acres | 40.5% Impervious | Q100 = 11.6 cfs)*
Sub-basins D5.1 and D5.2 contain the east and west halves of Gambel Ridge Blvd., respectively. Sub-basin D5.2 also receives a small area of stormwater run-on from the cut slope west of the Gambel Ridge Blvd. high point. The sub-basin areas surface drain via curb/gutter to a pair of on-grade curb inlets on Gambel Ridge Blvd. just north of the roundabout intersection with Schroeder Drive. Intercepted flows rout immediately west to water quality Pond D5.

Basin D9 sub-basins (Rational Method Analysis): [Proposed Detailed Drainage Maps 10-11, 14-15]

D9.1 *(1.86 acres | 2.0% Impervious interim, 45% ultimate | Q100 = 6.44 cfs)*
Sub-basin D9.1 contains the small area northeast of Gambel Ridge Blvd. / Schroeder Drive roundabout that drains to a gully at Schroeder Drive road station 12+30. The proposed roadway embankment for Schroeder Drive interrupts the historic flow path from the gully to North Dawson Tributary and will require a culvert underneath the roadway. There is no land plan or overlot grading design for the area within Sub-basin D9.1; therefore, existing topography and imperviousness are used for analysis. A 24" RCP culvert is proposed to convey flows from sub-basin D9.1 to North Dawson Tributary.

D9.2 *(6.32 acres | 2.0% Impervious interim, 45% ultimate | Q100 = 19.4 cfs)*
Sub-basin D9.2 contains the area north of Schroeder Drive intersection that drains to a gully at Schroeder Drive road station 18+20. The proposed roadway embankment for Schroeder Drive interrupts the historic flow path from the gully to North Dawson Tributary and will require a culvert underneath the roadway. There is no land plan or overlot grading design for the area within Sub-basin D9.2; therefore, existing topography and imperviousness are used for analysis. A 48" RCP culvert is proposed to convey flows from sub-basin D9.2 to North Dawson Tributary. The culvert is oversized to anticipate future developed flows from the areas of Planning Area C-2 that are north and west of the culvert entrance.

Basin D10 sub-basin (Rational Method Analysis): [Proposed Detailed Drainage Maps 10-11, 14-15]

D10.1 *(26.7 acres | 2.0% Impervious | Q100 = 51.2 cfs)*
Sub-basin D10.1 contains the area north of Schroeder Drive that drains to the gully northwest of the Schroeder Drive / Blanca Peak Pkwy. roundabout. The proposed roadway embankment for Schroeder Drive interrupts the historic flow path from the gully to North Dawson Tributary and will require a culvert underneath the roadway. There is no land plan or overlot grading design for the area within Sub-basin D10.1; therefore, existing topography and imperviousness are used for analysis. A 48" RCP culvert is proposed to convey flows from sub-basin D10.1 to North Dawson Tributary. The culvert is oversized to anticipate future developed flows from Planning Area PL-1.04.

III. DRAINAGE DESIGN CRITERIA

A. Regulations

This Phase III Drainage report is prepared in accordance with the Town of Castle Rock (TOCR) Storm Drainage Design and Technical Criteria Manual (Criterial Manual) and the Mile High Flood District (MHFD) Urban Storm Drainage Criteria Manual Volumes 1-3 (USDCM). The drainage design also complies with the Chatfield Reservoir Control Regulation No. 73. Phase III pond designs will comply with CRS §37-92-602 (8).

Proposed stormwater facilities are designed to be complaint with Town of Castle Rock drainage criteria, specifically: design rainfall, allowable inlet ponding, pipe velocities, open channel flow, pond storage, freeboard and maintenance provisions.

The USDCM is referenced for drop structure design and for principles of Water Quality Capture Volume and 100-year detention where these functions separated out from a typical full-spectrum design.

B. Drainage Studies, Master Plans, Site Constraints

Two drainageway master plans overlap with the Dawson Trails Filing No. 2 project area:

- Flood Hazard Area – Delineation Gambel Ridge and Douglas Lane Tributary Watersheds by Respec Consulting and Service, July 2014 [Reference F]

  This FHAD study shows the limits of flood hazard areas along Gamble Ridge Tributary and where the floodplain crosses into the Dawson Trails planned development. The water surface elevations, cross-sections, and developed flow rates from this study are used to assess potential impact to the flood zone from development activities. This information is also used the ensure that proposed drainage elements near the drainageway will be adequately protected from potential flooding.

- Gambel Ridge and Douglas Lane Tributary Watersheds – Master Plan by Respec Consulting and Service, July 2014. [Reference G]

This drainageway master plan identifies recommended improvements to Gamble Ridge Tributary. There are no recommendations for engineered improvements on the reach the crosses into the Filing 2 project limits.

The lower reaches of Gambel Ridge Tributary are not within the boundary or scope of the Filing 2 project. However, channel improvements to that portion of the drainageway are being concurrently design with Crystal Valley Interchange project. The primary importance of lower Gambel Ridge Tributary's design to the Filing 2 project is to ensure that the overall developed flows exiting the development meet the constraints imposed on the project by the existing railway and interstate culverts. In order to do this, the 100-yr release rate from Pond C1 will be limited to 115 cfs. The design presented with this document stays within this release rate. The proposed Filing 2 project will not adversely affect the Gamble Ridge Tributary. The only impact will be the construction of pond B1 and this pond shall release less than the historic flows into the Gamble Ridge Tributary.

- North and South Dawson Watershed Master Plan Conceptual Preliminary Design, by CH2MHILL, June 2009.

This study presents preliminary design concepts for these watersheds.

Pertinent excerpts from this report are included in **Appendix D.**

Drainage plan general concepts:

Key components of the drainage plan are briefly described as follows:

1. Impacts to impervious area and hydrology by planned development will be mitigated by a network of planned regional and sub-regional ponds.

2. A CUHP/SWMM models for the Gambel Ridge and North Dawson watersheds, and tributary offsite area, are used to model post-development hydrographs and peak flows exiting the planned development boundary.

3. Channel improvements are proposed for major drainageways crossing the site. Improvements to open drainageways will be implemented where hydrology or alignment will be altered, or where improvements are recommended by previously developed drainageway master plans. Refer to the FMS for further information.

4. Existing drainage culverts under the BNSF railway and Interstate 25 are physical constraints between the site's outfall and East Plum Creek, the receiving major drainageway. Combined flows in the Gambel Ridge Tributary—both from on-site releases within the Dawson Trails Planned development and off-site flows from west of the development—must be adequately conveyed through the existing culverts, with consideration to their studied capacities, associated design storms and acceptable performance criteria. Basin transfer is occurring on the eastern fringe of the site so that all flow can be released via the main stem of the North Dawson Tributary or the main stem of the Gambel Ridge tributary. Impacts to water rights or wetlands are not anticipated with this basin transfer.

5. Mile High Flood District drainage policy states that the maximum allowable 100-year release rate from detention ponds is 0.9 of the pre-development peak 100-year flows. However, to account for upstream drainageway flows while meeting the constraint described in (4) above, 100-year detention release rates will need to be further restricted beyond 0.9 of pre-development peak to ensure existing capacities downstream are not exceeded. The railway crossings and I-25 culverts are the governing restriction for the detention ponds in this project.

Drainage components specifically integrated with the Crystal Valley Interchange:
Two components of the Crystal Valley Interchange are key elements of the Gambel Ridge Watershed as it relates Filing 2 drainage design. These elements—the Gambel Ridge Channel Improvements and Regional Pond C1—are explained as follows:

Gambel Ridge Channel Improvements (by others)
The runoff analysis in the Gambel Ridge and Douglas Lane Tributary Master Plan [Ref. G] indicates that Gambel Ridge Tributary will see an increase of flow under developed conditions, and that channel stabilization improvements will be warranted.

The design of the Gambel Ridge Tributary improvements is not within the scope of the Filing 2 project or within the scope of this drainage report.

Improvements to the 1,000-foot segment of Gambel Ridge Tributary between the BNSF right-of-way and Dawson Trails Boulevard are included in the ongoing design of the Crystal Valley Interchange by Jacobs Engineering Group. Construction plans for the interchange are in development, and the channel improvements will be referenced in future iterations of this report as design progresses.

Subsequent versions of this report will reference updates to the Crystal Valley Interchange design documents. The final Phase III Drainage report for the Dawson Trails Filing No. 2 project expects to reference a fully approved and accepted drainage report for the Crystal Valley Interchange to support the design bases and interdependencies between the two projects.

Regional Pond C1 (by others)
Pond C1 is located immediately south of Crystal Valley Parkway, between Dawson Trails Boulevard and Intestate 25. Because Pond C1 is responsible for detention and water quality treatment of the segment of Crystal Valley Parkway between Dawson Trails Boulevard and Interstate 25, its design is programmed with the Crystal Valley Interchange project, by Jacobs Engineering Group. However, Pond C1 also plays an important role in the Dawson Trails Filing No. 2 drainage design because it provides detention and water quality treatment for development parcels in the lower part of the Gambel Ridge watershed. Land use assumptions for basins tributary to Pond C1 within Filing 2 fit within the assumptions of the Pond C1 design in the CVI project.

In addition to the critical improvements described above, the following design elements also interface with off-site infrastructure:

Off-site Design Coordination Element Summary				
Filing 2 Design Element	**Coordinating Off-site Element**	**Project**	**Consultant**	**Latest Reference**
Lower Gambel Watershed 100-year Detention, EURV	Pond C1	Crystal Valley Interchange	Jacobs	Phase III Drainage [Ref. I]
Over-detention to limit peak flow at Lower Gambel outfall	Pond C1	Crystal Valley Interchange	Jacobs	Phase III Drainage [Ref. I]
Lower Gambel Floodplain modification	Floodplain Modification Study	Crystal Valley Interchange	Jacobs	FMS pending [Ref. I]
Ike Street C6.X Inlets and HGL	Pond C1	Crystal Valley Interchange	Jacobs	Phase III Drainage [Ref. I]
Arterial A C5.0X Main and HGL	Crystal Valley Pkwy Storm Main	Crystal Valley Interchange	Jacobs	Phase III Drainage [Ref. I]
Dawson Trails Blvd C5.1X Inlets	Dawson Trails Blvd C5 Storm Main	Dawson Trails Blvd	EMK	Phase 3 Drainage [Ref L]
Water Quality Pond D1	DTB WQ Pond B	Dawson Trails Blvd	EMK	Phase 3 Drainage [Ref L]
North Dawson Floodplain modification at DTB	Floodplain Modification Study	Dawson Trails Blvd	EMK	FMS [included with Ref. L]

In addition to the above, A floodplain modification study is being prepared by Core Consultants for the Upper Gamble Ridge Tributary.

Outfall Constraints and Considerations

For the purposes of the Filing 2 project, the importance of the existing Gambel Ridge Tributary and North Dawson Tributary culverts is to:

1. Assess its suitability as an outfall, relative to existing and fully developed flows
2. Determine an overall release rate that complies with drainage policy and physical constraints
3. Re-evaluate culvert performance under the specified release rates

North Dawson Outfall

The ultimate outfall for the northern part of the project area is the culvert crossing of North Dawson Tributary under the BNSF railroad. There are two sequential culvert crossing in this location:

- A 7.5' high x 28' span trapezoidal bridge opening under the BNSF railway
- An 8' x 4' concrete box culvert under Interstate 25, immediately downstream.

Culvert Hydrologic Analysis Summary for North Dawson Outfall					
Source	**Crossing**	**Culvert Size**	**Existing Q50 [cfs]**	**Existing Q100 [cfs]**	**Capacity [cfs]**
North & South Dawson Master Plan [CH2MHill; Ref. L]	BNSF RR (Link 16)	BNSF Bridge	203	261	400
I-25 Gap Hydrology/Hydraulics Report [ch2m; Ref. K]	I-25 (MP 177.87)	8' x 4' CBC	206	269	383
North & South Dawson Master Plan [CH2MHill; Ref. L]	BNSF RR (Link 17)	24" DIP Culvert	64	79	Not evaluated
I-25 Gap Hydrology/Hydraulics Report [ch2m; Ref. K]	I-25 (MP 177.80)	36" RCP	16	23	70
CUHP Analysis (this report)	BNSF RR (Culvert 10)	7.5' H x 28' Span Bridge	177	**235 ***	235*
CUHP Analysis (this report)	I-25 (Culvert 10.5)	8' x 4' CBC	177	**235 ***	370
CUHP Analysis (this report)	BNSF RR (Culvert 11)	24" Steel Pipe	27	**35**	Not used or evaluated
CUHP Analysis (this report)	I-25 (Culvert 11.5)	36" RCP	27	**35**	Not used or evaluated

* Controlling outfall capacity

1. Outfall assessment

The North and South Dawson Master Plan [Ref. L], the I-25 Gap Hydrology/Hydraulics Report [Ref. K] and the CUHP analysis in this report estimates an existing 100-year flow rate between 235 cfs and 270 cfs. These three analyses are reasonably consistent in their flow assessments, and the 235 cfs flow rate computed in this study is the most conservative. The stated capacities in the BNSF and I-25 culverts from the above study are well above the estimated 100-year flows.

All studies identify a much smaller flow rate through culverts 11 and 11.5 due to an existing split-flow condition. However, since the drainage design will consolidate all of the North Dawson flows into the predominant, northern flow path, Culverts 11 and 11.5 are not assessed any further.

2. Release rate determination

The critical constraint of the North Dawson Tributary Outfall is the existing bridge crossing in the BNSF right-of-way. Unlike culverts, which are designed to fairly consistent headwater-to-depth limits, it is difficult to accurately predict the sustainable flow capacity under the railroad span. In particular, the center pier of the span can be impacted by excessive flow in multiple ways, including hydrodynamic pressure on the

pier and scour at the pier's foundation. For these reasons, the 100-year release rate into North Dawson Tributary at the BNSF railway is limited to the most conservative existing 100-year flow rate of 235 cfs.

3. Culvert performance under proposed release rates

Since the release rate from Pond A1 is set to match the existing 100-year flow rate, the performance of Culverts 10 (under BNSF railway) and Culvert 10.5 (under I-25) is not expected to vary from existing conditions. Additionally, the split flow condition that produces the flows through Culverts 11 and 11.5 will be eliminated.

Gamble Ridge Outfall

The ultimate outfall for the northern part of the project area is the culvert crossing of Gambel Ridge Tributary under the BNSF railroad. There are two culvert crossings in series in this location:

- A set of three 6' x 9' CMP culverts under the BNSF railway
- A 10' x 6' concrete box culvert under Interstate 25, immediately downstream.

The Gambel Ridge culverts and their respective capacities are critical to the drainage design of this area of Dawson Trails. The culverts were analyzed in the Gambel Ridge FHAD [Reference F] and are re-evaluted with this study.. The culvert under Interstate 25 was also analyzed in the 2020 South Interstate 25 Express Lanes Hydrology and Hydraulics Report [Reference K].

All three of these studies included hydrologic analyses of the Gambel Ridge Tributary Basin to determine existing peak flows for various recurrence intervals. The conclusions of these studies are summarized below:

Culvert Hydrologic Analysis Summary for Gambel Ridge Outfall

Source	Crossing	Culvert Size	Existing Q50 [cfs]	Existing Q100 [cfs]	Capacity [cfs]
Gambel Ridge FHAD (Respec; Ref. F]]	BNSF RR (DP 1020)	Triple 9' x 6' CMP Arch	682	901	650-700
Gambel Ridge FHAD (Respec; Ref. F]]	I-25 (DP 1020)	10' x 6' CBC	682	901	650-700
I-25 Gap Hydrology/Hydraulics Report [ch2m; Ref. K]	I-25 (MP 178.94)	10' x 6' CBC	533	698	726
CUHP Analysis (this report)	BNSF RR (Culvert 7)	Triple 9' x 6' CMP Arch	485	**640 ***	1698
CUHP Analysis (this report)	I-25 (Culvert 7.5)	10' x 6' CBC	485	**640 ***	768

* Controlling outfall capacity

1. Outfall assessment

The Gambel Ridge FHAD [Ref. F] estimates an overall capacity of 650-700 cfs through the culvert crossing under the BNSF railway and Interstate 25. The I-25 Gap study determined the capacity of the I-25 culvert to be 726 cfs. A separate analysis included herein—

which is based on independent survey, field observations and hydraulic assumptions—computes a resultant crossing capacity of 768 cfs, with the Interstate 25 culvert controlling. The separate hydraulic analyses are reasonably consistent in their conclusions.

2. Release rate determination

All three studies also estimate a peak 100-year flow at the upstream end of the BNSF culvert. This location is designated as Design Point 1020 in the FHAD study, MP 178.94 in the I-25 study, and Culvert 7 in the Existing Conditions Drainage Map. The existing basin CUHP analysis determines an existing 100-year flow rate of 640 cfs at this point. While this result is reasonably close to the 698 cfs identified in the I-25 Study, the flowrate from the FHAD study is somewhat of an outlier. A more in-depth analysis of the input parameters of each study's hydrologic models shows that FHAD study assumes a greater residential density than what is used in the other studies or observed in the field.

The pre-development peak of 640 cfs is lesser than the values presented in the other 2 studies and thus more conservative from an allowable release rate standpoint. 640 cfs is also less than the crossing capacities determined by all 3 studies and is therefore selected as the maximum allowable discharge rate from Gambel Ridge Tributary where it enters the BNSF right-of-way.

3. Culvert performance under proposed release rates

The I-25 hydrology and hydraulics report identifies 50 years as the design recurrence interval for its assessment of the existing culverts within the study area. Hydraulic evaluations of the existing culverts are done for both 100-year and 50-year event to verify acceptable performance under the design recurrence intervals of both the drainageway and the crossing infrastructure.

BNSF Culvert Hydraulic Performance for Gambel Ridge Outfall					
Design Storm	**Culvert Size**	**Allowable HW/D**	**Flow**	**Depth at Inlet**	**Actual HW/D**
50-year	Triple 9' x 6' Arch	1.2 *	485	4.03	0.67
100-year	Triple 9' x 6' Arch	1.2 *	640	4.74	0.79

* 1.2 Headwater to depth ratio taken from most restrictive value stated in TOCR Drainage Criteria, Section 11.2.3

I-25 Culvert Hydraulic Performance for Gambel Ridge Outfall					
Design Storm	**Culvert Size**	**Allowable HW/D**	**Flow**	**Depth at Inlet**	**Actual HW/D**
50-year	10' x 6' CBC	1.5	485	6.55	1.09
100-year	10' x 6' CBC	N/A	640	8.33	1.38

The Gamble Ridge Tributary culverts are identified on the drainage plan. HY-8 culvert performance calculations are included in Appendix B (B.1)

The summary of hydrologic results from the CUHP calculations can be found in the Culvert Summary Table below. Culverts crossings 8, 9, and 11 will not be utilized as

outfalls by the Dawson Trails development. They will continue to convey runoff from the BNSF right-of-way and immediately adjacent areas with no increase in flows. Culverts 7 and Culvert 10 will have full spectrum detention facilities included, where the ultimate outfall location and flowrate will be at or below that of the historic condition. The detention facilities that outfall to Culverts 7 and 10 are sized based on full buildout of their respective watersheds per the approved developed plan.

EXISTING CULVERT SUMMARY TABLE					
BASIN	**CULVERT ID**	**DESIGN POINT**	**100-Year FLOW (CFS)**		**CAPACITY (CFS)**
			EXISTING	**FUTURE**	
EX-8	7	8	633	571 **	1599
	7.5	178.94 *			726.7 *
EX-9	8	9	230	Not Utilized	173
	8.5	178.39 *			277.8 *
EX-10	9	10	122	Not Utilized	344
	9.5	178.13 *			247.4 *
EX-11	10	11	235	221	400 ***
	10.5	177.87 *			382.9 *
EX-12	11	12	35	Not Utilized	28
	11.5	177.80 *			69.5 *

Shading denotes controlling culvert capacity at each outfall
* Design points and culvert capacities reference Interstate 25 South Express Lanes: Castle Rock to Monument (The Gap) Hydrology and Hydraulics Report by ch2m, December 2020. [Reference K]
** Future flows in Gambel Ridge Tributary partly based on Crystal Valley Interchange design.
*** Conveyance capacity of North Dawson Channel under 7.5' x 28' BNSF railway bridge taken from North and South Dawson Master Plan. Future flows through bridge opening will be well below stated capacity.

SWMM

CORE Consultants INC. engaged in meetings with TOCR early and throughout the preliminary design process to gain technical concurrence as well as ensure that the vision of the Town was met in the process.

Hydraulic routing analysis for North Dawson Tributary and Gambel Ridge Tributary was done using the United States Environmental Protection Agencies (EPA) Storm Water Management Model (SWMM) version 5.2.4. EPA SWMM is a dynamic rainfall-runoff simulation model used for single event or long term (continuous) simulation of runoff quantities. EPA SWMM has the capability to interface with hydrograph data computed by the Colorado Urban Hydrograph Procedure (CUHP) and route storm flows through drainage systems. Additionally, EPA SWMM will produce inflow hydrographs at points of interest which then can be inserted into the MHFD Detention workbook to represent flows more accurately in complicated hydraulic systems including ponds in series. For these reasons, EPA SWMM was chosen as the preferred hydraulic analysis method when analyzing each major tributary on a holistic scale. Please see section **Section III.C** of this report for discussion on the CUHP method.

SWMM is an open-source software and is available for free on the EPAs website.

Two separate SWMM models were used to imitate the hydraulic performance of the developed Gambel Ridge and North Dawson watersheds. Both models were ran using a Kinematic Wave solver with a reporting time step of 5 minutes. No infiltration parameters were utilized, and all hydrology was completed using CUHP. Start analysis dates were left at the default of 01/01/2005 and end analysis dates were set to 1/05/2005 to ensure the storm event was able to run fully. The models account for planned development within Dawson Trails, off-site undeveloped areas, and proposed drainage improvements. The models account for attenuation effects from regional detention facilities and does not credit any other incidental detention in non-regional ponds or water quality ponds unless otherwise specified. Inflow hydrographs were extracted from EPA SWMM and inserted into the MHFD Detention workbooks for downstream, in-series ponds Pond A-1 and B-1. Ponds A-1 and B-1 have regional detention facilities upstream of them which help reduce flows in the 100-year storm event and therefore can reduce the sizing of these ponds where appropriate. Please see further discussion on this analysis for each major tributary below.

Due to the Phasing of the overall Dawson Trails project site, two conditions were modeled and accounted for within this analysis. These conditions were the ultimate build out condition and the interim condition. The ultimate build out condition accounts for anticipated development beyond what is part of the Filing 2 project using best available data and engineering judgement. The interim condition accounts for portions of each major tributary being undeveloped and therefore lacking in upstream regional detention. The interim condition was considered to better understand when upstream regional detention would be necessary during the construction process.

In depth descriptions of each individual model are as follows:

North Dawson Tributary:

The North Dawson Tributary SWMM model is made of up two major drainage points of interest. The area in the upper watershed has been designated as "E" basins and the area in the lower water shed has been designated as "A" basins. These drainage systems are built of junction nodes which coincide with their assigned basins. Pipe links, which are primarily used to ensure the maximum flow is conveyed through the system with minimal routing error, dummy links, and storage nodes to represent the proposed flood control facilities. Junctions, links, and storage nodes have been named in accordance with what drainage system they are considered within.

Manning N values of 0.016 were used to model concrete pipes and 0.05 for proposed grass lined channels. In accordance with section MHFD USDCM Vol. 1 – Chapter 6; Section 4.2, N values were increased by 25% within the SWMM Model. Entry and Exit loss coefficients were taken from the EPA SWMM User's Manual Version 5.1, Tables A.11 and B.7 and were applied where appropriate. Please see **Appendix D** for relevant excerpts.

The overall drainage concept of the North Dawson Tributary is to use the proposed major channel as the main flow conveyance with two in-line Regional Flood Control Ponds (Pond A1 and E1) utilized to attenuate flows during major storm events. Parcels within the North Dawson Tributary will have private Water Quality (WQ) ponds which will

accomplish Water Quality Capture Volume (WQCV) and Excess Urban Runoff Volume (EURV) treatment before releasing into the North Dawson proposed channel. All WQ ponds have been modeled as junctions.

The two in-line Regional Flood Control Pond which were considered in the SWMM model were Pond E1 and Pond A1. Pond E1's proposed location is on the eastern most edge of Basin E-1, just upstream of Collector Road A, also known as OSP-1 planning area of the approved Dawson Trails Planned Development Plan (PDP) document. This location also corresponds to Basin E-1 of the Proposed Overall SWMM Map provided in **Appendix D.** Pond A1's proposed location is on the east side of Dawson Trail Boulevard within Basin D1.6 of the proposed drainage map, also known as OSP-4 planning area of the approved Dawson Trails Planned Development Plan (PDP) document. This location also corresponds to Basin A-1 of the Proposed Overall SWMM Map provided in **Appendix D.** Inflow hydrograph data was extracted from SWMM and routed through the MHFD Detention workbook for each pond to ensure proper sizing of outlet structures, outlet pipes, and emergency overflow weirs as well as to account for the volume and flow reduction which Pond A1 will benefit from in the ultimate condition. Both the ultimate and interim conditions were analyzed during design to ensure no adverse effects to downstream storm infrastructure.

The storage curve and rating curves for Pond E1 and A1 were developed using the MHFD detention workbook version 4.06. The storage curves in SWMM reflect the most up to date proposed topography available and the release rates were determined by necessity of attenuation in the upper watershed while meeting historic flow conditions in the downstream reach of the system. The upstream Pond E1 saw a maximum percent full of 38.9% with a maximum release of 65 CFS during the 100-year storm event. The downstream Pond A1 saw a maximum percent full of 96.7% with a maximum release of 232 CFS during the 100-year storm event. The designed release from Pond A1 is below both the existing CUHP analysis completed by EMK and the *North and South Dawson Watersheds Baseline Hydrology Report* completed by *CH2M Hill*. Please see **Appendix B** for SWMM results.

Basin FZ-2 has not been included in the SWMM analysis for North Dawson Tributary and the flows generated within FZ-2 will not interact with the proposed major channel or flood control ponds. Flows that are generated within FZ-2 will be subject to separate water quality and detention before being released at 0.9 of historic flows or less. Basin FZ-1 is the anticipated area of the future substation and will be required to treat and detain any storm water flows generated from their site. These basins have been shown for coordination purposes only.

Due to the phasing of the construction around North Dawson Tributary, Pond A1 will be constructed prior to the development of Pond E1 and the development of its tributary area (Basins E-1 through E-3). However, due to flooding concerns of Pond A1 in the interim condition, the construction of Pond E1 will be required when either of the following conditions are met; when 83% of the land downstream of the proposed Pond E1 (Approx. 230 acres) is developed or the area downstream of Pond E1 reaches a total 50% impervious.

Routed flows from the SWMM model were used in the design process of the North Dawson proposed channel. 2-year, 5-year, 10-year, 25-year, 50-year, 100-year, and 500-year storm events were analyzed and input into HEC-RAS to develop channel cross

sections, water surface elevations, and velocity profiles. Please see **Section IV.A** of this report for discussion on Storm Water Conveyance Facilities.

Report Output files, Link flow, Storage Volume, and outfall loading results have been provided in **Appendix B** and the North Dawson Tributary FMS.

Gambel Ridge Tributary:

The Gambel Ridge SWMM model is made up of two major drainage basin drainage systems, which together form the Gambel Ridge Tributary. The area in the upper watershed has been designated as "H" basins and the area in the lower water shed has been designated as "C" basins. "C" basins are, by and in large, associated with the Crystal Valley Interchange (CVI) project that is anticipated to be in construction prior to the build out of Dawson Trails Filing No. 2 . These drainage systems are built of junction nodes which coincide with their assigned basins. Pipe links, which are primarily used to ensure the maximum flow is conveyed through the system with minimal routing error, dummy links, and storage nodes to represent the proposed flood control facilities. Junctions, links, and storage nodes have been named in accordance with what drainage system they are considered within.

Manning N values are consistent with those used in the North Dawson Tributary SWMM analysis. Please see **Appendix D** for relevant excerpts.

The overall drainage concept of the Gambel Ridge Tributary is to use proposed and existing off-site channels as the main flow conveyance with three full spectrum Extended Detention Basins (EDB) utilized to attenuate flows during major storm events. These ponds are identified as Pond B1, Pond B2, and Pond C1. Several parcels within the Gambel Ridge Tributary will have private Water Quality (WQ) ponds which will accomplish Water Quality Capture Volume (WQCV) and Excess Urban Runoff Volume (EURV) treatment before releasing into the Gambel Ridge proposed channel. All WQ ponds have been modeled as junctions.

Within the "H" basins, two in-line EDB's were considered in the SWMM model. These Ponds are identified as Pond B2 and Pond B1. Pond B1's proposed location is on the northern property line, in the northeast corner of Basin B7 of the Proposed Drainage Map. This location also corresponds to Basin H-7 of the Proposed Overall SWMM Map provided in **Appendix D.** Pond B1's proposed location coincides with the "Regional Pond Location A" from the approved PDP. Pond B2's proposed location is on the northeast corner of Basin B1 of the Proposed Drainage Map. This location also corresponds to Basin H-1 of the Proposed Overall SWMM Map provided in **Appendix D** Pond B2's proposed location will be within the northern portion of PL-1.03 of the approved PDP. Pond B1 is part of the Phase I construction process and will be required as part of the Filing 2 construction efforts. No flooding concerns of Pond B1 were immediately present during the interim condition analysis and therefore, Pond B2 will be built as part of the future Phase II construction process and is not required until Parcel B – Phase II begins development. Both the ultimate and interim conditions were analyzed to ensure no adverse effects to downstream storm infrastructure. Inflow hydrograph data was extracted from SWMM and routed through the MHFD Detention workbook for Pond B-1.
The outflow of Pond B1 will exit the Dawson Trail Development on the north property line before reentering the site on the west side of the Crystal Valley Interchange and into the "C" basins.

"C" basins within this model largely represent the CVI project area and outfall from Gambel Ride Tributary. Within the "C" basin, one regional EDB was considered in the SWMM model. This pond is identified as Pond C1. Pond C1's proposed location will be at the intersection of Dawson Trails Boulevard and Crystal Valley Parkway within Basin C3 of the Proposed Drainage Basin Map and will be required as construction begins on and around the Crystal Valley Interchange. This location also corresponds to Basin C-3 of the Proposed Overall SWMM Map provided in **Appendix D**. CORE Consultants collaborated and shared anticipated tributary areas and impervious percentages with others to help facilitate the most efficient and accurate design of this regional facility. Pond C1's design, construction, and certification will ultimately be the responsibility of the consultants and engineers associated with the CVI project. Basins C-7 and C-8 are anticipated to only require WQ and EURV ponds within their basins. Pond C1 will be designed to over detain to account for those basins lack of detention within the Gambel Ridge Tributary system.

The storage curve and rating curves for Ponds B-1 and B-2 were developed using the MHFD detention workbook version 4.06. The storage curves in SWMM reflect the most up to date proposed topography available and release rates were developed in coordination with Shrewsberry and Jacob's Engineering to best ensure proposed flow rates do not exceed historic flow conditions. The upstream Pond B2 saw a maximum percent full of 80% with a maximum release of 49 CFS during the 100-year storm event. The downstream Pond B1 saw a maximum percent full of 97.3% with a maximum release of 147 CFS during the 100-year storm event. With the most up to date information available through coordination with the consultants involved in the CVI project, Pond C1 saw a maximum percent full of 93.9% with a maximum release of 115 CFS during the 100-year storm event.

A significant amount of un-detained offsite flow will enter the Gambel Ridge at several points along the main tributary. These offsite basins have been identified as OS-1, OS-2, OS-3, and OS-4. Offsite flow which enters the site will not be treated or detained within the proposed EDBs and will instead be conveyed along their historic drainage routes to Gambel Ridge, entering the tributary at different locations along its reach.

Report Output files, Link flow, Storage Volume, and outfall loading results have been provided in **Appendix B.**

The combined release rates from Pond B1 and Pond C1, in addition to un-detained off-site flow, is below both the existing CUHP analysis completed by CORE consultants and the *Flood Hazard Area Delineation – Gambel Ridge and Douglas Lane Tributary Watersheds* completed by *RESPEC Consulting & Services.* Please see the table on the following page for a results summary of the SWMM model.

SWMM Key Design Pont Summary				
Key Flow Location	**Model Node**	**Tributary Basins**	**100-year Peak Flow**	**Peak Flow Modeled Time**
Future Pond B2 Release	EDB-B2	H-1	48.5	1:05
Pond B1 Release	EDB-B1	H2-H7	146.6	1:45
Gambel Ridge Offsite + Pond B1 Release	J_6	H1-H7, OS1-OS4	470.9	1:05
Pond C1 Release	EDB-C1	C1-C6	110.1	1:35
Total Basin Release at BNSF Culvert	OUT-1	All	631	1:10
Max Allowable at Outfall	OUT-1	All	640 (Existing)	N/A

C. Hydrology

Colorado Urban Hydrograph Procedure (CUHP) Method

The Colorado Urban Hydrograph Procedure (CUHP) is a hydrologic analysis method based upon the Snyder's Unit Hydrograph. It has been calibrated by the Mile High Flood District (MHFD) for the front range region using local simulations of rainfall-runoff data. CUHP considers physical characteristics of each watershed basin including shape, slope, impervious area, and soil conditions. CUHP is able to produce hydrographs based on these characteristics for each basin and route them together using EPA SWMM. This results in a more accurate representation of peak flow times throughout the drainage systems. The Rational Method is a simpler hydrologic approach and is only able to produce peak flows from each subject basin. For this reason, CUHP was chosen as the preferred methodology when analyzing each major tributary on a holistic scale. Please see **Section III.B** of this report for further discussion on EPA SWMM.

Per the TOCR SDDTCM, Chapter 6, Section 6.2; Table 6-3, CUHP is an appropriate methodology to determine runoff values for basins ranging from 5-3,000 or more acres. For basins less than 5 acres, flows from the rational method will be used to determine peak flow values. CUHP method is used for calculations of major basin flows, offsite flows, and future development area flows.

Runoff calculations use CUHP 2005v_2.0.1 for the minor (5-year) and the major (100-year) storm events. The workbook utilizes rainfall data found in Table 6-1 of the TOCR Criteria Manual as well as imperviousness values for the various land uses per Table 6-3 of the MHFD Criteria Manual Volume 1. Tables 6-1 & 6-3 are included in **Appendix D.**

Maximum Depression Storage, Horton's infiltration Parameters and Disconnected Impervious Areas (DCIA) standard values were determined by using recommended values from Table B-1 & B-2 within the *CUHP 2005 User Manual, Version 2.0.0* dated September 9, 2016, prepared by the MHFD.

Rational Method

Rational method is used for calculations of roadway runoff and local minor basin flows. Rational method calculations were performed using a rational method workbook, developed by EMK in Microsoft Excel, to estimate peak overland runoff flows resulting from the minor (5-year) and major (100-year) storm events. The workbook utilizes rainfall data found in Table 6-1 of the TOCR Criteria Manual and conforms to the guidance set forth by MHFD Criteria Manual Volume 1, Chapter 6. Imperviousness values for the various land uses are per Table 6-3 of the MHFD Criteria Manual Volume 1. Tables 6-1 & 6-3 are included in **Appendix A.** Evaluation of street flows, inlet sizing, and pipe outfalls into Channel B are all based on rational method to compute local flows.

The 5-year mean recurrence interval is used for the minor drainage system design. The 100-year mean recurrence interval is used for the major drainage system design.

Design 1-hour rainfall amounts are 1.43 in. for the 5-year event and 2.60 in. for the 100-year event.

Storage Calculations

The MHFD-Detention_v4-05 spreadsheet used for all pond designs, including full-spectrum facilities, exclusive water-quality facilities, and detention-only facilities. Regional ponds use routed hydrograph data for pond inflow inputs. The integration of regional pond hydraulics with the SWMM is detailed in Section III.B of this report.

D. Hydraulics

Street conveyance and Inlets

Street and inlet capacity designed based on Chapters 7 and 8 of the TOCR Criteria Manual, and design spreadsheets provided by MHFD. Street conveyance for Dawson Trails Blvd and Gambel Ridge Blvd east of Quandary Peak Drive is designed for compliance with drainage classification C. For all other proposed roadways street conveyance is designed for compliance with drainage classification B.

Minor storm capacities for street conveyance and inlet are based on Table 7-2 of the Town's storm drainage criteria. Major storm flow and ponding depth is controlled by the back-of-walk elevation relative to flowline, based on each street's typical section.

Street Conveyance and Inlet parameters for proposed roadways							
Road	**Station Range**	**Drainage Classification**	**t_{BACK} [ft.]**	**t_{CROWN} [ft.]**	**t_{MAX} (minor) [ft.]**	**d_{MAX} (minor) [in.]**	**d_{MAX} (major) [in.]**
Dawson Trails Blvd (median)	126+10 to 174+60	C	20.0	29.0	19.0	6.0	10.8
Arterial A (median)	69+43 to 88+45	C	18.0	29.0	19.0	6.0	10.3
Gambel Ridge Blvd. (median)	34+50 to 69+43	B	18.0	18.0	8.0	6.0	10.3
Gambel Ridge Blvd. (no median)	10+00 to 34+50	B	18.0	17.0	12.0	6.0	10.3
Schroeder Drive (no median)	10+00 to 23+57	B	18.0	17.0	12.0	6.0	10.3
Blanca Peak Pkwy. (no median)	10+00 to 37+73	B	18.0	17.0	12.0	6.0	10.3
Quandary Peak Drive (no median)	10+00 to 27+54	B	20.0	18.0	13.0	6.0	10.8
Ike Street (no median)	10+00 to 25+75	B	20.0	18.0	13.0	6.0	10.8

Roundabout Drainage

Where roundabouts are proposed, on-grade curb inlets are designed on the uphill approaches of the roundabout to intercept as much flow as practical before entering the roundabout. In places where bicycle lanes are proposed, the inlets are placed upstream of the bicycle lane slip lane to the outside of the roundabout.

Inlet Placement

On-grade and sump inlets are located on roadways as necessary for compliance with Chapter 8 of the Town's drainage criteria. Additionally, inlets are placed upstream on future intersections that are anticipated with reasonable confidence according to land plans in current development. Storm sewer stubs are proposed at future intersection locations where extensions of the storm sewer planned. Area inlets are proposed where existing or interim flow patterns necessitate diversion from proposed roadways.

Culverts

One box culvert and four pipe culverts are proposed with the project. Culvert performance for proposed culverts is analyzed using HY-8 software. All culverts are designed to be compliant with the Town's requirements for major drainageway crossings. All culverts are designed to pass the major storm flow with a headwater to pipe height

ratio specified for the crossing street drainage classification (Section 11.2.3) and with internal flow velocities less than 15 feet per second (Section 11.3.7). Additionally, culverts are designed for a minimum velocity of 3 feet per second during frequently occurring storm events. The culvert performance properties during the major storm are also used as design parameters for riprap aprons at the culvert outlets. Culvert calculations are included in Appendix B.

Open Channels
Major drainageway channels and drop structures are modeled using HEC-RAS. A detailed discussion of major drainageway design is included in Section II.A of this report. See also the floodplain modification studies for the North Dawson Tributary and Gamble Ridge Tributary being prepared concurrently with this report.

Storm Sewers
Hydraulic grade lines for on-site, detained storm sewers and pond outfall pipes are computed through StormCAD software. Headloss coefficients are applied in accordance with HEC-22, 2nd edition. Storm sewers were designed to keep the 100-yr HGl at least 1-foot below final grade and the EGL below final grade. Hydraulic performance of off-site culverts is evaluated through HY-8 software version 7.80.0.2.

E. Storage and Water Quality Enhancement

The storage and water quality strategy the two watersheds covering the project area is described as follows:

Gambel Ridge Watershed
A regional, full spectrum approach is used for water quality and detention in the Gamble Ridge watershed. Proposed regional pond B1 and future regional Pond B2 will provide full-spectrum storage for the upper portion of the watershed (Major Basin B). Pond C1, which is being concurrently designed with the Crystal Valley Interchange, will provide full-spectrum storage for the lower part of the watershed (Major Basin C).

North Dawson Tributary Watershed
Proposed regional detention pond A1 at the bottom of the basin provides 100-year storage and flood attenuation for the lower 2/3 of the watershed. A future regional detention facility, Pond E1, is planned to provide flood control for future development in the upper third of the watershed. Since A1 is exclusively flood-control (no inclusion of water quality capture volume), dispersed water quality ponds will need to be constructed upstream as individual development parcels are built out. Three water quality ponds—D3, D4 and D5—will be constructed with the Filing 2 project to serve the proposed roadways and imminent initial-phase development. The implementation of water quality facilities for upstream sub-basins helps to prevent sedimentation and pollutant transport in the North Dawson drainageway.

Adherence to the four-step process for water quality control is detailed in Section IV.C of this report. All pond designs include overflow provisions to safely convey fully developed flows to the receiving drainageways in the event that the 100-year design water surface elevation is exceeded. These provisions are discussed in Section IV.B (for Ponds B1, A1 and D1) and in Section IV.C (for Ponds D3, D4 and D5)

IV. STORMWATER MANAGEMENT FACILITY DESIGN

A. Stormwater Conveyance Facilities

Major Drainageways

North Dawson Tributary Channel

CORE Consultants Inc. engaged in multiple meetings with the Town of Castle Rock early and throughout the preliminary design process to have technical concurrence as well as ensure that the channel design met the aesthetic goals that the town had intended.

Hydraulic analysis for North Dawson Tributary was done using the United States Army Corps of Engineers (USACE) Hydrologic Engineer Center River Analysis System (HEC-RAS) Version 6.4.1. HEC-RAS is an open-source program developed by USACE.

Through on-site investigations and research, no perennial or intermittent stream flows are present within the North Dawson Tributary subject area. Flows tributary to the drainageway are ephemeral. The existing condition of the stream bed shows signs of significant head cutting with no established wetland vegetation present throughout the tributary reach prior to the BNSF railway. Instability is evidenced by variations in channel alignment and significant erosion.

The intent for drainageways throughout the Site is to improve the existing hydraulic condition while preserving historic drainage patterns with improved drainage characteristics. This is to be performed through the development of engineered channels that provide grade control structures and vegetation establishment following a natural aesthetic. A natural channel approach was not chosen due to the tributary ephemeral flows being insufficient to establish wetland benefits and the inability for stabilization due to the steep, existing grades.

A combination of engineered cross sections, Grouted Stepped Boulder Drop Structures, and vegetation-lined channel conveyance were chosen to best accomplish improving the North Dawson Tributary. Figure 12-3 of TOCR SDDTCM was used to help develop the channel concept with supplemental design information from MHFD Chapter 8 – Open Channel criteria manual where needed.

The longitudinal slope of the channel was determined by first using the recommended equilibrium slope of 0.4% per the FHAD study for the North Dawson Tributary. Iterations of the channel design showed that this slope resulted in velocities and Froude numbers that exceeded the design criteria set forth by TOCR. Altering the longitudinal slope to 0.3% resulted in velocities and Froude numbers which were within acceptable ranges. Please see **Appendix B** for a PDF printout of the proposed HEC-RAS analysis.

Initial sizing parameters of the Low Flow channel and Floodplain Terrace were taken from MHFD Criteria Manual, Volume 2; Chapter 8 – Open Channels, Table 8-2: Minimum

Dimensions for Naturalized Channels. The channel design also incorporates TOCR SDDTCM Table 12-3 which specifies 2.0-feet of freeboard within a Grass-Lined channel. Manning's N values were maintained consistent with the approved FHAD and 0.04 was chosen to represent the left and right overbanks within the channel.

Where velocities are outside the range of acceptable values from the TOCR SDDTCM, soil stabilization measures will be taken to help with reduce erosivity in the channel and on the banks as required. Steps to be taken include additional rip rap protection and protective liners to reduce erosion in major storm events.

The Town of Castle Rock section 12.4.3 outlines preferred methods of drop structures and considerations during the design process. The design of Gambel Ridge North Tributary utilizes the GSBs to dissipate energy, develop a stable channel grade, and produce a more natural aesthetic. Design parameters are discussed below:

- 4-ft and 5-ft Grouted Stepped Boulder Drop Structures with no stilling basins
- Using Equation 9-7 of the MHFD Criteria Manual, B24 boulders have been selected to help dissipate energy and provide sufficient grade control.
- Table 9-1 within Volume 2 of the MHFD Criteria Manual specifies a maximum unit discharge over any portion of the drop width to be 35 CFS/FT of drop width at any point over the drop structure. With an average drop structure width of 132 feet and a proposed flow rate of 670.4 CFS, the expected unit discharge Is approximately 5.1 CFS/FT across the drop structures.
- A Manning's N value of 0.07 was used in the HEC-RAS analysis to emulate the GSBs within the proposed drop structures. Resulting water surface elevations meet and exceed the minimum 2.0-foot required freeboard within the channel. Please see **Appendix B** for resulting subcritical flow regime cross section results).
- Design guidance and detailed design criteria used for the drop structures was governed by MHFD Vol. 2; Chapter 9 – Section 2.2 of the design Criteria Manual. Please see **Appendix B** for results analysis of the drop structure design including a HEC-RAS results tables, Cross Sections, and Drop Structure Boulder Sizing.
- Please see **Appendix D** for excerpts of tables and figures used for drop structure design from appropriate design and criteria manual references.

Gambel Ridge by others

There are no proposed improvements to Gambel Ridge Tributary within the Dawson Trails Filing No. 2 project limits or scope. Channel Improvements to the lower reaches of the drainageway will be designed and constructed with the Crystal Valley Interchange project.

Storm Sewer Networks:

Eight storm sewer networks are proposed with the Filing 2 project to convey roadway and development site drainage to detention basins. The storm sewer networks area identified by the major basins that they serve and are described as follows:

B6 (Gambel Ridge Blvd. north)
Storm sewer line B6 includes 10 street inlets, 4 area inlets and 3300 LF of trunk line in Gambel Ridge Blvd.. The network collects runoff from major basin B6 and outfalls to regional pond B1.

C5.0 (Gambel Ridge Blvd. far north)
Storm sewer line C5.0 includes 4 inlets and 700 LF of trunk line in Gambel Ridge Blvd.. The network collects runoff from minor basins C5.1-C5.4 and outfalls to regional pond C1. Storm line C5.0 is a proposed extension of a network that is anticipated to be constructed with Crystal Valley Parkway

C5.1 (Dawson Trails Boulevard north, Quandary Peak Drive)
Storm sewer line C5.1 includes 4 inlets and 1500 LF of existing trunk line in Dawson Trails Boulevard, with 200 LF of proposed connecting storm sewer from Quandary Peak Drive. The network collects runoff from minor basins C5.11 – C5.16 and outfalls to regional pond C1. Storm line C5.1 is a proposed extension of a network that is anticipated to be constructed with Crystal Valley Parkway and initially extended with the east half of Dawson Trails Boulevard.

C6.0 (Ike Street)
Storm sewer line C6.0 includes 4 inlets and 450 LF of storm sewer in and adjacent to Ike Street. The network collects runoff from minor basins C6.3 and C6.4 and outfalls to regional pond C1.

D5 (Gambel Ridge Blvd. south)
Storm sewer line D5 includes 2 inlets and 80 LF of storm sewer that conveys Gambel Ridge Blvd. roadway runoff from minor basin D5.1 and D5.2 to water quality Pond D5.

D4 (Schroeder Drive)
Storm sewer line D4 includes 2 inlets and 85 LF of storm sewer that conveys Schroeder Drive roadway runoff from minor basin D4.1 and D4.2 to water quality Pond D4.

D3 (Blanca Peak Pkwy. west)
Storm sewer line D3 includes 9 inlets and 2650 LF of storm sewer that conveys runoff from Blanca Peak Pkwy. and planning area D to Water Quality Pond D3. The storm sewer line is designed to accommodate future connections from Parcel D residential development north and south of Blanca Peak Pkwy..

D1 (Dawson Trail Boulevard south)
Storm sewer line D1 includes 4 inlets and 1050 LF of storm sewer that conveys runoff from Dawson Trails Boulevard, the Blanca Peak Pkwy. roundabout, and planning area E-2 to full-spectrum Pond D1. The storm sewer line connects to pre-existing storm sewer constructed with the Dawson Trails Boulevard project that was designed to accommodate the increase in flows from this project.

Culvert Crossings

Box Culverts C1 and C2 are modeled with 45-degree wingwalls for inlet conditions. Both box culverts operate under inlet control in the major storm. The designer to the south is responsible for the design of these box culverts.

Dawson Trails Boulevard box culvert

Culvert C1 is an 8' x 6' concrete box culvert proposed under Dawson Trails Boulevard at station 161+60. The box culvert is designed to convey un-detained, developed 100-year (141 cfs) flows from sub-basin C1 (Planning Area E2) to surface conveyance east of Dawson Trails Boulevard.

Quandary Peak Drive box culvert

Culvert C2 is an 8' x 6' concrete box culvert proposed under Quandary Peak Drive at station 161+60. The box culvert is designed to convey un-detained, developed 100-yer flows (300 cfs) from sub-basin C1 and C2 (Planning Area E2 and F3) to surface conveyance that routs to Pond C1. The design flow rate used for the box culvert is the 100-year combined flow at node J_3-8 of the SWMM.

Schroeder Drive culverts

Pipe culverts under Schroeder Drive that outfall to the North Dawson channel are aligned such that the culverts outlet to the channel overbank at the top of a grouted stepped boulder drop structure. The outlet configuration is intended to minimize tailwater at the culvert outlet under most conditions, while utilizing the channel drop structures for energy dissipation and erosions protection.

Surface conveyances channels

An interim series of conveyance swale is proposed to convey pre-development flows from Basins C1.0 and C2.0 to Pond C1. The swales are not necessary for the overlot grading of the Filing 2 area (CD23-0015), or for the initial construction of Dawson Trails Boulevard (CIP22-0012). Need for the swales arises when construction of Collectors D and E disrupts the surface drainage patterns of the overlot graded condition. Regional Pond C1 is anticipated to be in place before Filing 2 roadway construction or swale construction begins. Future development in Basins C1.0, C2.0 or C3.0 will require improvements of the drainage path to permanent convey fully developed flows.

Interim drainage in undeveloped parcels immediately west of Dawson Trails Boulevard will rely on the existing roadside ditches installed with that roadway's initial phase.

B. Stormwater Storage Facilities

Five stormwater storage facilities are proposed with the Dawson Trails Filing No. 2 project: One regional full spectrum pond (B1), one regional flood-control pond (A1), and three water-quality ponds (D3, D4 and D5). A sixth, existing pond (D1) will be modified to provide full spectrum detention for an expanded tributary area. The proposed ponds are designed to function with other existing, future, and proposed ponds by separate projects. In particular, Regional full-spectrum pond C1 serves a critical role in managing stormwater originating within the project limits. Pond C1 is being concurrently designed, and coordination with that effort will be detailed in this report as design progresses.

Specifically, the following hydrologic and hydraulic parameters have been stated as bases on design for Pond C1:

- Watershed Area of 185.2 acres
- Watershed Imperviousness of 76.9%
- 100-year release rate restricted to 115 cfs
- 100-year pond volume of approximately 27.7 acre-feet

The design parameters listed above are critical to ensuring that the Pond C1 can integrate with the ultimate development conditions of the watershed, hydrograph routing of upstream Regional Pond B1, and total anticipated discharge from Gambel Ridge Tributary across the eastern Dawson Trails Planned Development boundary.

The proposed, existing, and future storage facilities with the Gambel Ridge and North Dawson watersheds are listed below. Detention ponds and water quality ponds are listed separately, with full-spectrum ponds shown in both tables:

Gambel & North Dawson Watersheds:
Regional Detention Pond Summary (100-year Detention)

Pond	Tributary Basins (CUHP)	Tributary Area (ac)	% Imp.	Req. 100-year Volume (ac-ft)	Design/ Const
B1	B2-B7	170.8	40.0%	13.74	Proposed; Infra 1 by EMK
B2	B1	46.4	7.8%	1.58	Future; P.A. B1, Phase 2
C1	C1-C7	185.2	76.9%	24.42 *	Proposed; CVI by Jacobs
A1	A1-A8	277.5	63.9%	31.39 **	Proposed; Infra 1 by EMK
E1	E1-E3	133.8	32.6%	9.49 **	Future; Planning Area C1

* Basins C7 and C8 are not directly tributary to Pond C1; 100-year volume for C7 is accounted for in Pond C1

** Ponds A1 and E1 are in direct series and accommodate combined required volume between both ponds

Gambel & North Dawson Watersheds:
Water Quality / EURV Pond Summary

Pond	Tributary Basins (CUHP)	Tributary Area (ac)	% Imp.	WQCV / EURV (ac-ft)	Design/ Const
B1	H2-H8	170.8	40.0%	2.56	Proposed; Infra 1 by EMK
B2	H1	46.4	7.8%	0.21	Future; Planning Area B1
C1	C1-C6	185.2	76.9%	4.78	Proposed; CVI by Jacobs
C2	C7	9.1	90.8%	0.31	Proposed; DTB North by CORE
C3	C8	20.5	90.8%	0.70 (WQCV only)	Proposed; Costco

					by CORE
D3	A4	91.9	66.9%		Proposed; Infra 1 by EMK
D4	D4(minor basin)	2.77	100%		Proposed; Infra 1 by EMK
D5	D5(minor basin)	2.64	100%		Proposed; Infra 1 by EMK
A7	A7	35.2	TBD	TBD	Future; Planning Area C1
A6	A6	10.5	TBD	TBD	Future; Planning Area G1
E2	E2	39.7	TBD	TBD	Future; Planning Area D
A8	A8	34.8	TBD	TBD	Future; Planning Area C2,D
E3	E3	44.2	TBD	TBD	Future; Planning Area C1
A6	A6	8.2	TBD	TBD	Future; Planning Area C2

Regional Pond B1 (Full-spectrum)

Regional Pond B1 is proposed in the upper portion of the Gambel Ridge watershed. It is designed to treat and detain developed runoff from the areas of the upper watershed that lie within the planned development boundary. The pond is an off-line from the main drainageway stem, and off-site flows bypass the pond on the north. The pond outfall releases to Gambel Ridge Tributary immediately upstream of its (initial) exit from the planned development. A future regional facility (Pond B2) is planned upstream of Pond B1, when that area develops. Pond B1's storage volume is sized for tributary basins B2 through, downstream of Pond B2. The 100-year release rate for pond B1 is limited to 0.9 of the pre-development peak flow. The 100-year combined flow rate (off-site + detained) in Gamble Ridge Tributary across the Dawson Trails north boundary is less than the existing 100-year drainageway flow. Pond B1's incoming, outgoing and emergency conveyances are designed for the full developed flows in the tributary watershed, without reduction from attenuation in Pond B2.

The normal and emergency flow conditions for Pond B1 were at the forefront during the design process. In the normal outflow condition, flows will leave the pond by way of outlet structure and outfall pipe where they will enter Gambel Ridge Tributary at a point along the northern property line of the site. In the emergency overflow condition, riprap on the downstream side of the spillway will help to dissipate flow energy before storm flows leave the site via their historic conveyance the Gambel Ridge tributary.

Regional Pond A1 (Flood Control)

Regional Pond A1 is located at the low point of the North Dawson Watershed, adjacent to the eastern boundary of the planned development. Due to space constraints and land use considerations, it was determined that two regional ponds in series was the most efficient use of space and capital. These ponds are identified as Flood Control Ponds A1

and E1. Please see **Section III.B** of this report for detailed information on how these ponds interact.

The existing bridge crossing of the BNSF railway over North Dawson Tributary is a critical constraint that affects overall pond design.

The bridge crossing is under private ownership and has no known program for improvements. Additionally, uncertainties in the bridge's design, construction, and condition amplify the importance of mitigating any adverse hydraulic impact. The analysis of the existing drainageway crossing under the BNSF bridge and Interstate 25 immediately east is detailed in Section III.B of this report. The ultimate 100-year release rate from Pond A1 (and thus the entire watershed) is limited to 235 cfs, which is the most conservative evaluation of the pre-development peak flow rate. For storms of lesser magnitude than the 100-year event, the EURV functions of upstream Ponds D3, D4 and D5 ensures that peak runoff will be reduced, relative to the pre-developed condition, across a broad spectrum of rain events.

The normal and emergency flow conditions for Pond A1 were at the forefront during the design process. In the normal outflow condition, an impact basin has been designed to help dissipate energy and reduce erosive velocities during normal flow conditions. In the emergency overflow condition, riprap on the downstream side of the spillway will help to dissipate flow energy before storm flows leave the site via their historic conveyance of the BNSF bridge.

Regional Pond C1 (Full Spectrum, By others)

Pond C1 is not designed or constructed with the Dawson Trails Filing No. 2 project, but does provide detention and water quality for some of the project's improvements. Pond C1 is also designed to accommodate full-spectrum detention and water quality treatment for 177 acres of development parcels within the Dawson Trails Planned Development. The Pond's detailed design and construction is included in the Crystal Valley Interchange project, for which it also provides detention and water quality treatment. Ongoing coordination between EMK consultants and the Crystal Valley Interchange project's engineers has guided the pond's sizing and outlet design.

Future versions of this drainage report will reference pertinent design information from the Crystal Valley Interchange Phase III Drainage Report, once that report is published.

Verification of design compatibility will contain checks on the watershed parameters, (Imperviousness, basin area, inflow hydrograph) and checks of the outflow properties (release rates, routed outflow hydrograph, SWMM model of peak combined flows in Gamble Ridge Tributary at east development boundary.

Full-spectrum Pond D1

Basin D1 includes the segment of Dawson Trails Boulevard that traverses the North Dawson watershed. The proposed drainage system for Basin D1 will integrate with previously installed infrastructure from that project.

Full-spectrum Pond D1 will retrofit the full-spectrum pond identified as Pond B in the Dawson Trails Boulevard Project.

Full-spectrum Pond D1 will see a slight increase in roadway area routed to it from roundabout construction at Dawson Trail Boulevard and Blanca Peak Pkwy., and about 500 feet of the western leg. A more significant area of undeveloped land in Basin D.0, which currently drains to the western roadside ditch of Dawson Trails Boulevard, will also be routed to the pond. That pond incorporated an assumed imperviousness of 100% within the right-of-way to account for future changes to the road section and future intersections. Since the right-of-way for Dawson Trails Boulevard and intersecting collector roads are being built-out with the Filing 2 project, a more precise analysis of right-of-way imperviousness can be made. A more detailed assessment of ground cover within the right-of-way reveals a lower impervious area than what was assumed in the Dawson Trails Boulevard, which is offset by the increase in impervious area from Blanca Peak Pkwy.. Since the remaining additional area is undeveloped, the impact to the EURV requirement is minimal. Consequently, Pond D1 can satisfy its WQCV and EURV functions with no alteration to the existing outlet structure, orifice plate or top of berm elevation. However, the increase in 100-year storage volume caused by the additional tributary area will require the spillway crest to raise 2 feet. There is sufficient freeboard in the existing pond such that the required minimum 1 foot over overflow depth can still be accommodated. In the interim condition, Pond D1—with the proposed spillway modification--can continue to function as a full-spectrum facility for the area that it serves. When Basin D.0 develops, a more significant alteration of the pond, outlet structure and outfall will be necessary. 100-year detention for the area served by pond D1 is accounted for in regional Pond A1, so Pond D1 may be converted to a water quality/EURV-only pond in the future if its outfall is redirected to Pond A1. Pond D1 will utilize pre-existing spillway embankment protection designed for Dawson Trails Boulevard Pond B1 (TOCR Project #CIP22-0012)

Maintenance accommodations are designed for all ponds constructed with this project. These accommodations include vehicle access paths to the pond's forebay and outlet structure, compliant with Town criteria.

Regional detention ponds B1 and A1 will be owned and maintained by the town of Castle Rock. Full-spectrum Pond D1 and water quality ponds D3, D4 and D5 will be owned and maintained by the metro district.

C. Water Quality Enhancement Control Measures

Implementation of the four-step process of water quality control includes the following features:

1) The Dawson Trails Planned Development Plan reserves a significant amount of land as open space, creating a significant reduction in overall runoff at the development's build-out. Open spaces will be dedicated as large contiguous tracts, as well as smaller areas within planned development parcels. Within the developed areas the following features will further contribute to runoff reduction:

    a. Residential lot roof areas, which are anticipated to be a significant element of the development's ultimate impervious area, drain to pervious yard space before concentrating in street gutters.

b. Proposed and future runoff flows within the North Dawson Watershed will conveyed be through the development area in a vegetated, pervious open channel stabilized with grouted boulder drop structures.

2) Water quality treatment is incorporated into all of the watersheds within the project area. Water quality capture volume is provided for all development areas within the Upper Gambel watershed in regional full-spectrum Pond B1. Water quality capture volume is provided for all development areas within the Lower Gambel watershed in regional full-spectrum Pond C1, constructed separately with the Crystal Valley Interchange.

Water quality capture volume for proposed roadways and development areas of the North Dawson Tributary will be provided in proposed water quality ponds D3, D4 and D5 or full-spectrum Pond D1. The regional detention design for the North Dawson Watershed accounts for future water quality treatment to provided with separate development areas as they are built out.

3) Open channels that convey runoff through or around the site are designed to maintain stable flow velocities. Drop structures or check structures are used to manage topographical fall and to maintain a stable grade for each channel's design flow. Channels are designed to be grass-lined as much as possible, avoiding excessive use of riprap. Additionally, pipe outfalls are designed to dissipate energy and slow water flow to non-erosive velocities. Flows discharged to receiving drainageways downstream of the project area will be attenuated to rates that are less than existing flows for a full spectrum of storm events.

4) The proposed residential land uses of Planning Areas B1 and D have relatively low risk of illicit discharge compared to other land uses. Incidental pollutants sources are generally not concentrated. Runoff from all proposed roadways, will be conveyed to water quality pond D3, D4 or, D5, or full spectrum ponds B1 or D1 before discharge into any open drainageway. Future development of individual parcels within the planned development area will be required to adhere to reasonable site-specific source controls as part of their development plan processes.

Water Quality Ponds D3, D4 and D5 are discussed below.

Water Quality Pond D3

Water Quality Pond D3 is an off-line facility that is proposed on the west side of Dawson Trails Boulevard. The Pond captures runoff from Blanca Peak Pkwy., most of northern portion of Planning Area D, and Planning area PL-1.05. The pond is sized for WQCV and EURV volumes based on an overall basin area of 91.7 acres and an assumed imperviousness of 38.3%. The basin's hydrology characteristics and land plan are described in further detail in section II.

The outlet structure in Water Quality Pond D3 is designed to pass the pond outflow for events up to the 25-year without spillway activation. Outflow for the 50-year and 100-year events is accommodated by a combination of outlet structure and spillway flow. The berm between Pond D3 and the adjacent drainageway serves as a spillway crest

and is fortified with a cutoff wall along its length. Water Quality Pond D3 outfalls directly to North Dawson Tributary and ultimately onto the Flood Control Pond A1.

Water quality Ponds D3 is designed with an emergency overflow spillway that is sized to pass the 100-year developed flow with 1 foot of freeboard above the spillway's weir flow depth. The overflow path from Pond D3 discharges directly to the North Dawson drainageway and is designed with riprap erosion protection. The Culvert Crossing of North Dawson Tributary is sized for fully developed, un-attenuated flows from all of the Lower North Dawson watershed ('A' basins of the CUHP), including the entire tributary area of Pond D3.

Water Quality Ponds D4 and D5

Water Quality Pond D4 is an off-line facility that is proposed near the intersection of Schroeder Drive and Blanca Peak Pkwy., adjacent to North Dawson Tributary. The Pond captures runoff from the segment of Schroeder Drive right-of-way, between Gambel Ridge Blvd. and Blanca Peak Pkwy..

Water Quality Pond D5 is an off-line facility that is proposed near the intersection of Gambel Ridge Blvd. and Schroeder Drive, north of the North Dawson Tributary. The Pond captures runoff from the segment of Gambel Ridge Blvd. right-of-way, between the high point at station 27+14 and Schroeder Drive.

Ponds D4 and D5 are both sized for their tributary areas' water quality capture volume, excess urban runoff volume, and headwater depth to bypass the 100-year event. Aside from incidental detention within the EURV and WQCV stages, the D4 and D5 ponds do not attenuate for flood control. Major storm flows bypass through grated outlet structures to North Dawson Drainageway. Flood control is provided in regional pond A1 downstream. Water quality Ponds D4 and D5 are designed with an emergency overflow spillway that is sized to pass the 100-year developed flow with 1 foot of freeboard above the spillway's weir flow depth. The ponds are both adjacent to the North Dawson drainageway and their downstream embankments are designed with riprap erosion protection.

D. Floodplain Modification

There are currently no FEMA designated floodplains on-site. The site falls on FEMA Flood Insurance Rate Map (FIRM) number 08035C0284G. This FIRM Map is included in **Appendix A**.

Impacts to Town-mapped Floodplains along the site's two major drainageways are described below:

Gambel Ridge Tributary

A separate floodplain modification study (FD24-0003) supports the channel improvement for Gambel Ridge Tributary adjacent to the site. The Gambel Ridge Tributary improvements are under construction and will be completed prior to any Filing 2 development. They are a component of the Crystal Valley Interchange project, which is essential for site access.

North Dawson Tributary
The proposed improvements to North Dawson Tributary will confine the floodplain limits within the channel banks. Additionally, the split flows condition that occurs at the east end of the drainageway will be consolidated into a single flow path. A Floodplain Modification Study (FMS) based on fully developed flows will accompany the channel improvements. Formal FMS documentation is included with this drainage report and construction plans submittal. A HEC-RAS model of the improved channel and drop structures is included to support the design and floodplain modification.

The North Dawson Tributary improvements will be constructed with the Filing 2 general Infrastructure improvements. They will be completed prior to any parcel development, except Parcel D which may be partly concurrent at the earliest.

The timing of drainageway improvements will be compliant with the Dawson Trails Development Agreement (Ordinance No. 2022-018), Section 7.07, which states: *"The Drainageway Improvements shall be constructed and completed concurrently with any adjacent subdivision improvements and as part of the Public Improvements necessary to serve the Property. The Drainageway Improvements located within the Town boundaries shall be dedicated to the Town in a separate floodplain tract"*

E. Geotechnical Investigation and Sub-surface Collection System Design

Kumar & Associates, Inc. prepared a draft of the *Geotechnical Engineering Study South I-25 Frontage Road Phase 2 Tomah Road to Territorial Road* in August 8, 2003. No underdrain systems are proposed. There are no significant sub-surface elements that would expect impacts from the groundwater table.

F. Operation and Maintenance

North Dawson Drainageway
The North Dawson Drainageway will be contained within public open-space tracts (OSP1-OSP4) and outlined on the Planned Development Plan. The drainageway will function as a regional conveyance facility between Gambel Ridge Blvd. and the eastern development boundary. The regional drainageway segment of North Dawson will be owned and maintained by the Town of Castle Rock. Proposed and future segments of the drainageway west of Gambel Ridge Blvd. will be owned and maintained by the metro district. A maintenance access path adhering to section 12.5.4 of the Town's drainage criteria will be constructed along the entire improved length of the drainageway.

Regular maintenance of the drainageway will include:
- Inspection and debris removal – annually, and after significant storm events

Regular maintenance of the drop structures will include:
- Inspection – annually, and after significant storm events

Occasional or as-needed maintenance activities will include:
- Repair of eroded areas—as determined by inspection

Detention and Water Quality Ponds
Full-spectrum Pond B1, and Detention Pond A1 will be regional facilities, with ownership and ongoing maintenance by the Town of Castle Rock.

Full-spectrum Pond D1, and Water Quality Ponds D3, D4 and D5 will be owned and maintained by the metro district.

Vehicle access to all pond forebays and outlet structures are complaint with maintenance requirements in Section 13.6 of the Town's storm drainage criteria.

Recommended maintenance practices for extended detention basins in the Denver region are detailed in MHFD Criteria Manual Volume 3, Chapter 6, Section 7.

Regular maintenance of the stormwater facilities will include:
- Inspection and debris removal – twice annually, and after significant storm events
- Aeration – annually
- Sediment removal from forebay and trickle channel – annually

Occasional or as-needed maintenance activities will include:
- Sediment removal from basin bottom—when sediment volume reaches 20% WQCV (~15 to 25 years)
- Repair of eroded areas—as determined by inspection

G. Additional Permitting Requirements

There are no attributes of this project, associated disturbance areas, or impacted drainages that are expected to trigger additional permitting requirements.

H. General

Applicable tables and figures from the criteria manuals used in the drainage design of the Site can be found in **Appendix D**.

The following published tables and charts have been used in the drainage design and are referenced in the Appendices:
a. *TOCR Criteria Manual Table* 6-1: Point Rainfall Values
b. *TOCR Criteria Manual Table 6-3*: Comparison of Hydrological Methods
c. *TOCR Criteria Manual Figure 7-7*: Street Capacity Chart
d. *TOCR Criteria Manual Figure 12-3*: Major Drainageway Stabilization Design Elements
e. *TOCR Criteria Manual Section 12.2.2*: Low Flow Channel Design Criteria
f. *TOCR Criteria Manual Table 12-3*: Hydraulic Design Criteria for Grass-Lined Channels
g. *TOCR Criteria Manual Figure 13-7*: Embankment Protection Details and Rock Sizing Chart
h. *MHFD USDCM Table 6-3: Recommended Impervious Values*
i. *MHFD USDCM Table 8-2: Minimum Dimensions for Naturalized Channels*
j. *HFD USDCM Table 8-22: Swale Stability Chart*

k. *MHFD USDCM Table 9-1: Design Criteria for Drop Structures Using Simplified Design Procedures*
l. *MHFD USDCM Table 9-3: Drop Structure Manning's N Value*

V. CONCLUSIONS

A. Compliance with Standards

The drainage design for Dawson Trails Filing No. 2 conforms to the Town of Castle Rock Storm Drainage Design and Technical Criteria Manual, the Mile High Flood District Urban Storm Drainage Criteria Manuals, the Chatfield Reservoir Control Regulation No. 73, and all applicable local, state, and federal requirements for drainage design and stormwater discharge.

The project area and associated drainage areas are not within the Cherry Creek Reservoir Watershed.

The project area and associated drainage areas do lie within the Chatfield Reservoir Watershed. To date, the project has not been subjected to specific requirements regarding Regulation No. 73.

B. Variances

A variance request for section 12.2.3 of the TOCR Criteria Manual is submitted with this report. The variance request is for use of a maximum permitted drop structure height of 10' for the North Dawson Channel design, in deviation from the maximum heights noted in Table 12-1 of the Criteria Manual.

C. Drainage Concept

The stormwater strategy that guides the Dawson Trails Filing No. 2 drainage improvements utilizes a watershed-wide approach to managing runoff. The use of regional detention facilities promotes land-use efficiency and provides synergies among conveyance elements within development areas.

Stormwater conveyance and storage elements have been coordinated with currently proposed adjacent infrastructure projects in accordance with the overall vision of the Dawson Trails Planned Development Plan and existing drainageway master plans. This drainage plan also integrates runoff and storage analyses from separately designed projects within the watershed into a Stormwater Management Model. The comprehensive stormwater model helps ensure that total watershed flows across the east project boundary do not exceed historic flows rates or receiving infrastructure capacity. The future construction of flood control Pond E1 will be required when either of the following conditions are met; when 83% of the land downstream of the proposed Pond E1 (Approx. 230 acres) is developed or the area downstream of Pond E1 reaches a total 50% impervious.

No adverse impacts to upstream or downstream natural channels, infrastructure, property, public health, safety, or welfare are anticipated due to discharges from the Site.

VI. REFERENCES

- Town of Castle Rock Storm Drainage Design and Technical Criteria Manual, June 2019.
- Mile High Flood District Urban Storm Drainage Criteria Manual, January 2021.
- Web Soil Survey, Soil Survey Staff (Natural Resources Conservation Service), United States Department of Agriculture. Available online at the following link: https://websoilsurvey.sc.egov.usda.gov/. Accessed May 15, 2023.
- Flood Insurance Rate Map (FIRM) No. 08035C0284G, Federal Emergency Management Agency, Revised March 16, 2016. Available online at the following link: https://msc.fema.gov/portal/home. Accessed May 15, 2023.
- Modeling Hydraulic and Energy Gradients in Storm Sewers: A Comparison of Computational Methods by AMEC, October 2009
- Flood Hazard Area – Delineation Gambel Ridge and Douglas Lane Tributary Watersheds by Respec Consulting and Service, July 2014
- Gambel Ridge and Douglas Lane Tributary Watersheds – Master Plan by Respec Consulting and Service, July 2014.
- Dawson Trails Planned Development Plan and Zoning Regulations by Norris Design, June 9, 2022 (PDP-05)
- Crystal Valley Interchange Phase 1 Drainage Report, by Jacobs Engineering Group, July 2022
- Interstate 25 South Express Lanes: Castle Rock to Monument (The Gap) Hydrology and Hydraulics Report by ch2m, December 2020.
- North and South Dawson Watershed Master Plan Conceptual Preliminary Design, by CH2MHILL, June 2009.
- Final Drainage Report (Phase III) for Dawson Trails Blvd (West Frontage Road) CIP22-0012 by CORE Consultants, Inc., September 1, 2023

Computer Modeling Programs:

A. StormCAD by Bentley Systems, Inc., Version 10.03.04.53.

B. Hydraflow Express Extension for Autodesk Civil 3D by Autodesk, Version 2022.

C. Detention Basin Design Workbook (MHFD-Detention v4.04.xlsm) by Mile High Flood District, Version 4.04, February 2021.

D. Street and Inlet Hydraulics Workbook (MHFD-Detention v4.54.xlsm) by Mile High Flood District, Version 4.05, March 2017.

E. HY-8 by Federal Highway Administration, Version 7.80.0.2, November 2022.

F. Colorado Urban Hydrograph Procedure, by Urban Drainage and Flood Control District, Denver, Colorado, Version 2.0.1, Release Date 10/31/2019.

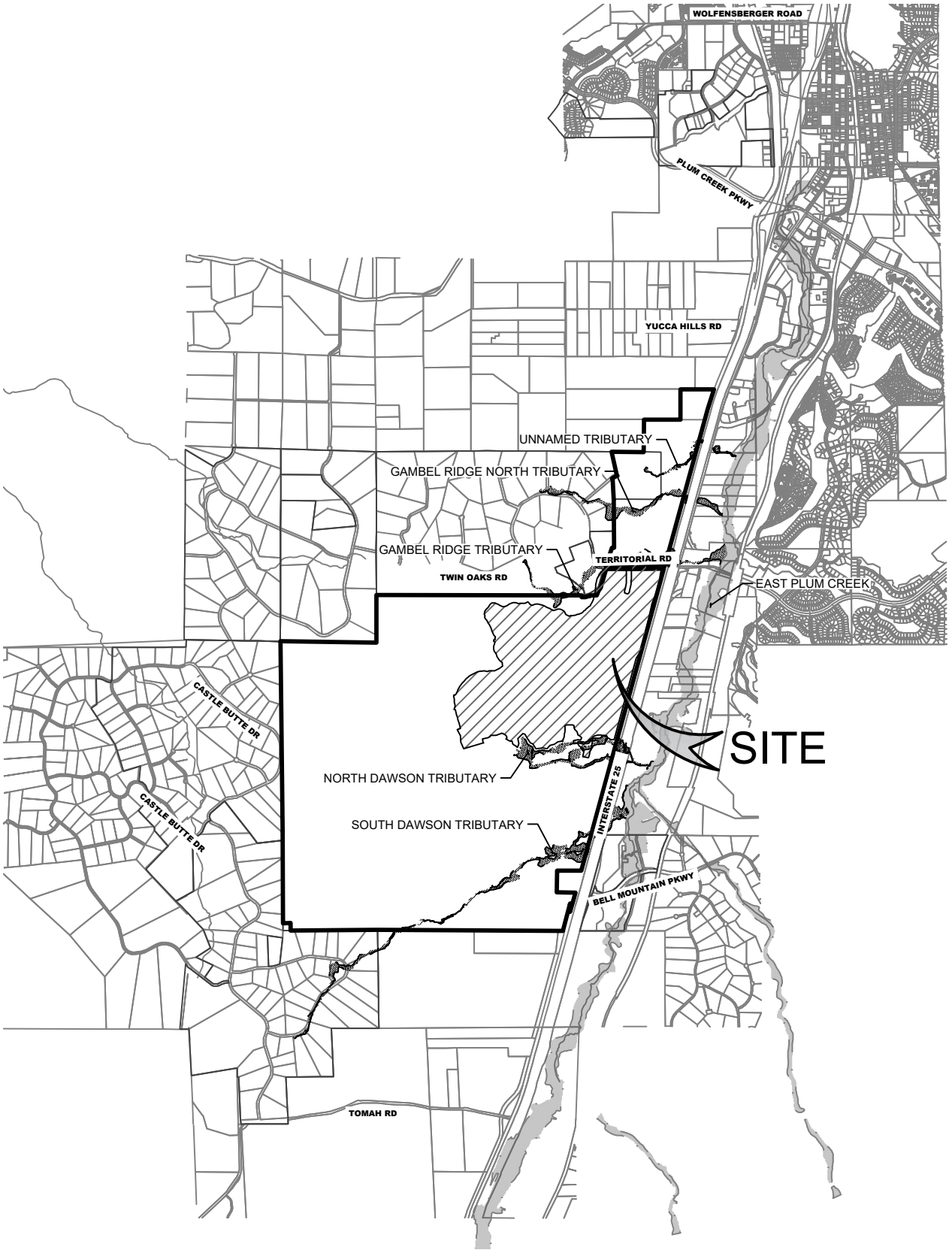
G. Storm Water Management Model Version 5.2, by U. S. Environmental Protection Agency, Release 5.2.3

H. River Analysis System (HEC-RAS) by U. S. Army Corp of Engineers Hydrologic Engineering Center, Version 6.4.1.

APPENDIX A

PROJECT INFORMATION & HYDROLOGIC COMPUTATIONS

VICINITY MAP
HYDROLOGIC SOIL GROUP
FLOODPLAIN MAPS
EXISTING CUHP CALCULATIONS
PROPOSED CUHP CALCULATIONS
PROPOSED SWMM ANALYSIS
RATIONAL METHOD CALCULATIONS



CORE CONSULTANTS. INC.
LIVEYOURCORE.COM

0 4,000'

1 inch = 4,000 ft.

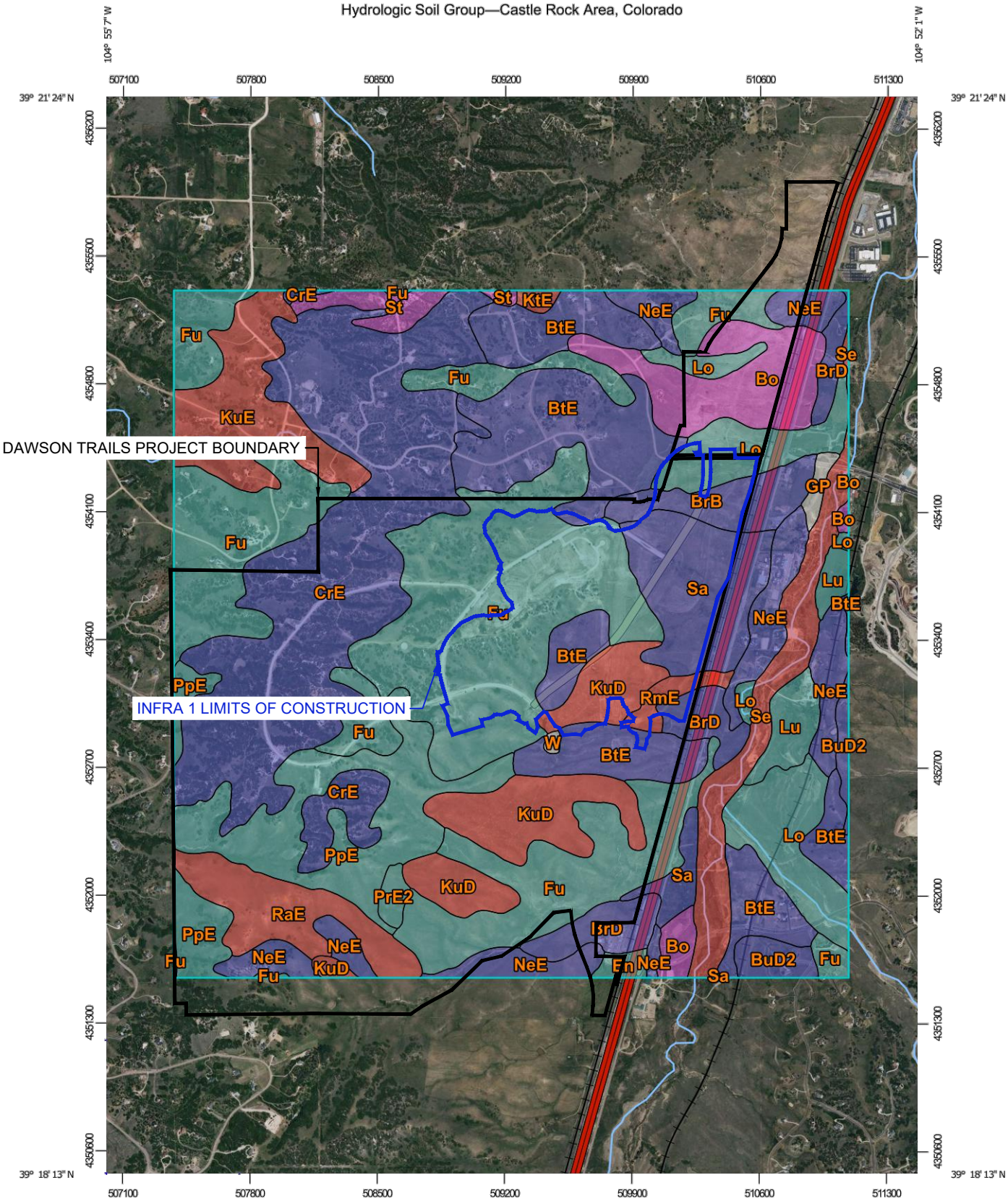
DAWSON TRAILS
VICINITY MAP

CREATED BY: MB DATE: 03/17/2023

SHEET NUMBER 1 OF 1 SHEETS

JOB NUMBER 20-224

3/17/2023 12:04 PM - X:\20-224 DAWSON\CIVIL\REPORTS\INFRA 1\EARLY GRADING\PHASE II DRAINAGE REPORT\2 - (A) FIGURES\VICINITY MAP\VICINITY MAP - INFRA 1 - EARLY GRADING - PHASE II DRAINAGE.DWG


104° 55' 7" W
104° 52' 1" W
39° 21' 24" N
39° 18' 13" N
507100
507800
508500
509200
509900
510600
511300
4356200
4355500
4354800
4354100
4353400
4352700
4352000
4351300
4350600
DAWSON TRAILS PROJECT BOUNDARY
INFRA 1 LIMITS OF CONSTRUCTION
CrE
Fu
St
KtE
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W
BuD2
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RaE
Map Scale: 1:28,700 if printed on A portrait (8.5" x 11") sheet.
N
Meters
0
400
800
1600
2400
Feet
0
1000
2000
4000
6000
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Lines

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Points

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

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

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

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

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

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

Soil Survey Area: Castle Rock Area, Colorado
Survey Area Data: Version 15, Sep 1, 2022

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

Date(s) aerial images were photographed: Jun 9, 2021—Jun 12, 2021

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
Bo	Blakeland-Orsa association, 1 to 4 percent slopes	A	135.9	3.9%
BrB	Bresser sandy loam, cool, 1 to 3 percent slopes	B	58.8	1.7%
BrD	Bresser sandy loam, cool, 5 to 9 percent slopes	B	83.8	2.4%
BtE	Bresser-Truckton sandy loams, 5 to 25 percent slopes	B	382.8	11.1%
BuD2	Bresser and Truckton soils, 3 to 12 percent slopes, eroded	B	31.9	0.9%
CrE	Crowfoot-Tomah sandy loams, 5 to 25 percent slopes	B	567.3	16.4%
En	Englewood clay loam	C	9.2	0.3%
Fu	Fondis-Kutch association	C	831.2	24.0%
GP	Pits, gravel		8.8	0.3%
KtE	Kutch sandy loam, 5 to 20 percent slopes	D	5.7	0.2%
KuD	Kutch clay loam, 4 to 8 percent slopes	D	172.2	5.0%
KuE	Kutch clay loam, 8 to 20 percent slopes	D	130.3	3.8%
Lo	Loamy alluvial land	C	173.6	5.0%
Lu	Loamy alluvial land, dark surface	C	44.2	1.3%
NeE	Newlin gravelly sandy loam, 8 to 30 percent slopes	B	176.6	5.1%
PpE	Peyton-Pring-Crowfoot sandy loams, 5 to 25 percent slopes	C	231.3	6.7%
PrE2	Peyton-Pring-Crowfoot complex, 3 to 15 percent slopes, eroded	C	10.5	0.3%
RaE	Razor clay, 3 to 25 percent slopes	D	92.0	2.7%
RmE	Renohill-Buick complex, 5 to 25 percent slopes	D	17.6	0.5%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
Sa	Sampson loam	B	152.4	4.4%
Se	Sandy wet alluvial land	D	114.2	3.3%
St	Stapleton-Bresser association	A	30.0	0.9%
W	Water		2.3	0.1%
Totals for Area of Interest			**3,462.7**	**100.0%**

Description

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

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

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

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

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

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

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

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

NOTES TO USERS

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

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

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

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD 83, GRS 1980 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

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

NGS Information Services
NOAA, NNGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

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

Base map information shown on this FIRM was provided by the Douglas County GIS Department and the Town of Castle Rock GIS Department. Additional input was provided by the City of Lone Tree and Town of Parker. These data are current as of 2010.

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

The **profile baselines** depicted on this map represent the hydraulic modeling baselines that match the flood profiles in the FIS report. As a result of improved topographic data, the **profile baseline**, in some cases, may deviate significantly from the channel centerline or appear outside the SFHA.

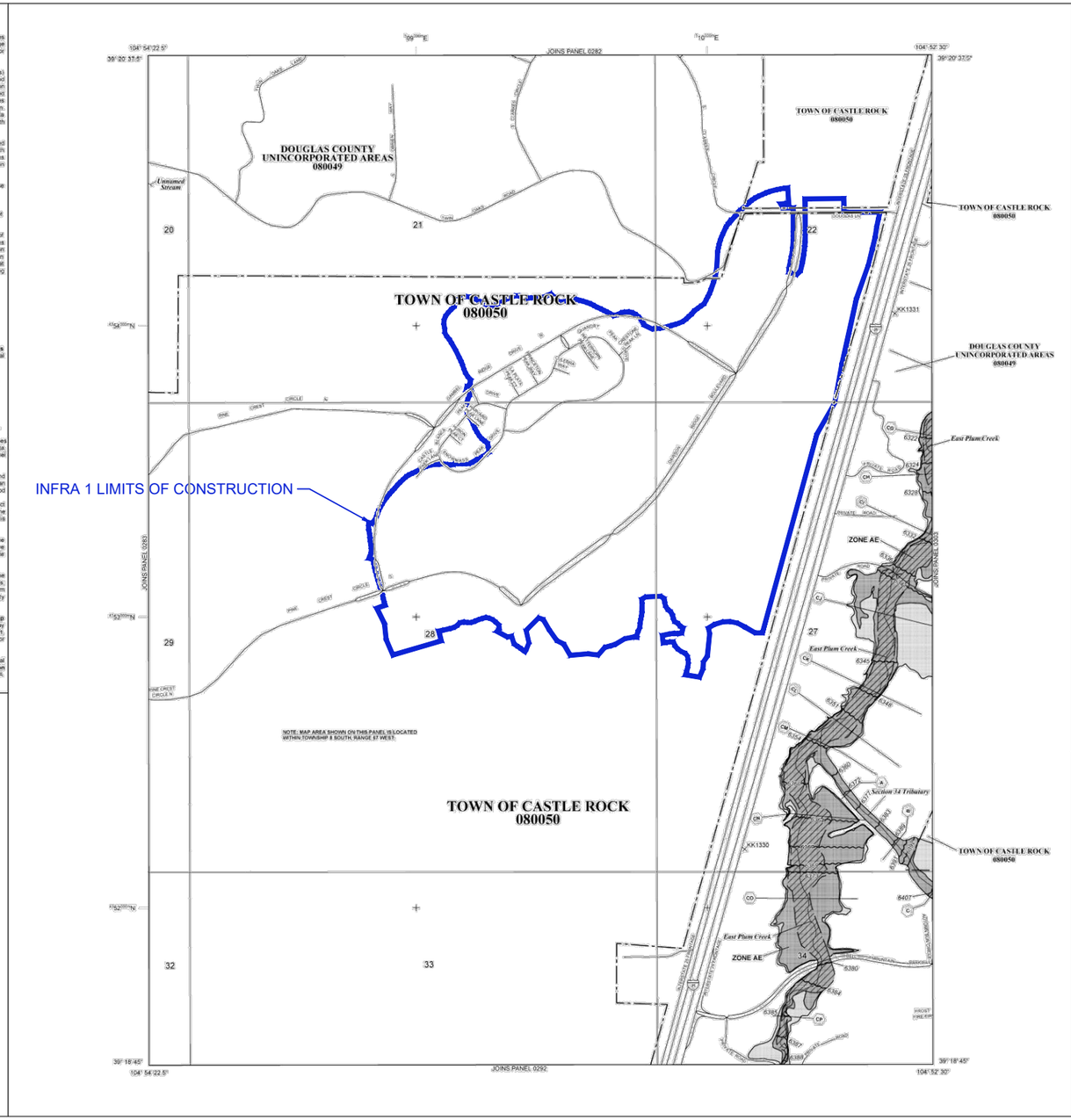
Based on updated topographic information, this map reflects more detailed and up-to-date **stream channel configurations** and **floodplain delineations** than those shown on the previous FIRM for this jurisdiction. As a result, the Flood Profiles and Floodway Data tables for multiple-streams in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on the map. Also, the road to floodplain relationships for unrevised streams may differ from what is shown on previous maps.

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

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

For information on available products associated with this FIRM visit the **Map Service Center (MSC)** website at http://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the MSC website.

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



LEGEND

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

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, AR/A, AR/AE, AR/AH, AR/AO, A99, V, and VE. The Base Flood Elevation is the water surface elevation of the 1% annual chance flood.

- ZONE A — No Base Flood Elevations determined.
- ZONE AE — Base Flood Elevations determined.
- ZONE AH — Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
- ZONE AO — Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
- ZONE AR — Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
- ZONE A99 — Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
- ZONE V — Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
- ZONE VE — Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

- ZONE X — Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

- ZONE X — Areas determined to be outside the 0.2% annual chance floodplain.
- ZONE D — Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- 1% Annual Chance Floodplain Boundary
- 0.2% Annual Chance Floodplain Boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities.
- 513 (EL 987) — Base Flood Elevation line and value; elevation in feet*
- Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

- A — A — Cross section line
- 23 — 23 — Transect line
- 45° 02' 08", 93° 02' 12" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere
- 4439000 mN — 1000-meter Universal Transverse Mercator grid values; zone 13
- 5535 10 — Bench mark (see explanation in notes to Users section of this FIRM panel)
- M1.5 — River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index.

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
SEPTEMBER 30, 2005

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
MARCH 16, 2016 - to update corporate limits, to change base flood elevations, to add base flood elevations, to add special flood hazard areas, to update map format, to add cross sections/transects, to reflect updated topographic information, to incorporate previously issued letters of map revision.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'
250 0 500 1000 FEET
150 0 150 300 METERS

NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0284G

FIRM

FLOOD INSURANCE RATE MAP

DOUGLAS COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 284 OF 495
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CASTLE ROCK, TOWN OF	080050	0284	G
DOUGLAS COUNTY	080049	0284	G

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

MAP NUMBER
08035C0284G
MAP REVISED
MARCH 16, 2016

Federal Emergency Management Agency

EXISTING CONDITION

CUHP SUBCATCHMENTS

Columns with this color heading are for required user-input
Columns with this color heading are for optional override values
Columns with this color heading are for program-calculated values

								Maximum Depression Storage (Watershed inches)		Horton's Infiltration Parameters			DCIA
Subcatchment Name	EPA SWMM Target Node	Raingage	Area (acre)	Length to Centroid (ft)	Length (ft)	Slope (ft/ft)	Percent Imperviousness	Pervious	Impervious	Initial Rate (in/hr)	Decay Coefficient (1/seconds)	Final Rate (in/hr)	Level 0, 1, or 2
EX 1	EX-1	50yr	19.113959	738	1678	0.09	2	0.4	0.05	3	0.0018	0.5	0
EX 2	EX-2	50yr	95.253874	2080.5887	3804.8586	0.0845	2	0.4	0.05	3	0.0018	0.5	0
EX 3	EX-3	50yr	515.88019	6777.7937	11445.724	0.0425	7.7	0.4	0.05	3	0.0018	0.5	0
EX 4	EX-4	50yr	30.607708	712.7952	2040.1747	0.0569	2	0.4	0.05	3	0.0018	0.5	0
EX 5	EX-5	50yr	77.05742	1673.76	3333.264	0.055	2.4	0.4	0.05	3	0.0018	0.5	0
EX 6	EX-6	50yr	149.45506	3527.04	6554.592	0.049	3	0.4	0.05	3	0.0018	0.5	0
EX 7	EX-7	50yr	305.94705	4338.08	7416.32	0.056	8.2	0.4	0.05	3	0.0018	0.5	0
EX 8	EX-8	50yr	607.627	5749.92	9934.6896	0.039	10.7	0.4	0.05	3	0.0018	0.5	0
EX 9	EX-9	50yr	136.83771	1393.392	3928.32	0.049	5.7	0.4	0.05	3	0.0018	0.5	0
EX 10	EX-10	50yr	91.523261	1948.32	4113.12	0.052	5.2	0.4	0.05	3	0.0018	0.5	0
EX 11	EX-11	50yr	237.18871	4386.7654	8078.55	0.044	6.8	0.4	0.05	3	0.0018	0.5	0
EX 12	EX-12	50yr	38.327731	1945.8598	3884.7477	0.036	2	0.4	0.05	3	0.0018	0.5	0
EX 13	EX-13	50yr	25.802694	895.488	2236.08	0.049	2	0.4	0.05	3	0.0018	0.5	0
EX 14	EX-14	50yr	6.888279	151.86	475.7432	0.1259	2	0.4	0.05	3	0.0018	0.5	0
EX 15	EX-15	50yr	821.93992	7431.72672	15055.392	0.037	5.3	0.4	0.05	3	0.0018	0.5	0
EX 16	EX-16	50yr	45.580925	832.6504	1893.5261	0.06257	17.1	0.4	0.05	3	0.0018	0.5	0
EX 17	EX-17	50yr	14.501774	810.2258	1260.6021	0.0414	5.6	0.4	0.05	3	0.0018	0.5	0
EX 18	EX-18	50yr	112.84155	2563.6306	5464.323	0.0577	2.3	0.4	0.05	3	0.0018	0.5	0
EX 19	EX-19	50yr	74.095909	1298.352	2016.432	0.051	2.7	0.4	0.05	3	0.0018	0.5	0
EX 20	EX-20	50yr	142.67068	2366.6016	3631.584	0.041	2.6	0.4	0.05	3	0.0018	0.5	0
EX 21	EX-21	50yr	7.7993624	523.54896	909.1632	0.09	2	0.4	0.05	3	0.0018	0.5	0
EX 22	EX-22	50yr	56.653046	1407.57936	2809.488	0.068	3.9	0.4	0.05	3	0.0018	0.5	0
EX 23	EX-23	50yr	76.251151	1710.192	3715.536	0.049	4.3	0.4	0.05	3	0.0018	0.5	0
EX 24	EX-24	50yr	90.044363	1874.7168	3658.9344	0.064	4.1	0.4	0.05	3	0.0018	0.5	0
EX 25	EX-25	50yr	27.54177	572.5632	1021.68	0.081	2	0.4	0.05	3	0.0018	0.5	0

EXISTING CONDITION - 5 YEAR STORM EVENT

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 2.0.1)

		Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph			
Catchment Name/ID	User Comment for Catchment	CT	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)	Runoff per Unit Area (cfs/acre)
EX 1		0.157	0.097	30.4	2.56	15.8	1.81	4.3	29	69,384	0.30	20,652	37.0	7	20,652	0.37
EX 2		0.157	0.199	36.5	5.88	19.0	4.16	9.8	122	345,772	0.30	102,916	42.0	31	102,915	0.32
EX 3		0.139	0.303	75.0	17.74	39.0	12.54	29.6	322	1,872,645	0.36	674,983	63.0	105	674,972	0.20
EX 4		0.157	0.120	29.7	3.02	15.4	2.14	5.0	48	111,106	0.30	33,070	38.0	12	33,068	0.38
EX 5		0.156	0.180	37.6	5.49	19.6	3.88	9.2	96	279,718	0.30	84,471	42.0	25	84,469	0.32
EX 6		0.154	0.229	59.3	10.74	30.9	7.59	17.9	118	542,522	0.31	167,377	52.0	33	167,376	0.22
EX 7		0.137	0.256	53.7	10.88	27.9	7.69	18.1	267	1,110,588	0.37	406,527	51.0	83	406,527	0.27
EX 8		0.129	0.299	62.3	14.59	32.4	10.31	24.3	457	2,205,686	0.39	870,139	57.0	156	870,131	0.26
EX 9		0.145	0.212	30.4	5.24	15.8	3.70	8.7	211	496,721	0.34	167,982	40.0	56	167,966	0.41
EX 10		0.147	0.184	41.8	6.21	21.8	4.39	10.3	103	332,229	0.33	110,518	43.0	28	110,514	0.31
EX 11		0.142	0.244	64.6	12.42	33.6	8.78	20.7	172	860,995	0.35	301,689	55.0	53	301,686	0.22
EX 12		0.157	0.132	66.0	7.00	34.3	4.95	11.7	27	139,130	0.30	41,411	50.0	7	41,410	0.19
EX 13		0.157	0.111	38.7	3.59	20.1	2.54	6.0	31	93,664	0.30	27,878	41.0	8	27,878	0.30
EX 14		0.157	0.061	11.4	0.83	5.9	0.59	1.4	28	25,004	0.30	7,441	30.0	5	7,429	0.78
EX 15		0.147	0.365	80.9	22.98	42.0	16.24	38.3	476	2,983,642	0.33	995,818	70.0	148	995,806	0.18
EX 16		0.117	0.113	23.8	2.37	12.4	1.67	3.9	90	165,459	0.47	77,983	35.0	28	77,982	0.61
EX 17		0.146	0.080	37.6	2.60	19.6	1.84	4.3	18	52,641	0.34	17,744	40.0	5	17,744	0.34
EX 18		0.156	0.214	48.7	8.30	25.3	5.87	13.8	109	409,615	0.30	123,252	47.0	29	123,250	0.26
EX 19		0.155	0.176	27.1	3.96	14.1	2.80	6.6	128	268,968	0.31	82,102	38.0	31	82,093	0.42
EX 20		0.155	0.228	39.1	7.13	20.3	5.04	11.9	171	517,895	0.30	157,523	44.0	45	157,517	0.31
EX 21		0.157	0.065	28.8	1.73	15.0	1.22	2.9	13	28,312	0.30	8,425	36.0	3	8,424	0.38
EX 22		0.151	0.152	34.8	4.36	18.1	3.08	7.3	76	205,651	0.32	65,470	40.0	20	65,469	0.35
EX 23		0.150	0.172	41.3	5.77	21.5	4.07	9.6	87	276,792	0.32	89,333	43.0	23	89,330	0.31
EX 24		0.150	0.187	37.3	5.64	19.4	3.99	9.4	113	326,861	0.32	104,775	42.0	30	104,774	0.33
EX 25		0.157	0.114	18.5	1.92	9.6	1.35	3.2	70	99,977	0.30	29,757	34.0	15	29,754	0.55

EXISTING CONDITION - 50 YEAR STORM EVENT

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 2.0.1)

		Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph			
Catchment Name/ID	User Comment for Catchment	CT	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)	Runoff per Unit Area (cfs/acre)
EX 1		0.156	0.096	30.4	2.55	15.8	1.80	4.3	29	69,384	1.15	79,965	42.0	24	79,966	1.24
EX 2		0.156	0.199	36.5	5.87	19.0	4.15	9.8	122	345,772	1.15	398,503	47.0	105	398,499	1.11
EX 3		0.137	0.300	74.9	17.55	38.9	12.40	29.3	323	1,872,645	1.22	2,287,081	70.0	347	2,287,071	0.67
EX 4		0.156	0.119	29.7	3.01	15.4	2.13	5.0	48	111,106	1.15	128,050	42.0	39	128,042	1.27
EX 5		0.155	0.179	37.6	5.47	19.6	3.87	9.1	96	279,718	1.16	323,720	47.0	83	323,714	1.08
EX 6		0.153	0.228	59.3	10.69	30.8	7.56	17.8	118	542,522	1.16	631,776	58.0	116	631,770	0.78
EX 7		0.136	0.254	53.7	10.75	27.9	7.60	17.9	267	1,110,588	1.23	1,363,118	57.0	268	1,363,109	0.87
EX 8		0.127	0.295	62.1	14.37	32.3	10.15	23.9	459	2,205,686	1.26	2,775,367	63.0	485	2,775,325	0.80
EX 9		0.144	0.210	30.4	5.20	15.8	3.67	8.7	211	496,721	1.20	594,614	44.0	178	594,562	1.30
EX 10		0.146	0.183	41.8	6.17	21.7	4.36	10.3	103	332,229	1.19	395,697	50.0	93	395,688	1.02
EX 11		0.140	0.242	64.6	12.31	33.6	8.70	20.5	172	860,995	1.21	1,042,143	61.0	177	1,042,137	0.75
EX 12		0.156	0.132	66.0	6.98	34.3	4.94	11.6	27	139,130	1.15	160,347	57.0	27	160,345	0.69
EX 13		0.156	0.110	38.7	3.58	20.1	2.53	6.0	31	93,664	1.15	107,948	46.0	27	107,948	1.04
EX 14		0.156	0.061	11.4	0.83	5.9	0.59	1.4	28	25,004	1.15	28,817	35.0	16	28,770	2.37
EX 15		0.145	0.363	80.8	22.81	42.0	16.12	38.0	477	2,983,642	1.19	3,557,227	76.0	517	3,557,181	0.63
EX 16		0.116	0.113	23.7	2.35	12.3	1.66	3.9	90	165,459	1.34	221,817	40.0	74	221,814	1.62
EX 17		0.144	0.079	37.6	2.58	19.6	1.83	4.3	18	52,641	1.20	62,952	44.0	16	62,952	1.08
EX 18		0.155	0.213	48.7	8.28	25.3	5.85	13.8	109	409,615	1.16	473,558	53.0	101	473,548	0.90
EX 19		0.154	0.175	27.1	3.94	14.1	2.79	6.6	128	268,968	1.16	312,248	42.0	102	312,217	1.37
EX 20		0.154	0.227	39.1	7.10	20.3	5.02	11.8	171	517,895	1.16	600,607	49.0	152	600,585	1.06
EX 21		0.156	0.064	28.8	1.72	15.0	1.22	2.9	13	28,312	1.15	32,629	41.0	10	32,623	1.28
EX 22		0.150	0.151	34.7	4.34	18.1	3.06	7.2	76	205,651	1.18	241,712	45.0	65	241,706	1.15
EX 23		0.149	0.171	41.3	5.73	21.5	4.05	9.6	87	276,792	1.18	326,662	49.0	78	326,652	1.02
EX 24		0.149	0.186	37.3	5.61	19.4	3.96	9.3	113	326,861	1.18	384,964	47.0	99	384,961	1.10
EX 25		0.156	0.114	18.5	1.91	9.6	1.35	3.2	70	99,977	1.15	115,223	40.0	48	115,210	1.74

EXISTING CONDITION - 100 YEAR STORM EVENT

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 2.0.1)

		Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph			
Catchment Name/ID	User Comment for Catchment	CT	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)	Runoff per Unit Area (cfs/acre)
EX 1		0.156	0.096	30.4	2.55	15.8	1.80	4.2	29	69,384	1.57	108,985	43.0	31	108,987	1.61
EX 2		0.156	0.199	36.5	5.86	19.0	4.14	9.8	122	345,772	1.57	543,126	48.0	138	543,121	1.45
EX 3		0.137	0.299	74.9	17.50	38.9	12.37	29.2	323	1,872,645	1.64	3,063,532	71.0	465	3,063,524	0.90
EX 4		0.156	0.119	29.7	3.01	15.4	2.13	5.0	48	111,106	1.57	174,521	43.0	50	174,510	1.65
EX 5		0.155	0.179	37.6	5.47	19.6	3.87	9.1	96	279,718	1.58	440,643	48.0	109	440,636	1.42
EX 6		0.153	0.228	59.3	10.68	30.8	7.55	17.8	118	542,522	1.58	858,343	60.0	154	858,332	1.03
EX 7		0.135	0.253	53.6	10.72	27.9	7.58	17.9	267	1,110,588	1.64	1,823,250	58.0	351	1,823,231	1.15
EX 8		0.127	0.294	62.1	14.31	32.3	10.12	23.9	459	2,205,686	1.67	3,685,996	65.0	640	3,685,915	1.05
EX 9		0.144	0.210	30.4	5.19	15.8	3.67	8.6	211	496,721	1.61	801,196	45.0	231	801,129	1.68
EX 10		0.146	0.182	41.8	6.16	21.7	4.35	10.3	103	332,229	1.61	533,974	50.0	122	533,963	1.34
EX 11		0.140	0.242	64.5	12.28	33.6	8.68	20.5	172	860,995	1.63	1,399,624	64.0	235	1,399,615	0.99
EX 12		0.156	0.132	66.0	6.98	34.3	4.93	11.6	27	139,130	1.57	218,540	59.0	35	218,537	0.93
EX 13		0.156	0.110	38.7	3.58	20.1	2.53	6.0	31	93,664	1.57	147,124	47.0	35	147,123	1.37
EX 14		0.156	0.061	11.4	0.83	5.9	0.59	1.4	28	25,004	1.57	39,276	35.0	21	39,212	3.10
EX 15		0.145	0.362	80.8	22.77	42.0	16.09	37.9	477	2,983,642	1.61	4,798,856	78.0	697	4,798,809	0.85
EX 16		0.116	0.113	23.6	2.35	12.3	1.66	3.9	90	165,459	1.75	289,621	40.0	94	289,618	2.06
EX 17		0.144	0.079	37.6	2.58	19.5	1.82	4.3	18	52,641	1.61	84,849	46.0	20	84,848	1.41
EX 18		0.155	0.213	48.7	8.27	25.3	5.84	13.8	109	409,615	1.57	644,804	54.0	134	644,792	1.19
EX 19		0.154	0.175	27.1	3.94	14.1	2.78	6.6	128	268,968	1.58	424,626	43.0	132	424,585	1.78
EX 20		0.154	0.227	39.1	7.10	20.3	5.02	11.8	171	517,895	1.58	817,022	50.0	200	816,991	1.40
EX 21		0.156	0.064	28.8	1.72	15.0	1.22	2.9	13	28,312	1.57	44,471	41.0	13	44,463	1.66
EX 22		0.150	0.151	34.7	4.33	18.1	3.06	7.2	76	205,651	1.59	327,476	46.0	85	327,468	1.50
EX 23		0.149	0.171	41.3	5.72	21.5	4.05	9.5	87	276,792	1.60	442,024	49.0	102	442,011	1.34
EX 24		0.149	0.185	37.3	5.60	19.4	3.96	9.3	113	326,861	1.59	521,236	48.0	130	521,232	1.44
EX 25		0.156	0.114	18.5	1.91	9.6	1.35	3.2	70	99,977	1.57	157,040	37.0	62	157,022	2.27

NORTH DAWSON TRIBUTARY

CUHP MODEL RESULTS

North Dawson Tributary - CUHP Input Data
Historic Conditions

Basin ID	Area (mi^2)	Length to Centroid (mi)	Length (mi)	Slope (ft/ft)	Percent Imperviousness (%)	Maximum Depression Storage (Watershed inches)		Horton's Infiltration Parameters		
						Pervious (in)	Impervious (in)	Initial Infiltration (in/hr)	Decay Coefficient (1/second)	Final Infiltration (in/hr)
SUB_H1	0.032	0.276	0.484	0.037	5.0	0.40	0.1	4.5	0.0018	0.6
SUB_H2a	0.190	0.470	0.888	0.051	5.0	0.40	0.1	3	0.0018	0.5
SUB_H2b	0.149	0.643	1.005	0.044	5.0	0.40	0.1	3	0.0018	0.5
SUB_H10	0.060	0.306	0.676	0.027	5.0	0.40	0.1	4.5	0.0018	0.6

TABLE 6-9. TYPICAL DEPRESSION STORAGE FOR VARIOUS LAND COVERS OR SURFACE TYPES (ALL VALUES IN WATERSHED INCHES FOR USE WITH THE CUHP)

LAND COVER/SURFACE TYPE	DEPRESSION STORAGE (INCHES)	RECOMMENDED (INCHES)
Impervious		
Large, Paved Areas	0.05 – 0.15	0.10
Roofs – Flat	0.10 – 0.30	0.10
Roofs – Sloped	0.05 – 0.10	0.05
Pervious		
Lawn Grass	0.20 – 0.50	0.35
Wooded Areas and Open Fields	0.20 – 0.60	0.40

TABLE 6-10. RECOMMENDED HORTON'S EQUATION PARAMETERS

NRCS HYDROLOGIC SOIL GROUP	INFILTRATION (INCHES PER HOUR)		DECAY COEFFICIENT – a
	INITIAL – f_i	FINAL – f_o	
A	5.0	1.0	0.0007
B	4.5	0.6	0.0018
C	3.0	0.5	0.0018
D	3.0	0.5	0.0018

HISTORIC CONDITIONS 100-YR CUHP OUTPUT

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 2.0.1)

		Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph			
Catchment Name/ID	User Comment for Catchment	CT	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)	Runoff per Unit Area (cfs/acre)
SUB_H1		0.147	0.094	61.6	4.74	32.0	3.35	7.9	16	74,488	1.44	107,441	55.0	18	107,440	0.90
SUB_H2a		0.146	0.205	44.9	7.37	23.3	5.21	12.3	127	440,682	1.60	706,883	52.0	155	706,871	1.27
SUB_H2b		0.146	0.187	63.1	9.34	32.8	6.60	15.6	71	345,939	1.60	554,909	60.0	94	554,899	0.98
SUB_H10		0.147	0.124	62.0	6.21	32.2	4.39	10.3	29	139,029	1.44	200,535	57.0	34	200,530	0.90

CUHP SUBCATCHMENTS

Columns with this color heading are for required user-input
Columns with this color heading are for optional override values
Columns with this color heading are for program-calculated values

								Maximum Depression Storage (Watershed inches)		Horton's Infiltration Parameters			DCIA
Subcatchment Name	EPA SWMM Target Node	Raingage	Area (mi^2)	Length to Centroid (mi)	Length (mi)	Slope (ft/ft)	Percent Imperviousness	Pervious	Impervious	Initial Rate (in/hr)	Decay Coefficient (1/seconds)	Final Rate (in/hr)	Level 0, 1, or 2
SUB_E3	WQPOND_E3	2-yr	0.0751875	0.197348485	0.3653409	0.051877154	53.98379052	0.4	0.1	3	0.0018	0.5	0
SUB_E2	WQPOND_E2	2-yr	0.0626406	0.263636364	0.4666667	0.055871017	46.56647543	0.4	0.1	3	0.0018	0.5	0
SUB_E1	J_E1	2-yr	0.0779219	0.202083333	0.4439394	0.054872529	32.1305394	0.4	0.1	3	0.0018	0.5	0
SUB_A9	J_A9	2-yr	0.0090625	0.09469697	0.1954545	0.049880314	20	0.4	0.1	3	0.0018	0.5	0
SUB_A8	WQPOND_A8	2-yr	0.054375	0.134469697	0.2670455	0.027920022	60.15229885	0.4	0.1	3	0.0018	0.5	0
SUB_A7	WQPOND_A7	2-yr	0.059625	0.193560606	0.3833333	0.019937505	65	0.4	0.1	3	0.0018	0.5	0
SUB_A6	WQPOND_A6	2-yr	0.013125	0.065719697	0.1621212	0.059865108	55	0.4	0.1	3	0.0018	0.5	0
SUB_A5	WQPOND_A5	2-yr	0.0441563	0.152272727	0.2952652	0.054872529	43.35456476	0.4	0.1	3	0.0018	0.5	0
SUB_A4	WQPOND_A4	2-yr	0.1430938	0.395265152	0.5901515	0.051877154	53.61541821	0.4	0.1	3	0.0018	0.5	0
SUB_A3	WQPOND_A3	2-yr	0.0444375	0.134090909	0.3916667	0.035904389	63.8045007	0.4	0.1	3	0.0018	0.5	0
SUB_A2	J_A2	2-yr	0.0153125	0.107575758	0.4342803	0.03091397	20	0.4	0.1	4.5	0.0018	0.6	0
SUB_A1	J_A1	2-yr	0.0167656	0.044507576	0.13125	0.04189362	25	0.4	0.1	4.5	0.0018	0.6	0
C-1	4C	2-yr	0.05625	0.159280303	0.3554924	0.054872529	70	0.4	0.1	4.5	0.0018	0.6	0
C-2	3C	2-yr	0.0935938	0.215340909	0.5515152	0.015947157	71.39398998	0.4	0.1	4.5	0.0018	0.6	0
C-2a	2C	2-yr	0.0032813	0.100568182	0.1577652	0.029915961	70	0.4	0.1	4.5	0.0018	0.6	0
C-3	1C	2-yr	0.030625	0.130492424	0.3477273	0.016944676	70	0.4	0.1	4.5	0.0018	0.6	0

FUTURE CONDITIONS 100-YR CUHP OUTPUT

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 2.0.1)

		Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph			
Catchment Name/ID	User Comment for Catchment	CT	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)	Runoff per Unit Area (cfs/acre)
SUB_E3		0.087	0.175	13.4	2.10	7.0	1.48	3.5	168	174,676	2.19	382,813	36.0	163	382,592	3.39
SUB_E2		0.090	0.150	20.7	2.68	10.8	1.89	4.5	91	145,527	2.10	305,784	38.0	101	305,777	2.53
SUB_E1		0.099	0.132	22.2	2.54	11.5	1.80	4.2	105	181,028	1.93	348,637	40.0	114	348,601	2.28
SUB_A9		0.112	0.044	36.1	1.52	18.7	1.07	2.5	8	21,054	1.78	37,482	45.0	9	37,480	1.53
SUB_A8		0.084	0.158	11.9	1.75	6.2	1.23	2.9	137	126,324	2.27	286,362	35.0	128	286,154	3.66
SUB_A7		0.082	0.170	16.7	2.47	8.7	1.75	4.1	107	138,521	2.33	322,257	37.0	118	322,228	3.09
SUB_A6		0.086	0.080	11.2	0.99	5.8	0.70	1.7	35	30,492	2.20	67,203	35.0	31	67,101	3.71
SUB_A5		0.092	0.123	15.9	1.80	8.3	1.27	3.0	83	102,584	2.06	211,541	36.0	83	211,445	2.95
SUB_A4		0.087	0.233	17.7	3.47	9.2	2.45	5.8	242	332,435	2.19	727,062	38.0	265	727,018	2.89
SUB_A3		0.083	0.148	14.2	1.91	7.4	1.35	3.2	94	103,237	2.31	238,656	36.0	96	238,601	3.38
SUB_A2		0.112	0.056	50.0	2.44	26.0	1.73	4.1	9	35,574	1.64	58,281	50.0	11	58,283	1.14
SUB_A1		0.106	0.058	15.7	0.99	8.1	0.70	1.7	32	38,950	1.71	66,433	36.0	28	66,365	2.60
C-1		0.080	0.169	11.3	1.76	5.9	1.25	2.9	150	130,680	2.33	304,533	35.0	137	304,441	3.81
C-2		0.080	0.214	17.0	3.09	8.8	2.19	5.2	165	217,437	2.35	510,947	37.0	184	510,836	3.08
C-2a		0.080	0.047	25.4	1.22	13.2	0.86	2.0	4	7,623	2.33	17,764	40.0	5	17,766	2.31
C-3		0.080	0.129	17.7	2.05	9.2	1.45	3.4	52	71,148	2.33	165,801	37.0	58	165,743	2.95

GAMBEL RIDGE TRIBUTARY

CUHP MODEL RESULTS

INTERIM BUILDOUT CONDITION

CUHP SUBCATCHMENTS

Columns with this color heading are for required user-input
Columns with this color heading are for optional override values
Columns with this color heading are for program-calculated values

								Maximum Depression Storage (Watershed inches)		Horton's Infiltration Parameters			DCIA
Subcatchment Name	EPA SWMM Target Node	Raingage	Area (mi^2)	Length to Centroid (mi)	Length (mi)	Slope (ft/ft)	Percent Imperviousness	Pervious	Impervious	Initial Rate (in/hr)	Decay Coefficient (1/seconds)	Final Rate (in/hr)	Level 0, 1, or 2
H-1	J_H1	100-year	0.0725514	0.221212121	0.5210227	0.058	2	0.4	0.1	3.7	0.0018	0.5	0
H-2	J_H2	100-year	0.1187964	0.357386364	0.7441288	0.045	2	0.35	0.05	3.5	0.0018	0.5	0
H-3	J_H3	100-year	0.0086165	0.098863636	0.1977273	0.033	45	0.35	0.05	3	0.0018	0.5	0
H-4	J_H4	100-year	0.0126001	0.131439394	0.2606061	0.045	45	0.35	0.05	3	0.0018	0.5	0
H-5	J_H5	100-year	0.0614924	0.2	0.4005682	0.036	45	0.35	0.05	3.1	0.0018	0.5	0
H-6	J_H6	100-year	0.0394709	0.359469697	0.7189394	0.045	32.6	0.35	0.1	3	0.0018	0.5	0
H-7	J_H7	100-year	0.0100076	0.052840909	0.1988636	0.031	51.5	0.35	0.05	4.2	0.0018	0.6	0
H-8	J_H8	100-year	0.0165493	0.225776932	0.4346471	0.0533	2	0.4	0.01	3	0.0018	0.5	0
C-1	J_C1	100-year	0.0570767	0.16969697	0.4077652	0.06321412	75	0.35	0.1	4	0.0018	0.6	0
C-2	J_C2	100-year	0.0760191	0.226704545	0.4401515	0.022934596	75	0.35	0.1	3.3	0.001745	0.5	0
C-3	J_C3	100-year	0.0508346	0.219128788	0.4765152	0.019475358	75	0.35	0.1	3.4	0.0018	0.5	0
C-4	J_C4	100-year	0.033502	0.130681818	0.3314394	0.024257143	75	0.35	0.1	3.7	0.0018	0.5	0
C-5	J_C5	100-year	0.0377594	0.358522727	0.7168561	0.018124174	80.4	0.35	0.1	3.7	0.0018	0.5	0
C-6	J_C6	100-year	0.0130523	0.21969697	0.5893939	0.01722365	80.4	0.35	0.1	4.2	0.001714589	0.6	0
C-7	J_C7	100-year	0.0210999	0.148674242	0.2666667	0.011576705	88.6	0.35	0.1	4.4	0.001010314	0.9	0
C-8	J_C8	100-year	0.030106	0.130492424	0.2907197	0.015	95	0.35	0.1	4.5	0.001	0.9	0
C-9	J_C9	100-year	0.0066354	0.131439394	0.2712121	0.02	2	0.35	0.05	3	0.0018	0.5	0
OS-1	J_O1	100-year	0.1084434	0.422916667	0.7518939	0.066	8.7	0.4	0.05	4.1	0.0018	0.6	0
OS-2	J_O2	100-year	0.1579448	0.522727273	0.9541667	0.059	3.9	0.4	0.05	4.2	0.0018	0.6	0
OS-3	J_O3	100-year	0.1543167	0.297727273	0.8047348	0.059	10.4	0.4	0.05	3	0.0018	0.5	0
OS-4	J_O4	100-year	0.0394811	0.148106061	0.4035985	0.057	11.5	0.4	0.05	3	0.0018	0.5	0

INTERIM BUILDOUT CONDITION - 100 YEAR STORM EVENT

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 2.0.1)

		Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph			
Catchment Name/ID	User Comment for Catchment	CT	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)	Runoff per Unit Area (cfs/acre)
H-1		0.156	0.144	35.8	5.45	18.6	3.85	9.1	61	168,551	1.53	257,995	45.0	66	257,577	1.43
H-2		0.156	0.179	45.5	7.77	23.7	5.49	13.0	78	275,988	1.59	438,879	50.0	96	438,634	1.26
H-3		0.091	0.060	24.3	2.63	12.7	1.86	4.4	11	20,018	2.13	42,550	40.0	12	41,629	2.24
H-4		0.091	0.071	24.9	2.87	13.0	2.03	4.8	15	29,273	2.13	62,222	40.0	18	61,250	2.23
H-5		0.091	0.146	19.4	3.67	10.1	2.59	6.1	95	142,859	2.12	303,242	35.0	106	301,391	2.69
H-6		0.098	0.098	51.8	5.39	27.0	3.81	9.0	23	91,699	1.96	180,024	50.0	33	179,860	1.30
H-7		0.088	0.069	15.5	2.32	8.1	1.64	3.9	19	23,250	2.12	49,276	35.0	19	47,053	2.95
H-8		0.156	0.074	65.8	5.23	34.2	3.70	8.7	8	38,447	1.57	60,277	55.0	10	60,204	0.92
C-1		0.079	0.174	11.4	3.03	6.0	2.14	5.0	150	132,601	2.42	320,554	35.0	141	312,291	3.86
C-2		0.079	0.198	15.3	3.82	7.9	2.70	6.4	149	176,608	2.45	433,560	35.0	168	431,561	3.46
C-3		0.079	0.165	19.5	3.96	10.1	2.80	6.6	78	118,099	2.46	290,053	35.0	95	288,347	2.93
C-4		0.079	0.137	14.6	3.03	7.6	2.14	5.1	69	77,832	2.45	190,843	35.0	74	186,479	3.45
C-5		0.077	0.147	33.6	5.29	17.5	3.74	8.8	34	87,723	2.52	220,908	45.0	50	220,635	2.08
C-6		0.077	0.091	39.5	4.26	20.5	3.01	7.1	10	30,323	2.49	75,389	45.0	15	75,187	1.83
C-7		0.075	0.115	19.0	3.17	9.9	2.24	5.3	33	49,019	2.53	124,250	35.0	41	122,947	3.01
C-8		0.074	0.136	14.4	3.01	7.5	2.13	5.0	63	69,942	2.66	186,018	35.0	70	181,518	3.61
C-9		0.156	0.049	77.2	4.40	40.2	3.11	7.3	3	15,415	1.62	24,918	60.0	4	24,888	0.83
OS-1		0.134	0.150	46.5	6.86	24.2	4.84	11.4	70	251,936	1.50	377,209	50.0	81	377,215	1.17
OS-2		0.150	0.196	50.7	9.14	26.3	6.46	15.2	94	366,937	1.44	526,741	55.0	108	526,352	1.07
OS-3		0.128	0.169	35.3	6.07	18.3	4.29	10.1	131	358,509	1.66	596,421	45.0	153	596,044	1.55
OS-4		0.125	0.090	33.6	3.81	17.4	2.69	6.4	35	91,722	1.68	153,820	45.0	40	153,345	1.58

ULTIMATE BUILDOUT CONDITION

CUHP SUBCATCHMENTS

Columns with this color heading are for required user-input
Columns with this color heading are for optional override values
Columns with this color heading are for program-calculated values

								Maximum Depression Storage (Watershed inches)		Horton's Infiltration Parameters			DCIA
Subcatchment Name	EPA SWMM Target Node	Raingage	Area (acre)	Length to Centroid (ft)	Length (ft)	Slope (ft/ft)	Percent Imperviousness	Pervious	Impervious	Initial Rate (in/hr)	Decay Coefficient (1/seconds)	Final Rate (in/hr)	Level 0, 1, or 2
H-1	J_H1	2-year	46.432874	1168	2751	0.058	7.8	0.4	0.1	3.7	0.0018	0.5	0
H-2	J_H2	2-year	76.029706	1887	3929	0.045	28.2	0.35	0.05	3.5	0.0018	0.5	0
H-3	J_H3	2-year	5.5145776	522	1044	0.033	45	0.35	0.05	3	0.0018	0.5	0
H-4	J_H4	2-year	8.0640496	694	1376	0.045	45	0.35	0.05	3	0.0018	0.5	0
H-5	J_H5	2-year	39.355119	1056	2115	0.036	45	0.35	0.05	3.1	0.0018	0.5	0
H-6	J_H6	2-year	25.261364	1898	3796	0.045	32.6	0.35	0.1	3	0.0018	0.5	0
H-7	J_H7	2-year	6.4048898	279	1050	0.031	51.5	0.35	0.05	4.2	0.0018	0.6	0
H-8	J_H8	2-year	10.591578	1192	2295	0.053	2	0.4	0.01	3	0.0018	0.5	0
C-1	J_C1	2-year	36.529109	896	2153	0.063	75	0.35	0.1	4	0.0018	0.6	0
C-2	J_C2	2-year	48.652227	1197	2324	0.023	75	0.35	0.1	3.3	0.001745	0.5	0
C-3	J_C3	2-year	32.53416	1157	2516	0.019	75	0.35	0.1	3.4	0.0018	0.5	0
C-4	J_C4	2-year	21.441253	690	1750	0.024	75	0.35	0.1	3.7	0.0018	0.5	0
C-5	J_C5	2-year	24.166001	1893	3785	0.018	80.4	0.35	0.1	3.7	0.0018	0.5	0
C-6	J_C6	2-year	8.3534605	1160	3112	0.017	80.4	0.35	0.1	4.2	0.001714589	0.6	0
C-7	J_C7	2-year	13.503926	785	1408	0.012	88.6	0.35	0.1	4.4	0.001010314	0.9	0
C-8	J_C8	2-year	19.267837	689	1535	0.015	95	0.35	0.1	4.5	0.001	0.9	0
C-9	J_C9	2-year	4.2466253	694	1432	0.020	2	0.35	0.05	3	0.0018	0.5	0
OS-1	J_O1	2-year	69.403792	2233	3970	0.066	8.7	0.4	0.05	4.1	0.0018	0.6	0
OS-2	J_O2	2-year	101.08469	2760	5038	0.059	3.9	0.4	0.05	4.2	0.0018	0.6	0
OS-3	J_O3	2-year	98.762718	1572	4249	0.059	10.4	0.4	0.05	3	0.0018	0.5	0
OS-4	J_O4	2-year	25.267883	782	2131	0.057	11.5	0.4	0.05	3	0.0018	0.5	0

ULTIMATE BUILDOUT CONDITION - 2 YEAR STORM EVENT

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 2.0.1)

		Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph			
Catchment Name/ID	User Comment for Catchment	CT	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)	Runoff per Unit Area (cfs/acre)
H-1		0.140	0.130	35.5	5.05	18.5	3.57	8.4	61	168,551	0.07	11,034	40.0	3	11,009	0.06
H-2		0.104	0.141	38.7	5.68	20.1	4.01	9.5	92	275,988	0.32	88,762	40.0	21	88,680	0.27
H-3		0.092	0.059	24.8	2.63	12.9	1.86	4.4	10	20,018	0.52	10,368	35.0	3	10,151	0.53
H-4		0.092	0.070	25.4	2.88	13.2	2.03	4.8	15	29,273	0.52	15,161	35.0	4	14,940	0.53
H-5		0.092	0.144	19.8	3.68	10.3	2.60	6.1	93	142,859	0.52	73,722	30.0	25	73,175	0.64
H-6		0.100	0.095	54.0	5.44	28.1	3.85	9.1	22	91,699	0.37	33,623	40.0	6	33,596	0.23
H-7		0.089	0.068	15.8	2.32	8.2	1.64	3.9	19	23,250	0.54	12,647	30.0	5	12,098	0.73
H-8		0.157	0.074	65.8	5.25	34.2	3.71	8.8	8	38,447	0.04	1,465	45.0	0	1,464	0.03
C-1		0.079	0.173	11.5	3.03	6.0	2.14	5.1	149	132,601	0.78	103,829	30.0	45	101,107	1.24
C-2		0.079	0.197	15.4	3.83	8.0	2.70	6.4	148	176,608	0.80	141,348	30.0	54	140,725	1.12
C-3		0.079	0.164	19.6	3.97	10.2	2.81	6.6	78	118,099	0.80	94,626	30.0	31	94,031	0.94
C-4		0.079	0.136	14.7	3.04	7.6	2.15	5.1	68	77,832	0.80	62,147	30.0	24	60,766	1.12
C-5		0.077	0.146	33.8	5.29	17.6	3.74	8.8	34	87,723	0.86	75,055	35.0	16	74,963	0.68
C-6		0.077	0.091	39.7	4.27	20.7	3.02	7.1	10	30,323	0.84	25,500	40.0	5	25,432	0.58
C-7		0.075	0.115	19.0	3.18	9.9	2.25	5.3	33	49,019	0.92	45,075	30.0	15	44,607	1.08
C-8		0.074	0.136	14.5	3.01	7.5	2.13	5.0	62	69,942	1.00	70,115	30.0	27	68,423	1.38
C-9		0.157	0.049	77.2	4.42	40.2	3.13	7.4	3	15,415	0.09	1,340	45.0	0	1,338	0.05
OS-1		0.139	0.154	46.7	7.03	24.3	4.96	11.7	70	251,936	0.07	16,883	40.0	4	16,884	0.05
OS-2		0.152	0.199	50.7	9.25	26.4	6.54	15.4	93	366,937	0.03	10,527	45.0	2	10,520	0.02
OS-3		0.132	0.173	35.5	6.21	18.4	4.39	10.4	131	358,509	0.11	40,206	40.0	11	40,179	0.11
OS-4		0.128	0.092	33.8	3.87	17.6	2.74	6.5	35	91,722	0.12	11,260	40.0	3	11,229	0.13

ULTIMATE BUILDOUT CONDITION - 5 YEAR STORM EVENT

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 2.0.1)

		Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph			
Catchment Name/ID	User Comment for Catchment	CT	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)	Runoff per Unit Area (cfs/acre)
H-1		0.139	0.129	35.4	5.01	18.4	3.54	8.4	61	168,551	0.32	54,347	40.0	15	54,227	0.33
H-2		0.103	0.143	37.8	5.65	19.7	3.99	9.4	94	275,988	0.62	171,597	40.0	40	171,306	0.53
H-3		0.091	0.060	24.6	2.63	12.8	1.86	4.4	10	20,018	0.85	16,973	30.0	5	16,614	0.90
H-4		0.091	0.071	25.2	2.87	13.1	2.03	4.8	15	29,273	0.85	24,820	30.0	7	24,439	0.89
H-5		0.091	0.145	19.6	3.68	10.2	2.60	6.1	94	142,859	0.84	120,707	30.0	43	119,890	1.09
H-6		0.099	0.096	53.1	5.42	27.6	3.83	9.0	22	91,699	0.68	62,565	40.0	11	62,507	0.43
H-7		0.088	0.068	15.7	2.32	8.1	1.64	3.9	19	23,250	0.86	19,981	30.0	8	19,101	1.20
H-8		0.157	0.074	65.8	5.25	34.2	3.71	8.7	8	38,447	0.29	11,330	45.0	2	11,317	0.19
C-1		0.079	0.173	11.5	3.03	6.0	2.14	5.0	149	132,601	1.14	151,819	30.0	67	147,868	1.82
C-2		0.079	0.197	15.3	3.82	8.0	2.70	6.4	149	176,608	1.17	207,162	30.0	80	206,234	1.64
C-3		0.079	0.165	19.5	3.97	10.2	2.80	6.6	78	118,099	1.17	138,658	30.0	45	137,811	1.38
C-4		0.079	0.136	14.7	3.04	7.6	2.15	5.1	69	77,832	1.17	91,068	30.0	35	89,021	1.63
C-5		0.077	0.146	33.7	5.29	17.5	3.74	8.8	34	87,723	1.24	108,383	35.0	23	108,251	0.96
C-6		0.077	0.091	39.6	4.26	20.6	3.01	7.1	10	30,323	1.21	36,726	35.0	7	36,629	0.82
C-7		0.075	0.115	19.0	3.18	9.9	2.25	5.3	33	49,019	1.28	62,765	30.0	20	62,111	1.48
C-8		0.074	0.136	14.5	3.01	7.5	2.13	5.0	62	69,942	1.39	97,150	30.0	36	94,804	1.85
C-9		0.157	0.049	77.2	4.42	40.2	3.12	7.4	3	15,415	0.34	5,297	45.0	1	5,290	0.19
OS-1		0.137	0.152	46.6	6.95	24.2	4.91	11.6	70	251,936	0.26	64,435	40.0	15	64,438	0.22
OS-2		0.152	0.198	50.7	9.21	26.4	6.51	15.3	93	366,937	0.20	72,312	45.0	17	72,264	0.17
OS-3		0.130	0.171	35.4	6.15	18.4	4.35	10.3	131	358,509	0.39	139,202	40.0	39	139,114	0.40
OS-4		0.126	0.090	33.7	3.84	17.5	2.71	6.4	35	91,722	0.40	36,795	35.0	10	36,688	0.41

ULTIMATE BUILDOUT CONDITION - 100 YEAR STORM EVENT

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 2.0.1)

		Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph			
Catchment Name/ID	User Comment for Catchment	CT	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)	Runoff per Unit Area (cfs/acre)
H-1		0.137	0.127	35.4	4.96	18.4	3.50	8.3	62	168,551	1.60	269,381	45.0	69	268,785	1.48
H-2		0.102	0.146	36.6	5.61	19.0	3.96	9.3	97	275,988	1.90	524,509	45.0	125	523,680	1.64
H-3		0.091	0.060	24.3	2.63	12.7	1.86	4.4	11	20,018	2.13	42,550	40.0	12	41,629	2.24
H-4		0.091	0.071	24.9	2.87	13.0	2.03	4.8	15	29,273	2.13	62,222	40.0	18	61,250	2.23
H-5		0.091	0.146	19.4	3.67	10.1	2.59	6.1	95	142,859	2.12	303,242	35.0	106	301,391	2.69
H-6		0.098	0.098	51.8	5.39	27.0	3.81	9.0	23	91,699	1.96	180,024	50.0	33	179,860	1.30
H-7		0.088	0.069	15.5	2.32	8.1	1.64	3.9	19	23,250	2.12	49,276	35.0	19	47,053	2.95
H-8		0.156	0.074	65.8	5.23	34.2	3.70	8.7	8	38,447	1.57	60,277	55.0	10	60,204	0.92
C-1		0.079	0.174	11.4	3.03	6.0	2.14	5.0	150	132,601	2.42	320,554	35.0	141	312,291	3.86
C-2		0.079	0.198	15.3	3.82	7.9	2.70	6.4	149	176,608	2.45	433,560	35.0	168	431,561	3.46
C-3		0.079	0.165	19.5	3.96	10.1	2.80	6.6	78	118,099	2.46	290,053	35.0	95	288,347	2.93
C-4		0.079	0.137	14.6	3.03	7.6	2.14	5.1	69	77,832	2.45	190,843	35.0	74	186,479	3.45
C-5		0.077	0.147	33.6	5.29	17.5	3.74	8.8	34	87,723	2.52	220,908	45.0	50	220,635	2.08
C-6		0.077	0.091	39.5	4.26	20.5	3.01	7.1	10	30,323	2.49	75,389	45.0	15	75,187	1.83
C-7		0.075	0.115	19.0	3.17	9.9	2.24	5.3	33	49,019	2.53	124,250	35.0	41	122,947	3.01
C-8		0.074	0.136	14.4	3.01	7.5	2.13	5.0	63	69,942	2.66	186,018	35.0	70	181,518	3.61
C-9		0.156	0.049	77.2	4.40	40.2	3.11	7.3	3	15,415	1.62	24,918	60.0	4	24,888	0.83
OS-1		0.134	0.150	46.5	6.86	24.2	4.84	11.4	70	251,936	1.50	377,209	50.0	81	377,215	1.17
OS-2		0.150	0.196	50.7	9.14	26.3	6.46	15.2	94	366,937	1.44	526,741	55.0	108	526,352	1.07
OS-3		0.128	0.169	35.3	6.07	18.3	4.29	10.1	131	358,509	1.66	596,421	45.0	153	596,044	1.55
OS-4		0.125	0.090	33.6	3.81	17.4	2.69	6.4	35	91,722	1.68	153,820	45.0	40	153,345	1.58

NORTH DAWSON TRIBUTARY

SWMM MODEL RESULTS

LEGEND

- XXX / 341.8 / 0.00 — CATCHMENT DESIGNATION
- % IMPERVIOUS
- CATCHMENT AREA IN ACRES
- X — DESIGN POINT
- CATCHMENT BOUNDARY
- FLOW DIRECTION ARROW
- 5510 — EXISTING 10-FT CONTOUR
- 5510 — PROPOSED 10-FT CONTOUR

GRAPHIC SCALE
0 150 300 600 1500
1 INCH = 300 FEET

POND C1

C-3 19.6 70.0%
C-1 36.0 70.0%
C-2a 2.1 70.0%
C-2 59.9 71.4%

SUB_E2 40.1 64.5%
SUB_A5 28.3 64.4%
SUB_A4 91.4 53.4%
SUB_A3 47.0 69.2%
SUB_A6 8.4 65.0%
SUB_E1 49.9 35.4%
SUB_A9 5.8 63.0%
SUB_A2 9.8 60.0%
SUB_A1 13.5 65.0%
SUB_E3 48.1 64.0%
SUB_A8 34.8 60.0%
SUB_A7 38.2 60.0%
SUB_FZ1

WQ POND E2
WQ POND A6
WQ POND A5
WQ POND A3
WQ POND A4
DET POND E1
WQ POND E3
WQ POND A8
WQ POND A7
DET POND A1

POND E1
NO WQCV OR EURV
V100 STORED = 17.0 AC-FT (SWMM)
Q100 INFLOW = 375 CFS (SWMM)
Q100 OUTFLOW = 65 CFS (SWMM)

UPPER REACH
LOWER REACH
NORTH DAWSON TRIBUTARY
EXISTING BNSF RAILROAD
7.5' x 28' WOODEN BRIDGE
24" DIA STEEL CULVERT

POND A1
NO WQCV OR EURV
V100 STORED = 27.4 AC-FT (SWMM)
Q100 INFLOW = 774 CFS (SWMM)
Q100 OUTFLOW = 232 CFS (SWMM)
MAX ALLOWABLE UNDER RAILROAD IS 235 CFS

CATCHMENT BOUNDARIES ARE ESTIMATED BASED UPON PLANNING AREA LINES

FZ BASINS ARE FOR REFERENCE ONLY. NOT A PART OF THIS FLOODPLAIN MODIFICATION STUDY.

EMK CONSULTANTS, INC.
LAND DEVELOPMENT
ENGINEERING ■ SURVEYING
7006 SOUTH ALTON WAY, BLDG. F
CENTENNIAL, COLORADO 80112-2019
(303)694-1520
WWW.EMKC.COM

SCALE VERIFICATION BAR IS 1 INCH ON ORIGINAL DRAWING
0 1"
ADJUST SCALES ACCORDINGLY IF NOT ONE INCH ON THIS SHEET.

Know what's below. Call before you dig. 811

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REVISIONS

NO.	DESCRIPTION	DATE	BY

DESIGNED BY: DJO
DRAWN BY: DJO
CHECKED BY: ERM
APPROVED BY: ERM

DAWSON TRAILS

NORTH DAWSON TRIBUTARY FUTURE CONDITIONS

DATE: 04/30/2025
JOB NO: 13095.10
SCALE HORIZONTAL 1" = 300'

HISTORIC CONDITIONS SWMM INPUT

```
[TITLE]
;;Project Title/Notes
North Dawson Tributary Historic Conditions.

[OPTIONS]
;;Option             Value
FLOW_UNITS           CFS
INFILTRATION         HORTON
FLOW_ROUTING         KINWAVE
LINK_OFFSETS         DEPTH
MIN_SLOPE            0
ALLOW_PONDING        NO
SKIP_STEADY_STATE    NO

START_DATE           01/01/2005
START_TIME           00:00:00
REPORT_START_DATE    01/01/2005
REPORT_START_TIME    00:00:00
END_DATE             01/04/2005
END_TIME             06:00:00
SWEEP_START          01/01
SWEEP_END            12/31
DRY_DAYS             0
REPORT_STEP          00:00:30
WET_STEP             00:00:10
DRY_STEP             01:00:00
ROUTING_STEP         0:00:05
RULE_STEP            00:00:10

INERTIAL_DAMPING     PARTIAL
NORMAL_FLOW_LIMITED  BOTH
FORCE_MAIN_EQUATION  H-W
VARIABLE_STEP        0.75
LENGTHENING_STEP     0
MIN_SURFAREA         12.566
MAX_TRIALS           8
HEAD_TOLERANCE       0.005
SYS_FLOW_TOL         5
LAT_FLOW_TOL         5
MINIMUM_STEP         0.5
THREADS              1

[FILES]
;;Interfacing Files
USE INFLOWS "100-yr.txt"

[EVAPORATION]
;;Data Source    Parameters
;;-------------- ----------------
CONSTANT         0.0
```

```
DRY_ONLY         NO

[JUNCTIONS]
;;Name           Elevation  MaxDepth   InitDepth  SurDepth   Aponded
;;-------------- ---------- ---------- ---------- ---------- ----------
SUB_H2a          6480       10         0          0          0
SUB_H2b          6480       10         0          0          0
J_2              6470       10         0          0          0
J_1              6390       10         0          0          0
J_10             6390       10         0          0          0
SUB_H1           6400       10         0          0          0

[OUTFALLS]
;;Name           Elevation  Type       Stage Data       Gated    Route To
;;-------------- ---------- ---------- ---------------- -------- ----------------
ND_OUT           6350       FREE                        NO

[CONDUITS]
;;Name           From Node        To Node          Length     Roughness  InOffset   OutOffset  InitFlow   MaxFlow
;;-------------- ---------------- ---------------- ---------- ---------- ---------- ---------- ---------- ----------
D_SUB_H2a        SUB_H2a          J_2              400        0.01       0          0          0          0
D_SUB_H2b        SUB_H2b          J_2              400        0.01       0          0          0          0
C_1              J_2              J_1              2454       .035       0          0          0          0
D_J_10           J_10             ND_OUT           400        0.01       0          0          0          0
D_J1             J_1              ND_OUT           400        0.01       0          0          0          0
D_SUB_H1         SUB_H1           J_1              400        0.01       0          0          0          0

[XSECTIONS]
;;Link           Shape        Geom1            Geom2      Geom3      Geom4      Barrels    Culvert
;;-------------- ------------ ---------------- ---------- ---------- ---------- ---------- ----------
D_SUB_H2a        DUMMY        0                0          0          0          1
D_SUB_H2b        DUMMY        0                0          0          0          1
C_1              TRAPEZOIDAL  5                10         10         10         1
D_J_10           DUMMY        0                0          0          0          1
D_J1             DUMMY        0                0          0          0          1
D_SUB_H1         DUMMY        0                0          0          0          1

[REPORT]
;;Reporting Options
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]

[MAP]
DIMENSIONS -2500.000 0.000 12500.000 10000.000
Units      None

[COORDINATES]
```

```
;;Node           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
SUB_H2a          5292.865           6549.521
SUB_H2b          5037.274           5527.157
J_2              6581.470           5835.996
J_1              9797.657           6059.638
J_10             9680.511           5516.507
SUB_H1           7635.856           6342.246
ND_OUT           10330.138          5835.996

[VERTICES]
;;Link           X-Coord            Y-Coord
;;-------------- ------------------ ------------------

[Polygons]

[BACKDROP]
FILE       "DT-EXISTING CHUP-SWMM-Layout1.jpg"
DIMENSIONS -2500.000 0.000 12500.000 10000.000
```

HISTORIC CONDITIONS 100-YR SWMM OUTPUT

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.2 (Build 5.2.4)
------------------------------------------------------------

North Dawson Tributary Historic Conditions.

***************
Analysis Options
***************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ NO
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Flow Routing Method ...... KINWAVE
Starting Date ............ 01/01/2005 00:00:00
Ending Date .............. 01/04/2005 06:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:00:30
Routing Time Step ........ 5.00 sec


*************************        Volume        Volume
Flow Routing Continuity       acre-feet      10^6 gal
*************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         0.000         0.000
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........        36.035        11.743
External Outflow .........        36.126        11.772
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.000         0.000
Continuity Error (%) .....        -0.253


******************************
Highest Flow Instability Indexes
******************************
All links are stable.


************************
```

Routing Time Step Summary
****

Minimum Time Step	:	5.00 sec
Average Time Step	:	5.00 sec
Maximum Time Step	:	5.00 sec
% of Time in Steady State	:	0.00
Average Iterations per Step	:	1.00
% of Steps Not Converging	:	0.00

****
Node Depth Summary
****

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days hr:min	Reported Max Depth Feet
SUB_H2a	JUNCTION	0.00	0.00	6480.00	0 00:00	0.00
SUB_H2b	JUNCTION	0.00	0.00	6480.00	0 00:00	0.00
J_2	JUNCTION	0.04	1.42	6471.42	0 00:54	1.42
J_1	JUNCTION	0.04	1.42	6391.42	0 00:58	1.42
J_10	JUNCTION	0.00	0.00	6390.00	0 00:00	0.00
SUB_H1	JUNCTION	0.00	0.00	6400.00	0 00:00	0.00
ND_OUT	OUTFALL	0.00	0.00	6350.00	0 00:00	0.00

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal	Flow Balance Error Percent
SUB_H2a	JUNCTION	154.74	154.74	0 00:52	5.29	5.29	0.000
SUB_H2b	JUNCTION	93.84	93.84	0 01:00	4.15	4.15	0.000
J_2	JUNCTION	0.00	245.86	0 00:54	0	9.44	0.000
J_1	JUNCTION	0.00	262.98	0 00:58	0	10.3	0.000
J_10	JUNCTION	34.49	34.49	0 00:57	1.5	1.5	0.000
SUB_H1	JUNCTION	18.44	18.44	0 00:55	0.804	0.804	0.000
ND_OUT	OUTFALL	0.00	297.42	0 00:58	0	11.8	0.000

****
Node Flooding Summary
****

No nodes were flooded.

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CFS	Max Flow CFS	Total Volume 10^6 gal
ND_OUT	10.97	51.07	297.42	11.771
System	10.97	51.07	297.42	11.771

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
D_SUB_H2a	DUMMY	154.74	0 00:52			
D_SUB_H2b	DUMMY	93.84	0 01:00			
C_1	CONDUIT	244.65	0 00:58	7.14	0.05	0.28
D_J_10	DUMMY	34.49	0 00:57			
D_J1	DUMMY	262.98	0 00:58			
D_SUB_H1	DUMMY	18.44	0 00:55			

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Wed Nov 27 07:36:25 2024
Analysis ended on: Wed Nov 27 07:36:25 2024
Total elapsed time: < 1 sec

FUTURE CONDITIONS SWMM INPUT

```
[TITLE]
;;Project Title/Notes
Future Conditions Hydrology for the North Dawson Tributary.

[OPTIONS]
;;Option             Value
FLOW_UNITS           CFS
INFILTRATION         HORTON
FLOW_ROUTING         KINWAVE
LINK_OFFSETS         DEPTH
MIN_SLOPE            0
ALLOW_PONDING        NO
SKIP_STEADY_STATE    NO

START_DATE           01/01/2005
START_TIME           00:00:00
REPORT_START_DATE    01/01/2005
REPORT_START_TIME    00:00:00
END_DATE             01/04/2005
END_TIME             06:00:00
SWEEP_START          01/01
SWEEP_END            12/31
DRY_DAYS             0
REPORT_STEP          00:05:00
WET_STEP             00:00:10
DRY_STEP             01:00:00
ROUTING_STEP         0:00:05
RULE_STEP            00:00:10

INERTIAL_DAMPING     PARTIAL
NORMAL_FLOW_LIMITED  BOTH
FORCE_MAIN_EQUATION  H-W
VARIABLE_STEP        0.75
LENGTHENING_STEP     0
MIN_SURFAREA         12.566
MAX_TRIALS           8
HEAD_TOLERANCE       0.005
SYS_FLOW_TOL         5
LAT_FLOW_TOL         5
MINIMUM_STEP         0.5
THREADS              1

[FILES]
;;Interfacing Files
USE INFLOWS "North_Dawson_Future.txt"

[EVAPORATION]
;;Data Source    Parameters
;;-------------- ----------------
CONSTANT         0.0
```

```
DRY_ONLY         NO

[JUNCTIONS]
;;Name           Elevation  MaxDepth   InitDepth  SurDepth   Aponded
;;-------------- ---------- ---------- ---------- ---------- ----------
J_1              6390       10         0          0          0
WQPOND_E3        6560       10         0          0          0
J_E1             6560       10         0          0          0
WQPOND_E2        6560       10         0          0          0
J_4              6534       10         0          0          0
WQPOND_A6        6520       10         0          0          0
J_A9             6551       10         0          0          0
J_3              6490       10         0          0          0
WQPOND_A5        6500       10         0          0          0
WQPOND_A8        6500       10         0          0          0
J_2              6415       10         0          0          0
J_1a             6411       10         0          0          0
J_A2             6495       10         0          0          0
WQPOND_A4        6425       10         0          0          0
WQPOND_A7        6425       10         0          0          0
WQPOND_A3        6415       10         0          0          0
J_A1             6415       10         0          0          0
4C               6416       10         0          0          0
3C               6379       10         0          0          0
2C               6377       10         0          0          0
1C               6370       10         0          0          0

[OUTFALLS]
;;Name           Elevation  Type       Stage Data       Gated    Route To
;;-------------- ---------- ---------- ---------------- -------- ----------------
ND_OUT           6350       FREE                        NO
C1OUT            6369       FREE                        NO

[STORAGE]
;;Name           Elev.    MaxDepth   InitDepth  Shape      Curve Type/Params            SurDepth  Fevap    Psi      Ksat
 IMD
;;-------------- -------- ---------- ---------- ---------- ---------------------------- --------- --------
-------- --------
SU_E1            6535     10         0          TABULAR    STOR_E1                      0         0
SU_A1            6399.5   10         0          TABULAR    STOR_A1                      0         0

[CONDUITS]
;;Name           From Node        To Node          Length     Roughness  InOffset   OutOffset  InitFlow   MaxFlow
;;-------------- ---------------- ---------------- ---------- ---------- ---------- ---------- ---------- ----------
D_J1             J_1              ND_OUT           400        0.01       0          0          0          0
D_E1             J_E1             SU_E1            400        0.01       0          0          0          0
D_WQE3           WQPOND_E3        SU_E1            400        0.01       0          0          0          0
D_E2             WQPOND_E2        SU_E1            400        0.01       0          0          0          0
D_A9             J_A9             J_4              400        0.01       0          0          0          0
D_WQA6           WQPOND_A6        J_4              400        0.01       0          0          0          0
```

```
D_WQA5           WQPOND_A5       J_3             400        0.01       0          0          0          0
D_WQA8           WQPOND_A8       J_3             400        0.01       0          0          0          0
C_J3             J_4             J_3             1032       .035       0          0          0          0
C_J2             J_3             J_2             2293       .035       0          0          0          0
D_A2             J_A2            J_3             400        0.01       0          0          0          0
D_WQA4           WQPOND_A4       J_2             400        0.01       0          0          0          0
D_WQA7           WQPOND_A7       J_2             400        0.01       0          0          0          0
C_J_1a           J_2             J_1a            195        .013       0          0          0          0
D_A1             J_A1            SU_A1           400        0.01       0          0          0          0
D_J_1a           J_1a            SU_A1           400        0.01       0          0          0          0
D_WQA3           WQPOND_A3       SU_A1           400        0.01       0          0          0          0
4C-3C            4C              3C              970        0.01       0          0          0          0
2C-1C            2C              1C              1200       0.01       0          0          0          0
DL_C1OUT         1C              C1OUT           400        0.01       0          0          0          0
3C-2C            3C              2C              130        .013       0          0          0          0

[OUTLETS]
;;Name           From Node       To Node         Offset     Type            QTable/Qcoeff    Qexpon     Gated
;;-------------- --------------- --------------- ---------- --------------- ---------------- ---------- --------
E1_OUT           SU_E1           J_4             0          TABULAR/HEAD    OUT_E1                      NO
A1_OUT           SU_A1           J_1             0          TABULAR/HEAD    A1_OUT                      NO

[XSECTIONS]
;;Link           Shape        Geom1           Geom2      Geom3      Geom4      Barrels    Culvert
;;-------------- ------------ --------------- ---------- ---------- ---------- ---------- ----------
D_J1             DUMMY        0               0          0          0          1
D_E1             DUMMY        0               0          0          0          1
D_WQE3           DUMMY        0               0          0          0          1
D_E2             DUMMY        0               0          0          0          1
D_A9             DUMMY        0               0          0          0          1
D_WQA6           DUMMY        0               0          0          0          1
D_WQA5           DUMMY        0               0          0          0          1
D_WQA8           DUMMY        0               0          0          0          1
C_J3             TRAPEZOIDAL  10              20         10         10         1
C_J2             TRAPEZOIDAL  10              20         4          4          1
D_A2             DUMMY        0               0          0          0          1
D_WQA4           DUMMY        0               0          0          0          1
D_WQA7           DUMMY        0               0          0          0          1
C_J_1a           RECT_CLOSED  10              10         0          0          1
D_A1             DUMMY        0               0          0          0          1
D_J_1a           DUMMY        0               0          0          0          1
D_WQA3           DUMMY        0               0          0          0          1
4C-3C            TRAPEZOIDAL  10              10         4          4          1
2C-1C            TRAPEZOIDAL  10              10         4          4          1
DL_C1OUT         DUMMY        0               0          0          0          1
3C-2C            RECT_CLOSED  10              10         0          0          1

[LOSSES]
;;Link           Kentry     Kexit      Kavg       Flap Gate  Seepage
;;-------------- ---------- ---------- ---------- ---------- ----------
```

```
C_J_1a           .5         0          0          NO         0

[CURVES]
;;Name           Type       X-Value    Y-Value
;;-------------- ---------- ---------- ----------
;POND E1 HEAD VS DISCHARGE
OUT_E1           Rating     0.00       0.00
OUT_E1                      0.50       4.11
OUT_E1                      1.00       13.01
OUT_E1                      1.50       26.41
OUT_E1                      2.00       33.15
OUT_E1                      2.50       37.80
OUT_E1                      3.00       41.94
OUT_E1                      3.50       45.70
OUT_E1                      4.00       49.17
OUT_E1                      4.50       52.42
OUT_E1                      5.00       55.47
OUT_E1                      5.50       58.37
OUT_E1                      6.00       61.13
OUT_E1                      6.50       63.77
OUT_E1                      7.00       66.31
OUT_E1                      7.50       240.15
OUT_E1                      8.00       560.70
OUT_E1                      8.50       981.66
OUT_E1                      9.00       1487.55
;
;POND A1 HEAD VS OUTFLOW
A1_OUT           Rating     0.00       0.00
A1_OUT                      0.50       2.90
A1_OUT                      1.00       9.58
A1_OUT                      1.50       20.12
A1_OUT                      2.00       34.85
A1_OUT                      2.50       54.12
A1_OUT                      3.00       75.54
A1_OUT                      3.50       99.85
A1_OUT                      4.00       127.15
A1_OUT                      4.50       143.03
A1_OUT                      5.00       159.35
A1_OUT                      5.50       174.14
A1_OUT                      6.00       187.77
A1_OUT                      6.50       200.48
A1_OUT                      7.00       212.43
A1_OUT                      7.50       223.74
A1_OUT                      8.00       234.50
A1_OUT                      8.5        564.69
A1_OUT                      9          1164.27
A1_OUT                      9.5        1944.04
A1_OUT                      10         2873.25
;
;POND E1 DEPTH VS AREA
```

```
STOR_E1           Storage    0.00       92915
STOR_E1                      0.50       95518
STOR_E1                      1.00       98152
STOR_E1                      1.50       100819
STOR_E1                      2.00       103517
STOR_E1                      2.50       106248
STOR_E1                      3.00       109010
STOR_E1                      3.50       111805
STOR_E1                      4.00       114631
STOR_E1                      4.50       117490
STOR_E1                      5.00       120380
STOR_E1                      5.50       123303
STOR_E1                      6.00       126257
STOR_E1                      6.50       129244
STOR_E1                      7.00       132262
STOR_E1                      7.50       135313
STOR_E1                      8.00       138395
STOR_E1                      8.50       141510
STOR_E1                      9.00       144656
;
;POND A1 DEPTH VS AREA
STOR_A1           Storage    0.00       8
STOR_A1                      0.50       880
STOR_A1                      1.00       3478
STOR_A1                      1.50       8900
STOR_A1                      2.00       21039
STOR_A1                      2.50       40410
STOR_A1                      3.00       67457
STOR_A1                      3.50       103933
STOR_A1                      4.00       147842
STOR_A1                      4.50       195888
STOR_A1                      5.00       234841
STOR_A1                      5.50       263000
STOR_A1                      6.00       289871
STOR_A1                      6.50       306077
STOR_A1                      7.00       310769
STOR_A1                      7.50       315444
STOR_A1                      8.00       322437
STOR_A1                      8.50       329316
STOR_A1                      9.00       334026
STOR_A1                      9.50       338762
STOR_A1                      10.00      342453

[REPORT]
;;Reporting Options
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]
```

```
[MAP]
DIMENSIONS -2500.000 0.000 12779.329 12983.241
Units      None

[COORDINATES]
;;Node           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
J_1              10005.815          5949.016
WQPOND_E3        3392.405           5465.147
J_E1             3057.138           6540.132
WQPOND_E2        3993.758           6742.357
J_4              4184.154           6054.439
WQPOND_A6        4731.822           6722.203
J_A9             4424.817           5640.764
J_3              5538.736           6219.982
WQPOND_A5        5547.697           6933.939
WQPOND_A8        5270.969           5688.659
J_2              8465.462           6150.147
J_1a             8907.164           6160.791
J_A2             6133.085           6460.307
WQPOND_A4        7933.154           6772.956
WQPOND_A7        8007.658           5383.990
WQPOND_A3        9369.471           7173.288
J_A1             8768.662           6735.705
4C               9158.679           10564.430
3C               10479.233          10000.000
2C               10638.978          10351.438
1C               11096.912          11948.882
ND_OUT           10487.574          5788.440
C1OUT            10979.766          12406.816
SU_E1            3575.952           6133.091
SU_A1            9363.440           6208.634

[VERTICES]
;;Link           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
C_J3             4817.068           6237.931
C_J3             5205.326           6307.073
C_J2             6688.012           5628.620
C_J2             7076.496           5628.620

[Polygons]
;;Storage Node   X-Coord            Y-Coord
;;-------------- ------------------ ------------------
SU_E1            3547.919           6252.139
SU_E1            3547.919           6252.139
SU_E1            3547.919           6252.139
SU_E1            3547.919           6252.139
SU_E1            3664.996           6236.174
```

```
SU_E1            3744.822          6145.705
SU_E1            3710.263          6095.171
SU_E1            3627.824          6049.963
SU_E1            3478.736          6002.018
SU_E1            3430.841          6087.166
SU_E1            3468.093          6193.600
SU_E1            3547.919          6252.139
SU_A1            9483.084          6361.881
SU_A1            9483.084          6361.881
SU_A1            9578.875          6303.342
SU_A1            9573.553          6111.761
SU_A1            9444.519          6081.134
SU_A1            9201.033          6021.292
SU_A1            9147.816          6207.552
SU_A1            9222.320          6356.559
SU_A1            9483.084          6372.525


[BACKDROP]
FILE       "DT-FUTURE CHUP-SWMM-Layout1.jpg"
DIMENSIONS -2220.671 2983.241 12779.329 12983.241
```

FUTURE CONDITIONS 100-YR SWMM OUTPUT

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.2 (Build 5.2.4)
------------------------------------------------------------

Future Conditions Hydrology for the North Dawson Tributary.

***************
Analysis Options
***************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ NO
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Flow Routing Method ...... KINWAVE
Starting Date ............ 01/01/2005 00:00:00
Ending Date .............. 01/04/2005 06:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:05:00
Routing Time Step ........ 5.00 sec


*************************        Volume        Volume
Flow Routing Continuity        acre-feet      10^6 gal
*************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         0.000         0.000
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........        92.982        30.299
External Outflow .........        93.031        30.315
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.000         0.000
Continuity Error (%) .....        -0.053


*******************************
Highest Flow Instability Indexes
*******************************
All links are stable.


************************
```

Routing Time Step Summary
****

Minimum Time Step	:	5.00 sec
Average Time Step	:	5.00 sec
Maximum Time Step	:	5.00 sec
% of Time in Steady State	:	0.00
Average Iterations per Step	:	1.00
% of Steps Not Converging	:	0.00

****
Node Depth Summary
****

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days hr:min	Reported Max Depth Feet
J_1	JUNCTION	0.00	0.00	6390.00	0 00:00	0.00
WQPOND_E3	JUNCTION	0.00	0.00	6560.00	0 00:00	0.00
J_E1	JUNCTION	0.00	0.00	6560.00	0 00:00	0.00
WQPOND_E2	JUNCTION	0.00	0.00	6560.00	0 00:00	0.00
J_4	JUNCTION	0.04	0.58	6534.58	0 00:51	0.58
WQPOND_A6	JUNCTION	0.00	0.00	6520.00	0 00:00	0.00
J_A9	JUNCTION	0.00	0.00	6551.00	0 00:00	0.00
J_3	JUNCTION	0.06	1.36	6491.36	0 00:37	1.35
WQPOND_A5	JUNCTION	0.00	0.00	6500.00	0 00:00	0.00
WQPOND_A8	JUNCTION	0.00	0.00	6500.00	0 00:00	0.00
J_2	JUNCTION	0.07	2.74	6417.74	0 00:39	2.74
J_1a	JUNCTION	0.07	2.74	6413.74	0 00:39	2.74
J_A2	JUNCTION	0.00	0.00	6495.00	0 00:00	0.00
WQPOND_A4	JUNCTION	0.00	0.00	6425.00	0 00:00	0.00
WQPOND_A7	JUNCTION	0.00	0.00	6425.00	0 00:00	0.00
WQPOND_A3	JUNCTION	0.00	0.00	6415.00	0 00:00	0.00
J_A1	JUNCTION	0.00	0.00	6415.00	0 00:00	0.00
4C	JUNCTION	0.01	0.60	6416.60	0 00:35	0.60
3C	JUNCTION	0.02	1.85	6380.85	0 00:36	1.83
2C	JUNCTION	0.02	1.85	6378.85	0 00:36	1.83
1C	JUNCTION	0.02	1.60	6371.60	0 00:37	1.58
ND_OUT	OUTFALL	0.00	0.00	6350.00	0 00:00	0.00
C1OUT	OUTFALL	0.00	0.00	6369.00	0 00:00	0.00
SU_E1	STORAGE	0.32	6.67	6541.67	0 01:35	6.67
SU_A1	STORAGE	0.42	7.86	6407.36	0 01:25	7.86

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal	Flow Balance Error Percent
J_1	JUNCTION	0.00	231.56	0 01:25	0	22.8	0.000
WQPOND_E3	JUNCTION	163.12	163.12	0 00:36	2.86	2.86	0.000
J_E1	JUNCTION	113.63	113.63	0 00:40	2.61	2.61	0.000
WQPOND_E2	JUNCTION	101.25	101.25	0 00:38	2.29	2.29	0.000
J_4	JUNCTION	0.00	79.01	0 00:51	0	8.54	0.000
WQPOND_A6	JUNCTION	31.15	31.15	0 00:35	0.502	0.502	0.000
J_A9	JUNCTION	8.90	8.90	0 00:45	0.28	0.28	0.000
J_3	JUNCTION	0.00	283.60	0 00:37	0	12.7	0.000
WQPOND_A5	JUNCTION	83.27	83.27	0 00:36	1.58	1.58	0.000
WQPOND_A8	JUNCTION	127.53	127.53	0 00:35	2.14	2.14	0.000
J_2	JUNCTION	0.00	654.95	0 00:39	0	20.6	0.000
J_1a	JUNCTION	0.00	654.95	0 00:39	0	20.6	0.000
J_A2	JUNCTION	11.18	11.18	0 00:50	0.436	0.436	0.000
WQPOND_A4	JUNCTION	265.12	265.12	0 00:38	5.44	5.44	0.000
WQPOND_A7	JUNCTION	117.91	117.91	0 00:37	2.41	2.41	0.000
WQPOND_A3	JUNCTION	96.08	96.08	0 00:36	1.78	1.78	0.000
J_A1	JUNCTION	27.90	27.90	0 00:36	0.496	0.496	0.000
4C	JUNCTION	137.15	137.15	0 00:35	2.28	2.28	0.000
3C	JUNCTION	184.33	319.99	0 00:36	3.82	6.1	0.000
2C	JUNCTION	4.84	324.77	0 00:36	0.133	6.23	0.000
1C	JUNCTION	57.90	381.78	0 00:37	1.24	7.48	0.000
ND_OUT	OUTFALL	0.00	231.56	0 01:25	0	22.8	0.000
C1OUT	OUTFALL	0.00	381.78	0 00:37	0	7.48	0.000
SU_E1	STORAGE	0.00	374.96	0 00:37	0	7.76	0.012
SU_A1	STORAGE	0.00	773.90	0 00:39	0	22.8	0.015

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 ft³	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 ft³	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CFS
SU_E1	33.696	2.8	0.0	0.0	741.759	61.3	0 01:35	64.66

SU_A1 34.654 1.8 0.0 0.0 1191.667 62.6 0 01:25 231.56

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CFS	Max Flow CFS	Total Volume 10^6 gal
ND_OUT	32.53	33.42	231.56	22.838
C1OUT	4.78	74.50	381.78	7.475
System	18.66	107.92	540.22	30.313

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days	hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
D_J1	DUMMY	231.56	0	01:25			
D_E1	DUMMY	113.63	0	00:40			
D_WQE3	DUMMY	163.12	0	00:36			
D_E2	DUMMY	101.25	0	00:38			
D_A9	DUMMY	8.90	0	00:45			
D_WQA6	DUMMY	31.15	0	00:35			
D_WQA5	DUMMY	83.27	0	00:36			
D_WQA8	DUMMY	127.53	0	00:35			
C_J3	CONDUIT	78.99	0	00:53	5.32	0.00	0.06
C_J2	CONDUIT	280.00	0	00:41	8.26	0.02	0.13
D_A2	DUMMY	11.18	0	00:50			
D_WQA4	DUMMY	265.12	0	00:38			
D_WQA7	DUMMY	117.91	0	00:37			
C_J_1a	CONDUIT	654.95	0	00:39	23.94	0.22	0.27
D_A1	DUMMY	27.90	0	00:36			
D_J_1a	DUMMY	654.95	0	00:39			
D_WQA3	DUMMY	96.08	0	00:36			
4C-3C	CONDUIT	136.92	0	00:35	18.33	0.00	0.06
2C-1C	CONDUIT	324.12	0	00:37	12.38	0.02	0.16
DL_C1OUT	DUMMY	381.78	0	00:37			
3C-2C	CONDUIT	319.99	0	00:36	17.31	0.12	0.18
E1_OUT	DUMMY	64.66	0	01:35			
A1_OUT	DUMMY	231.56	0	01:25			

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Mon Apr 28 14:58:59 2025
Analysis ended on: Mon Apr 28 14:59:00 2025
Total elapsed time: 00:00:01

GAMBEL RIDGE TRIBUTARY

SWMM MODEL RESULTS

INTERIM BUILDOUT CONDITION - 100 YEAR STORM EVENT

```
  EPA STORM WATER MANAGEMENT MODEL - VERSION 5.2 (Build 5.2.4)
  ------------------------------------------------------------

  WARNING 02: maximum depth increased for Node J_2
  WARNING 02: maximum depth increased for Node
FLOOD_CONTROL_POND_E1

  ****************
  Analysis Options
  ****************
  Flow Units ............... CFS
  Process Models:
    Rainfall/Runoff ........ NO
    RDII ................... NO
    Snowmelt ............... NO
    Groundwater ............ NO
    Flow Routing ........... YES
    Ponding Allowed ........ NO
    Water Quality .......... NO
  Flow Routing Method ...... KINWAVE
  Starting Date ............ 01/01/2005 00:00:00
  Ending Date .............. 01/05/2005 06:00:00
  Antecedent Dry Days ...... 0.0
  Report Time Step ......... 00:05:00
  Routing Time Step ........ 20.00 sec


  *************************        Volume        Volume
  Flow Routing Continuity       acre-feet      10^6 gal
  *************************     ---------     ---------
  Dry Weather Inflow .......          0.000         0.000
  Wet Weather Inflow .......          0.000         0.000
  Groundwater Inflow .......          0.000         0.000
  RDII Inflow ..............          0.000         0.000
  External Inflow ..........         76.333        24.874
  External Outflow .........         68.658        22.373
  Flooding Loss ............          7.666         2.498
  Evaporation Loss .........          0.000         0.000
```

```
  Exfiltration Loss ........          0.000          0.000
  Initial Stored Volume ....          0.000          0.000
  Final Stored Volume ......          0.000          0.000
  Continuity Error (%) .....          0.011


  ********************************
  Highest Flow Instability Indexes
  ********************************
  Link L_A1_OUTLET (5)
  Link L_3 (4)
  Link L_4_BNSF-BRIDGE (4)
  Link L_2_I-25_PIPE (4)
  Link L_1 (4)


  *************************
  Routing Time Step Summary
  *************************
  Minimum Time Step           :    20.00 sec
  Average Time Step           :    20.00 sec
  Maximum Time Step           :    20.00 sec
  % of Time in Steady State   :     0.00
  Average Iterations per Step :     1.01
  % of Steps Not Converging   :     0.00


  ******************
  Node Depth Summary
  ******************


------------------------------------------------------------------------
---------------
                                  Average  Maximum  Maximum  Time
of Max    Reported
                                    Depth    Depth      HGL
Occurrence   Max Depth
  Node                 Type         Feet     Feet     Feet  days
```

INTERIM BUILDOUT CONDITION - 100 YEAR STORM EVENT

hr:min	Feet					
J_E-3		JUNCTION	0.02	1.05	6552.05	0
00:45	1.04					
J_E-1		JUNCTION	0.01	0.67	6548.87	0
00:50	0.67					
J_E-2		JUNCTION	0.02	0.97	6551.97	0
00:45	0.97					
J_A-8		JUNCTION	0.01	1.19	6498.19	0
00:35	1.18					
J_A-6		JUNCTION	0.01	0.53	6525.53	0
00:35	0.53					
J_A-5		JUNCTION	0.01	0.76	6503.76	0
00:35	0.76					
J_A-7		JUNCTION	0.01	1.09	6443.09	0
00:35	1.08					
J_A-3		JUNCTION	0.01	1.40	6412.40	0
00:35	1.40					
J_A-1		JUNCTION	0.01	0.70	6405.70	0
00:40	0.70					
J_A-4		JUNCTION	0.02	2.05	6431.05	0
00:35	2.05					
J_15		JUNCTION	0.04	2.28	6547.28	0
00:45	2.28					
J_14		JUNCTION	0.04	2.28	6542.28	0
00:46	2.27					
WQ_E3		JUNCTION	0.02	1.43	6551.38	0
00:45	1.43					
WQ_A8		JUNCTION	0.02	1.72	6497.57	0
00:35	1.72					
WQ_A7		JUNCTION	0.02	1.25	6441.35	0
00:35	1.24					
WQ_E2		JUNCTION	0.02	1.45	6551.45	0
00:45	1.45					
WQ_A5		JUNCTION	0.01	1.30	6500.30	0
00:35	1.29					
J_12		JUNCTION	0.03	1.72	6491.72	0

INTERIM BUILDOUT CONDITION - 100 YEAR STORM EVENT

00:42	1.72					
J_13		JUNCTION	0.02	1.21	6506.21	0
00:46	1.21					
J_6		JUNCTION	0.03	2.79	6414.79	0
00:41	2.77					
J_11		JUNCTION	0.02	1.72	6453.72	0
00:45	1.72					
WQ_A6		JUNCTION	0.01	0.80	6523.55	0
00:35	0.80					
J_4		JUNCTION	0.04	0.91	6389.91	0
01:04	0.91					
J_2		JUNCTION	0.10	2.46	6387.76	0
01:05	2.46					
WQ_A4		JUNCTION	0.03	2.53	6429.53	0
00:35	2.51					
J_7		JUNCTION	0.04	2.79	6416.79	0
00:41	2.78					
J_1		JUNCTION	0.10	2.46	6385.54	0
01:05	2.46					
J_3		JUNCTION	0.04	0.99	6388.99	0
01:05	0.99					
J_5		JUNCTION	0.08	7.37	6411.37	0
00:41	7.33					
J_10		JUNCTION	0.02	1.41	6436.41	0
00:45	1.41					
J_9		JUNCTION	0.02	1.75	6431.75	0
00:45	1.75					
J_FZ-2		JUNCTION	0.01	1.08	6417.08	0
00:35	1.08					
EDB_FZ2		JUNCTION	0.01	1.18	6415.35	0
00:35	1.18					
WQ_A3		JUNCTION	0.02	2.41	6410.86	0
00:35	2.40					
J_A-2		JUNCTION	0.00	0.00	6420.00	0
00:00	0.00					
J_8		JUNCTION	0.03	2.52	6421.52	0
00:35	2.51					
FLOOD_CONTROL_POND_E1		JUNCTION	0.02	1.45	6549.45	0
00:46	1.45					

```
  OUT-1                OUTFALL      0.00     0.00  6380.00     0
00:00        0.00
  OUT-2                OUTFALL      0.01     1.18  6393.18     0
00:35        1.18
  FLOOD_CONTROL_POND_A1 STORAGE      0.28     8.00  6410.00     0
 01:04        8.00


  ********************
  Node Inflow Summary
  ********************


-------------------------------------------------------------------
--------------------------------
                                  Maximum  Maximum
  Lateral       Total        Flow
                                  Lateral    Total  Time of Max
   Inflow      Inflow     Balance
                                   Inflow   Inflow   Occurrence
   Volume      Volume       Error
  Node                 Type           CFS      CFS  days hr:min
 10^6 gal    10^6 gal     Percent

-------------------------------------------------------------------
--------------------------------
  J_E-3                JUNCTION     65.07    65.07     0  00:45
    1.94        1.94       0.000
  J_E-1                JUNCTION     66.80    66.80     0  00:50
    2.12        2.12       0.000
  J_E-2                JUNCTION     54.36    54.36     0  00:45
    1.74        1.74       0.000
  J_A-8                JUNCTION    119.07   119.07     0  00:35
    2.12        2.12       0.000
  J_A-6                JUNCTION     31.04    31.04     0  00:35
   0.487       0.487       0.000
  J_A-5                JUNCTION     92.37    92.37     0  00:35
    1.72        1.72       0.000
  J_A-7                JUNCTION     95.55    95.55     0  00:35
```

2.04	2.04	0.000				
J_A-3		JUNCTION	182.98	182.98	0	00:35
3.25	3.25	0.000				
J_A-1		JUNCTION	27.76	27.76	0	00:40
0.597	0.597	0.000				
J_A-4		JUNCTION	332.82	332.82	0	00:35
5.65	5.65	0.000				
J_15		JUNCTION	0.00	186.12	0	00:45
0	5.8	0.000				
J_14		JUNCTION	0.00	186.08	0	00:46
0	5.8	0.000				
WQ_E3		JUNCTION	0.00	65.06	0	00:45
0	1.94	0.000				
WQ_A8		JUNCTION	0.00	119.06	0	00:35
0	2.11	0.000				
WQ_A7		JUNCTION	0.00	95.53	0	00:35
0	2.04	0.000				
WQ_E2		JUNCTION	0.00	54.36	0	00:45
0	1.74	0.000				
WQ_A5		JUNCTION	0.00	92.36	0	00:35
0	1.72	0.000				
J_12		JUNCTION	0.00	381.31	0	00:42
0	10.1	0.000				
J_13		JUNCTION	0.00	206.61	0	00:46
0	6.29	0.000				
J_6		JUNCTION	0.00	777.16	0	00:41
0	19.2	0.000				
J_11		JUNCTION	0.00	379.58	0	00:45
0	10.1	0.000				
WQ_A6		JUNCTION	0.00	31.04	0	00:35
0	0.487	0.000				
J_4		JUNCTION	0.00	212.53	0	01:04
0	20.5	0.000				
J_2		JUNCTION	0.00	212.76	0	01:05
0	20.5	0.000				
WQ_A4		JUNCTION	0.00	333.53	0	00:35
0	5.65	0.000				
J_7		JUNCTION	0.00	777.12	0	00:41
0	19.2	0.000				

```
  J_1                      JUNCTION      0.00   212.55     0  01:05
        0        20.5        0.000
  J_3                      JUNCTION      0.00   212.62     0  01:05
        0        20.5        0.000
  J_5                      JUNCTION      0.00   804.67     0  00:41
        0        19.8        0.000
  J_10                     JUNCTION      0.00   379.43     0  00:45
        0        10.1        0.000
  J_9                      JUNCTION      0.00   379.43     0  00:45
        0        10.1        0.000
  J_FZ-2                   JUNCTION     92.75    92.75     0  00:35
     1.86        1.86        0.000
  EDB_FZ2                  JUNCTION      0.00    92.75     0  00:35
        0        1.86        0.000
  WQ_A3                    JUNCTION      0.00   182.97     0  00:35
        0        3.24        0.000
  J_A-2                    JUNCTION     36.40    36.40     0  00:45
     1.35        1.35        0.000
  J_8                      JUNCTION      0.00   777.12     0  00:41
        0        19.2        0.000
  FLOOD_CONTROL_POND_E1 JUNCTION       0.00   186.12     0  00:45
         0         5.8        0.000
  OUT-1                    OUTFALL       0.00   212.55     0  01:05
        0        20.5        0.000
  OUT-2                    OUTFALL       0.00    92.55     0  00:35
        0        1.86        0.000
  FLOOD_CONTROL_POND_A1 STORAGE        0.00   959.99     0  00:41
         0          23        0.018


  **********
  Node Flooding Summary
  **********

  Flooding refers to all water that overflows a node, whether it
ponds or not.

--------------------------------------------------------------
---------
```

INTERIM BUILDOUT CONDITION - 100 YEAR STORM EVENT

Node	Total Flooded Hours	Maximum Rate CFS	Time of Max Occurrence days hr:min	Maximum Flood Volume 10^6 gal	Ponded Volume 1000 ft³
FLOOD_CONTROL_POND_A1	0.56	398.29	0 01:05	2.498	0.000

Storage Volume Summary

Storage Unit	Average Volume 1000 ft³	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 ft³	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CFS
FLOOD_CONTROL_POND_A1	38.607	2.6	0.0	0.0	1466.227	100.0	0 01:04	212.53

Outfall Loading Summary

INTERIM BUILDOUT CONDITION - 100 YEAR STORM EVENT

Outfall Node	Flow Freq Pcnt	Avg Flow CFS	Max Flow CFS	Total Volume 10^6 gal
OUT-1	9.07	82.29	212.55	20.509
OUT-2	2.81	24.13	92.55	1.863
System	5.94	106.42	257.40	22.372

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
L_15	CONDUIT	186.08	0 00:46	15.73	0.18	0.29
L_A-8	CONDUIT	119.06	0 00:35	25.49	0.05	0.15
L_E-3	CONDUIT	65.06	0 00:45	21.81	0.10	0.21
L_A-7	CONDUIT	95.53	0 00:35	30.21	0.10	0.22
L_E-2	CONDUIT	54.36	0 00:45	20.33	0.08	0.19
L_WQ-E2	CONDUIT	54.34	0 00:46	7.73	0.05	0.14

L_WQ-E3		CONDUIT	65.03	0	00:45	10.70
0.07	0.18					
L_A-5		CONDUIT	92.36	0	00:35	37.90
0.02	0.10					
L_WQ-A5		CONDUIT	92.24	0	00:35	22.74
0.15	0.26					
L_14		CONDUIT	185.75	0	00:47	6.11
0.02	0.12					
L_13		CONDUIT	206.27	0	00:48	4.89
0.03	0.16					
L_7		CONDUIT	777.16	0	00:41	13.94
0.22	0.28					
L_12		CONDUIT	379.58	0	00:45	6.03
0.06	0.23					
L_11		CONDUIT	379.43	0	00:45	7.58
0.04	0.19					
L_A-6		CONDUIT	31.04	0	00:35	21.48
0.01	0.07					
L_WQ-A6		CONDUIT	30.99	0	00:35	15.19
0.06	0.16					
L_6		DUMMY	777.16	0	00:41	
L_A-1		CONDUIT	27.76	0	00:40	16.71
0.04	0.14					
L_4_BNSF-BRIDGE		CONDUIT	212.62	0	01:05	7.39
0.04	0.17					
L_2_I-25_PIPE		CONDUIT	212.55	0	01:05	10.81
0.67	0.61					
L_A-4		CONDUIT	333.53	0	00:35	43.84
0.35	0.41					
L_WQ-A7		CONDUIT	95.32	0	00:36	24.91
0.14	0.25					
L_WQ-A8		CONDUIT	118.73	0	00:35	19.86
0.25	0.34					
L_1		DUMMY	212.55	0	01:05	
L_3		CONDUIT	212.76	0	01:05	7.23
0.03	0.20					
L_5		CONDUIT	804.01	0	00:42	10.93
0.90	0.92					
L_WQ-A4		CONDUIT	331.43	0	00:35	26.58

0.28	0.36					
L_10		DUMMY	379.43	0	00:45	
L_9		CONDUIT	379.31	0	00:45	15.49
0.11	0.22					
L_E-1		CONDUIT	66.80	0	00:50	3.05
0.01	0.09					
L_A-3		CONDUIT	182.97	0	00:35	40.69
0.17	0.28					
L_FZ-2		CONDUIT	92.75	0	00:35	29.53
0.10	0.22					
L_BNSF_CULVERT		CONDUIT	92.55	0	00:35	26.09
0.12	0.24					
L_WQ_A3		CONDUIT	182.68	0	00:35	19.52
0.47	0.48					
L_A-2		DUMMY	36.40	0	00:45	
L_8		CONDUIT	777.12	0	00:41	>50.00
0.05	0.15					
L_E1_OUTLET		CONDUIT	186.12	0	00:45	43.52
0.16	0.27					
L_A1_OUTLET		DUMMY	212.53	0	01:04	

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Tue Oct 10 12:37:48 2023
Analysis ended on: Tue Oct 10 12:37:48 2023
Total elapsed time: < 1 sec

INTERIM BUILDOUT CONDITION - 100 YEAR STORM EVENT

Link Flow Summary

Link	Type	Maximum |Flow| CFS	Day of Maximum Flow	Hour of Maximum Flow	Maximum |Velocity| ft/sec	Max / Full Flow	Max / Full Depth
L_C9	DUMMY	3.53	0	01:00			
L_1	CONDUIT	611.07	0	01:12	9.52	0.70	0.62
L_10	CONDUIT	307.92	0	01:03	5.26	0.07	0.30
L_11	CONDUIT	308.24	0	00:59	10.22	0.46	0.47
L_12	CONDUIT	308.27	0	00:59	5.26	0.07	0.30
L_12-1	CONDUIT	188.52	0	00:53	4.52	0.04	0.24
L_12-2	CONDUIT	81.32	0	00:51	3.49	0.02	0.16
L_13	CONDUIT	144.39	0	01:38	8.90	0.75	0.65
L_13-1	DUMMY	32.71	0	00:51			
L_13-2	CONDUIT	32.71	0	00:51	10.36	0.69	0.61
L_14	DUMMY	266.96	0	00:51			
L_15	CONDUIT	266.96	0	00:51	17.42	0.25	0.34
L_16	CONDUIT	170.07	0	00:55	3.03	0.20	0.53
L_17	CONDUIT	171.77	0	00:51	15.04	0.09	0.20
L_18	CONDUIT	160.80	0	00:51	2.96	0.19	0.52
L_19	CONDUIT	66.23	0	00:46	12.21	0.86	0.72
L_2	CONDUIT	611.06	0	01:12	3.86	0.28	0.50
L_2-1	DUMMY	69.30	0	00:36			
L_2-2	CONDUIT	69.30	0	00:36	12.42	0.23	0.33
L_3-1	DUMMY	108.37	0	01:38			
L_3-10	CONDUIT	140.54	0	00:35	14.77	0.85	0.71

INTERIM BUILDOUT CONDITION - 100 YEAR STORM EVENT

Link	Type	Maximum |Flow| CFS	Day of Maximum Flow	Hour of Maximum Flow	Maximum |Velocity| ft/sec	Max / Full Flow	Max / Full Depth
L_3-11	DUMMY	73.59	0	00:36			
L_3-12	CONDUIT	73.59	0	00:36	12.74	0.64	0.58
L_3-13	DUMMY	50.24	0	00:45			
L_3-14	CONDUIT	50.24	0	00:45	11.52	0.30	0.38
L_3-2	CONDUIT	108.37	0	01:38	13.65	0.94	0.77
L_3-3	DUMMY	0.00	0	00:00			
L_3-4	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
L_3-5	DUMMY	389.80	0	00:45			
L_3-6	CONDUIT	389.80	0	00:45	9.67	0.37	0.42
L_3-7	CONDUIT	374.85	0	00:44	4.04	0.40	0.70
L_3-8	CONDUIT	300.11	0	00:37	18.00	0.29	0.37
L_3-9	CONDUIT	136.79	0	00:38	2.92	0.16	0.48
L_4	CONDUIT	500.48	0	01:05	3.63	0.23	0.45
L_5	CONDUIT	498.38	0	01:03	10.50	0.84	0.74
L_5-1	DUMMY	40.60	0	00:36			
L_5-2	CONDUIT	40.60	0	00:36	10.80	0.86	0.72
L_6	CONDUIT	473.95	0	01:03	3.56	0.21	0.43
L_6-1	DUMMY	39.79	0	00:45			
L_6-2	CONDUIT	39.79	0	00:45	10.77	0.84	0.70
L_7	CONDUIT	440.10	0	01:02	3.48	0.20	0.41
L_8	CONDUIT	307.85	0	01:05	3.06	0.16	0.43
L_9	CONDUIT	307.91	0	01:03	10.22	0.46	0.47

Link	Type	Maximum |Flow| CFS	Day of Maximum Flow	Hour of Maximum Flow	Maximum |Velocity| ft/sec	Max / Full Flow	Max / Full Depth
L_C1	DUMMY	140.96	0	00:35			
L_C2	DUMMY	168.23	0	00:35			
L_C3	DUMMY	95.41	0	00:35			
L_C4	DUMMY	73.89	0	00:35			
L_C5	DUMMY	50.24	0	00:45			
L_C6	DUMMY	15.26	0	00:45			
L_C7	DUMMY	40.69	0	00:35			
L_C8	DUMMY	69.61	0	00:35			
L_H1	DUMMY	66.41	0	00:45			
L_H2	DUMMY	95.75	0	00:50			
L_H3	DUMMY	12.35	0	00:40			
L_H4	DUMMY	17.99	0	00:40			
L_H5	DUMMY	106.01	0	00:35			
L_H6	DUMMY	32.73	0	00:50			
L_H7	DUMMY	18.89	0	00:35			
L_H8	DUMMY	9.70	0	00:55			
L_O1	DUMMY	81.38	0	00:50			
L_O2	DUMMY	108.41	0	00:55			
L_O4	DUMMY	39.81	0	00:45			
L_WQ_C2	DUMMY	69.61	0	00:35			
L_WQ_C3	DUMMY	40.69	0	00:35			
L_3	CONDUIT	587.49	0	01:12	3.81	0.26	0.49

Link	Type	Maximum |Flow| CFS	Day of Maximum Flow	Hour of Maximum Flow	Maximum |Velocity| ft/sec	Max / Full Flow	Max / Full Depth
L-O3	DUMMY	153.27	0	00:45			
L_B2_OUTLET	CONDUIT	66.36	0	00:46	10.33	0.17	0.28
L_B1_OUTLET	DUMMY	144.39	0	01:38			
L_C1_OUTLET	DUMMY	108.37	0	01:38			

INTERIM BUILDOUT CONDITION - 100 YEAR STORM EVENT

Storage Volume Summary

Storage Unit	Average Volume 1000 ft³	Average Percent Full	Evaporation Loss %	Exfiltration Loss %	Maximum Volume 1000 ft³	Maximum Percent Full	Day of Maximum Volume	Hour of Maximum Volume	Maximum Outflow CFS
EDB-C1	192.148	16.3	0.0	0.0	1073.060	91.2	0	01:38	108.37
EDB-B1	90.502	13.0	0.0	0.0	652.580	93.7	0	01:38	144.39

INTERIM BUILDOUT CONDITION - 100 YEAR STORM EVENT

Outfall Loading Summary

Outfall Node	Flow Frequency %	Avgerage Flow CFS	Maximum Flow CFS	Total Volume 10^6 gal
OUT_1	88.70	15.95	611.07	36.573

ULTIMATE BUILDOUT CONDITION - 100 YEAR STORM EVENT

```
  EPA STORM WATER MANAGEMENT MODEL - VERSION 5.2 (Build 5.2.4)
  ------------------------------------------------------------

  WARNING 10: crest elevation is below downstream invert for
regulator Link L_C1_OUTLET
  WARNING 02: maximum depth increased for Node J_4
  WARNING 02: maximum depth increased for Node J_13

  ****************
  Analysis Options
  ****************
  Flow Units ..............  CFS
  Process Models:
    Rainfall/Runoff ........  NO
    RDII ...................  NO
    Snowmelt ...............  NO
    Groundwater ............  NO
    Flow Routing ...........  YES
    Ponding Allowed ........  NO
    Water Quality ..........  NO
  Flow Routing Method ......  KINWAVE
  Starting Date ............  01/01/2005 00:00:00
  Ending Date ..............  01/05/2005 00:00:00
  Antecedent Dry Days ......  0.0
  Report Time Step .........  00:05:00
  Routing Time Step ........  30.00 sec


  **************************        Volume         Volume
  Flow Routing Continuity        acre-feet      10^6 gal
  **************************     ---------     ---------
  Dry Weather Inflow .......         0.000         0.000
  Wet Weather Inflow .......         0.000         0.000
  Groundwater Inflow .......         0.000         0.000
  RDII Inflow ..............         0.000         0.000
  External Inflow ..........       114.336        37.258
  External Outflow .........       114.418        37.285
  Flooding Loss ............         0.000         0.000
```

```
  Evaporation Loss .........          0.000          0.000
  Exfiltration Loss ........          0.000          0.000
  Initial Stored Volume ....          0.000          0.000
  Final Stored Volume ......          0.000          0.000
  Continuity Error (%) .....         -0.071

  ******************************
  Highest Flow Instability Indexes
  ******************************
  All links are stable.


  *************************
  Routing Time Step Summary
  *************************
  Minimum Time Step           :    30.00 sec
  Average Time Step           :    30.00 sec
  Maximum Time Step           :    30.00 sec
  % of Time in Steady State   :     0.00
  Average Iterations per Step :     1.02
  % of Steps Not Converging   :     0.00


  ******************
  Node Depth Summary
  ******************


------------------------------------------------------------------
---------------
                                  Average  Maximum  Maximum  Time
of Max    Reported
                                    Depth    Depth      HGL
Occurrence   Max Depth
  Node                 Type          Feet     Feet     Feet  days
hr:min        Feet

------------------------------------------------------------------
```

```
----------------
  J_12                  JUNCTION     0.32     3.59  6382.33     0
01:43        3.59
  J_10                  JUNCTION     1.66     5.27  6380.87     0
00:58        5.27
  J_6-1                 JUNCTION     0.03     1.76  6359.20     0
00:45        1.76
  J_5-1                 JUNCTION     0.02     1.79  6357.99     0
00:36        1.76
  J_4                   JUNCTION     3.72     9.45  6361.24     0
01:03        9.44
  J_3-1                 JUNCTION     0.29     2.73  6352.04     0
01:37        2.73
  J_2-1                 JUNCTION     0.02     1.64  6350.61     0
00:36        1.63
  J_18                  JUNCTION     0.11     3.07  6407.53     0
00:56        3.07
  J_16                  JUNCTION     0.11     3.15  6403.29     0
00:56        3.15
  J_3-9                 JUNCTION     0.04     2.94  6374.57     0
00:35        2.94
  J_3-7                 JUNCTION     0.06     4.28  6367.21     0
00:37        4.24
  J_19                  JUNCTION     0.07     1.73  6418.59     0
01:15        1.73
  J_17                  JUNCTION     0.11     3.07  6406.21     0
00:57        3.07
  J_15                  JUNCTION     0.12     3.14  6398.56     0
01:02        3.14
  J_13-2                JUNCTION     0.03     1.53  6386.65     0
00:50        1.53
  J_3-10                JUNCTION     0.03     2.84  6378.17     0
00:35        2.83
  J_3-8                 JUNCTION     0.04     2.93  6371.16     0
00:37        2.89
  J_3-14                JUNCTION     0.03     1.51  6358.88     0
00:45        1.51
  J_3-12                JUNCTION     0.02     2.03  6363.40     0
00:35        2.02
```

J_1		JUNCTION	0.18	3.04	6351.75	0
01:07	3.02					
J_2-2		JUNCTION	0.02	1.64	6352.91	0
00:35	1.63					
J_3-3		JUNCTION	0.00	0.00	6355.57	0
00:00	0.00					
J_6-2		JUNCTION	0.03	1.76	6365.00	0
00:45	1.76					
J_5-2		JUNCTION	0.02	1.79	6361.19	0
00:35	1.77					
J_9		JUNCTION	0.18	3.77	6365.50	0
01:05	3.77					
J_8		JUNCTION	1.89	5.49	6364.92	0
01:05	5.49					
J_13		JUNCTION	0.32	3.59	6383.70	0
01:43	3.59					
J_7		JUNCTION	0.21	2.56	6360.47	0
01:06	2.56					
J_3-11		JUNCTION	0.02	2.03	6357.60	0
00:36	2.01					
J_5		JUNCTION	0.20	5.93	6362.12	0
01:03	5.91					
J_3-2		JUNCTION	0.29	2.73	6358.28	0
01:37	2.73					
J_3-5		JUNCTION	0.05	3.38	6356.53	0
00:45	3.38					
J_14		JUNCTION	0.08	2.70	6382.83	0
00:53	2.70					
J_13-1		JUNCTION	0.03	1.53	6381.66	0
00:51	1.53					
J_11		JUNCTION	0.18	3.77	6381.37	0
00:58	3.77					
J_3-13		JUNCTION	0.03	1.51	6357.08	0
00:45	1.51					
J_12-1		JUNCTION	0.03	1.43	6389.67	0
00:51	1.42					
J_12-2		JUNCTION	0.02	0.97	6391.30	0
00:50	0.97					
J_3-4		JUNCTION	0.00	0.00	6359.87	0

00:00	0.00					
J_3		JUNCTION	0.17	2.96	6352.17	0
01:07	2.95					
J_2		JUNCTION	0.18	3.04	6351.91	0
01:07	3.02					
J_C1		JUNCTION	0.00	0.00	6385.00	0
00:00	0.00					
J_C2		JUNCTION	0.00	0.00	6380.00	0
00:00	0.00					
J_C3		JUNCTION	0.00	0.00	6370.00	0
00:00	0.00					
J_C4		JUNCTION	0.00	0.00	6370.00	0
00:00	0.00					
J_C5		JUNCTION	0.00	0.00	6370.00	0
00:00	0.00					
J_C6		JUNCTION	0.00	0.00	6355.00	0
00:00	0.00					
J_C7		JUNCTION	0.00	0.00	6370.00	0
00:00	0.00					
J_C8		JUNCTION	0.00	0.00	6360.00	0
00:00	0.00					
J_C9		JUNCTION	0.00	0.00	6370.00	0
00:00	0.00					
J_H1		JUNCTION	0.00	0.00	6425.00	0
00:00	0.00					
J_H2		JUNCTION	0.00	0.00	6415.00	0
00:00	0.00					
J_H3		JUNCTION	0.00	0.00	6315.00	0
00:00	0.00					
J_H4		JUNCTION	0.00	0.00	6400.00	0
00:00	0.00					
J_H5		JUNCTION	0.00	0.00	6400.00	0
00:00	0.00					
J_H6		JUNCTION	0.00	0.00	6400.00	0
00:00	0.00					
J_H7		JUNCTION	0.00	0.00	6400.00	0
00:00	0.00					
J_O1		JUNCTION	0.00	0.00	6400.00	0
00:00	0.00					

J_O2		JUNCTION	0.00	0.00	6400.00	0
00:00	0.00					
J_O3		JUNCTION	0.00	0.00	6370.00	0
00:00	0.00					
J_O4		JUNCTION	0.00	0.00	6370.00	0
00:00	0.00					
J_6		JUNCTION	0.11	2.59	6360.02	0
01:02	2.58					
WQ_C3		JUNCTION	0.00	0.00	6359.41	0
00:00	0.00					
WQ_C2		JUNCTION	0.00	0.00	6351.28	0
00:00	0.00					
J_3-6		JUNCTION	0.25	4.19	6358.42	0
00:44	4.19					
J_H8		JUNCTION	0.00	0.00	6572.27	0
00:00	0.00					
OUT_1		OUTFALL	3.14	5.53	6350.59	0
01:08	5.51					
EDB-C1		STORAGE	2.03	7.72	6357.72	0
01:37	7.71					
EDB-B1		STORAGE	2.68	7.87	6387.99	0
01:43	7.87					
EDB-B2		STORAGE	0.70	5.47	6422.34	0
01:15	5.47					

****
Node Inflow Summary
****

			Maximum	Maximum		
Lateral	Total	Flow	Lateral	Total	Time of Max	
Inflow	Inflow	Balance	Inflow	Inflow	Occurrence	
Volume	Volume	Error				

ULTIMATE BUILDOUT CONDITION - 100 YEAR STORM EVENT

Node	Type	CFS	CFS	days	hr:min	10^6 gal	10^6 gal	Percent
J_12	JUNCTION	0.00	308.13	0	00:58	0	17.8	-0.000
J_10	JUNCTION	0.00	308.10	0	00:58	0	17.8	0.000
J_6-1	JUNCTION	0.00	39.79	0	00:45	0	1.15	0.000
J_5-1	JUNCTION	0.00	40.60	0	00:36	0	0.919	0.000
J_4	JUNCTION	0.00	501.76	0	01:03	0	24.6	0.000
J_3-1	JUNCTION	0.00	110.17	0	01:37	0	11.3	0.000
J_2-1	JUNCTION	0.00	69.30	0	00:36	0	1.36	0.000
J_18	JUNCTION	0.00	156.77	0	00:56	0	5.92	0.000
J_16	JUNCTION	0.00	166.71	0	00:56	0	6.23	0.000
J_3-9	JUNCTION	0.00	140.54	0	00:35	0	2.33	0.000
J_3-7	JUNCTION	0.00	394.71	0	00:37	0	7.72	0.000
J_19	JUNCTION	0.00	48.53	0	01:15	0	2.01	-0.000
J_17	JUNCTION	0.00	166.71	0	00:56	0	6.24	0.000
J_15	JUNCTION	0.00	257.45	0	00:52	0	8.95	0.000
J_13-2	JUNCTION	0.00	32.73	0	00:50	0	1.35	0.000
J_3-10	JUNCTION	0.00	140.96	0	00:35	0	2.34	0.000
J_3-8	JUNCTION	0.00	300.03	0	00:37	0	5.57	0.000

J_3-14		JUNCTION	0.00	50.24	0	00:45
0	1.65	0.000				
J_3-12		JUNCTION	0.00	73.89	0	00:35
0	1.39	0.000				
J_1		JUNCTION	0.00	631.00	0	01:07
0	37.3	0.000				
J_2-2		JUNCTION	0.00	69.61	0	00:35
0	1.36	0.000				
J_3-3		JUNCTION	0.00	0.00	0	00:00
0	0	0.000	gal			
J_6-2		JUNCTION	0.00	39.81	0	00:45
0	1.15	0.000				
J_5-2		JUNCTION	0.00	40.69	0	00:35
0	0.92	0.000				
J_9		JUNCTION	0.00	307.71	0	01:05
0	17.9	0.000				
J_8		JUNCTION	0.00	307.71	0	01:05
0	17.9	0.000				
J_13		JUNCTION	0.00	146.60	0	01:43
0	11.1	0.000				
J_7		JUNCTION	0.00	440.00	0	01:02
0	22.3	0.000				
J_3-11		JUNCTION	0.00	73.59	0	00:36
0	1.39	0.000				
J_5		JUNCTION	0.00	498.32	0	01:03
0	24.4	0.000				
J_3-2		JUNCTION	0.00	110.17	0	01:37
0	11.3	0.000				
J_3-5		JUNCTION	0.00	389.80	0	00:45
0	8.31	0.000				
J_14		JUNCTION	0.00	257.43	0	00:53
0	8.94	0.000				
J_13-1		JUNCTION	0.00	32.71	0	00:51
0	1.34	0.000				
J_11		JUNCTION	0.00	308.15	0	00:58
0	17.8	0.000				
J_3-13		JUNCTION	0.00	50.24	0	00:45
0	1.65	0.000				
J_12-1		JUNCTION	0.00	188.79	0	00:51

	0	6.76	0.000				
J_12-2			JUNCTION	0.00	81.38	0	00:50
	0	2.82	0.000				
J_3-4			JUNCTION	0.00	0.00	0	00:00
	0	0	0.000	gal			
J_3			JUNCTION	0.00	602.12	0	01:07
	0	35.9	0.000				
J_2			JUNCTION	0.00	631.14	0	01:07
	0	37.3	0.000				
J_C1			JUNCTION	140.96	140.96	0	00:35
	2.34	2.34	0.000				
J_C2			JUNCTION	168.23	168.23	0	00:35
	3.23	3.23	0.000				
J_C3			JUNCTION	95.41	95.41	0	00:35
	2.16	2.16	0.000				
J_C4			JUNCTION	73.89	73.89	0	00:35
	1.39	1.39	0.000				
J_C5			JUNCTION	50.24	50.24	0	00:45
	1.65	1.65	0.000				
J_C6			JUNCTION	15.26	15.26	0	00:45
	0.562	0.562	0.000				
J_C7			JUNCTION	40.69	40.69	0	00:35
	0.92	0.92	0.000				
J_C8			JUNCTION	69.61	69.61	0	00:35
	1.36	1.36	0.000				
J_C9			JUNCTION	3.53	3.53	0	01:00
	0.186	0.186	0.000				
J_H1			JUNCTION	68.70	68.70	0	00:45
	2.01	2.01	0.000				
J_H2			JUNCTION	124.75	124.75	0	00:45
	3.92	3.92	0.000				
J_H3			JUNCTION	12.35	12.35	0	00:40
	0.311	0.311	0.000				
J_H4			JUNCTION	17.99	17.99	0	00:40
	0.458	0.458	0.000				
J_H5			JUNCTION	106.01	106.01	0	00:35
	2.25	2.25	0.000				
J_H6			JUNCTION	32.73	32.73	0	00:50
	1.35	1.35	0.000				

J_H7		JUNCTION	18.89	18.89	0	00:35
0.352	0.352	0.000				
J_O1		JUNCTION	81.38	81.38	0	00:50
2.82	2.82	0.000				
J_O2		JUNCTION	108.41	108.41	0	00:55
3.94	3.94	0.000				
J_O3		JUNCTION	153.27	153.27	0	00:45
4.46	4.46	0.000				
J_O4		JUNCTION	39.81	39.81	0	00:45
1.15	1.15	0.000				
J_6		JUNCTION	0.00	474.10	0	01:02
0	23.5	0.000				
WQ_C3		JUNCTION	0.00	40.69	0	00:35
0	0.92	0.000				
WQ_C2		JUNCTION	0.00	69.61	0	00:35
0	1.36	0.000				
J_3-6		JUNCTION	0.00	390.05	0	00:44
0	8.32	0.000				
J_H8		JUNCTION	9.70	9.70	0	00:55
0.45	0.45	0.000				
OUT_1		OUTFALL	0.00	630.99	0	01:08
0	37.3	0.000				
EDB-C1		STORAGE	0.00	502.22	0	00:44
0	11.4	0.079				
EDB-B1		STORAGE	0.00	312.65	0	00:52
0	11.1	0.055				
EDB-B2		STORAGE	0.00	68.70	0	00:45
0	2.01	0.047				

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary

****

	Max Pcnt Storage Full	Time of Max Occurrence Unit days	hr:min	Average Maximum Volume 1000 ft³ CFS	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 ft³
EDB-C1	93.9	0	01:37	132.994 110.17	12.0	0.0	0.0	1041.106
EDB-B1	97.3	0	01:43	96.205 146.60	13.8	0.0	0.0	677.922
EDB-B2	80.0	0	01:15	3.392 48.53	3.3	0.0	0.0	82.171

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CFS	Max Flow CFS	Total Volume 10^6 gal
OUT_1	88.18	16.36	630.99	37.282
System	88.18	16.36	630.99	37.282

****
Link Flow Summary
****

ULTIMATE BUILDOUT CONDITION - 100 YEAR STORM EVENT

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days	hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
L_C9	DUMMY	3.53	0	01:00			
L_1	CONDUIT	630.99	0	01:08	9.63	0.72	0.63
L_10	CONDUIT	307.71	0	01:05	5.26	0.07	0.30
L_11	CONDUIT	308.10	0	00:58	10.22	0.46	0.47
L_12	CONDUIT	308.15	0	00:58	5.26	0.07	0.30
L_12-1	CONDUIT	188.52	0	00:53	4.52	0.04	0.24
L_12-2	CONDUIT	81.32	0	00:51	3.49	0.02	0.16
L_13	CONDUIT	146.60	0	01:43	8.92	0.76	0.65
L_13-1	DUMMY	32.71	0	00:51			
L_13-2	CONDUIT	32.71	0	00:51	10.36	0.69	0.61
L_14	DUMMY	257.43	0	00:53			
L_15	CONDUIT	257.43	0	00:53	17.25	0.25	0.34
L_16	CONDUIT	166.19	0	01:02	3.01	0.19	0.52
L_17	CONDUIT	166.71	0	00:56	14.90	0.09	0.20
L_18	CONDUIT	156.75	0	00:57	2.94		

0.18	0.51					
L_19		CONDUIT	48.53	0	01:16	11.47
0.63	0.58					
L_2		CONDUIT	631.00	0	01:07	3.90
0.28	0.51					
L_2-1		DUMMY	69.30	0	00:36	
L_2-2		CONDUIT	69.30	0	00:36	12.42
0.23	0.33					
L_3-1		DUMMY	110.17	0	01:37	
L_3-10		CONDUIT	140.54	0	00:35	14.77
0.85	0.71					
L_3-11		DUMMY	73.59	0	00:36	
L_3-12		CONDUIT	73.59	0	00:36	12.74
0.64	0.58					
L_3-13		DUMMY	50.24	0	00:45	
L_3-14		CONDUIT	50.24	0	00:45	11.52
0.30	0.38					
L_3-2		CONDUIT	110.17	0	01:37	13.67
0.95	0.78					
L_3-3		DUMMY	0.00	0	00:00	
L_3-4		CONDUIT	0.00	0	00:00	0.00
0.00	0.00					
L_3-5		DUMMY	389.80	0	00:45	
L_3-6		CONDUIT	389.80	0	00:45	9.67
0.37	0.42					
L_3-7		CONDUIT	374.85	0	00:44	4.04
0.40	0.70					
L_3-8		CONDUIT	300.11	0	00:37	18.00
0.29	0.37					
L_3-9		CONDUIT	136.79	0	00:38	2.92
0.16	0.48					
L_4		CONDUIT	500.38	0	01:05	3.63
0.23	0.45					
L_5		CONDUIT	498.24	0	01:03	10.50
0.83	0.74					
L_5-1		DUMMY	40.60	0	00:36	
L_5-2		CONDUIT	40.60	0	00:36	10.80
0.86	0.72					
L_6		CONDUIT	473.81	0	01:03	3.56

0.21	0.43					
L_6-1		DUMMY	39.79	0	00:45	
L_6-2		CONDUIT	39.79	0	00:45	10.77
0.84	0.70					
L_7		CONDUIT	439.96	0	01:02	3.48
0.20	0.41					
L_8		CONDUIT	307.70	0	01:06	3.06
0.16	0.43					
L_9		CONDUIT	307.71	0	01:05	10.21
0.46	0.47					
L_C1		DUMMY	140.96	0	00:35	
L_C2		DUMMY	168.23	0	00:35	
L_C3		DUMMY	95.41	0	00:35	
L_C4		DUMMY	73.89	0	00:35	
L_C5		DUMMY	50.24	0	00:45	
L_C6		DUMMY	15.26	0	00:45	
L_C7		DUMMY	40.69	0	00:35	
L_C8		DUMMY	69.61	0	00:35	
L_H1		DUMMY	68.70	0	00:45	
L_H2		DUMMY	124.75	0	00:45	
L_H3		DUMMY	12.35	0	00:40	
L_H4		DUMMY	17.99	0	00:40	
L_H5		DUMMY	106.01	0	00:35	
L_H6		DUMMY	32.73	0	00:50	
L_H7		DUMMY	18.89	0	00:35	
L_H8		DUMMY	9.70	0	00:55	
L_O1		DUMMY	81.38	0	00:50	
L_O2		DUMMY	108.41	0	00:55	
L_O4		DUMMY	39.81	0	00:45	
L_WQ_C2		DUMMY	69.61	0	00:35	
L_WQ_C3		DUMMY	40.69	0	00:35	
L_3		CONDUIT	601.93	0	01:08	3.84
0.27	0.49					
L-O3		DUMMY	153.27	0	00:45	
L_B2_OUTLET		DUMMY	48.53	0	01:15	
L_B1_OUTLET		DUMMY	146.60	0	01:43	
L_C1_OUTLET		DUMMY	110.17	0	01:37	

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Wed Sep 27 14:01:31 2023
Analysis ended on: Wed Sep 27 14:01:31 2023
Total elapsed time: < 1 sec

Link Flow Summary

Link	Type	Maximum |Flow| CFS	Day of Maximum Flow	Hour of Maximum Flow	Maximum |Velocity| ft/sec	Max / Full Flow
L_1	CONDUIT	630.99	0	01:08	9.63	0.72
L_10	CONDUIT	307.71	0	01:05	5.26	0.07
L_11	CONDUIT	308.10	0	00:58	10.22	0.46
L_12	CONDUIT	308.15	0	00:58	5.26	0.07
L_12-1	CONDUIT	188.52	0	00:53	4.52	0.04
L_12-2	CONDUIT	81.32	0	00:51	3.49	0.02
L_13	CONDUIT	146.60	0	01:43	8.92	0.76
L_13-1	DUMMY	32.71	0	00:51		
L_13-2	CONDUIT	32.71	0	00:51	10.36	0.69
L_14	DUMMY	257.43	0	00:53		
L_15	CONDUIT	257.43	0	00:53	17.25	0.25
L_16	CONDUIT	166.19	0	01:02	3.01	0.19
L_17	CONDUIT	166.71	0	00:56	14.90	0.09
L_18	CONDUIT	156.75	0	00:57	2.94	0.18
L_19	CONDUIT	48.53	0	01:16	11.47	0.63
L_2	CONDUIT	631.00	0	01:07	3.90	0.28
L_2-1	DUMMY	69.30	0	00:36		
L_2-2	CONDUIT	69.30	0	00:36	12.42	0.23
L_3	CONDUIT	601.93	0	01:08	3.84	0.27
L_3-1	DUMMY	110.17	0	01:37		
L_3-10	CONDUIT	140.54	0	00:35	14.77	0.85
L_3-11	DUMMY	73.59	0	00:36		
L_3-12	CONDUIT	73.59	0	00:36	12.74	0.64
L_3-13	DUMMY	50.24	0	00:45		
L_3-14	CONDUIT	50.24	0	00:45	11.52	0.30
L_3-2	CONDUIT	110.17	0	01:37	13.67	0.95
L_3-3	DUMMY	0.00	0	00:00		
L_3-4	CONDUIT	0.00	0	00:00	0.00	0.00
L_3-5	DUMMY	389.80	0	00:45		

Link	Type	Maximum |Flow| CFS	Day of Maximum Flow	Hour of Maximum Flow	Maximum |Velocity| ft/sec	Max / Full Flow
L_3-6	CONDUIT	389.80	0	00:45	9.67	0.37
L_3-7	CONDUIT	374.85	0	00:44	4.04	0.40
L_3-8	CONDUIT	300.11	0	00:37	18.00	0.29
L_3-9	CONDUIT	136.79	0	00:38	2.92	0.16
L_4	CONDUIT	500.38	0	01:05	3.63	0.23
L_5	CONDUIT	498.24	0	01:03	10.50	0.83
L_5-1	DUMMY	40.60	0	00:36		
L_5-2	CONDUIT	40.60	0	00:36	10.80	0.86
L_6	CONDUIT	473.81	0	01:03	3.56	0.21
L_6-1	DUMMY	39.79	0	00:45		
L_6-2	CONDUIT	39.79	0	00:45	10.77	0.84
L_7	CONDUIT	439.96	0	01:02	3.48	0.20
L_8	CONDUIT	307.70	0	01:06	3.06	0.16
L_9	CONDUIT	307.71	0	01:05	10.21	0.46
L_B1_OUTLET	DUMMY	146.60	0	01:43		
L_B2_OUTLET	DUMMY	48.53	0	01:15		
L_C1	DUMMY	140.96	0	00:35		
L_C1_OUTLET	DUMMY	110.17	0	01:37		
L_C2	DUMMY	168.23	0	00:35		
L_C3	DUMMY	95.41	0	00:35		
L_C4	DUMMY	73.89	0	00:35		
L_C5	DUMMY	50.24	0	00:45		
L_C6	DUMMY	15.26	0	00:45		
L_C7	DUMMY	40.69	0	00:35		
L_C8	DUMMY	69.61	0	00:35		
L_C9	DUMMY	3.53	0	01:00		
L_H1	DUMMY	68.70	0	00:45		
L_H2	DUMMY	124.75	0	00:45		
L_H3	DUMMY	12.35	0	00:40		
L_H4	DUMMY	17.99	0	00:40		

Link	Type	Maximum |Flow| CFS	Day of Maximum Flow	Hour of Maximum Flow	Maximum |Velocity| ft/sec	Max / Full Flow
L_H5	DUMMY	106.01	0	00:35		
L_H6	DUMMY	32.73	0	00:50		
L_H7	DUMMY	18.89	0	00:35		
L_H8	DUMMY	9.70	0	00:55		
L_O1	DUMMY	81.38	0	00:50		
L_O2	DUMMY	108.41	0	00:55		
L_O4	DUMMY	39.81	0	00:45		
L_WQ_C2	DUMMY	69.61	0	00:35		
L_WQ_C3	DUMMY	40.69	0	00:35		
L-O3	DUMMY	153.27	0	00:45		

Link Flow Summary

Link	Max / Full Depth
L_1	0.63
L_10	0.30
L_11	0.47
L_12	0.30
L_12-1	0.24
L_12-2	0.16
L_13	0.65
L_13-1	
L_13-2	0.61
L_14	
L_15	0.34
L_16	0.52
L_17	0.20
L_18	0.51
L_19	0.58
L_2	0.51
L_2-1	
L_2-2	0.33
L_3	0.49
L_3-1	
L_3-10	0.71
L_3-11	
L_3-12	0.58
L_3-13	
L_3-14	0.38
L_3-2	0.78
L_3-3	
L_3-4	0.00
L_3-5	

Link	Max / Full Depth
L_3-6	0.42
L_3-7	0.70
L_3-8	0.37
L_3-9	0.48
L_4	0.45
L_5	0.74
L_5-1	
L_5-2	0.72
L_6	0.43
L_6-1	
L_6-2	0.70
L_7	0.41
L_8	0.43
L_9	0.47
L_B1_OUTLET	
L_B2_OUTLET	
L_C1	
L_C1_OUTLET	
L_C2	
L_C3	
L_C4	
L_C5	
L_C6	
L_C7	
L_C8	
L_C9	
L_H1	
L_H2	
L_H3	
L_H4	

Link	Max / Full Depth
L_H5	
L_H6	
L_H7	
L_H8	
L_O1	
L_O2	
L_O4	
L_WQ_C2	
L_WQ_C3	
L-O3	

ULTIMATE BUILDOUT CONDITION - 100 YEAR STORM EVENT

Storage Volume Summary

Storage Unit	Average Volume 1000 ft³	Average Percent Full	Evaporation Loss %	Exfiltration Loss %	Maximum Volume 1000 ft³	Maximum Percent Full
EDB-C1	132.994	12.0	0.0	0.0	1041.106	93.9
EDB-B1	96.205	13.8	0.0	0.0	677.922	97.3
EDB-B2	3.392	3.3	0.0	0.0	82.171	80.0

Storage Volume Summary

Storage Unit	Day of Maximum Volume	Hour of Maximum Volume	Maximum Outflow CFS
EDB-C1	0	01:37	110.17
EDB-B1	0	01:43	146.60
EDB-B2	0	01:15	48.53

ULTIMATE BUILDOUT CONDITION - 100 YEAR STORM EVENT

Outfall Loading Summary

Outfall Node	Flow Frequency %	Avgerage Flow CFS	Maximum Flow CFS	Total Volume 10^6 gal
OUT_1	88.18	16.36	630.99	37.282

Dawson Trails Filing 2 - Gambel Ridge Watershed (B & C Sub-basins)

CORE Project #: 20-224
Prepared By: LCC

IMPERVIOUS CALCULATIONS

-REFERENCE UDFCD Vol.1 RUNOFF Table 6-3

		Residential & Commercial							Landscape Area					Soil Type		
		Single Family			Multi-Family											
		0.25 acres or less	0.25 - 0.75 acres	2.5 acres or larger	Attached	Right Of Way	Asphalt/ Ponded Water	Schools	2-7% Slope	>7% Slope	Historic			Soil Type A Area	Soil Type B Area	Soil Type C/D Area
% Imperv.		45.00%	30.00%	12.00%	75.00%	90.00%	100.00%	55.00%	2.00%	2.00%	2.00%					
BASIN	Design Point	Area (ac)	Area (ac)	Area (ac)	Area (ac)	Area (ac)	Area (ac)	Area (ac)	Area (ac)	Area (ac)	Area (ac)	Total Area (ac)	Percent Impervious	Area (ac)	Area (ac)	Area (ac)
B6.10	B6.10	-	-	-	-	-	-	-	-	-	1.89	1.89	2.0%	-	-	1.89
B6.11	B6.11	-	-	-	-	0.72	-	-	-	-	0.00	0.72	90.0%	-	-	0.72
B6.12	B6.12	-	-	-	-	0.85	-	-	-	-	-	0.85	90.0%	-	-	0.85
B6.20	B6.20	-	-	-	-	-	-	-	-	-	6.69	6.69	2.0%	-	-	6.69
B6.21	B6.21	-	-	-	-	1.47	-	-	-	-	-	1.47	90.0%	-	-	1.47
B6.22	B6.22	-	-	-	-	1.39	-	-	-	-	-	1.39	90.0%	-	-	1.39
B6.30	B6.30	-	-	-	-	-	-	-	-	-	3.65	3.65	2.0%	-	-	3.65
B6.31	B6.31	-	-	-	-	1.22	-	-	-	-	-	1.22	90.0%	-	-	1.22
B6.32	B6.32	-	-	-	-	0.90	-	-	-	-	-	0.90	90.0%	-	-	0.90
B6.40	B6.40	-	-	-	-	-	-	-	-	-	0.87	0.87	2.0%	-	-	0.87
B6.41	B6.41	-	-	-	-	0.76	-	-	-	-	-	0.76	90.0%	-	-	0.76
B6.42	B6.42	-	-	-	-	0.59	-	-	-	-	-	0.59	90.0%	-	-	0.59
B6.51	B6.51	-	-	-	-	0.66	-	-	-	-	-	0.66	90.0%	-	-	0.66
B6.52	B6.52	-	-	-	-	0.63	-	-	-	-	-	0.63	90.0%	-	-	0.63
		-	-	-	-	-	-	-	-	-	-	-		-	-	-
C1.0	C1.0	-	-	-	-	-	-	-	-	-	35.15	35.15	2.0%	-	-	35.15
C2.0	C2.0	-	-	-	-	-	-	-	-	-	47.21	47.21	2.0%	-	-	47.21
C3.0	C3.0	-	-	-	-	-	-	-	-	-	33.15	33.15	2.0%	-	-	33.15
C4.0	C4.0	-	-	-	-	-	-	-	-	-	21.53	20.59	2.1%	-	-	20.59
		-	-	-	-	-	-	-	-	-	-	-		-	-	-
C5.01	C5.01	-	-	-	-	2.61	-	-	-	-	-	2.61	90.0%	-	-	2.61
C5.02	C5.02	-	-	-	-	2.11	-	-	-	-	-	2.11	90.0%	-	-	2.11
C5.03	C5.03	-	-	-	-	1.36	-	-	-	-	-	1.36	90.0%	-	-	1.36
C5.04	C5.04	-	-	-	-	1.22	-	-	-	-	-	1.22	90.0%	-	-	1.22
		-	-	-	-	-	-	-	-	-	-	-		-	-	-
C5.11	C5.11	-	-	-	-	1.56	-	-	-	-	-	1.56	90.0%	-	-	1.56
C5.12	C5.12	-	-	-	-	1.56	-	-	-	-	-	1.56	90.0%	-	-	1.56
C5.13	C5.13	-	-	-	-	1.81	-	-	-	-	-	1.81	90.0%	-	-	1.81
C5.14	C5.14	-	-	-	-	0.76	-	-	-	-	-	0.76	90.0%	-	-	0.76
C5.15	C5.15	-	-	-	-	1.81	-	-	-	-	-	1.81	90.0%	-	-	1.81
C5.16	C5.16	-	-	-	-	1.65	-	-	-	-	-	1.65	90.0%	-	-	1.65
		-	-	-	-	-	-	-	-	-	-	-		-	-	-
TOTAL		**0.00**	**0.00**	**0.00**	**0.00**	**31.15**	**0.00**	**0.00**	**0.00**	**0.00**	**150.15**	**180.35**	**17.2%**			

Dawson Trails Filing 2 - Gambel Ridge Watershed (B & C Sub-basins)

CORE Project #: 20-224
Prepared By: LCC

COMPOSITE DEVELOPED BASIN WEIGHTED "C" CALCULATIONS
-REFERENCE UDFCD Vol.1 RUNOFF Table 6-4

Table 6-4. Runoff coefficient equations based on NRCS soil group and storm return period

NRCS Soil Group	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	500-Year
	Storm Return Period						
A	$C_A = 0.84i^{1.302}$	$C_A = 0.86i^{1.276}$	$C_A = 0.87i^{1.232}$	$C_A = 0.84i^{1.124}$	$C_A = 0.85i+0.025$	$C_A = 0.78i+0.110$	$C_A = 0.65i+0.254$
B	$C_B = 0.84i^{1.169}$	$C_B = 0.86i^{1.088}$	$C_B = 0.81i+0.057$	$C_B = 0.63i+0.249$	$C_B = 0.56i+0.328$	$C_B = 0.47i+0.426$	$C_B = 0.37i+0.536$
C/D	$C_{C/D} = 0.83i^{1.122}$	$C_{C/D} = 0.82i+0.035$	$C_{C/D} = 0.74i+0.132$	$C_{C/D} = 0.56i+0.319$	$C_{C/D} = 0.49i+0.393$	$C_{C/D} = 0.41i+0.484$	$C_{C/D} = 0.32i+0.588$

i = % imperviousness/100 expressed as a decimal
C_A = Runoff coefficient for NRCS HSG A soils
C_B = Runoff coefficient for NRCS HSG B soils
C_{CD} = Runoff coefficient for NRCS HSG C and D soils.
Natural Resource Conservation Service (NRCS)

Total Weighted Runoff Coefficients, C			
2-Year	5-Year	10-Year	100-Year
0.14	0.18	0.26	0.55

Basin ID	% Imperv.	*i*	Soil Type	Runoff Coefficients, C				Basin Area	Total Area	Weighted Runoff Coefficients, C			
				2-Year	5-Year	10-Year	100-Year			2-Year	5-Year	10-Year	100-Year
B6.10	2.0%	0.02	A	0.01	0.01	0.01	0.13		1.89	0.01	0.05	0.15	0.49
			B	0.01	0.01	0.07	0.44						
			C or D	0.01	0.05	0.15	0.49	1.89					
B6.11	90.0%	0.90	A	0.73	0.75	0.76	0.81		0.72	0.74	0.77	0.80	0.85
			B	0.74	0.77	0.79	0.85						
			C or D	0.74	0.77	0.80	0.85	0.72					
B6.12	90.0%	0.90	A	0.73	0.75	0.76	0.81		0.85	0.74	0.77	0.80	0.85
			B	0.74	0.77	0.79	0.85						
			C or D	0.74	0.77	0.80	0.85	0.85					
B6.20	2.0%	0.02	A	0.01	0.01	0.01	0.13		6.69	0.01	0.05	0.15	0.49
			B	0.01	0.01	0.07	0.44						
			C or D	0.01	0.05	0.15	0.49	6.69					
B6.21	90.0%	0.90	A	0.73	0.75	0.76	0.81		1.47	0.74	0.77	0.80	0.85
			B	0.74	0.77	0.79	0.85						
			C or D	0.74	0.77	0.80	0.85	1.47					
B6.22	90.0%	0.90	A	0.73	0.75	0.76	0.81		1.39	0.74	0.77	0.80	0.85
			B	0.74	0.77	0.79	0.85						
			C or D	0.74	0.77	0.80	0.85	1.39					
B6.30	2.0%	0.02	A	0.01	0.01	0.01	0.13		3.65	0.01	0.05	0.15	0.49
			B	0.01	0.01	0.07	0.44						
			C or D	0.01	0.05	0.15	0.49	3.65					
B6.31	90.0%	0.90	A	0.73	0.75	0.76	0.81		1.22	0.74	0.77	0.80	0.85
			B	0.74	0.77	0.79	0.85						
			C or D	0.74	0.77	0.80	0.85	1.22					
B6.32	90.0%	0.90	A	0.73	0.75	0.76	0.81		0.90	0.74	0.77	0.80	0.85
			B	0.74	0.77	0.79	0.85						
			C or D	0.74	0.77	0.80	0.85	0.90					
B6.40	2.0%	0.02	A	0.01	0.01	0.01	0.13		0.87	0.01	0.05	0.15	0.49
			B	0.01	0.01	0.07	0.44						
			C or D	0.01	0.05	0.15	0.49	0.87					
B6.41	90.0%	0.90	A	0.73	0.75	0.76	0.81		0.76	0.74	0.77	0.80	0.85
			B	0.74	0.77	0.79	0.85						
			C or D	0.74	0.77	0.80	0.85	0.76					
B6.42	90.0%	0.90	A	0.73	0.75	0.76	0.81		0.59	0.74	0.77	0.80	0.85
			B	0.74	0.77	0.79	0.85						
			C or D	0.74	0.77	0.80	0.85	0.59					
B6.51	90.0%	0.90	A	0.73	0.75	0.76	0.81		0.66	0.74	0.77	0.80	0.85
			B	0.74	0.77	0.79	0.85						
			C or D	0.74	0.77	0.80	0.85	0.66					
B6.52	90.0%	0.90	A	0.73	0.75	0.76	0.81		0.63	0.74	0.77	0.80	0.85
			B	0.74	0.77	0.79	0.85						
			C or D	0.74	0.77	0.80	0.85	0.63					
										-	-	-	-

Basin ID	% Imperv.	*i*	Soil Type	Runoff Coefficients, C				Basin Area	Total Area	Weighted Runoff Coefficients, C			
				2-Year	5-Year	10-Year	100-Year			2-Year	5-Year	10-Year	100-Year
C1.0	2.0%	0.02	A	0.01	0.01	0.01	0.13		35.15	0.01	0.05	0.15	0.49
			B	0.01	0.01	0.07	0.44						
			C or D	0.01	0.05	0.15	0.49	35.15					
C2.0	2.0%	0.02	A	0.01	0.01	0.01	0.13		47.21	0.01	0.05	0.15	0.49
			B	0.01	0.01	0.07	0.44						
			C or D	0.01	0.05	0.15	0.49	47.21					
C3.0	2.0%	0.02	A	0.01	0.01	0.01	0.13		33.15	0.01	0.05	0.15	0.49
			B	0.01	0.01	0.07	0.44						
			C or D	0.01	0.05	0.15	0.49	33.15					
C4.0	2.1%	0.02	A	0.01	0.01	0.01	0.13		20.59	0.01	0.05	0.15	0.49
			B	0.01	0.01	0.07	0.44						
			C or D	0.01	0.05	0.15	0.49	20.59					
										-	-	-	-
C5.01	90.0%	0.90	A	0.73	0.75	0.76	0.81		2.61	0.74	0.77	0.80	0.85
			B	0.74	0.77	0.79	0.85						
			C or D	0.74	0.77	0.80	0.85	2.61					
C5.02	90.0%	0.90	A	0.73	0.75	0.76	0.81		2.11	0.74	0.77	0.80	0.85
			B	0.74	0.77	0.79	0.85						
			C or D	0.74	0.77	0.80	0.85	2.11					
C5.03	90.0%	0.90	A	0.73	0.75	0.76	0.81		1.36	0.74	0.77	0.80	0.85
			B	0.74	0.77	0.79	0.85						
			C or D	0.74	0.77	0.80	0.85	1.36					
C5.04	90.0%	0.90	A	0.73	0.75	0.76	0.81		1.22	0.74	0.77	0.80	0.85
			B	0.74	0.77	0.79	0.85						
			C or D	0.74	0.77	0.80	0.85	1.22					
										-	-	-	-
C5.11	90.0%	0.90	A	0.73	0.75	0.76	0.81		1.56	0.74	0.77	0.80	0.85
			B	0.74	0.77	0.79	0.85						
			C or D	0.74	0.77	0.80	0.85	1.56					
C5.12	90.0%	0.90	A	0.73	0.75	0.76	0.81		1.56	0.74	0.77	0.80	0.85
			B	0.74	0.77	0.79	0.85						
			C or D	0.74	0.77	0.80	0.85	1.56					
C5.13	90.0%	0.90	A	0.73	0.75	0.76	0.81		1.81	0.74	0.77	0.80	0.85
			B	0.74	0.77	0.79	0.85						
			C or D	0.74	0.77	0.80	0.85	1.81					
C5.14	90.0%	0.90	A	0.73	0.75	0.76	0.81		0.76	0.74	0.77	0.80	0.85
			B	0.74	0.77	0.79	0.85						
			C or D	0.74	0.77	0.80	0.85	0.76					
C5.15	90.0%	0.90	A	0.73	0.75	0.76	0.81		1.81	0.74	0.77	0.80	0.85
			B	0.74	0.77	0.79	0.85						
			C or D	0.74	0.77	0.80	0.85	1.81					
C5.16	90.0%	0.90	A	0.73	0.75	0.76	0.81		1.65	0.74	0.77	0.80	0.85
			B	0.74	0.77	0.79	0.85						
			C or D	0.74	0.77	0.80	0.85	1.65					
										-	-	-	-
C6.01	90.0%	0.90	A	0.73	0.75	0.76	0.81		1.89	0.74	0.77	0.80	0.85
			B	0.74	0.77	0.79	0.85						
			C or D	0.74	0.77	0.80	0.85	1.89					
C6.02	90.0%	0.90	A	0.73	0.75	0.76	0.81		1.13	0.74	0.77	0.80	0.85
			B	0.74	0.77	0.79	0.85						
			C or D	0.74	0.77	0.80	0.85	1.13					
C6.03	90.0%	0.90	A	0.73	0.75	0.76	0.81		1.27	0.74	0.77	0.80	0.85
			B	0.74	0.77	0.79	0.85						
			C or D	0.74	0.77	0.80	0.85	1.27					
C6.04	90.0%	0.90	A	0.73	0.75	0.76	0.81		1.22	0.74	0.77	0.80	0.85
			B	0.74	0.77	0.79	0.85						
			C or D	0.74	0.77	0.80	0.85	1.22					

Dawson Trails Filing 2 - Gambel Ridge Watershed (B & C Sub-basins)

CORE Project #: 20-224

Prepared By: LCC

TIME OF CONCENTRATION CALCULATIONS | BASIN A

-REFERENCE UDFCD Vol.1 Section 2.4

NRCS Conveyance factors, K -REFERENCE UDFCD Vol.1 RUNOFF Table 6-2

SF-2

Heavy Meadow	3	Short Grass Pasture & Lawns	7	Grassed Waterway	15
Tillage/field	5	Nearly Bare Ground	10	Paved Area & Shallow Gutter	20

SUB-BASIN DATA			INITIAL / OVERLAND TIME			CHANNEL / TRAVEL TIME T(t)						T(c) CHECK (URBANIZED BASINS)		FINAL T(c)
DRAIN BASIN	AREA ac.	C(5)	Length ft.	Slope %	T(i) min	Length ft.	Slope %	Coeff.	Velocity fps	T(t) min.	COMP. T(c)	% IMPER-VIOUS	USDCM Eq . 6-5	min.
B6.10	1.89	0.05	40	25.0	4.1	525	5.1	7	1.6	5.5	9.7	2.0%		9.7
B6.11	0.72	0.77	25	2.0	2.3	700	3.9	20	3.9	3.0	5.3	90.0%	13.5	5.3
B6.12	0.85	0.77	40	2.0	3.0	700	3.9	20	3.9	3.0	5.9	90.0%	13.5	5.9
B6.20	6.69	0.05	200	20.0	10.0	1380	4.3	7	1.5	15.8	25.7	2.0%		25.7
B6.21	1.47	0.77	25	2.0	2.3	1300	4.6	20	4.3	5.0	7.4	90.0%	15.4	7.4
B6.22	1.39	0.77	25	2.0	2.3	1300	4.6	20	4.3	5.0	7.4	90.0%	15.4	7.4
B6.30	3.65	0.05	240	25.0	10.1	860	4.1	7	1.4	10.1	20.3	2.0%		20.3
B6.31	1.22	0.77	25	2.0	2.3	840	4.2	20	4.1	3.4	5.8	90.0%	13.9	5.8
B6.32	0.90	0.77	25	2.0	2.3	840	4.2	20	4.1	3.4	5.8	90.0%	13.9	5.8
B6.40	0.87	0.05	100	20.0	7.0	555	4.9	7	1.5	6.0	13.0	2.0%		13.0
B6.41	0.76	0.77	45	2.0	3.2	500	5.0	20	4.5	1.9	5.0	90.0%	12.4	5.0
B6.42	0.59	0.77	40	2.0	3.0	500	5.0	20	4.5	1.9	4.8	90.0%	12.4	5.0
B6.51	0.66	0.77	50	2.0	3.3	500	5.0	20	4.5	1.9	5.2	90.0%	12.4	5.2
B6.52	0.63	0.77	25	2.0	2.3	500	5.0	20	4.5	1.9	4.2	90.0%	12.4	5.0

SUB-BASIN DATA			INITIAL / OVERLAND TIME			CHANNEL / TRAVEL TIME T(t)						T(c) CHECK (URBANIZED BASINS)		FINAL T(c)
DRAIN BASIN	AREA ac.	C(5)	Length ft.	Slope %	T(i) min	Length ft.	Slope %	Coeff.	Velocity fps	T(t) min.	COMP. T(c)	% IMPER-VIOUS	USDCM Eq . 6-5	min.
C1.0	35.15	0.05	500	13.0	18.2	2020	4.5	7	1.5	22.7	40.8	2.0%		40.8
C2.0	47.21	0.05	500	3.0	29.5	2400	2.3	7	1.1	37.7	67.2	2.0%		67.2
C3.0	33.15	0.05	500	5.0	24.9	2380	1.6	7	0.9	44.8	69.7	2.0%		69.7
C4.0	20.59	0.05	500	3.0	29.4	1650	1.8	7	0.9	29.1	58.6	2.1%		58.6
C5.01	2.61	0.77	30	4.3	2.0	1400	2.9	20	3.4	6.9	8.9	90.0%	17.1	8.9
C5.02	2.11	0.77	30	4.3	2.0	1050	2.1	20	2.9	6.0	8.0	90.0%	16.3	8.0
C5.03	1.36	0.77	35	2.9	2.5	500	2.2	20	3.0	2.8	5.3	90.0%	13.3	5.3
C5.04	1.22	0.77	35	2.9	2.5	500	2.2	20	3.0	2.8	5.3	90.0%	13.3	5.3
C5.11	1.56	0.77	35	2.9	2.5	1000	1.5	20	2.4	6.8	9.3	90.0%	17.0	9.3
C5.12	1.56	0.77	35	2.9	2.5	1000	1.5	20	2.4	6.8	9.3	90.0%	17.0	9.3
C5.13	1.81	0.77	15	4.7	1.4	650	4.6	20	4.3	2.5	3.9	90.0%	13.0	5.0
C5.14	0.76	0.77	15	4.7	1.4	400	3.8	20	3.9	1.7	3.1	90.0%	12.3	5.0
C5.15	1.81	0.77	70	2.9	3.5	950	2.1	20	2.9	5.5	8.9	90.0%	15.8	8.9
C5.16	1.65	0.77	70	2.9	3.5	950	2.1	20	2.9	5.5	8.9	90.0%	15.8	8.9
C6.01	1.89	0.77	60	5.0	2.7	850	4.0	20	4.0	3.5	6.2	90.0%	14.0	6.2
C6.02	1.13	0.77	60	5.0	2.7	700	4.4	20	4.2	2.8	5.5	90.0%	13.3	5.5
C6.03	1.27	0.77	30	3.0	2.3	1500	1.2	20	2.2	11.4	13.7	90.0%	21.3	13.7
C6.04	1.22	0.77	30	3.0	2.3	1350	1.2	20	2.2	10.3	12.6	90.0%	20.3	12.6

Dawson Trails Filing 2 - Gambel Ridge Watershed (B & C Sub-basins)

CORE Project #: 20-224

Prepared By: LCC

RATIONAL METHOD PEAK RUNOFF

5-Year STORM Rainfall Depth-Duration-Frequency (1-hr) = **1.43**

SF-3

-REFERENCE UDFCD Vol.1 EQ 5-1 & EQ 6-1

BASIN INFORMATON				DIRECT RUNOFF			
DESIGN POINT	DRAIN BASIN	AREA ac.	5yr Runoff COEFF	T(c) min	C x A	I in/hr	Q cfs
B6.10	B6.10	1.89	0.05	9.7	0.10	3.92	0.38
B6.11	B6.11	0.72	0.77	5.3	0.56	4.77	2.65
B6.12	B6.12	0.85	0.77	5.9	0.66	4.62	3.05
B6.20	B6.20	6.69	0.05	25.7	0.34	2.45	0.84
B6.21	B6.21	1.47	0.77	7.4	1.13	4.32	4.90
B6.22	B6.22	1.39	0.77	7.4	1.07	4.32	4.63
B6.30	B6.30	3.65	0.05	20.3	0.19	2.79	0.52
B6.31	B6.31	1.22	0.77	5.8	0.94	4.66	4.39
B6.32	B6.32	0.90	0.77	5.8	0.70	4.66	3.26
B6.40	B6.40	0.87	0.05	13.0	0.04	3.46	0.15
B6.41	B6.41	0.76	0.77	5.0	0.59	4.85	2.85
B6.42	B6.42	0.59	0.77	5.0	0.45	4.85	2.20
B6.51	B6.51	0.66	0.77	5.2	0.51	4.80	2.44
B6.52	B6.52	0.63	0.77	5.0	0.49	4.85	2.37
C1.0	C1.0	35.15	0.05	40.8	1.81	1.86	3.36
C2.0	C2.0	47.21	0.05	67.2	2.43	1.34	3.25
C3.0	C3.0	33.15	0.05	69.7	1.70	1.30	2.22
C4.0	C4.0	20.59	0.05	58.6	1.07	1.47	1.58
C5.01	C5.01	2.61	0.77	8.9	2.01	4.05	8.15
C5.02	C5.02	2.109	0.773	8.038	1.63	4.20	6.84
C5.03	C5.03	1.362	0.773	5.279	1.05	4.78	5.03
C5.04	C5.04	1.219	0.773	5.279	0.94	4.78	4.50
C5.11	C5.11	1.559	0.773	9.274	1.21	3.98	4.80
C5.12	C5.12	1.560	0.773	9.274	1.21	3.98	4.80
C5.13	C5.13	1.81	0.77	5.0	1.40	4.85	6.80
C5.14	C5.14	0.76	0.77	5.0	0.59	4.85	2.86
C5.15	C5.15	1.81	0.77	8.9	1.40	4.04	5.65
C5.16	C5.16	1.65	0.77	8.9	1.27	4.04	5.15
C6.01	C6.01	1.89	0.77	6.2	1.46	4.56	6.65
C6.02	C6.02	1.13	0.77	5.5	0.88	4.74	4.15
C6.03	C6.03	1.27	0.77	13.7	0.98	3.39	3.32
C6.04	C6.04	1.22	0.77	12.6	0.94	3.52	3.31

Dawson Trails Filing 2 - Gambel Ridge Watershed (B & C Sub-basins)

CORE Project #: 20-224

Prepared By: LCC

RATIONAL METHOD PEAK RUNOFF

100-YR STORM

SF-3 Rainfall Depth-Duration-Frequency (1-hr) = **2.60**

-REFERENCE UDFCD Vol.1 EQ 5-1 & EQ 6-1

BASIN INFORMATON				DIRECT RUNOFF			
DESIGN POINT	DRAIN BASIN	AREA ac.	100YR RUNNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs
B6.10	B6.10	1.89	0.49	9.7	0.93	7.13	6.64
B6.11	B6.11	0.72	0.85	5.3	0.61	8.67	5.31
B6.12	B6.12	0.85	0.85	5.9	0.73	8.41	6.12
B6.20	B6.20	6.69	0.49	25.7	3.29	4.46	14.67
B6.21	B6.21	1.47	0.85	7.4	1.25	7.85	9.83
B6.22	B6.22	1.39	0.85	7.4	1.18	7.85	9.30
B6.30	B6.30	3.65	0.49	20.3	1.80	5.08	9.12
B6.31	B6.31	1.22	0.85	5.8	1.04	8.48	8.81
B6.32	B6.32	0.90	0.85	5.8	0.77	8.48	6.54
B6.40	B6.40	0.87	0.49	13.0	0.43	6.29	2.68
B6.41	B6.41	0.76	0.85	5.0	0.65	8.81	5.72
B6.42	B6.42	0.59	0.85	5.0	0.50	8.82	4.42
B6.51	B6.51	0.66	0.85	5.2	0.56	8.73	4.90
B6.52	B6.52	0.63	0.85	5.0	0.54	8.82	4.75
C1.0	C1.0	35.15	0.49	40.8	17.30	3.38	58.48
C2.0	C2.0	47.21	0.49	67.2	23.24	2.43	56.54
C3.0	C3.0	33.15	0.49	69.7	16.32	2.37	38.71
C4.0	C4.0	20.59	0.49	58.6	10.14	2.67	27.09
C5.01	C5.01	2.61	0.85	8.9	2.22	7.36	16.34
C5.02	C5.02	2.109	0.853	8.038	1.80	7.63	13.72
C5.03	C5.03	1.362	0.853	5.279	1.16	8.69	10.10
C5.04	C5.04	1.219	0.853	5.279	1.04	8.69	9.04
C5.11	C5.11	1.559	0.853	9.274	1.33	7.24	9.63
C5.12	C5.12	1.560	0.853	9.274	1.33	7.24	9.64
C5.13	C5.13	1.81	0.85	5.0	1.55	8.82	13.65
C5.14	C5.14	0.76	0.85	5.0	0.65	8.82	5.73
C5.15	C5.15	1.81	0.85	8.9	1.54	7.34	11.34
C5.16	C5.16	1.65	0.85	8.9	1.41	7.34	10.32
C6.01	C6.01	1.89	0.85	6.2	1.61	8.29	13.33
C6.02	C6.02	1.13	0.85	5.5	0.97	8.61	8.33
C6.03	C6.03	1.27	0.85	13.7	1.08	6.16	6.67
C6.04	C6.04	1.22	0.85	12.6	1.04	6.39	6.63

		Residential & Commercial												Soil Type		
		Single Family			0.00				Landscape Area							
		0.25 acres or less	Attached	Basin D3.2	Parks	Roof/ Concrete	Asphalt/ Ponded Water	Schools	2-7% Slope	>7% Slope	Historic			Soil Type A Area	Soil Type B Area	Soil Type C/D Area
% Imperv.		45.00%	75.00%	18.85%	10.00%	90.00%	100.00%	55.00%	2.00%	2.00%	2.00%					
BASIN	Design Point	Area (ac)	Area (ac)	Area (ac)	Area (ac)	Area (ac)	Area (ac)	Area (ac)	Area (ac)	Area (ac)	Area (ac)	Total Area (ac)	Percent Impervious	Area (ac)	Area (ac)	Area (ac)
D4.0	D4.0	-	-	-	-	-	0.12	-	-	0.26	-	0.38	32.6%	-	-	0.38
D4.1	D4.1	-	-	-	-	0.25	0.56	-	0.28	-	0.00	1.08	72.4%	-	-	1.08
D4.2	D4.2	-	-	-	-	0.23	0.48	-	0.25	-	0.00	0.97	71.7%	-	-	0.97
		-	-	-	-	-	-	-	-	-	-	-		-	-	-
POND D4	D4	-	-	-	-	0.48	1.15	-	0.53	0.26	0.00	2.43	65.9%	-	-	2.43
		-	-	-	-	-	-	-	-	-	-	-		-	-	-
D5.0	D5.0	-	-	-	-	-	0.14	-	-	0.23	-	0.37	38.8%	-	-	0.37
D5.1	D5.1	-	-	-	-	0.26	0.55	-	0.35	0.86	-	2.03	39.9%	-	-	2.03
D5.2	D5.2	-	-	-	-	0.27	0.56	-	0.36	0.74	0.00	1.92	42.6%	-	-	1.92
D5.3	D5.3	-	-	-	-	-	0.25	-	0.06	-	0.00	0.31	81.9%	-	-	0.31
D5.4	D5.4	-	-	-	-	-	0.11	-	0.03	-	-	0.14	80.7%	-	-	0.14
		-	-	-	-	-	-	-	-	-	-	-		-	-	-
POND D5	D5	-	-	-	-	0.52	1.61	-	0.80	1.83	0.00	4.77	44.8%	-	-	4.77
		-	-	-	-	-	-	-	-	-	-	-		-	-	-
D9.1	D9.1	-	-	-	-	-	-	-	-	-	1.86	1.86	2.0%	-	-	1.86
D9.2	D9.2	-	-	-	-	-	-	-	-	-	6.32	6.32	2.0%	-	-	6.32
		-	-	-	-	-	-	-	-	-	-	-		-	-	-
D10.1	D10.1	-	-	-	-	-	-	-	-	-	26.72	26.72	2.0%	-	-	26.72
		-	-	-	-	-	-	-	-	-	-	-		-	-	-
FD9.1	FD9.1	1.86	-	-	-	-	-	-	-	-	-	1.86	45.0%	-	-	1.86
FD9.2	FD9.2	13.30	-	-	-	-	-	-	-	-	-	13.30	45.0%	-	-	13.30
		-	-	-	-	-	-	-	-	-	-	-		-	-	-
FD10.1	FD10.1	8.47	-	-	-	-	-	-	-	-	-	8.47	45.0%	-	-	8.47
FD10.2	FD10.2	-	-	-	-	-	-	10.46	-	-	-	10.46	55.0%	-	-	10.46

PERCENT IMPERVIOUS CALCULATIONS
PROPOSED CONDITIONS - DAWSON TRAILS - FILING 2 - POND D1

Note: Dawson Trails Filing 2 is grandfathered into the previous MHFD impervious values (pre June 2024). In some instances the new, higher values have been used to match surrounding filings.

Basin	Total Area	Asphalt/ Ponded Water	Roof/ Concrete	Commercial - Medium to High Density	MFH - High Density MFH (>20 du/ac)	SFH - High-density (5-20 du/ac) and Commercial - Low-density	SFH - Low & Medium-density (5-20 du/ac)	Community Parks/ Extended Detention Basins	Neighborhood Parks	Open Space - Undisturbed Native Grass, Landscaping	Composite Percent Impervious
%IMP	(acres)	100% (acres)	90% (acres)	80% (acres)	70% (acres)	65% (acres)	55% (acres)	25% (acres)	15% (acres)	2% (acres)	
D1-1	5.11				5.11						70.0%
D1-2	1.36	0.94	0.20							0.22	82.7%
D1-3	0.73	0.50	0.10							0.13	81.2%
D1-4	1.17	0.79	0.15							0.23	79.5%
D1-5	0.41	0.05	0.29							0.07	76.2%
D1-6	4.79				4.79						70.0%
D1-7	5.87				5.87						70.0%
D1-8a	1.43	0.91	0.20							0.32	76.7%
D1-8b	0.54	0.29	0.10							0.15	70.9%
D1-9a	1.43	0.90	0.20							0.33	76.0%
D1-9b	0.56	0.29	0.10							0.17	68.5%
D1-10	0.85							0.85			25.0%
Pond D1	24.25	4.67	1.34		15.77			0.85		1.62	70.8%

Table 6-3. Recommended percentage imperviousness values

Land Use or Surface Characteristics	Percentage Imperviousness (%)
Business:	
Downtown Areas	95
Suburban Areas	75
Residential lots (lot area only):	
Single-family	
2.5 acres or larger	12
0.75 – 2.5 acres	20
0.25 – 0.75 acres	30
0.25 acres or less	45
Apartments	75
Industrial:	
Light areas	80
Heavy areas	90
Parks, cemeteries	10
Playgrounds	25
Schools	55
Railroad yard areas	50
Undeveloped Areas:	
Historic flow analysis	2
Greenbelts, agricultural	2
Off-site flow analysis (when land use not defined)	45
Streets:	
Paved	100
Gravel (packed)	40
Drive and walks	90
Roofs	90
Lawns, sandy soil	2
Lawns, clayey soil	2

TABLE 6-2. RECOMMENDED IMPERVIOUSNESS BY LAND USE

LAND USE/DENSITY	IMPERVIOUSNESS
Residential	
Single-family Housing (SFH) – Rural (0 – 3 du/ac)	35%
SFH – Low & Medium-density (3 – 5 du/ac)	55%
SFH – High-density (5 - 20 du/ac)	65%
Manufactured Housing (>= 10 du/ac)	65%
Multi-family Housing (MFH) – Medium-density (5 – 20 du/ac)	65%
MFH – High-density MFH (>20 du/ac)	70%
Commercial	
Commercial – Low-density	65%
Commercial – Medium- to High-density	80%
Commercial – Urban Core	90%
Industrial/Institutional	
Schools	55%
Office/institutional	65%
Industrial Areas	75%
Solar Fields, Gravel Cover[1,2]	60%
Solar Fields, Grass Cover[1,2]	45%
Parks and Open Space	
Open Space, Undisturbed Native Grasses	5%
Community Parks	25%
Neighborhood Parks	15%
Golf Courses	30%
Cemeteries	25%

Note: Recommended imperviousness values shown in the table are the minimum imperviousness values for a specific land use. It is the engineer's responsibility to select imperviousness values that appropriately reflect the actual density of the proposed development.

[1] Use these values at the master planning scale or when the specific layout of panels is not known. Use values from the surface type (Table 6-3) at the site planning and design stage when panel width, panel spacing, and panel orientation relative to contours are known.

[2] Assumes 1:1 ratio of panels to aisles. See MHFD's technical memorandum regarding *Determination of Solar Panel Field Runoff Coefficients and Imperviousness Values* for additional information on procedures to reflect other impervious areas such as roads and pads that may be part of a solar field and layouts with wider inter-panel spacing.

TABLE 6-3. RECOMMENDED IMPERVIOUSNESS BY SURFACE TYPES

SURFACE TYPES		IMPERVIOUSNESS
Roadways and Paved Streets		95%
Concrete Driveways and Walks		95%
Roofs		95%
Gravel	No Traffic (Pedestrian Use)	40%
	Low-traffic Areas (Maintenance Paths and Substations)	60%
	High-traffic Areas (Roadways and Parking)	80%
Disturbed Soil (Including Lawns, Managed/Active Turf, Landscaped Areas with Water-Wise Vegetation, and Uncompacted Gravel/Mulch Planting Beds)		20%
Undisturbed or Decompacted Soil (Native Grasses and Open Space Areas)		5%
Artificial Turfs[1]	Landscape Applications (without Subgrade Drainage Layer)	25% – 45%
	Sport Fields (with Underdrain Pipe System)	60% – 80%
Water Surfaces (Lakes/Reservoirs/Irrigation Ponds)		100%
Solar Fields[2]	Grass Cover (Varies with Panel Orientation Relative to Ground Contours)	10% – 45%
	Gravel Cover (Varies with Panel Orientation Relative to Ground Contours)	50% – 75%
Historic Flow Analysis, Greenbelts, Agricultural		5%
Newly Graded Areas		65%
Stormwater Control Measures[3]	Retention Ponds & Constructed Wetland Ponds	100%
	Rooftop Systems – Blue Roofs	95%
	Rooftop Systems – Green Roofs (extensive)	65%
	Rooftop Systems – Green Roofs (intensive)	50%
	Permeable Pavement – CGP/PGP/RGP	55%
	Permeable Pavement – PICP	45%
	Extended Detention Basins	25%
	Receiving Pervious Areas (incl. Grass Buffers & Grass Swales)	20%
	Bioretention & Sand Filters	10%

[1] Consult with the manufacturer to get a recommended value.

[2] Assumes 1:1 ratio of panels to aisles. See MHFD's technical memorandum regarding *Determination of Solar Panel Field Runoff Coefficients and Imperviousness Values* for additional information on procedures for determining percent imperviousness based on panel width, panel spacing, and panel orientation relative to ground contours and how to reflect other impervious areas such as roads and pads that may be part of a solar field and layouts with wider inter-panel spacing.

[3] See MHFD's technical memorandum regarding *Evaluation of Percent Imperviousness for Stormwater Control Measures* for background information.

Dawson Trails Filing 2 - North Dawson Watershed

CORE Project #: 20-224
Prepared By: LCC

COMPOSITE DEVELOPED BASIN WEIGHTED "C" CALCULATIONS
-REFERENCE UDFCD Vol.1 RUNOFF Table 6-4

i = % imperviousness/100 expressed as a decimal
C_A = Runoff coefficient for NRCS HSG A soils
C_B = Runoff coefficient for NRCS HSG B soils
C_{CD} = Runoff coefficient for NRCS HSG C and D soils.
Natural Resource Conservation Service (NRCS)

Table 6-4. Runoff coefficient equations based on NRCS soil group and storm return period

NRCS Soil Group		Storm Return Period					
	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	500-Year
A	$C_A = 0.84i^{1.302}$	$C_A = 0.86i^{1.276}$	$C_A = 0.87i^{1.232}$	$C_A = 0.84i^{1.124}$	$C_A = 0.85i+0.025$	$C_A = 0.78i+0.110$	$C_A = 0.65i+0.254$
B	$C_B = 0.84i^{1.169}$	$C_B = 0.86i^{1.088}$	$C_B = 0.81i+0.057$	$C_B = 0.63i+0.249$	$C_B = 0.56i+0.328$	$C_B = 0.47i+0.426$	$C_B = 0.37i+0.536$
C/D	$C_{C/D} = 0.83i^{1.122}$	$C_{C/D} = 0.82i+0.035$	$C_{C/D} = 0.74i+0.132$	$C_{C/D} = 0.56i+0.319$	$C_{C/D} = 0.49i+0.393$	$C_{C/D} = 0.41i+0.484$	$C_{C/D} = 0.32i+0.588$

Total Weighted Runoff Coefficients, C			
2-Year	5-Year	10-Year	100-Year
0.25	0.30	0.37	0.62

Basin ID	% Imperv.	*i*	Soil Type	Runoff Coefficients, C				Basin Area	Total Area	Weighted Runoff Coefficients, C			
				2-Year	5-Year	10-Year	100-Year			2-Year	5-Year	10-Year	100-Year
D			A				0.11			-	-	-	-
			B			0.06	0.43						
			C or D		0.04	0.13	0.48						
										-	-	-	-
D1.0	2.0%	0.02	A	0.01	0.01	0.01	0.13		7.98	0.01	0.05	0.15	0.49
			B	0.01	0.01	0.07	0.44						
			C or D	0.01	0.05	0.15	0.49	7.98					
D1.08	100.0%	1.00	A	0.84	0.86	0.87	0.89		0.52	0.83	0.86	0.87	0.89
			B	0.84	0.86	0.87	0.90						
			C or D	0.83	0.86	0.87	0.89	0.52					
										-	-	-	-
D1.10	82.4%	0.82	A	0.65	0.67	0.69	0.75		1.36	0.67	0.71	0.74	0.82
			B	0.67	0.70	0.72	0.81						
			C or D	0.67	0.71	0.74	0.82	1.36					
D1.11	81.6%	0.82	A	0.64	0.66	0.68	0.75		0.73	0.66	0.70	0.74	0.82
			B	0.66	0.69	0.72	0.81						
			C or D	0.66	0.70	0.74	0.82	0.73					
D1.12	79.6%	0.80	A	0.62	0.64	0.66	0.73		1.17	0.64	0.69	0.72	0.81
			B	0.64	0.67	0.70	0.80						
			C or D	0.64	0.69	0.72	0.81	1.17					
D1.13	82.5%	0.83	A	0.65	0.67	0.69	0.75		0.41	0.67	0.71	0.74	0.82
			B	0.67	0.70	0.73	0.81						
			C or D	0.67	0.71	0.74	0.82	0.41					
D1.30	76.6%	0.77	A	0.59	0.61	0.63	0.71		1.42	0.62	0.66	0.70	0.80
			B	0.62	0.64	0.68	0.79						
			C or D	0.62	0.66	0.70	0.80	1.42					
D1.31	70.6%	0.71	A	0.53	0.55	0.57	0.66		0.54	0.56	0.61	0.65	0.77
			B	0.56	0.59	0.63	0.76						
			C or D	0.56	0.61	0.65	0.77	0.54					
D1.30+31	75.0%	0.75	A	0.58	0.60	0.61	0.69		1.96	0.60	0.65	0.69	0.79
			B	0.60	0.63	0.66	0.78						
			C or D	0.60	0.65	0.69	0.79	1.96					
D1.32	76.2%	0.76	A	0.59	0.61	0.62	0.70		1.43	0.61	0.66	0.70	0.80
			B	0.61	0.64	0.67	0.78						
			C or D	0.61	0.66	0.70	0.80	1.43					
D1.33	68.8%	0.69	A	0.52	0.53	0.55	0.65		0.55	0.55	0.60	0.64	0.77
			B	0.54	0.57	0.61	0.75						
			C or D	0.55	0.60	0.64	0.77	0.55					
D1.32+33	74.2%	0.74	A	0.57	0.59	0.60	0.69		1.98	0.59	0.64	0.68	0.79
			B	0.59	0.62	0.66	0.77						
			C or D	0.59	0.64	0.68	0.79	1.98					
D1.5	53.8%	0.54	A	0.37	0.39	0.41	0.53		0.85	0.41	0.48	0.53	0.70
			B	0.41	0.44	0.49	0.68						
			C or D	0.41	0.48	0.53	0.70	0.85					

Basin ID	% Imperv.	*i*	Soil Type	Runoff Coefficients, C				Basin Area	Total Area	Weighted Runoff Coefficients, C			
				2-Year	5-Year	10-Year	100-Year			2-Year	5-Year	10-Year	100-Year
										-	-	-	-
POND D1	34.2%	0.34	A B C or D	0.21 0.24 0.25	0.22 0.27 0.32	0.23 0.33 0.38	0.38 0.59 0.62	 20.90	20.90	0.25	0.32	0.38	0.62
										-	-	-	-
A3.1	2.0%	0.02	A B C or D	0.01 0.01 0.01	0.01 0.01 0.05	0.01 0.07 0.15	0.13 0.44 0.49	 17.34	17.34	0.01	0.05	0.15	0.49
										-	-	-	-
A1.0	85.3%	0.85	A B C or D	0.68 0.70 0.69	0.70 0.72 0.73	0.72 0.75 0.76	0.78 0.83 0.83	 13.42	13.42	0.69	0.73	0.76	0.83
										-	-	-	-
D3.0	3.0%	0.03	A B C or D	0.01 0.01 0.01	0.01 0.01 0.05	0.01 0.07 0.15	0.13 0.44 0.49	 12.31	12.31	0.01	0.05	0.15	0.48
D3.10	62.1%	0.62	A B C or D	0.45 0.48 0.49	0.47 0.51 0.54	0.48 0.56 0.59	0.59 0.72 0.74	 0.67	0.67	0.49	0.54	0.59	0.74
D3.11	64.5%	0.65	A B C or D	0.47 0.50 0.51	0.49 0.53 0.56	0.51 0.58 0.61	0.61 0.73 0.75	 0.64	0.64	0.51	0.56	0.61	0.75
D3.12	67.7%	0.68	A B C or D	0.51 0.53 0.54	0.52 0.56 0.59	0.54 0.60 0.63	0.64 0.74 0.76	 0.61	0.61	0.54	0.59	0.63	0.76
D3.1	2.0%	0.02	A B C or D	0.01 0.01 0.01	0.01 0.01 0.05	0.01 0.07 0.15	0.13 0.44 0.49	 2.41	2.41	0.01	0.05	0.15	0.49
D3.13	45.8%	0.46	A B C or D	0.30 0.34 0.35	0.32 0.37 0.41	0.33 0.43 0.47	0.47 0.64 0.67	 0.90	0.90	0.35	0.41	0.47	0.67
										-	-	-	-
D3.15	67.7%	0.68	A B C or D	0.51 0.53 0.54	0.52 0.56 0.59	0.54 0.61 0.63	0.64 0.74 0.76	 0.31	0.31	0.54	0.59	0.63	0.76
D3.16	19.9%	0.20	A B C or D	0.10 0.13 0.14	0.11 0.15 0.20	0.12 0.22 0.28	0.27 0.52 0.57	 1.14	1.14	0.14	0.20	0.28	0.57
D3.18	67.9%	0.68	A B C or D	0.51 0.53 0.54	0.52 0.56 0.59	0.54 0.61 0.63	0.64 0.75 0.76	 0.33	0.33	0.54	0.59	0.63	0.76
D3.19	21.2%	0.21	A B C or D	0.11 0.14 0.15	0.12 0.16 0.21	0.13 0.23 0.29	0.28 0.53 0.57	 1.12	1.12	0.15	0.21	0.29	0.57

Basin ID	% Imperv.	*i*	Soil Type	Runoff Coefficients, C				Basin Area	Total Area	Weighted Runoff Coefficients, C			
				2-Year	5-Year	10-Year	100-Year			2-Year	5-Year	10-Year	100-Year
[redacted]			A	0.10	0.10	0.11	0.26						
			B										
			C or D	0.13	0.19	0.27	0.56	28.10					
			A	0.52	0.54	0.55	0.65						
D3.20	69.1%	0.69	B	0.54	0.57	0.62	0.75		0.47	0.55	0.60	0.64	0.77
			C or D	0.55	0.60	0.64	0.77	0.47					
			A	0.32	0.33	0.34	0.48						
D3.21	47.1%	0.47	B	0.35	0.38	0.44	0.65		0.55	0.36	0.42	0.48	0.68
			C or D	0.36	0.42	0.48	0.68	0.55					
			A	0.84	0.86	0.87	0.89						
D3.22	100.0%	1.00	B	0.84	0.86	0.87	0.90		0.25	0.83	0.86	0.87	0.89
			C or D	0.83	0.86	0.87	0.89	0.25					
[redacted]			A	0.44	0.46	0.47	0.59						
			B										
			C or D	0.48	0.53	0.58	0.73	34.71					
			A	0.01	0.01	0.01	0.13						
D3.4	2.0%	0.02	B	0.01	0.01	0.07	0.44		2.90	0.01	0.05	0.15	0.49
			C or D	0.01	0.05	0.15	0.49	2.90					
			A	0.01	0.01	0.01	0.13						
D3.5	2.0%	0.02	B	0.01	0.01	0.07	0.44		9.02	0.01	0.05	0.15	0.49
			C or D	0.01	0.05	0.15	0.49	9.02					
			A	0.17	0.17	0.19	0.33						
D3.6	28.7%	0.29	B	0.20	0.22	0.29	0.56		5.31	0.20	0.27	0.34	0.60
			C or D	0.20	0.27	0.34	0.60	5.31					
										-	-	-	-
			A	0.19	0.20	0.21	0.35						
POND D3	31.3%	0.31	B	0.22	0.24	0.31	0.57		101.76	0.23	0.29	0.36	0.61
			C or D	0.23	0.29	0.36	0.61	101.76					
										-	-	-	-
			A	0.20	0.21	0.22	0.36						
D4.0	32.6%	0.33	B	0.23	0.25	0.32	0.58		0.38	0.24	0.30	0.37	0.62
			C or D	0.24	0.30	0.37	0.62	0.38					
			A	0.55	0.57	0.58	0.67						
D4.1	72.4%	0.72	B	0.58	0.61	0.64	0.77		1.08	0.58	0.63	0.67	0.78
			C or D	0.58	0.63	0.67	0.78	1.08					
			A	0.55	0.56	0.58	0.67						
D4.2	71.7%	0.72	B	0.57	0.60	0.64	0.76		0.97	0.57	0.62	0.66	0.78
			C or D	0.57	0.62	0.66	0.78	0.97					
										-	-	-	-
			A	0.49	0.51	0.52	0.62						
POND D4	65.9%	0.66	B	0.52	0.55	0.59	0.74		2.43	0.52	0.58	0.62	0.75
			C or D	0.52	0.58	0.62	0.75	2.43					

Basin ID	% Imperv.	*i*	Soil Type	Runoff Coefficients, C				Basin Area	Total Area	Weighted Runoff Coefficients, C			
				2-Year	5-Year	10-Year	100-Year			2-Year	5-Year	10-Year	100-Year
										-	-	-	-
			A	0.24	0.26	0.27	0.41						
D5.0	38.8%	0.39	B	0.28	0.31	0.37	0.61		0.37	0.29	0.35	0.42	0.64
			C or D	0.29	0.35	0.42	0.64	0.37					
			A	0.25	0.27	0.28	0.42						
D5.1	39.9%	0.40	B	0.29	0.32	0.38	0.61		2.03	0.30	0.36	0.43	0.65
			C or D	0.30	0.36	0.43	0.65	2.03					
			A	0.28	0.29	0.30	0.44						
D5.2	42.6%	0.43	B	0.31	0.34	0.40	0.63		1.92	0.32	0.38	0.45	0.66
			C or D	0.32	0.38	0.45	0.66	1.92					
			A	0.65	0.67	0.68	0.75						
D5.3	81.9%	0.82	B	0.67	0.69	0.72	0.81		0.31	0.66	0.71	0.74	0.82
			C or D	0.66	0.71	0.74	0.82	0.31					
			A	0.64	0.65	0.67	0.74						
D5.4	80.7%	0.81	B	0.65	0.68	0.71	0.81		0.14	0.65	0.70	0.73	0.81
			C or D	0.65	0.70	0.73	0.81	0.14					
										-	-	-	-
			A	0.30	0.31	0.32	0.46						
POND D5	44.8%	0.45	B	0.33	0.36	0.42	0.64		4.77	0.34	0.40	0.46	0.67
			C or D	0.34	0.40	0.46	0.67	4.77					
										-	-	-	-
			A	0.01	0.01	0.01	0.13						
D9.1	2.0%	0.02	B	0.01	0.01	0.07	0.44		1.86	0.01	0.05	0.15	0.49
			C or D	0.01	0.05	0.15	0.49	1.86					
			A	0.01	0.01	0.01	0.13						
D9.2	2.0%	0.02	B	0.01	0.01	0.07	0.44		6.32	0.01	0.05	0.15	0.49
			C or D	0.01	0.05	0.15	0.49	6.32					
										-	-	-	-
			A	0.01	0.01	0.01	0.13						
D10.1	2.0%	0.02	B	0.01	0.01	0.07	0.44		26.72	0.01	0.05	0.15	0.49
			C or D	0.01	0.05	0.15	0.49	26.72					
										-	-	-	-
			A	0.30	0.31	0.33	0.46						
FD9.1	45.0%	0.45	B	0.33	0.36	0.42	0.64		1.86	0.34	0.40	0.47	0.67
			C or D	0.34	0.40	0.47	0.67	1.86					
			A	0.30	0.31	0.33	0.46						
FD9.2	45.0%	0.45	B	0.33	0.36	0.42	0.64		13.30	0.34	0.40	0.47	0.67
			C or D	0.34	0.40	0.47	0.67	13.30					
										-	-	-	-
			A	0.30	0.31	0.33	0.46						
FD10.1	45.0%	0.45	B	0.33	0.36	0.42	0.64		8.47	0.34	0.40	0.47	0.67
			C or D	0.34	0.40	0.47	0.67	8.47					
			A	0.39	0.40	0.42	0.54						
FD10.2	55.0%	0.55	B	0.42	0.45	0.50	0.68		10.46	0.42	0.49	0.54	0.71
			C or D	0.42	0.49	0.54	0.71	10.46					

Dawson Trails Filing 2 - North Dawson Watershed

CORE Project #: 20-224

Prepared By: LCC

TIME OF CONCENTRATION CALCULATIONS

-REFERENCE UDFCD Vol.1 Section 2.4

NRCS Conveyance factors, K -REFERENCE UDFCD Vol.1 RUNOFF Table 6-2

SF-2

Heavy Meadow	3	Short Grass Pasture & Lawns	7	Grassed Waterway	15
Tillage/field	5	Nearly Bare Ground	10	Paved Area & Shallow Gutter	20

SUB-BASIN DATA			INITIAL / OVERLAND TIME			CHANNEL / TRAVEL TIME T(t)						T(c) CHECK (URBANIZED BASINS)		FINAL T(c)
DRAIN BASIN	AREA ac.	C(5)	Length ft.	Slope %	T(i) min	Length ft.	Slope %	Coeff.	Velocity fps	T(t) min.	COMP. T(c)	% IMPER-VIOUS	USDCM Eq . 6-5	min.
D	0.00	-									0.0	0.0%		5.0
D1.0	7.98	0.05	500	9.2	20.4	630	1.6	7	0.9	11.9	32.3	2.0%		32.3
D1.08	0.52	0.86	40	1.3	2.6	500	1.2	20	2.2	3.8	6.4	100.0%	12.3	6.4
D1.10	1.36	0.71	40	1.3	4.1	500	1.2	20	2.2	3.8	7.9	82.4%	15.7	7.9
D1.11	0.73	0.70	35	5.7	2.4	300	3.3	20	3.7	1.4	3.7	81.6%	13.5	5.0
D1.12	1.17	0.69	50	4.0	3.3	800	1.3	20	2.2	6.0	9.3	79.6%	18.4	9.3
D1.13	0.41	0.71	35	5.7	2.3	650	1.1	20	2.1	5.2	7.6	82.5%	17.0	7.6
D1.30	1.42	0.66	35	5.7	2.6	650	1.1	20	2.1	5.2	7.8	76.6%	18.3	7.8
D1.31	0.54	0.61	35	5.7	2.9	650	1.1	20	2.1	5.2	8.1	70.6%	19.5	8.1
D1.30+31	1.96	0.65	35	5.7	2.7	650	1.1	20	2.1	5.2	7.9	75.0%	18.6	7.9
D1.32	1.43	0.66	50	4.0	3.6	350	2.0	20	2.8	2.1	5.6	76.2%	15.1	5.6
D1.33	0.55	0.60	50	4.0	4.0	350	2.0	20	2.8	2.1	6.1	68.8%	16.5	6.1
D1.33+32	1.98	0.64	50	4.0	3.7	350	2.0	21	3.0	2.0	5.7	74.2%	15.5	5.7
D1.5	0.85	0.48	50	20.0	3.0						3.0	53.8%		5.0
POND D1	20.90	0.32	500	9.2	15.2	2050	1.5	20	2.4	14.1	29.4	34.2%	40.7	29.4
A3.1	17.34	0.05	100	4.0	12.0	800	2.0	20	2.8	4.7	16.7	2.0%		16.7
A1.0	13.42	0.73	50	20.0	1.7						1.7	85.3%		5.0

SUB-BASIN DATA			INITIAL / OVERLAND TIME			CHANNEL / TRAVEL TIME T(t)						T(c) CHECK (URBANIZED BASINS)		FINAL T(c)
DRAIN BASIN	AREA ac.	C(5)	Length ft.	Slope %	T(i) min	Length ft.	Slope %	Coeff.	Velocity fps	T(t) min.	COMP. T(c)	% IMPER-VIOUS	USDCM Eq . 6-5	min.
D3.0	12.31	0.05	500	14.0	17.7	1000	5.5	7	1.4	10.2	27.9	2.0%		27.9
D3.10	0.67	0.54	20	2.5	3.3	280	1.8	20	2.7	1.7	5.1	62.1%	17.4	5.1
D3.11	0.64	0.56	20	2.5	3.2	180	2.8	20	3.3	0.9	4.1	64.5%	16.0	5.0
D3.12	0.61	0.59	260	21.2	5.4	290	2.1	20	2.9	1.7	7.1	67.7%	16.3	7.1
D3.1	2.41	0.05	300	25.0	11.3	120	2.5	7	1.1	1.8	13.1	2.0%		13.1
D3.13	0.90	0.41	20	2.5	4.1	640	2.0	20	2.9	3.7	7.9	45.8%	23.1	7.9
D3.15	0.31	0.59	100	3.0	6.4	280	5.0	20	4.5	1.0	7.4	67.7%	15.6	7.4
D3.16	1.14	0.20	100	3.0	11.3	280	5.0	20	4.5	1.0	12.4	19.9%		12.4
D3.18	0.33	0.59	35	5.7	3.1	320	5.0	20	4.5	1.2	4.2	67.9%	15.7	5.0
D3.19	1.12	0.21	100	3.0	11.2	320	5.0	20	4.5	1.2	12.4	21.2%	24.4	12.4
D3.2	28.10	0.18	500	20.0	13.7	1250	4.8	7	1.5	13.4	27.2	18.9%		27.2
D3.20	0.47	0.60	100	10.0	4.2	600	4.2	20	4.1	2.4	6.7	69.1%	16.9	6.7
D3.21	0.55	0.42	100	10.0	5.7	600	4.2	20	4.1	2.4	8.2	47.1%	21.1	8.2
D3.22	0.25	0.86	100	10.0	2.1	200	2.0	20	2.8	1.2	3.2	100.0%	10.0	5.0
D3.3	34.71	0.53	100	5.0	6.0	1000	7.0	7	1.8	9.0	15.0	61.9%	19.9	15.0
D3.4	2.90	0.05	150	6.7	12.4						12.4	2.0%		12.4
D3.5	9.02	0.05	50	4.0	8.5	800	1.3	7	0.8	17.0	25.5	2.0%		25.5
D3.6	5.31	0.27	150	6.7	9.8						9.8	28.7%		9.8
POND D3	101.76	0.29									0.0	31.3%		5.0
D4.0	0.38	0.30	180	6.7	10.3			7			10.3	32.6%		10.3
D4.1	1.08	0.63	19	2.0	3.0	1220	4.3	20	4.1	4.9	7.9	72.4%	18.8	7.9
D4.2	0.97	0.62	19	2.0	3.0	1110	4.4	20	4.2	4.4	7.4	71.7%	18.4	7.4
POND D4	2.43	0.58									0.0	65.9%		5.0

SUB-BASIN DATA			INITIAL / OVERLAND TIME			CHANNEL / TRAVEL TIME T(t)						T(c) CHECK (URBANIZED BASINS)		FINAL T(c)
DRAIN BASIN	AREA ac.	C(5)	Length ft.	Slope %	T(i) min	Length ft.	Slope %	Coeff.	Velocity fps	T(t) min.	COMP. T(c)	% IMPER-VIOUS	USDCM Eq . 6-5	min.
D5.0	0.37	0.35	80	5.6	6.8	1400	3.9	20	4.0	5.9	12.7	38.8%	27.6	12.7
D5.1	2.03	0.36	74	13.5	4.9	1400	3.9	20	4.0	5.9	10.7	39.9%	27.3	10.7
D5.2	1.92	0.38	230	6.5	10.6			7			10.6	42.6%		10.6
D5.3	0.31	0.71									0.0	81.9%		5.0
D5.4	0.14	0.70									0.0	80.7%		5.0
POND D5	4.77	0.40	75	20.0	4.1	270	5.6	5	1.2	3.8	7.9	44.8%	19.6	7.9
			75	20.0	6.4	520	5.8	5	1.2	7.2				
D9.1	1.86	0.05									0.0	2.0%		5.0
D9.2	6.32	0.05	500	13.0	18.2	1400	4.6	5	1.1	21.7	39.8	2.0%		39.8
D10.1	26.72	0.05	150	10.0	10.8	800	6.3	20	5.0	2.7	13.5	2.0%		13.5
			150	10.0	11.4	800	6.3	20	5.0	2.7				
FD9.1	1.86	0.40									0.0	45.0%		5.0
FD9.2	13.30	0.40	150	10.0	7.2	900	6.7	20	5.2	2.9	10.1	45.0%	22.1	10.1
			50	10.0	6.6	800	4.4	20	4.2	3.2				
FD10.1	8.47	0.40									0.0	45.0%		5.0
FD10.2	10.46	0.49									0.0	55.0%		5.0

Calculation of Peak Runoff using Rational Method

Designer: David Ott
Company: EMK Consultants
Date: 4/25/2025
Project: Dawson Trails Filing 2
Location: Pond D1

Version 2.00 released May 2017

Cells of this color are for required user-input
Cells of this color are for optional override values
Cells of this color are for calculated results based on overrides

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

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

Computed $t_c = t_i + t_t$

Regional $t_c = (26 - 17i) + \frac{L_t}{60(14i + 9)\sqrt{S_t}}$

$t_{minimum}$ = 5 (urban)
$t_{minimum}$ = 10 (non-urban)

Selected $t_c = \max\{t_{minimum}, \min(\text{Computed } t_c, \text{Regional } t_c)\}$

Select UDFCD location for NOAA Atlas 14 Rainfall Depths from the pulldown list OR enter your own depths obtained from the NOAA website (click this link)

	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
1-hour rainfall depth, P1 (in) =	1.06	1.43	1.66	2.00	2.26	2.60	3.20
	a	b	c				
Rainfall Intensity Equation Coefficients =	28.50	10.00	0.786				

$$I(in/hr) = \frac{a * P_1}{(b + t_c)^c}$$

$$Q(cfs) = CIA$$

Subcatchment Name	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C							Overland (Initial) Flow Time					Channelized (Travel) Flow Time							Time of Concentration			Rainfall Intensity, I (in/hr)							Peak Flow, Q (cfs)						
				2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)	Overland Flow Time t_i (min)	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Velocity V_t (ft/sec)	Channelized Flow Time t_t (min)	Computed t_c (min)	Regional t_c (min)	Selected t_c (min)	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
D1-1	5.11	D	70.00	0.56	0.61	0.65	0.71	0.74	0.77	0.81	150.00			0.023	8.31	369.00			0.024	20	3.10	1.98	10.29	16.21	10.29	2.84	3.82	4.44	5.35	6.05	6.95	8.56	8.10	11.83	14.67	19.44	22.82	27.37	35.36
D1-2	1.36	D	82.68	0.67	0.71	0.74	0.78	0.80	0.82	0.85	20.00			0.025	2.33	507.00			0.014	20	2.37	3.57	5.91	15.42	5.91	3.43	4.63	5.38	6.48	7.32	8.42	10.37	3.15	4.47	5.41	6.89	7.98	9.42	11.96
D1-3	0.73	D	81.18	0.66	0.70	0.73	0.77	0.79	0.82	0.84	20.00			0.025	2.41	382.00			0.035	20	3.74	1.70	4.11	13.87	5.00	3.60	4.85	5.63	6.78	7.67	8.82	10.85	1.73	2.47	2.99	3.83	4.44	5.25	6.69
D1-4	1.17	D	79.45	0.64	0.68	0.72	0.76	0.79	0.81	0.84	20.00			0.025	2.49	650.00			0.012	20	2.19	4.94	7.44	17.41	7.44	3.19	4.31	5.00	6.03	6.81	7.84	9.64	2.41	3.44	4.19	5.39	6.26	7.42	9.46
D1-5	0.41	D	76.20	0.61	0.66	0.69	0.75	0.77	0.80	0.83	20.00			0.025	2.65	215.00			0.013	20	2.28	1.57	4.22	14.64	5.00	3.60	4.85	5.63	6.78	7.67	8.82	10.85	0.91	1.30	1.60	2.07	2.42	2.88	3.68
D1-6	4.79	D	70.00	0.56	0.61	0.65	0.71	0.74	0.77	0.81	100.00			0.020	7.10	613.00			0.020	20	2.83	3.61	10.71	17.94	10.71	2.79	3.76	4.37	5.26	5.95	6.84	8.42	7.47	10.92	13.53	17.93	21.05	25.25	32.61
D1-7	5.87	D	70.00	0.56	0.61	0.65	0.71	0.74	0.77	0.81	100.00			0.020	7.10	529.00			0.030	20	3.46	2.55	9.65	16.81	9.65	2.91	3.92	4.55	5.49	6.20	7.13	8.78	9.54	13.94	17.28	22.90	26.89	32.25	41.66
D1-8a	1.43	D	76.67	0.62	0.66	0.70	0.75	0.77	0.80	0.83	20.00			0.025	2.63	750.00			0.010	20	2.00	6.25	8.88	19.30	8.88	3.00	4.05	4.70	5.66	6.40	7.36	9.06	2.66	3.82	4.67	6.06	7.06	8.40	10.75
D1-8b	0.54	D	70.93	0.57	0.61	0.65	0.72	0.74	0.77	0.81	20.00			0.025	2.91	500.00			0.025	20	3.16	2.64	5.54	16.73	5.54	3.50	4.72	5.48	6.60	7.46	8.58	10.56	1.07	1.56	1.93	2.55	2.99	3.59	4.63
D1-9a	1.43	D	75.99	0.61	0.65	0.69	0.74	0.77	0.79	0.83	20.00			0.025	2.66	750.00			0.010	20	2.00	6.25	8.91	19.45	8.91	3.00	4.04	4.69	5.65	6.39	7.35	9.05	2.63	3.78	4.63	6.02	7.02	8.35	10.70
D1-9b	0.56	D	68.46	0.55	0.59	0.64	0.70	0.73	0.76	0.80	20.00			0.025	3.03	500.00			0.025	20	3.16	2.64	5.66	17.20	5.66	3.48	4.69	5.44	6.56	7.41	8.52	10.49	1.06	1.56	1.94	2.58	3.03	3.65	4.72

Dawson Trails Filing 2 - North Dawson Watershed

CORE Project #: 20-224

Prepared By: LCC

RATIONAL METHOD PEAK RUNOFF

5-Year STORM Rainfall Depth-Duration-Frequency (1-hr) = **1.43**

SF-3

-REFERENCE UDFCD Vol.1 EQ 5-1 & EQ 6-1

BASIN INFORMATON				DIRECT RUNOFF			
DESIGN POINT	DRAIN BASIN	AREA ac.	5yr Runoff COEFF	T(c) min	C x A	I in/hr	Q cfs
	D	0.00		5.0		4.85	0.00
D1.0	D1.0	7.98	0.05	32.3	0.41	2.15	0.88
D1.08	D1.08	0.52	0.86	6.4	0.44	4.52	2.01
D1.10	D1.10	1.36	0.71	7.9	0.97	4.22	4.07
D1.11	D1.11	0.73	0.70	5.0	0.51	4.85	2.49
D1.12	D1.12	1.17	0.69	9.3	0.81	3.98	3.20
D1.13	D1.13	0.41	0.71	7.6	0.29	4.29	1.26
D1.30	D1.30	1.42	0.66	7.8	0.94	4.23	3.99
D1.31	D1.31	0.54	0.61	8.1	0.33	4.18	1.37
INLET D1.31	D1.30+31	1.96	0.65	7.9	1.27	4.22	5.37
D1.32	D1.32	1.43	0.66	5.6	0.94	4.70	4.43
D1.33	D1.33	0.55	0.60	6.1	0.33	4.59	1.51
INLET 6	D1.33+32	1.98	0.64	5.7	1.27	4.69	5.97
D1.5	D1.5	0.85	0.48	5.0	0.41	4.85	1.97
	POND D1	20.90		29.4		2.27	0.00
A3.1	A3.1	17.34	0.05	16.7	0.89	3.08	2.75
A1.0	A1.0	13.42	0.73	5.0	9.85	4.85	47.79
~~D3.0~~	~~D3.0~~	~~12.81~~	~~0.05~~	~~27.9~~	~~0.68~~	~~2.84~~	~~1.48~~
D3.10	D3.10	0.67	0.54	5.1	0.36	4.83	1.76
D3.11	D3.11	0.64	0.56	5.0	0.36	4.85	1.76
D3.12	D3.12	0.61	0.59	7.1	0.36	4.37	1.58
D3.1	D3.1	2.41	0.05	13.1	0.12	3.45	0.43
D3.13	D3.13	0.90	0.41	7.9	0.37	4.23	1.56
D3.15	D3.15	0.31	0.59	7.4	0.18	4.31	0.79
D3.16	D3.16	1.14	0.20	12.4	0.23	3.54	0.80
D3.18	D3.18	0.33	0.59	5.0	0.19	4.85	0.94
D3.19	D3.19	1.12	0.21	12.4	0.23	3.54	0.83
~~D3.2~~	~~D3.2~~	~~28.10~~	~~0.19~~	~~27.3~~	~~5.33~~	~~2.37~~	~~12.64~~
D3.20	D3.20	0.47	0.60	6.7	0.28	4.47	1.26
D3.21	D3.21	0.55	0.42	8.2	0.23	4.17	0.97
D3.22	D3.22	0.25	0.86	5.0	0.22	4.85	1.05
~~D3.3~~	~~D3.3~~	~~34.71~~	~~0.53~~	~~15.0~~	~~18.54~~	~~3.25~~	~~60.24~~
D3.4	D3.4	2.90	0.05	12.4	0.15	3.54	0.53
D3.5	D3.5	9.02	0.05	25.5	0.46	2.46	1.14
D3.6	D3.6	5.31	0.27	9.8	1.43	3.90	5.59

RATIONAL METHOD PEAK RUNOFF

5-Year STORM Rainfall Depth-Duration-Frequency (1-hr) = **1.43**

SF-3

-REFERENCE UDFCD Vol.1 EQ 5-1 & EQ 6-1

BASIN INFORMATON				DIRECT RUNOFF			
DESIGN POINT	DRAIN BASIN	AREA ac.	5yr Runoff COEFF	T(c) min	C x A	I in/hr	Q cfs
	POND D3	101.76		5.0		4.85	0.00
D4.0	D4.0	0.38	0.30	10.3	0.11	3.82	0.44
D4.1	D4.1	1.08	0.63	7.9	0.68	4.23	2.88
D4.2	D4.2	0.97	0.62	7.4	0.60	4.32	2.60
D4	POND D4	2.43	0.58	5.0	1.40	4.85	6.78
D5.0	D5.0	0.37	0.35	12.7	0.13	3.50	0.46
D5.1	D5.1	2.03	0.36	10.7	0.73	3.76	2.76
D5.2	D5.2	1.92	0.38	10.6	0.74	3.79	2.80
D5.3	D5.3	0.31	0.71	5.0	0.22	4.85	1.07
D5.4	D5.4	0.14	0.70	5.0	0.10	4.85	0.47
D5	POND D5	4.77	0.40	7.9	1.92	4.23	8.11
D9.1	D9.1	1.86	0.05	5.0	0.10	4.85	0.46
D9.2	D9.2	6.32	0.05	39.8	0.32	1.89	0.61
D10.1	D10.1	26.72	0.05	13.5	1.37	3.41	4.68
FD9.1	FD9.1	1.86	0.40	5.0	0.75	4.85	3.63
FD9.2	FD9.2	13.30	0.40	10.1	5.37	3.85	20.70
FD10.1	FD10.1	8.47	0.40	5.0	3.42	4.85	16.59
FD10.2	FD10.2	10.46	0.49	5.0	5.08	4.85	24.66

Dawson Trails Filing 2 - North Dawson Watershed

CORE Project #: 20-224

Prepared By: LCC

RATIONAL METHOD PEAK RUNOFF

100-YR STORM

SF-3 Rainfall Depth-Duration-Frequency (1-hr) = **2.60**

-REFERENCE UDFCD Vol.1 EQ 5-1 & EQ 6-1

BASIN INFORMATON				DIRECT RUNOFF			
DESIGN POINT	DRAIN BASIN	AREA ac.	100YR RUNNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs
	D	0.00					
D1.0	D1.0	7.98	0.49	32.3	3.93	3.91	15.35
D1.08	D1.08	0.52	0.89	6.4	0.46	8.22	3.81
D1.10	D1.10	1.36	0.82	7.9	1.12	7.66	8.57
D1.11	D1.11	0.73	0.82	5.0	0.60	8.82	5.26
D1.12	D1.12	1.17	0.81	9.3	0.95	7.24	6.86
D1.13	D1.13	0.41	0.82	7.6	0.34	7.79	2.65
D1.30	D1.30	1.42	0.80	7.8	1.14	7.69	8.74
D1.31	D1.31	0.54	0.77	8.1	0.41	7.59	3.15
INLET D1.31	D1.30+31	1.96	0.79	7.9	1.55	7.67	11.88
D1.32	D1.32	1.43	0.80	5.6	1.14	8.54	9.72
D1.33	D1.33	0.55	0.77	6.1	0.42	8.34	3.51
INLET 6	D1.33+32	1.98	0.79	5.7	1.56	8.53	13.29
D1.5	D1.5	0.85	0.70	5.0	0.60	8.82	5.29
	POND D1	20.90					
A3.1	A3.1	17.34	0.49	16.7	8.54	5.61	47.85
A1.0	A1.0	13.42	0.83	5.0	11.19	8.82	98.64
D3.9	D3.9	12.31	0.49	27.8	6.06	4.26	25.81
D3.10	D3.10	0.67	0.74	5.1	0.49	8.79	4.34
D3.11	D3.11	0.64	0.75	5.0	0.48	8.82	4.24
D3.12	D3.12	0.61	0.76	7.1	0.47	7.95	3.71
D3.1	D3.1	2.41	0.49	13.1	1.19	6.27	7.45
D3.13	D3.13	0.90	0.67	7.9	0.60	7.69	4.64
D3.15	D3.15	0.31	0.76	7.4	0.24	7.83	1.86
D3.16	D3.16	1.14	0.57	12.4	0.64	6.44	4.15
D3.18	D3.18	0.33	0.76	5.0	0.25	8.82	2.20
D3.19	D3.19	1.12	0.57	12.4	0.64	6.44	4.13
D3.2	D3.2	28.10	0.54	27.3	15.77	4.31	68.04
D3.20	D3.20	0.47	0.77	6.7	0.36	8.12	2.92
D3.21	D3.21	0.55	0.68	8.2	0.37	7.58	2.82
D3.22	D3.22	0.25	0.89	5.0	0.23	8.82	1.99
D3.3	D3.3	34.71	0.73	15.9	25.47	5.89	150.24
D3.4	D3.4	2.90	0.49	12.4	1.43	6.44	9.18
D3.5	D3.5	9.02	0.49	25.5	4.44	4.48	19.89
D3.6	D3.6	5.31	0.60	9.8	3.19	7.09	22.62

RATIONAL METHOD PEAK RUNOFF

100-YR STORM

SF-3 Rainfall Depth-Duration-Frequency (1-hr) = **2.60**

-REFERENCE UDFCD Vol.1 EQ 5-1 & EQ 6-1

BASIN INFORMATON				DIRECT RUNOFF			
DESIGN POINT	DRAIN BASIN	AREA ac.	100YR RUNNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs
	POND D3	101.76					
D4.0	D4.0	0.38	0.62	10.3	0.23	6.94	1.63
D4.1	D4.1	1.08	0.78	7.9	0.85	7.68	6.50
D4.2	D4.2	0.97	0.78	7.4	0.75	7.85	5.91
D4	POND D4	2.43	0.75	5.0	1.83	8.82	16.16
D5.0	D5.0	0.37	0.64	12.7	0.24	6.37	1.51
D5.1	D5.1	2.03	0.65	10.7	1.31	6.84	8.97
D5.2	D5.2	1.92	0.66	10.6	1.27	6.88	8.72
D5.3	D5.3	0.31	0.82	5.0	0.25	8.82	2.25
D5.4	D5.4	0.14	0.81	5.0	0.11	8.82	1.01
D5	POND D5	4.77	0.67	7.9	3.19	7.68	24.47
D9.1	D9.1	1.86	0.49	5.0	0.91	8.82	8.05
D9.2	D9.2	6.32	0.49	39.8	3.11	3.43	10.68
D10.1	D10.1	26.72	0.49	13.5	13.15	6.19	81.47
FD9.1	FD9.1	1.86	0.67	5.0	1.24	8.82	10.94
FD9.2	FD9.2	13.30	0.67	10.1	8.89	7.01	62.26
FD10.1	FD10.1	8.47	0.67	5.0	5.66	8.82	49.92
FD10.2	FD10.2	10.46	0.71	5.0	7.42	8.82	65.45

JOB NO: 13301.00
PROJECT: Dawson Trails - Filing 2, Pond D1
DSGN STRM: 5-year
CALC BY: DJO

RATIONAL METHOD
(5-YEAR DEVELOPED CONDITION)

DATE: 4/25/25

I=28.5*P1/(10+T)^0.786

	1 HR STORM=	*1.43*		Direct RUNOFF				TOTAL RUNOFF				TRAVEL TIME				PIPE FLOW		
Design Point	Basin		C	Tc	A*C	I	Q	Tc	A*C	I	Q	Length	Vel.	Time	From	A*C	Q	
		Ac				IN/HR	CFS			IN/HR	CFS		fps	(Min.)	To		CFS	Notes
1D1	D1-1	5.11	0.61	10.29	3.09	3.8	**11.8**					60	10	0.1	1D1 TO 2D1	3.09	11.8	DIRECT/ PIPE FLOW
	D1-2	1.36	0.71	5.91	0.96	4.6	**4.5**											DIRECT
2D1	DP 1D1 + D1-2							10.4	4.06	3.8	**15.5**	60	10	0.1	2D1 TO 3D1.1	4.06	15.5	COMBINED
3D1	D1-3	0.73	0.70	5.00	0.51	4.9	**2.5**									0.51	2.5	DIRECT/ PIPE FLOW
3D1.1	DP 2D1 + DP 3D1							10.5	4.57	3.8	**17.3**	200	10	0.3	3D1.1 TO 5D1.2	4.57	17.3	COMBINED
4D1	D1-4	1.17	0.68	7.44	0.80	4.3	**3.4**									0.80	3.4	DIRECT/ PIPE FLOW
5D1	D1-5	0.41	0.66	5.00	0.27	4.9	**1.3**									0.27	1.3	DIRECT/ PIPE FLOW
5D1.1	DP 4D1 + DP 5D1							7.4	1.07	4.3	**4.6**					1.07	4.6	COMBINED
5D1.3	DP 5D1.1 + DP 3D1.1							10.8	5.63	3.7	**21.1**	370	10	0.6	5D1.3 TO 6D1.1	5.63	21.1	COMBINED
6D1	D1-6	4.79	0.61	10.71	2.90	3.8	**10.9**									2.90	10.9	DIRECT/ PIPE FLOW
6D1.1	DP 5D1.3 + DP 6D1							11.4	8.53	3.7	**31.3**	330	10	0.6	6D1.1 TO 9D1.1	8.53	31.3	COMBINED
7D1	D1-7	5.87	0.61	9.65	3.55	3.9	**13.9**									3.55	13.9	DIRECT/ PIPE FLOW
	D1-8a	1.43	0.66	8.88	0.94	4.0	**3.8**											DIRECT
	D1-8b	0.54	0.61	5.54	0.33	4.7	**1.6**											DIRECT
	D1-8a + D1-8b							8.9	1.27	4.0	**5.2**							DIRECT
8D1	DP 7D1+D1-8a+D1-8b							9.6	4.83	3.9	**18.9**					4.83	18.9	COMBINED
	D1-9a	1.43	0.65	8.91	0.94	4.0	**3.8**											DIRECT
	D1-9b	0.56	0.59	5.66	0.33	4.7	**1.6**											DIRECT
9D1	D1-9a + D1-9b							8.9	1.27	4.0	**5.1**					1.27	5.1	COMBINED
9D1.1	DP 6D1.1 + DP 8D1 + DP 9D1							12.0	14.63	3.6	**52.5**					14.63	52.5	COMBINED

JOB NO: 13301.00
PROJECT: Dawson Trails - Filing 2, Pond D1
DSGN STRM: 100-year
CALC BY: DJO

RATIONAL METHOD
(100-YEAR DEVELOPED CONDITION)

DATE: 4/25/25

I=28.5*P1/(10+T)^0.786

		1 HR STORM=	*2.60*	DIRECT RUNOFF				TOTAL RUNOFF				TRAVEL TIME				PIPE FLOW		
Design Point	Basin			Tc	A*C	I	Q	Tc	A*C	I	Q	Length	Vel.	Time	From	A*C	Q	
		Ac	C			IN/HR	CFS			IN/HR	CFS			(Min.)	To		CFS	Notes
1D1	D1-1	5.11	0.77	10.29	3.94	7.0	**27.4**									3.94	27.4	DIRECT/ PIPE FLOW
	D1-2	1.36	0.82	5.91	1.12	8.4	**9.4**											DIRECT
2D1	DP 1D1 + D1-2							10.3	5.05	7.0	**35.2**					5.05	35.2	COMBINED
3D1	D1-3	0.73	0.82	5.00	0.60	8.8	**5.3**									0.60	5.3	DIRECT/ PIPE FLOW
3D1.1	DP 2D1 + DP 3D1							10.3	5.65	7.0	**39.3**	600	10	1.0	2D3 TO 3D3	5.65	39.3	COMBINED
4D1	D1-4	1.17	0.81	7.44	0.95	7.8	**7.4**									0.95	7.4	DIRECT/ PIPE FLOW
5D1	D1-5	0.41	0.80	5.00	0.33	8.8	**2.9**					100	10	0.2	3D3 TO 4D3	0.33	2.9	DIRECT/ PIPE FLOW
5D1.1	DP 4D1 + DP 5D1							7.4	1.27	7.8	**10.0**					1.27	10.0	COMBINED
5D1.3	DP 5D1.1 + DP 3D1.1							11.3	6.92	6.7	**46.4**					6.92	46.4	COMBINED
6D1	D1-6	4.79	0.77	10.71	3.69	6.8	**25.2**					80	10	0.13	4D3 TO 5D3	3.69	25.2	DIRECT/ PIPE FLOW
6D1.1	DP 5D1.3 + DP 6D1							11.3	10.61	6.7	**71.1**					10.61	71.1	COMBINED
7D1	D1-7	5.87	0.77	9.65	4.52	7.1	**32.3**					290	10	0.483	5D3 TO 6D3	4.52	32.3	DIRECT/ PIPE FLOW
	D1-8a	1.43	0.80	8.88	1.14	7.4	**8.4**											DIRECT
	D1-8b	0.54	0.77	5.54	0.42	8.6	**3.6**											DIRECT
	D1-8a + D1-8b							8.9	1.56	7.4	**11.5**	80	10	0.13	6D3 TO 7D3			DIRECT
8D1	DP 7D1+D1-8a+D1-8b							9.6	6.08	7.1	**43.4**					6.08	43.4	COMBINED
	D1-9a	1.43	0.79	8.91	1.14	7.4	**8.4**					140	10	0.2	7D3 TO 8D3			DIRECT
	D1-9b	0.56	0.76	5.66	0.43	8.5	**3.6**											DIRECT
9D1	D1-9a + D1-9b							8.9	1.56	7.4	**11.5**					1.56	11.5	COMBINED
9D1.1	DP 6D1.1 + DP 8D1 + DP 9D1							11.3	18.26	6.7	**122.3**	105	10	0.2	8D3 TO 9D3	18.26	122.3	COMBINED

PERCENT IMPERVIOUS CALCULATIONS
PROPOSED CONDITIONS - DAWSON TRAILS - FILING 2 - POND D3

Note: Dawson Trails Filing 2 is grandfathered into the previous MHFD impervious values (pre June 2024). In some instances the new, higher values have been used to match surrounding filings.

Basin	Total Area	Asphalt/ Ponded Water	Roof/ Concrete	Commercial - Medium to High Density	MFH - High Density MFH (>20 du/ac)	SFH - High-density (5-20 du/ac) and Commercial - Low-density	SFH - Low & Medium-density (5-20 du/ac)	Community Parks/ Extended Detention Basins	Neighborhood Parks	Open Space - Undisturbed Native Grass, Landscaping	Composite Percent Impervious
%IMP	(acres)	100% (acres)	90% (acres)	80% (acres)	70% (acres)	65% (acres)	55% (acres)	25% (acres)	15% (acres)	2% (acres)	
D3.0	12.30				7.50					4.80	43.5%
D3.10	0.67	0.33	0.09							0.25	62.1%
D3.11	0.64	0.29	0.13							0.22	64.3%
D3.12	3.03	0.29	0.14							2.60	15.4%
D3.13	0.62	0.28	0.13							0.21	64.7%
D3.15	0.83	0.28	0.07							0.48	42.5%
D3.16	0.50	0.14	0.07							0.29	41.8%
D3.18	0.32	0.15	0.07							0.10	67.2%
D3.19	1.12	0.15	0.07							0.90	20.6%
D3.20	0.47	0.32								0.15	68.7%
D3.21	0.55	0.25								0.30	46.5%
D3.22	0.25	0.25									100.0%
D3.2a	11.70									11.70	2.0%
D3.2b	3.00					3.00					65.0%
D3.2c	7.61					7.61					65.0%
D3.2d	2.90									2.90	2.0%
D3.2e	1.70					1.70					65.0%
D3.2f	1.10			1.10							80.0%
D3.3a	26.07					26.07					65.0%
D3.3b	7.89					7.89					65.0%
D3.4	2.90					2.90					65.0%
D3.6	4.45							4.45			25.0%
D3.2d + D3.2e	4.60					1.70				2.90	25.3%
Pond D3	90.62	2.73	0.77	1.10	7.50	49.17		4.45	0.00	24.90	47.6%

Table 6-3. Recommended percentage imperviousness values

Land Use or Surface Characteristics	Percentage Imperviousness (%)
Business:	
Downtown Areas	95
Suburban Areas	75
Residential lots (lot area only)**:**	
Single-family	
2.5 acres or larger	12
0.75 – 2.5 acres	20
0.25 – 0.75 acres	30
0.25 acres or less	45
Apartments	75
Industrial:	
Light areas	80
Heavy areas	90
Parks, cemeteries	10
Playgrounds	25
Schools	55
Railroad yard areas	50
Undeveloped Areas:	
Historic flow analysis	2
Greenbelts, agricultural	2
Off-site flow analysis (when land use not defined)	45
Streets:	
Paved	100
Gravel (packed)	40
Drive and walks	90
Roofs	90
Lawns, sandy soil	2
Lawns, clayey soil	2

TABLE 6-2. RECOMMENDED IMPERVIOUSNESS BY LAND USE

LAND USE/DENSITY	IMPERVIOUSNESS
Residential	
Single-family Housing (SFH) – Rural (0 – 3 du/ac)	35%
SFH – Low & Medium-density (3 – 5 du/ac)	55%
SFH – High-density (5 - 20 du/ac)	65%
Manufactured Housing (>= 10 du/ac)	65%
Multi-family Housing (MFH) – Medium-density (5 – 20 du/ac)	65%
MFH – High-density MFH (>20 du/ac)	70%
Commercial	
Commercial – Low-density	65%
Commercial – Medium- to High-density	80%
Commercial – Urban Core	90%
Industrial/Institutional	
Schools	55%
Office/institutional	65%
Industrial Areas	75%
Solar Fields, Gravel Cover[1,2]	60%
Solar Fields, Grass Cover[1,2]	45%
Parks and Open Space	
Open Space, Undisturbed Native Grasses	5%
Community Parks	25%
Neighborhood Parks	15%
Golf Courses	30%
Cemeteries	25%

Note: Recommended imperviousness values shown in the table are the minimum imperviousness values for a specific land use. It is the engineer's responsibility to select imperviousness values that appropriately reflect the actual density of the proposed development.

[1] Use these values at the master planning scale or when the specific layout of panels is not known. Use values from the surface type (Table 6-3) at the site planning and design stage when panel width, panel spacing, and panel orientation relative to contours are known.

[2] Assumes 1:1 ratio of panels to aisles. See MHFD's technical memorandum regarding *Determination of Solar Panel Field Runoff Coefficients and Imperviousness Values* for additional information on procedures to reflect other impervious areas such as roads and pads that may be part of a solar field and layouts with wider inter-panel spacing.

TABLE 6-3. RECOMMENDED IMPERVIOUSNESS BY SURFACE TYPES

SURFACE TYPES		IMPERVIOUSNESS
Roadways and Paved Streets		95%
Concrete Driveways and Walks		95%
Roofs		95%
Gravel	No Traffic (Pedestrian Use)	40%
	Low-traffic Areas (Maintenance Paths and Substations)	60%
	High-traffic Areas (Roadways and Parking)	80%
Disturbed Soil (Including Lawns, Managed/Active Turf, Landscaped Areas with Water-Wise Vegetation, and Uncompacted Gravel/Mulch Planting Beds)		20%
Undisturbed or Decompacted Soil (Native Grasses and Open Space Areas)		5%
Artificial Turfs[1]	Landscape Applications (without Subgrade Drainage Layer)	25% – 45%
	Sport Fields (with Underdrain Pipe System)	60% – 80%
Water Surfaces (Lakes/Reservoirs/Irrigation Ponds)		100%
Solar Fields[2]	Grass Cover (Varies with Panel Orientation Relative to Ground Contours)	10% – 45%
	Gravel Cover (Varies with Panel Orientation Relative to Ground Contours)	50% – 75%
Historic Flow Analysis, Greenbelts, Agricultural		5%
Newly Graded Areas		65%
Stormwater Control Measures[3]	Retention Ponds & Constructed Wetland Ponds	100%
	Rooftop Systems – Blue Roofs	95%
	Rooftop Systems – Green Roofs (extensive)	65%
	Rooftop Systems – Green Roofs (intensive)	50%
	Permeable Pavement – CGP/PGP/RGP	55%
	Permeable Pavement – PICP	45%
	Extended Detention Basins	25%
	Receiving Pervious Areas (incl. Grass Buffers & Grass Swales)	20%
	Bioretention & Sand Filters	10%

[1] Consult with the manufacturer to get a recommended value.

[2] Assumes 1:1 ratio of panels to aisles. See MHFD's technical memorandum regarding *Determination of Solar Panel Field Runoff Coefficients and Imperviousness Values* for additional information on procedures for determining percent imperviousness based on panel width, panel spacing, and panel orientation relative to ground contours and how to reflect other impervious areas such as roads and pads that may be part of a solar field and layouts with wider inter-panel spacing.

[3] See MHFD's technical memorandum regarding *Evaluation of Percent Imperviousness for Stormwater Control Measures* for background information.

Calculation of Peak Runoff using Rational Method

Designer: David Ott
Company: EMK Consultants
Date: 4/11/2025
Project: Dawson Trails Filing 2
Location: Castle Rock, CO

Version 2.00 released May 2017

Cells of this color are for required user-input
Cells of this color are for optional override values
Cells of this color are for calculated results based on overrides

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

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

Computed $t_c = t_i + t_t$

Regional $t_c = (26 - 17i) + \frac{L_t}{60(14i + 9)\sqrt{S_t}}$

$t_{minimum} = 5$ (urban)
$t_{minimum} = 10$ (non-urban)

Selected $t_c = \max\{t_{minimum}, \min(\text{Computed } t_c, \text{Regional } t_c)\}$

Select UDFCD location for NOAA Atlas 14 Rainfall Depths from the pulldown list OR enter your own depths obtained from the NOAA website (click this link)

	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
1-hour rainfall depth, P1 (in) =	1.06	1.43	1.66	2.00	2.26	2.60	3.20
	a	b	c				
Rainfall Intensity Equation Coefficients =	28.50	10.00	0.786				

$$I(in/hr) = \frac{a * P_1}{(b + t_c)^c}$$

$$Q(cfs) = CIA$$

Subcatchment Name	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C							Overland (Initial) Flow Time					Channelized (Travel) Flow Time							Time of Concentration			Rainfall Intensity, I (in/hr)							Peak Flow, Q (cfs)						
				2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)	Overland Flow Time t_i (min)	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Velocity V_t (ft/sec)	Channelized Flow Time t_t (min)	Computed t_c (min)	Regional t_c (min)	Selected t_c (min)	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
D3.0	12.30	C	43.5	0.33	0.39	0.45	0.56	0.61	0.66	0.72	300.00			0.140	9.30	1200.00			0.055	7	1.64	12.18	21.49	24.26	21.49	2.01	2.71	3.14	3.79	4.28	4.92	6.06	8.08	12.96	17.46	26.20	31.99	40.08	54.03
D3.10	0.67	C	62.1	0.49	0.54	0.59	0.67	0.70	0.74	0.78	20.00			0.025	3.34	280.00			0.018	20	2.68	1.74	5.07	17.41	5.07	3.58	4.83	5.61	6.76	7.64	8.78	10.81	1.17	1.75	2.21	3.02	3.58	4.34	5.68
D3.11	0.64	C	64.3	0.51	0.56	0.60	0.68	0.71	0.75	0.79	20.00			0.025	3.23	180.00			0.028	20	3.35	0.90	4.13	16.07	5.00	3.60	4.85	5.63	6.78	7.67	8.82	10.85	1.17	1.73	2.18	2.95	3.49	4.22	5.49
D3.12	3.03	B	15.4	0.09	0.11	0.18	0.35	0.41	0.50	0.59	300.00			0.200	11.49	290.00			0.021	20	2.90	1.67	13.16	26.36	13.16	2.56	3.45	4.00	4.82	5.45	6.27	7.71	0.73	1.17	2.20	5.05	6.84	9.45	13.85
D3.13	0.62	B	64.7	0.50	0.53	0.58	0.66	0.69	0.73	0.77	20.00			0.025	3.38	640.00			0.020	20	2.83	3.77	7.15	19.18	7.15	3.24	4.37	5.07	6.11	6.90	7.94	9.77	1.01	1.44	1.82	2.48	2.95	3.58	4.68
D3.15	0.83	B	42.5	0.31	0.34	0.40	0.52	0.57	0.62	0.69	100.00			0.030	9.58	280.00			0.050	20	4.47	1.04	10.62	20.17	10.62	2.80	3.78	4.38	5.28	5.97	6.87	8.45	0.71	1.06	1.45	2.26	2.80	3.55	4.85
D3.16	0.50	B	41.8	0.30	0.33	0.39	0.51	0.56	0.62	0.69	100.00			0.030	9.66	280.00			0.050	20	4.47	1.04	10.70	20.31	10.70	2.79	3.77	4.37	5.27	5.95	6.85	8.43	0.42	0.62	0.86	1.35	1.67	2.12	2.90
D3.18	0.32	B	67.2	0.52	0.56	0.60	0.67	0.70	0.74	0.78	35.00			0.057	3.27	320.00			0.050	20	4.47	1.19	4.46	15.87	5.00	3.60	4.85	5.63	6.78	7.67	8.82	10.85	0.60	0.86	1.08	1.46	1.72	2.08	2.72
D3.19	1.12	D	20.6	0.14	0.20	0.28	0.43	0.49	0.57	0.65	100.00			0.030	11.27	320.00			0.050	20	4.47	1.19	12.46	24.50	12.46	2.62	3.53	4.10	4.94	5.58	6.42	7.90	0.42	0.80	1.30	2.40	3.09	4.09	5.78
D3.20	0.47	D	68.7	0.55	0.60	0.64	0.70	0.73	0.77	0.80	100.00			0.100	4.26	600.00			0.042	20	4.10	2.44	6.70	16.94	6.70	3.30	4.46	5.17	6.23	7.04	8.10	9.97	0.85	1.25	1.55	2.06	2.43	2.91	3.77
D3.21	0.55	D	46.5	0.35	0.41	0.47	0.58	0.62	0.67	0.73	100.00			0.100	5.79	600.00			0.042	20	4.10	2.44	8.23	21.23	8.23	3.08	4.16	4.83	5.82	6.58	7.57	9.31	0.60	0.95	1.26	1.86	2.25	2.81	3.76
D3.22	0.25	D	100.0	0.83	0.85	0.87	0.88	0.89	0.89	0.90	100.00			0.100	2.11	200.00			0.020	20	2.83	1.18	3.29	10.02	5.00	3.60	4.85	5.63	6.78	7.67	8.82	10.85	0.75	1.03	1.22	1.49	1.70	1.97	2.45
D3.2a	11.70	C	2.0	0.01	0.05	0.15	0.33	0.40	0.49	0.59	261.00			0.240	10.72	866.00			0.028	20	3.35	4.31	15.03	34.95	15.03	2.40	3.24	3.76	4.54	5.13	5.90	7.26	0.29	1.95	6.46	17.52	24.16	33.96	50.47
D3.2b	3.00	B	65.0	0.50	0.54	0.58	0.66	0.69	0.73	0.77	125.00			0.056	6.44	650.00			0.040	20	4.00	2.71	9.15	17.94	9.15	2.97	4.00	4.65	5.60	6.33	7.28	8.96	4.49	6.44	8.11	11.04	13.11	15.90	20.80
D3.2c	7.61	B	65.0	0.50	0.54	0.58	0.66	0.69	0.73	0.77	152.00			0.020	9.98	520.00			0.050	20	4.47	1.94	11.92	17.09	11.92	2.67	3.60	4.18	5.03	5.69	6.55	8.06	10.25	14.69	18.49	25.18	29.90	36.27	47.44
D3.2d	2.90	C	2.0	0.01	0.05	0.15	0.33	0.40	0.49	0.59	339.00			0.165	13.82	503.00			0.028	20	3.35	2.50	16.33	31.06	16.33	2.31	3.12	3.62	4.36	4.93	5.67	6.98	0.07	0.46	1.54	4.17	5.76	8.09	12.02
D3.2e	1.70	B	65.0	0.50	0.54	0.58	0.66	0.69	0.73	0.77	100.00			0.050	5.98	500.00			0.050	7	1.57	5.32	11.31	17.01	11.31	2.73	3.68	4.27	5.15	5.82	6.69	8.24	2.34	3.36	4.22	5.75	6.83	8.29	10.84
D3.2f	1.10	B	80.0	0.64	0.67	0.70	0.75	0.77	0.80	0.83	150.00			0.050	5.56	250.00			0.050	7	1.57	2.66	8.22	13.32	8.22	3.09	4.16	4.83	5.82	6.58	7.57	9.31	2.18	3.08	3.73	4.81	5.60	6.64	8.49
D3.3a	26.07	D	65.0	0.51	0.56	0.61	0.68	0.71	0.75	0.79	100.00			0.020	7.69	1600.00			0.040	20	4.00	6.67	14.35	22.32	14.35	2.46	3.31	3.85	4.63	5.24	6.03	7.42	32.94	48.79	61.15	82.52	97.50	117.78	153.26
D3.3b	7.89	D	65.0	0.51	0.56	0.61	0.68	0.71	0.75	0.79	131.00			0.020	8.80	600.00			0.030	20	3.46	2.89	11.69	18.14	11.69	2.69	3.63	4.21	5.08	5.74	6.60	8.12	10.92	16.18	20.27	27.36	32.33	39.05	50.81
D3.4	2.90	D	65.0	0.51	0.56	0.61	0.68	0.71	0.75	0.79	120.00			0.060	5.86	380.00			0.010	7	0.70	9.05	14.91	18.45	14.91	2.41	3.26	3.78	4.55	5.15	5.92	7.29	3.60	5.33	6.68	9.02	10.66	12.87	16.75
D3.6	4.45	D	25.0	0.18	0.24	0.32	0.46	0.52	0.59	0.67	100.00			0.010	15.55	100.00			0.010	7	0.70	2.38	17.93	23.08	17.93	2.21	2.98	3.45	4.16	4.70	5.41	6.66	1.73	3.16	4.85	8.50	10.81	14.11	19.76

JOB NO: 13301.00

PROJECT: Dawson Trails - Filing 2, Pond D3

DSGN STRM: 5-year

CALC BY: DJO

RATIONAL METHOD
(5-YEAR DEVELOPED CONDITION)

DATE: 4/11/25

I=28.5*P1/(10+T)^0.786

	1 HR STORM=	*1.43*		Direct RUNOFF				TOTAL RUNOFF				TRAVEL TIME				PIPE FLOW		
Design Point	Basin		C	Tc	A*C	I	Q	Tc	A*C	I	Q	Length	Vel.	Time	From	A*C	Q	
		Ac				IN/HR	CFS			IN/HR	CFS		fps	(Min.)	To		CFS	Notes
	D3.0	12.30	0.39	21.49	4.79	2.7	**13.0**									4.79	13.0	DIRECT/ PIPE FLOW
	D3.10	0.67	0.54	5.07	0.36	4.8	**1.8**											DIRECT
1D3								21.5	5.15	2.7	**13.9**					5.15	13.9	COMBINED
	D3.11	0.64	0.56	5.00	0.36	4.9	**1.7**									0.36	1.7	DIRECT/ PIPE FLOW
2D3								21.5	5.51	2.7	**14.9**	600	10	1.0	2D3 TO 3D3	5.51	14.9	COMBINED
	D3.2a	11.70	0.05	15.03	0.60	3.2	**1.9**									0.60	1.9	DIRECT/ PIPE FLOW
3D3								22.5	6.11	2.6	**16.1**	100	10	0.2	3D3 TO 4D3	6.11	16.1	COMBINED
	D3.12	3.03	0.11	13.16	0.34	3.4	**1.2**									0.34	1.2	DIRECT/ PIPE FLOW
	D3.13	0.62	0.53	7.15	0.33	4.4	**1.4**									0.33	1.4	DIRECT/ PIPE FLOW
4D3								22.7	6.78	2.6	**17.8**	80	10	0.1	4D3 TO 5D3	6.78	17.8	COMBINED
	D3.2b	3.00	0.54	9.15	1.61	4.0	**6.4**									1.61	6.4	DIRECT/ PIPE FLOW
5D3								22.8	8.39	2.6	**22.0**	290	10	0.5	5D3 TO 6D3	8.39	22.0	COMBINED
	D3.15	0.83	0.34	10.62	0.28	3.8	**1.1**									0.28	1.1	DIRECT/ PIPE FLOW
	D3.16	0.50	0.33	10.70	0.17	3.8	**0.6**									0.17	0.6	DIRECT/ PIPE FLOW
6D3								23.3	8.83	2.6	**22.9**	80	10	0.1	6D3 TO 7D3	8.83	22.9	COMBINED
	D3.2c	7.61	0.54	11.92	4.08	3.6	**14.7**									4.08	14.7	DIRECT/ PIPE FLOW
7D3								23.4	12.92	2.6	**33.4**	140	10	0.2	7D3 TO 8D3	12.92	33.4	COMBINED
	D3.2d	2.90	0.05	16.33	0.15	3.1	**0.5**											DIRECT
	D3.2e	1.70	0.54	11.31	0.91	3.7	**3.4**	16.3	1.06	3.1	**3.3**					0.91	3.4	DIRECT/ PIPE FLOW
8D3								23.6	13.98	2.6	**35.9**	105	10	0.2	8D3 TO 9D3	13.98	35.9	COMBINED
	D3.18	0.32	0.56	5.00	0.18	4.9	**0.9**									0.18	0.9	DIRECT/ PIPE FLOW
	D3.19	1.12	0.20	12.46	0.23	3.5	**0.8**									0.23	0.8	DIRECT/ PIPE FLOW
9D3								23.8	14.38	2.6	**36.8**	40	10	0.1	9D3 TO 10D3	14.38	36.8	COMBINED
	D3.2f	1.10	0.67	8.22	0.74	4.2	**3.1**									0.74	3.1	DIRECT/ PIPE FLOW
10D3								23.9	15.12	2.6	**38.7**	50	10	0.1	10D3 TO 11D3	15.12	38.7	COMBINED
	D3.20	0.47	0.60	6.70	0.28	4.5	**1.2**									0.28	1.2	DIRECT/ PIPE FLOW
11D3								24.0	15.40	2.6	**39.3**	330	10	0.6	11D3 TO 12D3	15.40	39.3	COMBINED
	D3.21	0.55	0.41	8.23	0.23	4.2	**0.9**									0.23	0.9	DIRECT/ PIPE FLOW
	D3.22	0.25	0.85	5.00	0.21	4.9	**1.0**									0.21	1.0	DIRECT/ PIPE FLOW
12D3								24.5	15.84	2.5	**39.9**	90	10	0.2	12D3 TO 13D3	15.84	39.9	COMBINED
	D3.3a	26.07	0.56	14.35	14.72	3.3	**48.8**									14.72	48.8	DIRECT/ PIPE FLOW
13D3								24.7	30.56	2.5	**76.7**	530	10	0.9	13D3 TO 14D3	30.56	76.7	COMBINED
	D3.4	2.90	0.56	14.91	1.64	3.3	**5.3**											DIRECT
14D3								25.5	32.20	2.5	**79.3**	170	10	0.3	14D3 TO 15D3	32.20	79.3	COMBINED
	D3.3b	7.89	0.56	11.69	4.46	3.6	**16.2**									4.46	16.2	DIRECT/ PIPE FLOW
15D3								25.8	36.66	2.4	**89.7**					36.66	89.7	COMBINED

JOB NO: 13301.00
PROJECT: Dawson Trails - Filing 2, Pond D3
DSGN STRM: 100-year
CALC BY: DJO

RATIONAL METHOD
(100-YEAR DEVELOPED CONDITION)

DATE: 4/11/25

I=28.5*P1/(10+T)^0.786

	1 HR STORM=	*2.60*		DIRECT RUNOFF				TOTAL RUNOFF				TRAVEL TIME				PIPE FLOW		
Design Point	Basin			Tc	A*C	I	Q	Tc	A*C	I	Q	Length	Vel.	Time	From	A*C	Q	
		Ac	C			IN/HR	CFS			IN/HR	CFS			(Min.)	To		CFS	Notes
	D3.0	12.30	0.66	21.49	8.14	4.9	**40.1**									8.14	40.1	DIRECT/ PIPE FLOW
	D3.10	0.67	0.74	5.07	0.49	8.8	**4.3**											DIRECT
1D3								21.5	8.63	4.9	**42.5**					8.63	42.5	COMBINED
	D3.11	0.64	0.75	5.00	0.48	8.8	**4.2**									0.48	4.2	DIRECT/ PIPE FLOW
2D3								21.5	9.11	4.9	**44.9**	600	10	1.0	2D3 TO 3D3	9.11	44.9	COMBINED
	D3.2a	11.70	0.49	15.03	5.76	5.9	**34.0**									5.76	34.0	DIRECT/ PIPE FLOW
3D3								22.5	14.87	4.8	**71.4**	100	10	0.2	3D3 TO 4D3	14.87	71.4	COMBINED
	D3.12	3.03	0.50	13.16	1.51	6.3	**9.5**		0.16							1.51	9.5	DIRECT/ PIPE FLOW
	D3.13	0.62	0.73	7.15	0.45	7.9	**3.6**									0.45	3.6	DIRECT/ PIPE FLOW
4D3								22.7	16.83	4.8	**80.5**	80	10	0.1	4D3 TO 5D3	16.83	80.5	COMBINED
	D3.2b	3.00	0.73	9.15	2.18	7.3	**15.9**									2.18	15.9	DIRECT/ PIPE FLOW
5D3								22.8	19.01	4.8	**90.7**	290	10	0.5	5D3 TO 6D3	19.01	90.7	COMBINED
	D3.15	0.83	0.62	10.62	0.52	6.9	**3.6**									0.52	3.6	DIRECT/ PIPE FLOW
	D3.16	0.50	0.62	10.70	0.31	6.8	**2.1**									0.31	2.1	DIRECT/ PIPE FLOW
6D3								23.3	19.84	4.7	**93.6**	80	10	0.1	6D3 TO 7D3	19.84	93.6	COMBINED
	D3.2c	7.61	0.73	11.92	5.54	6.5	**36.3**									5.54	36.3	DIRECT/ PIPE FLOW
7D3								23.4	25.38	4.7	**119.3**	140	10	0.2	7D3 TO 8D3	25.38	119.3	COMBINED
	D3.2d	2.90	0.49	16.33	1.43	5.7	**8.1**											DIRECT
	D3.2e	1.70	0.73	11.31	1.24	6.7	**8.3**	16.3	2.67	4.9	**13.1**					1.24	8.3	DIRECT/ PIPE FLOW
8D3								23.6	28.05	4.7	**131.1**	105	10	0.2	8D3 TO 9D3	28.05	131.1	COMBINED
	D3.18	0.32	0.74	5.00	0.24	8.8	**2.1**									0.24	2.1	DIRECT/ PIPE FLOW
	D3.19	1.12	0.57	12.46	0.64	6.4	**4.1**									0.64	4.1	DIRECT/ PIPE FLOW
9D3								23.8	28.92	4.7	**134.6**	40	10	0.1	9D3 TO 10D3	28.92	134.6	COMBINED
	D3.2f	1.10	0.80	8.22	0.88	7.6	**6.6**									0.88	6.6	DIRECT/ PIPE FLOW
10D3								23.9	29.80	4.6	**138.5**	50	10	0.1	10D3 TO 11D3	29.80	138.5	COMBINED
	D3.20	0.47	0.77	6.70	0.36	8.1	**2.9**									0.36	2.9	DIRECT/ PIPE FLOW
11D3								24.0	30.16	4.6	**139.9**	330	10	0.6	11D3 TO 12D3	30.16	139.9	COMBINED
	D3.21	0.55	0.67	8.23	0.37	7.6	**2.8**									0.37	2.8	DIRECT/ PIPE FLOW
	D3.22	0.25	0.89	5.00	0.22	8.8	**2.0**									0.22	2.0	DIRECT/ PIPE FLOW
12D3								24.5	30.75	4.6	**140.9**	90	10	0.2	12D3 TO 13D3	30.75	140.9	COMBINED
	D3.3a	26.07	0.75	14.35	19.55	6.0	**117.8**									19.55	117.8	DIRECT/ PIPE FLOW
13D3								24.7	50.30	4.6	**229.7**	530	10	0.9	13D3 TO 14D3	50.30	229.7	COMBINED
	D3.4	2.90	0.75	14.91	2.17	5.9	**12.9**											DIRECT
14D3								25.5	52.48	4.5	**234.9**	170	10	0.3	14D3 TO 15D3	52.48	234.9	COMBINED
	D3.3b	7.89	0.75	11.69	5.92	6.6	**39.1**									5.92	39.1	DIRECT/ PIPE FLOW
15D3								25.8	58.39	4.4	**259.8**					58.39	259.8	COMBINED

APPENDIX B

HYDRAULIC COMPUTATIONS

Flood control Pond Design
Culvert Summary and Calculations
Roadside Swale Summary
HEC-RAS Results for Channel Design
MHFD Inlet Calculations
StormCAD Calculations

MILE HIGH FLOOD DISTRICT

DETENTION BASIN DESIGN WORKBOOK

MHFD-Detention, Version 4.06 (July 2022)
Mile High Flood District
Denver, Colorado
www.mhfd.org

Purpose:

This workbook aids in the estimation of stormwater detention basin sizing and outlet routing based on the modified puls routing method for urban watersheds. Several different BMP types and various outlet configurations can be sized.

Function:

1. Approximates the stage-area-volume relationship for a detention basin based on watershed parameters and basin geometry parameters. Also evaluates existing user-defined basin stage-area relationships.

2. Sizes filtration media orifice, outlet orifices, elliptical slots, weirs, trash racks, and develops stage-discharge relationships. Uses the Modified Puls method to route a series of hydrographs (i.e., 2-, 5-, 10-, 25-, 50-, 100- and 500-year) and calibrates the peak discharge out of the basin to match the pre-development peak discharges for the watershed.

Content: **This workbook consists of the following sheets:**

Basin	Tabulates stage-area-volume relationship estimates based on watershed parameters
Outlet Structure	Tabulates a stage-discharge relationship for the user-defined outlet structure (inlet control).
Reference	Provides reference equations and figures.
User Tips and Tools	Provides instructions and video links to assist in using this workbook. Includes a stage-area calculator.
BMP Zone Images	Provides images of typical BMP zone confirgurations corresponding with Zone pulldown selections.

Acknowledgements: ***Spreadsheet Development Team:***
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Peak Stormwater Engineering, LLC

Dr. James C.Y. Guo, Ph.D., P.E.
Professor, Department of Civil Engineering, University of Colorado at Denver

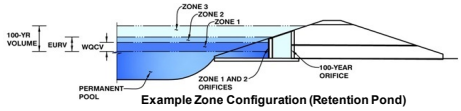
Comments? Direct all comments regarding this spreadsheet workbook to: **MHFD E-Mail**
Revisions? Check for revised versions of this or any other workbook at: **Downloads**

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: Dawson Trails Filing 2

Basin ID: Pond A1 (Stage 0.00 = 6399.50) 235 cfs is the max release rate under railroad



Example Zone Configuration (Retention Pond)

Watershed Information

Flood Control Only

Selected BMP Type =	**No BMP**	
Watershed Area =	256.00	acres
Watershed Length =	4,817	ft
Watershed Length to Centroid =	2,467	ft
Watershed Slope =	0.045	ft/ft
Watershed Imperviousness =	53.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	30.0%	percent
Percentage Hydrologic Soil Groups C/D =	70.0%	percent
Target WQCV Drain Time =	N/A	hours
Location for 1-hr Rainfall Depths =	User Input	

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	4.578	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	13.399	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.06 in.) =	11.983	acre-feet	1.06	inches
5-yr Runoff Volume (P1 = 1.43 in.) =	19.066	acre-feet	1.43	inches
10-yr Runoff Volume (P1 = 1.66 in.) =	23.829	acre-feet	1.66	inches
25-yr Runoff Volume (P1 = 2.01 in.) =	32.263	acre-feet	2.01	inches
50-yr Runoff Volume (P1 = 2.26 in.) =	37.779	acre-feet	2.26	inches
100-yr Runoff Volume (P1 = 2.6 in.) =	46.114	acre-feet	2.60	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	58.319	acre-feet	3.14	inches
Approximate 2-yr Detention Volume =	10.076	acre-feet		
Approximate 5-yr Detention Volume =	15.535	acre-feet		
Approximate 10-yr Detention Volume =	18.363	acre-feet		
Approximate 25-yr Detention Volume =	21.046	acre-feet		
Approximate 50-yr Detention Volume =	21.825	acre-feet		
Approximate 100-yr Detention Volume =	25.146	acre-feet		

Define Zones and Basin Geometry

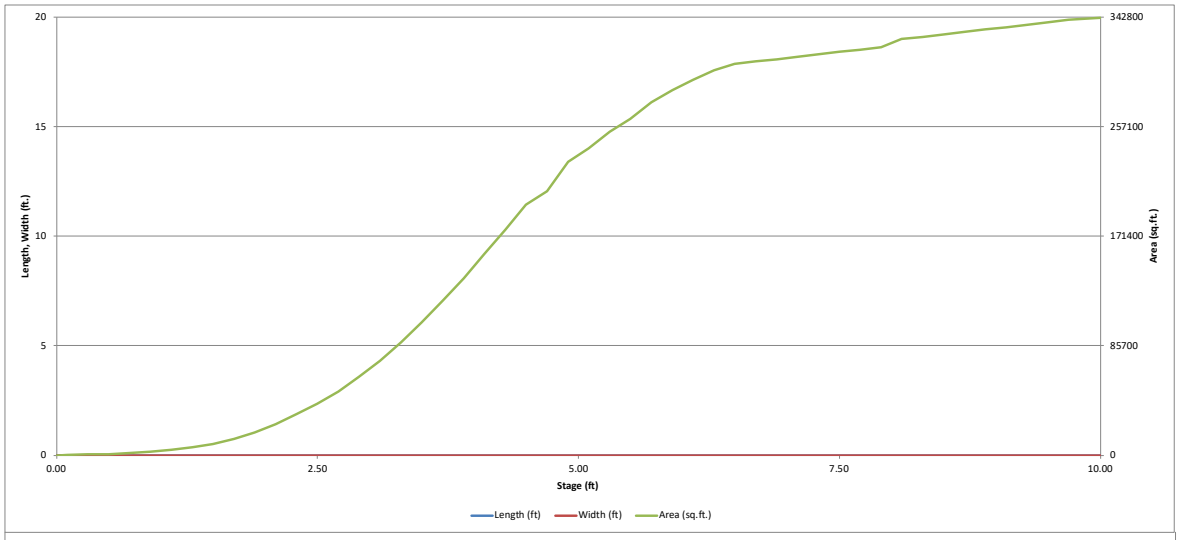
Zone 1 Volume (100-year) =	25.146	acre-feet
Select Zone 2 Storage Volume (Optional) =		acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	25.146	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

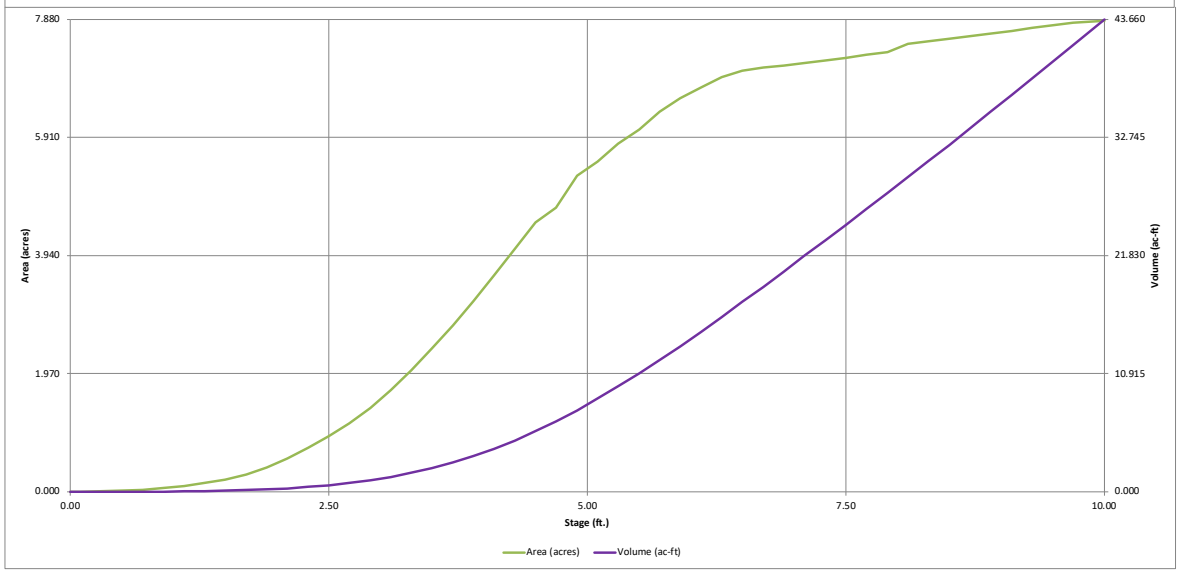
Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Media Surface	--	0.00	--	--	--	8	0.000		
	--	0.10	--	--	--	159	0.004	8	0.000
	--	0.30	--	--	--	518	0.012	76	0.002
	--	0.50	--	--	--	880	0.020	216	0.005
	--	0.70	--	--	--	1,476	0.034	451	0.010
	--	0.90	--	--	--	2,684	0.062	867	0.020
	--	1.10	--	--	--	4,272	0.098	1,563	0.036
	--	1.30	--	--	--	6,295	0.145	2,620	0.060
	--	1.50	--	--	--	8,900	0.204	4,139	0.095
	--	1.70	--	--	--	12,608	0.289	6,290	0.144
	--	1.90	--	--	--	17,799	0.409	9,330	0.214
	--	2.10	--	--	--	24,279	0.557	13,538	0.311
	--	2.30	--	--	--	32,002	0.735	19,166	0.440
	--	2.50	--	--	--	40,410	0.928	26,407	0.606
	--	2.70	--	--	--	49,714	1.141	35,420	0.813
	--	2.90	--	--	--	61,043	1.401	46,495	1.067
	--	3.10	--	--	--	73,871	1.696	59,987	1.377
	--	3.30	--	--	--	88,084	2.022	76,182	1.749
	--	3.50	--	--	--	103,933	2.386	95,384	2.190
	--	3.70	--	--	--	120,752	2.772	117,852	2.706
	--	3.90	--	--	--	138,451	3.178	143,772	3.301
	--	4.10	--	--	--	157,233	3.610	173,341	3.979
	--	4.30	--	--	--	176,561	4.053	206,720	4.746
	--	4.50	--	--	--	195,888	4.497	243,965	5.601
	--	4.70	--	--	--	206,309	4.736	284,185	6.524
	--	4.90	--	--	--	229,682	5.273	327,784	7.525
	--	5.10	--	--	--	240,000	5.510	374,752	8.603
	--	5.30	--	--	--	253,000	5.808	424,052	9.735
	--	5.50	--	--	--	263,000	6.038	475,652	10.919
	--	5.70	--	--	--	276,365	6.344	529,588	12.158
	--	5.90	--	--	--	285,840	6.562	585,809	13.448
	--	6.10	--	--	--	293,902	6.747	643,783	14.779
	--	6.30	--	--	--	301,086	6.912	703,282	16.145
	--	6.50	--	--	--	306,077	7.027	763,998	17.539
	--	6.70	--	--	--	308,020	7.071	825,408	18.949
	--	6.90	--	--	--	309,851	7.113	887,195	20.367
	--	7.10	--	--	--	311,688	7.155	949,349	21.794
	--	7.30	--	--	--	313,532	7.198	1,011,871	23.229
	--	7.50	--	--	--	315,444	7.242	1,074,768	24.673
	--	7.70	--	--	--	317,366	7.286	1,138,049	26.126
	--	7.90	--	--	--	319,309	7.330	1,201,717	27.588
	--	8.10	--	--	--	325,566	7.474	1,266,204	29.068
	--	8.30	--	--	--	327,439	7.517	1,331,505	30.567
	--	8.50	--	--	--	329,316	7.560	1,397,180	32.075
	--	8.70	--	--	--	331,196	7.603	1,463,231	33.591
	--	8.90	--	--	--	333,081	7.646	1,529,659	35.116
	--	9.10	--	--	--	334,970	7.690	1,596,464	36.650
	--	9.30	--	--	--	336,863	7.733	1,663,648	38.192
	--	9.50	--	--	--	338,762	7.777	1,731,210	39.743
	--	9.70	--	--	--	340,667	7.821	1,799,153	41.303
	--	10.00	--	--	--	342,453	7.862	1,901,621	43.655

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)



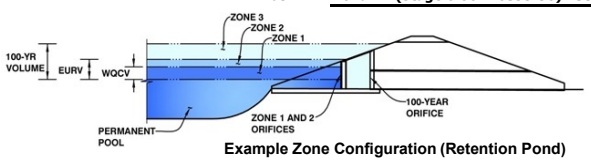


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **Dawson Trails Filing 2**

Basin ID: **Pond A1 (Stage 0.00 = 6399.50) 235 cfs is the max release rate under railroad**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (100-year)	7.57	25.146	Weir&Pipe (Restrict)
Zone 2			
Zone 3			
Total (all zones)		25.146	

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

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

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

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

Calculated Parameters for Plate

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

	Row 1 (optional)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Orifice Area (sq. inches)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

	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)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Orifice Area (sq. inches)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected			Not Selected	Not Selected	
Invert of Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =			ft^2
Depth at top of Zone using Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =			feet
Vertical Orifice Diameter =			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 1 Weir	Not Selected			Zone 1 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	0.00		ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	6.00		feet
Overflow Weir Front Edge Length =	8.00		feet	Overflow Weir Slope Length =	24.74		feet
Overflow Weir Grate Slope =	4.00		H:V	Grate Open Area / 100-yr Orifice Area =	6.68		
Horiz. Length of Weir Sides =	24.00		feet	Overflow Grate Open Area w/o Debris =	137.74		ft^2
Overflow Grate Type =	Type C Grate			Overflow Grate Open Area w/ Debris =	68.87		ft^2
Debris Clogging % =	50%		%				

Calculated Parameters for Overflow Weir

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

	Zone 1 Restrictor	Not Selected			Zone 1 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.00		ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	20.63		ft^2
Outlet Pipe Diameter =	66.00		inches	Outlet Orifice Centroid =	2.43		feet
Restrictor Plate Height Above Pipe Invert =	53.50		inches	Half-Central Angle of Restrictor Plate on Pipe =	2.24	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	8.00	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.98	feet
Spillway Crest Length =	300.00	feet	Stage at Top of Freeboard =	9.98	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	7.86	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	43.50	acre-ft

Calculated Parameters for Spillway

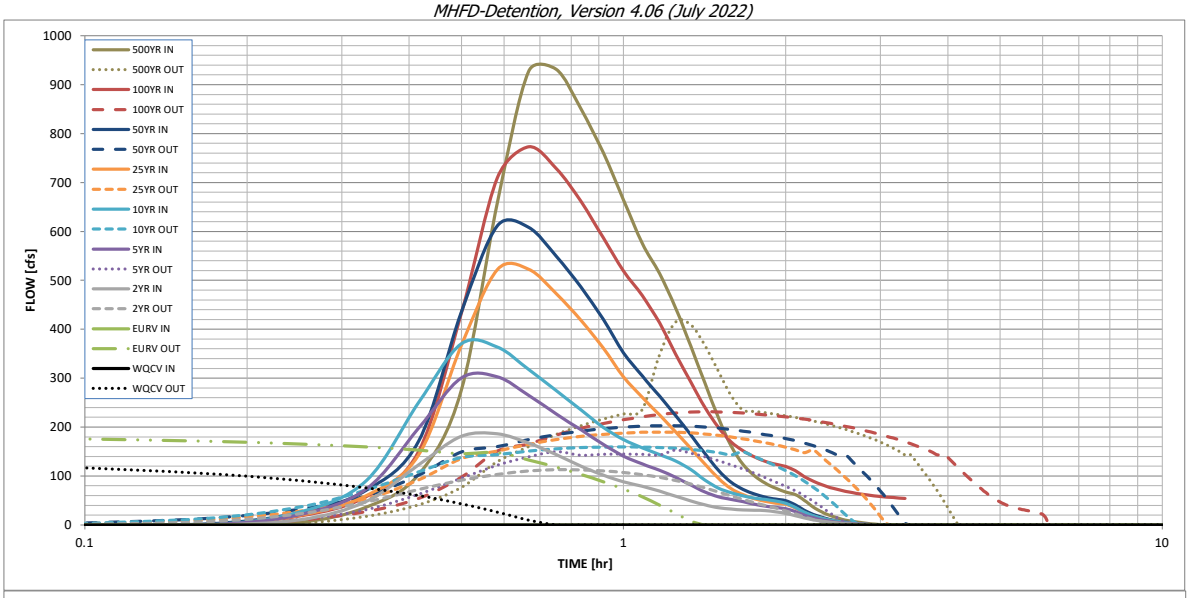
Routed Hydrograph Results

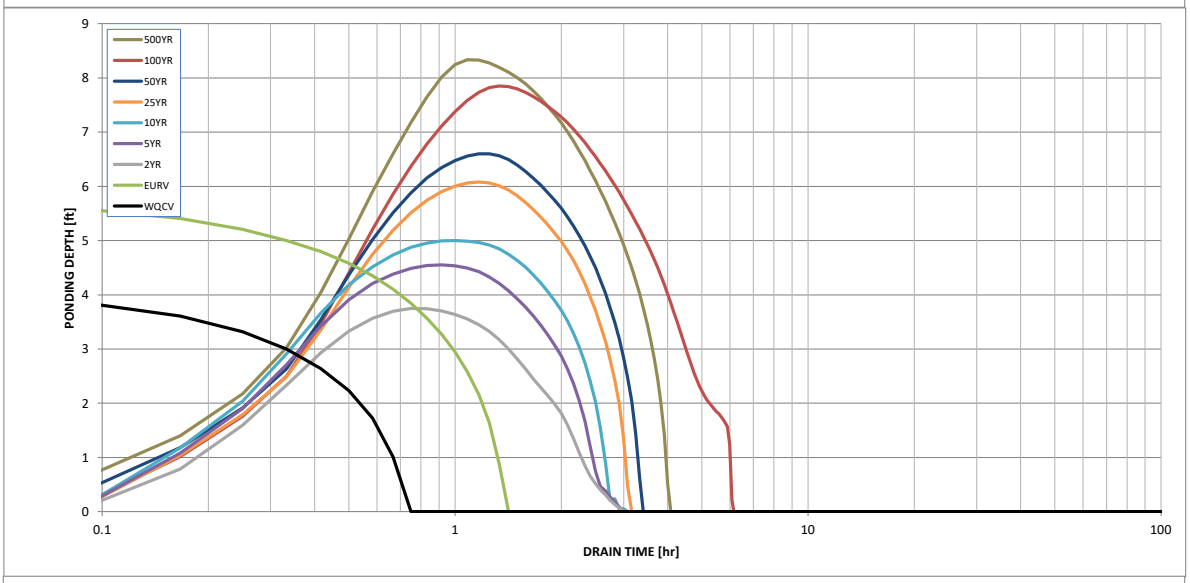
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

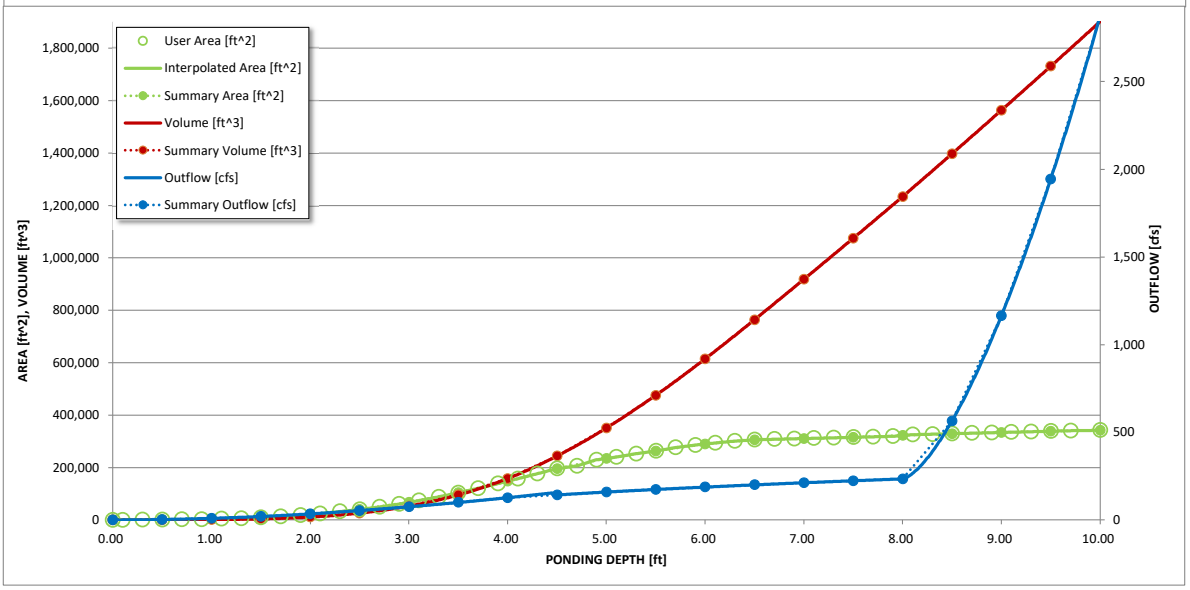
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.06	1.43	1.66	2.01	2.26	2.60	3.14
CUHP Runoff Volume (acre-ft) =	4.578	13.399	11.983	19.066	23.829	32.263	37.779	46.114	58.319
User Override Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	11.983	19.066	23.829	32.263	37.779	67.254	58.319
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	18.2	84.0	122.6	232.6	286.2	375.5	495.4
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.07	0.33	0.48	0.91	1.12	1.47	1.94
Peak Inflow Q (cfs) =	N/A	N/A	186.2	302.7	369.9	522.7	611.3	772.7	931.4
Peak Outflow Q (cfs) =	135.1	182.3	112.8	152.6	159.3	189.7	202.8	231.3	414.6
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	1.8	1.3	0.8	0.7	0.6	0.8
Structure Controlling Flow =	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	1.03	1.34	0.82	1.1	1.2	1.4	1.5	1.7	1.8
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	1	1	2	2	2	3	3	4	4
Time to Drain 99% of Inflow Volume (hours) =	**1**	1	2	2	3	3	3	5	4
Maximum Ponding Depth (ft) =	4.26	5.90	3.74	4.55	5.00	6.08	6.60	7.85	8.33
Area at Maximum Ponding Depth (acres) =	3.96	6.56	2.85	4.54	5.38	6.72	7.05	7.32	7.52
Maximum Volume Stored (acre-ft) =	4.585	13.448	2.818	5.781	8.004	14.577	18.172	27.148	30.793

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	USER	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	1.67	0.08	5.08
	0:15:00	0.00	0.00	10.20	20.71	25.65	19.10	24.81	17.90	36.25
	0:20:00	0.00	0.00	48.23	73.87	90.93	60.30	70.97	57.85	103.02
	0:25:00	0.00	0.00	122.82	197.70	250.20	143.05	171.38	150.50	274.62
	0:30:00	0.00	0.00	181.07	300.27	369.88	365.92	433.96	431.46	658.47
	0:35:00	0.00	0.00	186.22	302.72	363.61	521.77	611.29	709.56	927.35
	0:40:00	0.00	0.00	167.44	264.73	317.57	522.65	608.28	772.74	931.39
	0:45:00	0.00	0.00	143.48	226.68	274.71	472.72	549.16	728.68	851.07
	0:50:00	0.00	0.00	120.20	194.50	235.32	418.74	486.40	661.87	761.07
	0:55:00	0.00	0.00	101.60	164.72	199.40	361.72	420.27	587.16	664.73
	1:00:00	0.00	0.00	87.99	140.65	174.27	302.41	351.96	518.97	575.53
	1:05:00	0.00	0.00	78.72	124.51	157.70	260.95	304.57	468.77	513.96
	1:10:00	0.00	0.00	68.92	111.52	143.86	224.79	263.20	413.15	443.06
	1:15:00	0.00	0.00	58.43	97.29	130.36	190.14	223.50	349.27	364.72
	1:20:00	0.00	0.00	49.01	81.42	112.76	156.25	183.77	291.41	289.55
	1:25:00	0.00	0.00	40.93	67.18	91.53	124.27	145.74	240.03	219.01
	1:30:00	0.00	0.00	35.25	57.52	75.19	95.40	111.79	199.25	162.00
	1:35:00	0.00	0.00	32.21	52.43	65.62	74.32	87.39	170.11	123.74
	1:40:00	0.00	0.00	30.73	47.35	59.42	61.72	72.71	151.41	100.69
	1:45:00	0.00	0.00	29.92	42.16	54.97	53.65	63.23	138.93	85.36
	1:50:00	0.00	0.00	29.40	38.44	51.88	48.20	56.81	130.07	74.80
	1:55:00	0.00	0.00	26.93	35.69	48.75	44.54	52.48	123.82	67.36
	2:00:00	0.00	0.00	23.55	33.05	44.27	42.06	49.51	119.28	62.01
	2:05:00	0.00	0.00	18.99	26.99	35.58	34.73	40.83	110.76	50.25
	2:10:00	0.00	0.00	14.08	19.81	25.92	25.27	29.66	98.87	36.25
	2:15:00	0.00	0.00	10.41	14.52	18.78	18.38	21.54	89.40	26.36
	2:20:00	0.00	0.00	7.60	10.55	13.57	13.36	15.64	82.18	19.29
	2:25:00	0.00	0.00	5.49	7.50	9.75	9.58	11.22	76.55	13.94
	2:30:00	0.00	0.00	3.88	5.19	6.90	6.75	7.89	72.12	9.83
	2:35:00	0.00	0.00	2.67	3.58	4.83	4.79	5.60	68.60	6.97
	2:40:00	0.00	0.00	1.75	2.42	3.24	3.30	3.85	65.71	4.77
	2:45:00	0.00	0.00	1.04	1.53	1.98	2.08	2.42	63.24	2.99
	2:50:00	0.00	0.00	0.52	0.84	1.03	1.14	1.33	61.18	1.62
	2:55:00	0.00	0.00	0.21	0.36	0.41	0.49	0.56	59.50	0.66
	3:00:00	0.00	0.00	0.05	0.08	0.09	0.10	0.12	58.11	0.12
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	56.93	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	55.88	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	54.86	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.85	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	52.82	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	51.80	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50.79	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	49.79	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	48.80	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.85	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	46.93	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	46.03	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	45.11	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	44.19	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	43.29	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	42.41	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	41.50	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	40.57	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	39.66	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	38.77	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	37.85	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	36.90	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	35.96	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	35.03	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	34.16	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.15	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31.98	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.80	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	29.64	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	28.52	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.54	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	26.09	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24.36	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22.62	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.98	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19.45	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

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

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

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]
	0.00	8	0.000	0	0.000	0.00
	0.50	880	0.020	216	0.005	2.90
	1.00	3,478	0.080	1,175	0.027	9.58
	1.50	8,900	0.204	4,139	0.095	20.12
	2.00	21,039	0.483	11,272	0.259	34.85
	2.50	40,410	0.928	26,407	0.606	54.12
	3.00	67,457	1.549	52,920	1.215	75.54
	3.50	103,933	2.386	95,384	2.190	99.85
	4.00	147,842	3.394	158,087	3.629	127.15
	4.50	195,888	4.497	243,965	5.601	143.03
	5.00	234,841	5.391	351,010	8.058	159.35
	5.50	263,000	6.038	475,652	10.919	174.14
	6.00	289,871	6.655	614,594	14.109	187.77
	6.50	306,077	7.027	763,998	17.539	200.48
	7.00	310,769	7.134	918,226	21.080	212.43
	7.50	315,444	7.242	1,074,768	24.673	223.74
	8.00	322,437	7.402	1,233,804	28.324	234.50
	8.50	329,316	7.560	1,397,180	32.075	564.69
	9.00	334,026	7.668	1,563,015	35.882	1,164.27
	9.50	338,762	7.777	1,731,210	39.743	1,944.04
	10.00	342,453	7.862	1,901,621	43.655	2,873.25

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

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

FLOOD CONTROL POND A1 SPILLWAY & IMPACT BASIN RIPRAP CALCULATION

SPILLWAY:

100-Year Peak Inflow[1] = 874 cfs

Spillway Crest Length[1] = 284.0 ft

Longitudinal Slope = 25%

Unit Discharge = 874/284 = 3.07 cfs/ft

[1] *From MHFD Detention Workbook*

IMPACT BASIN:

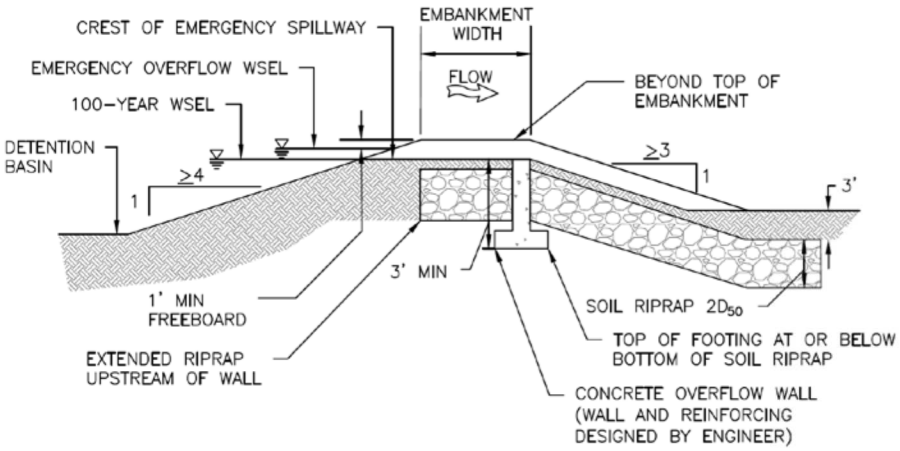
100-Year Peak Inflow[1] = 200 cfs

Spillway Crest Length[1] = 15.0 ft

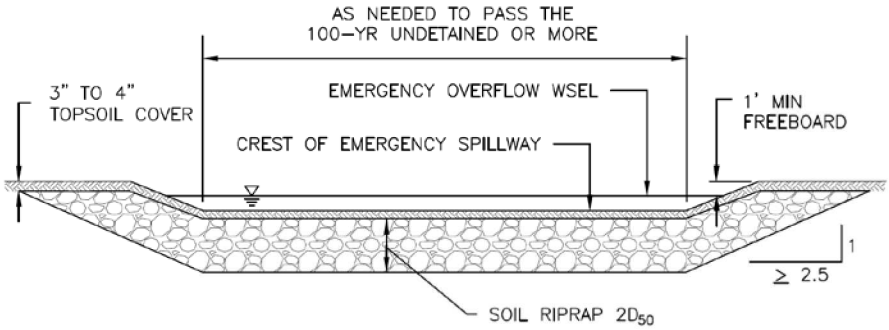
Longitudinal Slope = 5%

Unit Discharge = 200/15 = 13.33 cfs/ft

[1] *From MHFD Detention Workbook*



EMERGENCY SPILLWAY PROFILE



EMERGENCY SPILLWAY SECTION AND SPILLWAY CHANNEL

RIPRAP DESIGNATION
VL (D_{50} = 6 IN)
L (D_{50} = 9 IN)
M (D_{50} = 12 IN)
H (D_{50} = 18 IN)
VH (D_{50} = 24 IN)

* *If Type VL Riprap is calculated, use Type L (typical per USDCM Vol. 2, Ch. 9, Figure 9-38).*

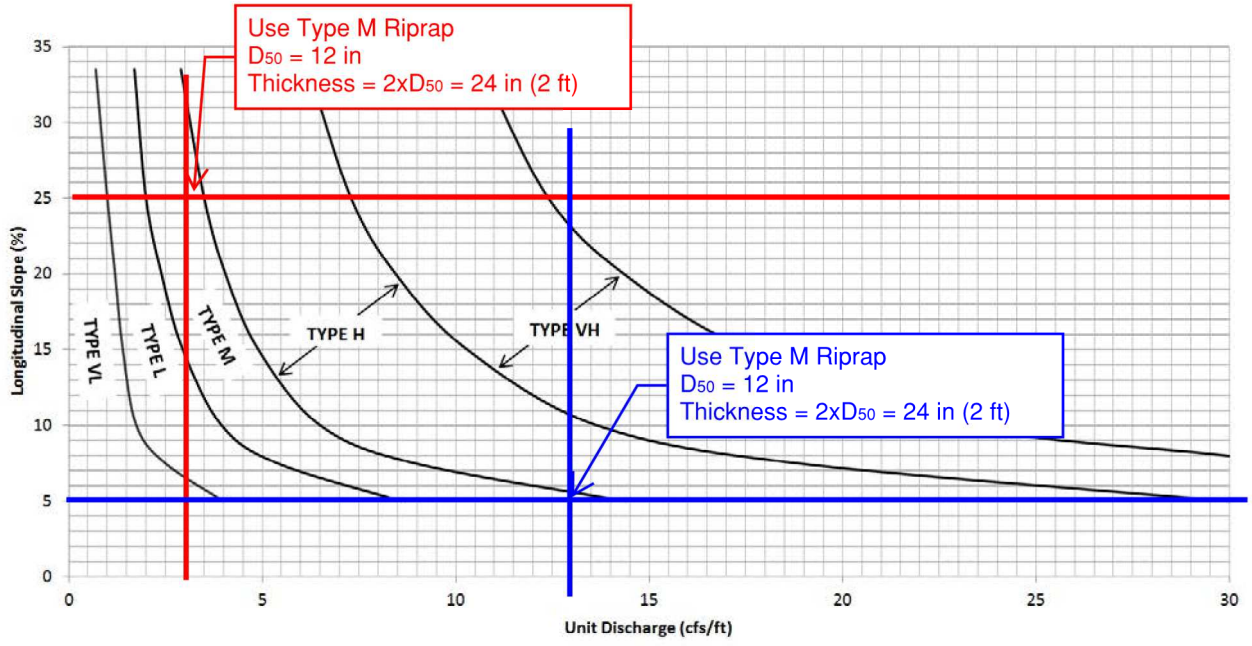


Figure 12-21. Embankment protection details and rock sizing chart (adapted from Arapahoe County)

Worksheet for Pond A1 Outfall Pipe

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.013
Channel Slope	0.030 ft/ft
Diameter	66.0 in
Discharge	231.00 cfs

Results	
Normal Depth	28.9 in
Flow Area	10.0 ft²
Wetted Perimeter	8.0 ft
Hydraulic Radius	15.1 in
Top Width	5.46 ft
Critical Depth	51.0 in
Percent Full	43.8 %
Critical Slope	0.005 ft/ft
Velocity	23.07 ft/s
Velocity Head	8.27 ft
Specific Energy	10.68 ft
Froude Number	3.003
Maximum Discharge	625.64 cfs
Discharge Full	581.61 cfs
Slope Full	0.005 ft/ft
Flow Type	Supercritical

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	43.8 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	28.9 in
Critical Depth	51.0 in
Channel Slope	0.030 ft/ft
Critical Slope	0.005 ft/ft

United States Bureau of Reclamation (USBR) Type VI Impact Basin

Project Name:	Dawson Trails - INFRA 1 CD Package
Project Number:	20-224
Date:	9/28/2023
Designer:	JCK

Filled in by designer

Calculated value

Per section 9.4 of the U.S Department of Transportation Federal Highway Administration (FHWA) Hydraulic Engineering Circular No. 14, Third Edition: Hydraulic Design of Energy Dissipators for Culverts and Channels

1) $Q =$ 231 CFS — Maximum Discharge

2) $V_o =$ 23.07 FT/S — Velocity in Pipe

3) $A =$ 10.013004 ft^2 — Calculted flow area at the end of the approach pipe — $A = Q/V_o$

4) $Y_e =$ 2.24 ft — Calculated equivalent depth — $y_e = (A/2)^{1/2}$

5) $Fr =$ 2.718 — Calculated Froude Number — $Fr = V_o/(gy_e)^{1/2}$

6) $H_o =$ 10.50 — Calculated energy at the end of the pipe — $H_o = y_e + V_o^2/(2g)$

7) Determine H_o/W from figure 9.14 below. Enter Value to the right — $H_o / W =$ 0.8

The design information is presented as a dimensionless curve in Figure 9.14. This curve incorporates the original information contained in ASCE (1957) and the results of additional experimentation performed by the Department of Public Works, City of Los Angeles. The curve

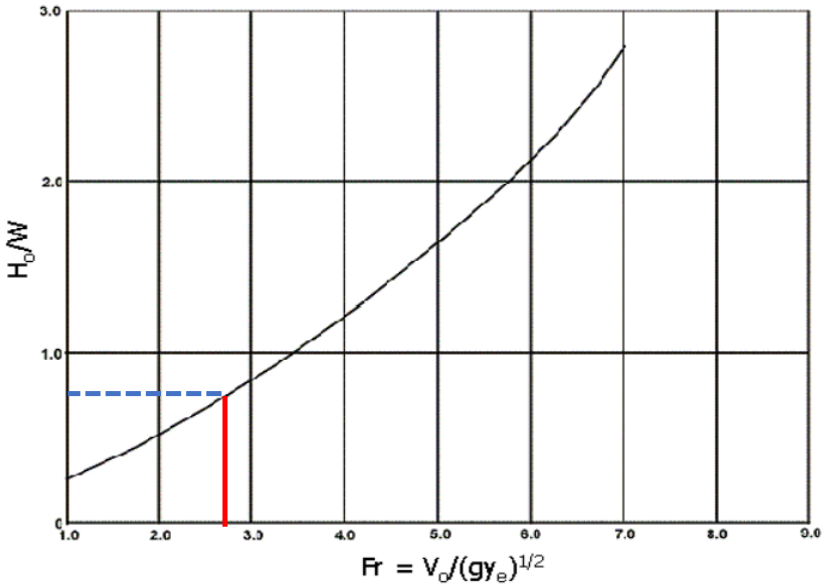


Figure 9.14. Design Curve for USBR Type VI Impact Basin

8) $W_B =$ 13.127354

W_B	h_1	h_2	h_3	h_4	L	L_1	L_2
4	3.08	1.50	0.67	1.67	5.42	2.33	3.08
5	3.83	1.92	0.83	2.08	6.67	2.92	3.83
6	4.58	2.25	1.00	2.50	8.00	3.42	4.58
7	5.42	2.58	1.17	2.92	9.42	4.00	5.42
8	6.17	3.00	1.33	3.33	10.67	4.58	6.17
9	6.92	3.42	1.50	3.75	12.00	5.17	6.92
10	7.58	3.75	1.67	4.17	13.42	5.75	7.58
11	8.42	4.17	1.83	4.58	14.58	6.33	8.42
12	9.17	4.50	2.00	5.00	16.00	6.83	9.17
13	10.17	4.92	2.17	5.42	17.33	7.42	10.17
14	10.75	5.25	2.33	5.83	18.67	8.00	10.75
15	11.50	5.58	2.50	6.25	20.00	8.50	11.50
16	12.25	6.00	2.67	6.67	21.33	9.08	12.25
17	13.00	6.33	2.83	7.08	21.50	9.67	13.00
18	13.75	6.67	3.00	7.50	23.92	10.25	13.75
19	14.58	7.08	3.17	7.92	25.33	10.83	14.58
20	15.33	7.50	3.33	8.33	26.58	11.42	15.33

W_B	W_1	W_2	t_1	t_2	t_3	t_4	t_5
4	0.33	1.08	0.50	0.50	0.50	0.50	0.25
5	0.42	1.42	0.50	0.50	0.50	0.50	0.25
6	0.50	1.67	0.50	0.50	0.50	0.50	0.25
7	0.50	1.92	0.50	0.50	0.50	0.50	0.25
8	0.58	2.17	0.50	0.58	0.58	0.50	0.25
9	0.67	2.50	0.58	0.58	0.67	0.58	0.25
10	0.75	2.75	0.67	0.67	0.75	0.67	0.25
11	0.83	3.00	0.67	0.75	0.75	0.67	0.33
12	0.92	3.00	0.67	0.83	0.83	0.75	0.33
13	1.00	3.00	0.67	0.92	0.83	0.83	0.33
14	1.08	3.00	0.67	1.00	0.92	0.92	0.42
15	1.17	3.00	0.67	1.00	1.00	1.00	0.42
16	1.25	3.00	0.75	1.00	1.00	1.00	0.50
17	1.33	3.00	0.75	1.08	1.00	1.00	0.50
18	1.33	3.00	0.75	1.08	1.08	1.08	0.58
19	1.42	3.00	0.83	1.17	1.08	1.08	0.58
20	1.50	3.00	0.83	1.17	1.17	1.17	0.67

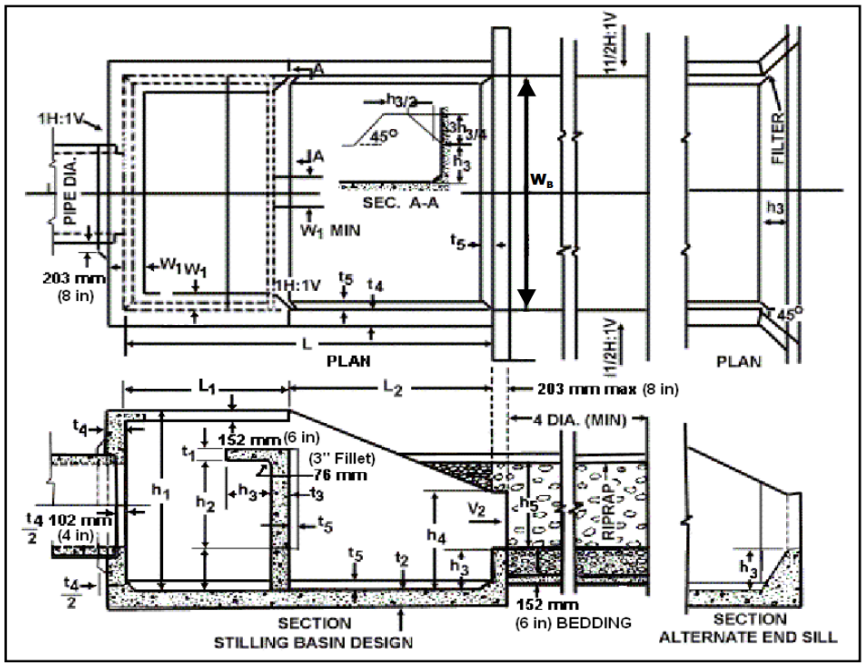


Figure 9.13. USBR Type VI Impact Basin

In non-cohesive soil channels and channels where future degradation is expected, especially where there is no drop structure immediately downstream, it is generally recommended that the stilling basin be eliminated and the sloping face extended five feet below the downstream future channel invert elevation (after accounting for future streambed degradation). A scour hole will form naturally downstream of a structure in non-cohesive soils and construction of a hard basin is an unnecessary cost. Additionally, a hard basin would be at risk for undermining. See Figure 9-12 for the profile of the GSB and Figure 9-17 for that of an SC in this configuration. In some cases, the structure may have a net drop height of zero immediately after construction, but is designed with a long-term net height of 3 to 5 feet to accommodate future lowering of the channel invert.

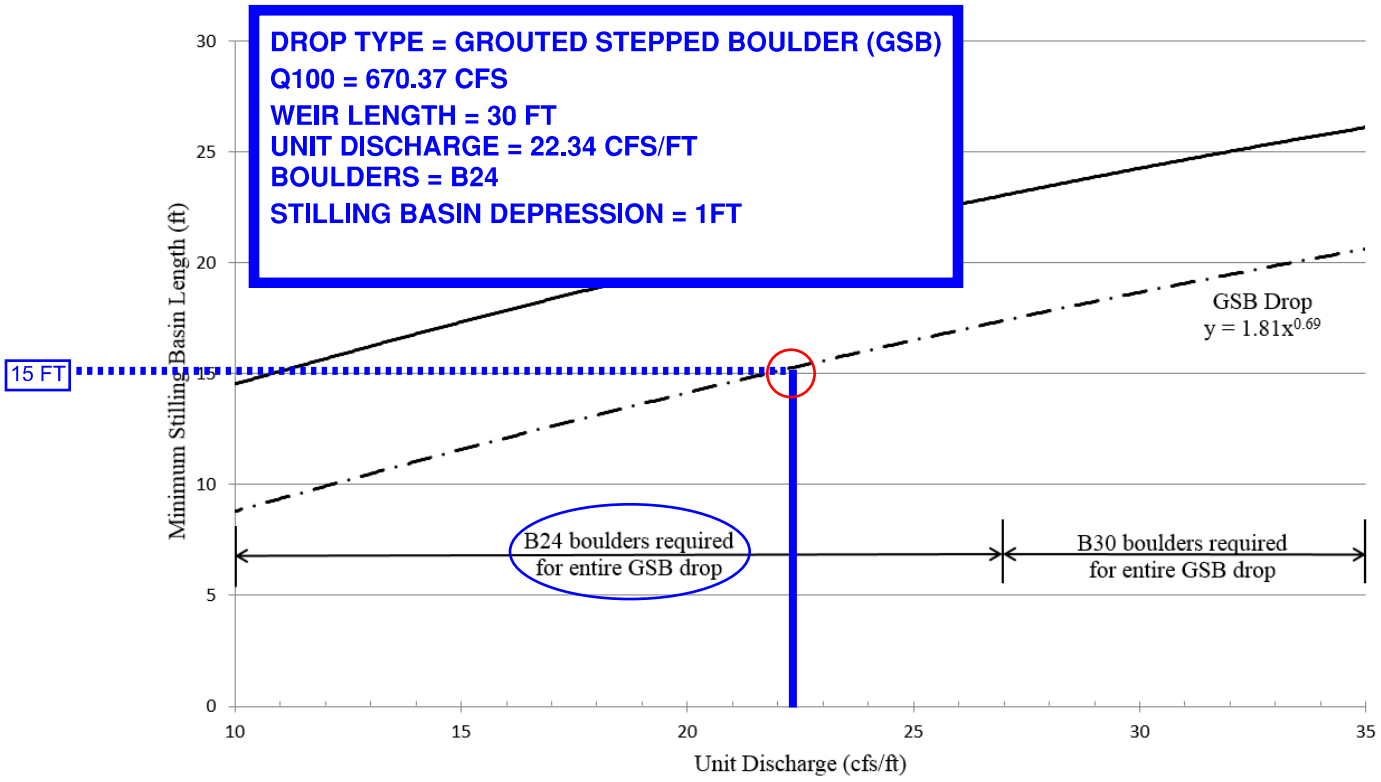


Figure 9-1. Stilling basin length based on unit discharge (for simplified design procedure)

2.2.6 Seepage Analysis and Cutoff Wall Design

The simplified drop structure design only applies to drops with cutoffs located in cohesive soils. Therefore, it is necessary to determine surface and subsurface soil conditions in the vicinity of a proposed drop structure prior to being able to use the simplified approach for cutoff design. For a drop structure constructed in cohesive soils meeting all requirements of a simplified design, the cutoff wall must be a minimum of six feet deep for concrete and ten feet deep for sheet pile.

If a proposed drop structure meets the requirements of the simplified approach, but is located in non-cohesive soils, guidance on determining the required cutoff wall depth is described in Section 2.4.

MILE HIGH FLOOD DISTRICT

DETENTION BASIN DESIGN WORKBOOK

MHFD-Detention, Version 4.06 (July 2022)
Mile High Flood District
Denver, Colorado
www.mhfd.org

Purpose:

This workbook aids in the estimation of stormwater detention basin sizing and outlet routing based on the modified puls routing method for urban watersheds. Several different BMP types and various outlet configurations can be sized.

Function:

1. Approximates the stage-area-volume relationship for a detention basin based on watershed parameters and basin geometry parameters. Also evaluates existing user-defined basin stage-area relationships.

2. Sizes filtration media orifice, outlet orifices, elliptical slots, weirs, trash racks, and develops stage-discharge relationships. Uses the Modified Puls method to route a series of hydrographs (i.e., 2-, 5-, 10-, 25-, 50-, 100- and 500-year) and calibrates the peak discharge out of the basin to match the pre-development peak discharges for the watershed.

Content: **This workbook consists of the following sheets:**

Basin	Tabulates stage-area-volume relationship estimates based on watershed parameters
Outlet Structure	Tabulates a stage-discharge relationship for the user-defined outlet structure (inlet control).
Reference	Provides reference equations and figures.
User Tips and Tools	Provides instructions and video links to assist in using this workbook. Includes a stage-area calculator.
BMP Zone Images	Provides images of typical BMP zone confirgurations corresponding with Zone pulldown selections.

Acknowledgements: ***Spreadsheet Development Team:***
Ken MacKenzie, P.E., Holly Piza, P.E.
Mile High Flood District

Derek N. Rapp, P.E.
Peak Stormwater Engineering, LLC

Dr. James C.Y. Guo, Ph.D., P.E.
Professor, Department of Civil Engineering, University of Colorado at Denver

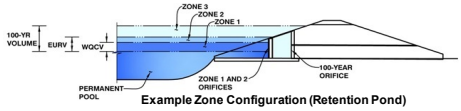
Comments? Direct all comments regarding this spreadsheet workbook to: **MHFD E-Mail**
Revisions? Check for revised versions of this or any other workbook at: **Downloads**

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: Dawson Trails

Basin ID: Pond E1 (Stage 0.00 = 6535.00)



Example Zone Configuration (Retention Pond)

Watershed Information

Flood Control Only

Selected BMP Type =	**No BMP**		**Note: L / W Ratio < 1**
Watershed Area =	138.10	acres	**L / W Ratio = 0.91**
Watershed Length =	2,344	ft	
Watershed Length to Centroid =	1,067	ft	
Watershed Slope =	0.060	ft/ft	
Watershed Imperviousness =	44.80%	percent	
Percentage Hydrologic Soil Group A =	0.0%	percent	
Percentage Hydrologic Soil Group B =	0.0%	percent	
Percentage Hydrologic Soil Groups C/D =	100.0%	percent	
Target WQCV Drain Time =	N/A	hours	
Location for 1-hr Rainfall Depths =	User Input		

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

			Optional User Overrides
Water Quality Capture Volume (WQCV) =	2.214	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	5.802	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 1.06 in.) =	5.608	acre-feet	1.06 inches
5-yr Runoff Volume (P1 = 1.43 in.) =	9.351	acre-feet	1.43 inches
10-yr Runoff Volume (P1 = 1.66 in.) =	11.892	acre-feet	1.66 inches
25-yr Runoff Volume (P1 = 2.01 in.) =	16.379	acre-feet	2.01 inches
50-yr Runoff Volume (P1 = 2.26 in.) =	19.325	acre-feet	2.26 inches
100-yr Runoff Volume (P1 = 2.6 in.) =	23.805	acre-feet	2.60 inches
500-yr Runoff Volume (P1 = 3.14 in.) =	30.259	acre-feet	3.14 inches
Approximate 2-yr Detention Volume =	4.535	acre-feet	
Approximate 5-yr Detention Volume =	7.399	acre-feet	
Approximate 10-yr Detention Volume =	8.402	acre-feet	
Approximate 25-yr Detention Volume =	9.703	acre-feet	
Approximate 50-yr Detention Volume =	10.072	acre-feet	
Approximate 100-yr Detention Volume =	11.966	acre-feet	

Define Zones and Basin Geometry

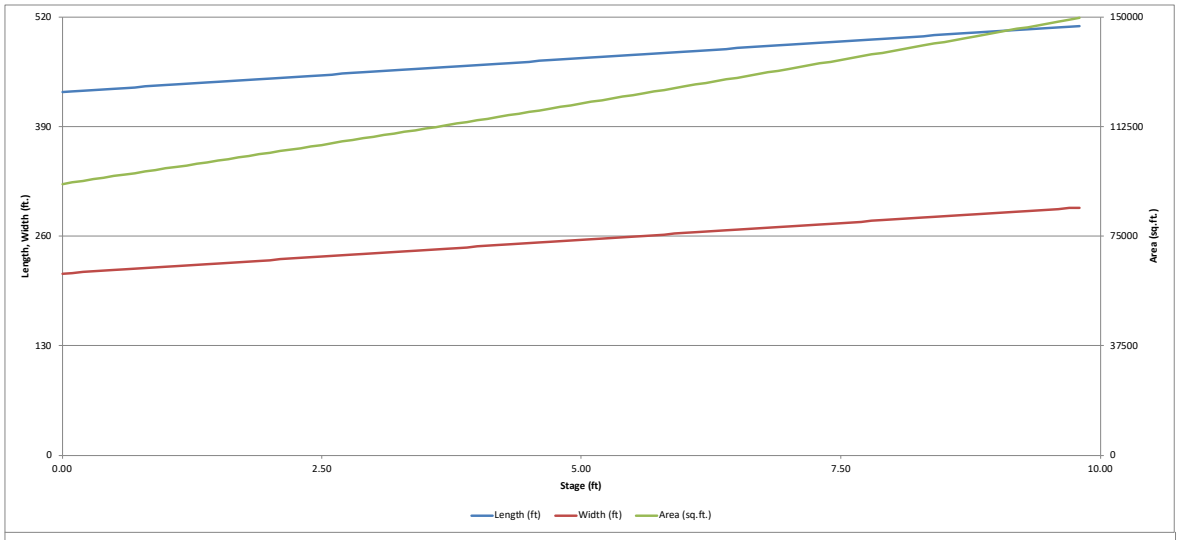
Zone 1 Volume (User Defined) =	18.000	acre-feet
Select Zone 2 Storage Volume (Optional) =		acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	18.000	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention Depth (H_{total}) =	7.00	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.005	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2	
Initial Surcharge Area (A_{ISV}) =	0	ft^2
Surcharge Volume Length (L_{ISV}) =	0.0	ft
Surcharge Volume Width (W_{ISV}) =	0.0	ft
Depth of Basin Floor (H_{FLOOR}) =	0.00	ft
Length of Basin Floor (L_{FLOOR}) =	431.1	ft
Width of Basin Floor (W_{FLOOR}) =	215.5	ft
Area of Basin Floor (A_{FLOOR}) =	92,915	ft^2
Volume of Basin Floor (V_{FLOOR}) =	0	ft^3
Depth of Main Basin (H_{MAIN}) =	7.00	ft
Length of Main Basin (L_{MAIN}) =	487.1	ft
Width of Main Basin (W_{MAIN}) =	271.5	ft
Area of Main Basin (A_{MAIN}) =	132,262	ft^2
Volume of Main Basin (V_{MAIN}) =	784,080	ft^3
Calculated Total Basin Volume (V_{total}) =	**18.000**	acre-feet

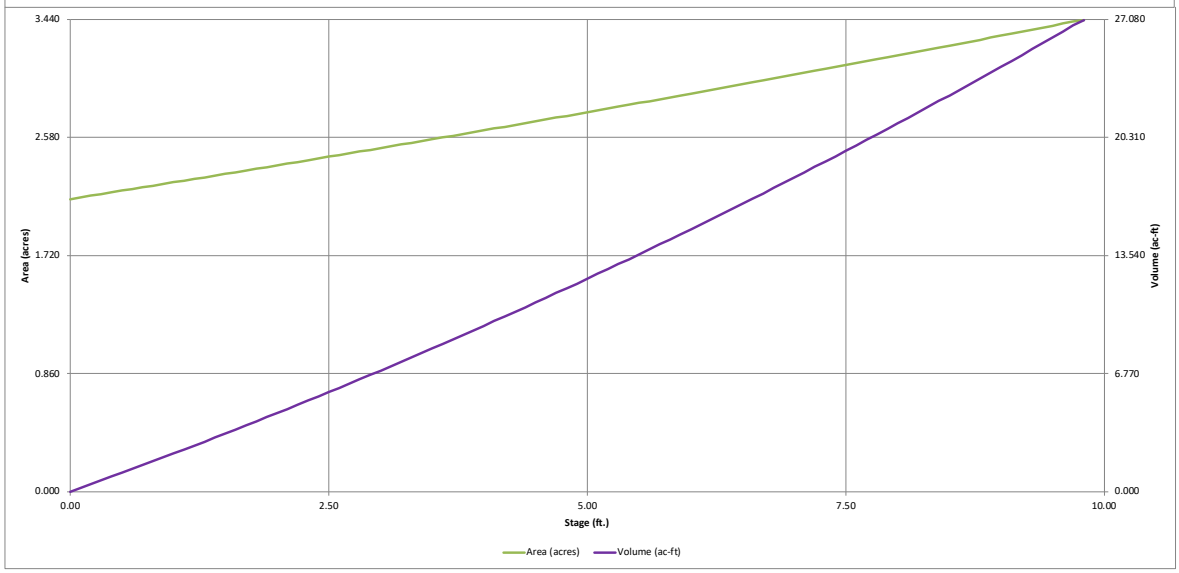
Depth Increment = 0.10 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Media Surface	0.00		431.1	215.5	92,915		2.133		
	0.10		431.9	216.3	93,433		2.145	9,317	0.214
	0.20		432.7	217.1	93,953		2.157	18,687	0.429
	0.30		433.5	217.9	94,473		2.169	28,108	0.645
	0.40		434.3	218.7	94,995		2.181	37,581	0.863
	0.50		435.1	219.5	95,518		2.193	47,107	1.081
	0.60		435.9	220.3	96,042		2.205	56,685	1.301
	0.70		436.7	221.1	96,568		2.217	66,315	1.522
	0.80		437.5	221.9	97,095		2.229	75,999	1.745
	0.90		438.3	222.7	97,623		2.241	85,734	1.968
	1.00		439.1	223.5	98,152		2.253	95,523	2.193
	1.10		439.9	224.3	98,683		2.265	105,365	2.419
	1.20		440.7	225.1	99,215		2.278	115,260	2.646
	1.30		441.5	225.9	99,748		2.290	125,208	2.874
	1.40		442.3	226.7	100,283		2.302	135,210	3.104
	1.50		443.1	227.5	100,819		2.314	145,265	3.335
	1.60		443.9	228.3	101,356		2.327	155,373	3.567
	1.70		444.7	229.1	101,894		2.339	165,536	3.800
	1.80		445.5	229.9	102,434		2.352	175,752	4.035
	1.90		446.3	230.7	102,975		2.364	186,023	4.270
	2.00		447.1	231.5	103,517		2.376	196,347	4.508
	2.10		447.9	232.3	104,061		2.389	206,726	4.746
	2.20		448.7	233.1	104,606		2.401	217,160	4.985
	2.30		449.5	233.9	105,152		2.414	227,648	5.226
	2.40		450.3	234.7	105,699		2.427	238,190	5.468
	2.50		451.1	235.5	106,248		2.439	248,787	5.711
	2.60		451.9	236.3	106,798		2.452	259,440	5.956
	2.70		452.7	237.1	107,349		2.464	270,147	6.202
	2.80		453.5	237.9	107,901		2.477	280,910	6.449
	2.90		454.3	238.7	108,455		2.490	291,727	6.697
	3.00		455.1	239.5	109,010		2.503	302,601	6.947
	3.10		455.9	240.3	109,567		2.515	313,529	7.198
	3.20		456.7	241.1	110,124		2.528	324,514	7.450
	3.30		457.5	241.9	110,683		2.541	335,554	7.703
	3.40		458.3	242.7	111,243		2.554	346,651	7.958
	3.50		459.1	243.5	111,805		2.567	357,803	8.214
	3.60		459.9	244.3	112,368		2.580	369,012	8.471
	3.70		460.7	245.1	112,932		2.593	380,277	8.730
	3.80		461.5	245.9	113,497		2.606	391,598	8.990
	3.90		462.3	246.7	114,063		2.619	402,976	9.251
	4.00		463.1	247.5	114,631		2.632	414,411	9.514
	4.10		463.9	248.3	115,200		2.645	425,902	9.777
	4.20		464.7	249.1	115,771		2.658	437,451	10.042
	4.30		465.5	249.9	116,343		2.671	449,057	10.309
	4.40		466.3	250.7	116,916		2.684	460,719	10.577
	4.50		467.1	251.5	117,490		2.697	472,440	10.846
	4.60		467.9	252.3	118,065		2.710	484,217	11.116
	4.70		468.7	253.1	118,642		2.724	496,053	11.388
	4.80		469.5	253.9	119,220		2.737	507,946	11.661
	4.90		470.3	254.7	119,800		2.750	519,897	11.935
	5.00		471.1	255.5	120,380		2.764	531,906	12.211
	5.10		471.9	256.3	120,962		2.777	543,973	12.488
	5.20		472.7	257.1	121,545		2.790	556,098	12.766
	5.30		473.5	257.9	122,130		2.804	568,282	13.046
	5.40		474.3	258.7	122,716		2.817	580,524	13.327
	5.50		475.1	259.5	123,303		2.831	592,825	13.609
	5.60		475.9	260.3	123,891		2.844	605,185	13.893
	5.70		476.7	261.1	124,481		2.858	617,604	14.178
	5.80		477.5	261.9	125,072		2.871	630,081	14.465
	5.90		478.3	262.7	125,664		2.885	642,618	14.752
	6.00		479.1	263.5	126,257		2.898	655,214	15.042
	6.10		479.9	264.3	126,852		2.912	667,869	15.332
	6.20		480.7	265.1	127,448		2.926	680,584	15.624
	6.30		481.5	265.9	128,045		2.940	693,359	15.917
	6.40		482.3	266.7	128,644		2.953	706,194	16.212
	6.50		483.1	267.5	129,244		2.967	719,088	16.508
	6.60		483.9	268.3	129,845		2.981	732,042	16.805
	6.70		484.7	269.1	130,447		2.995	745,057	17.104
	6.80		485.5	269.9	131,051		3.009	758,132	17.404
	6.90		486.3	270.7	131,656		3.022	771,267	17.706
Zone 1 (User)	7.00		487.1	271.5	132,262		3.036	784,463	18.009
	7.10		487.9	272.3	132,870		3.050	797,720	18.313
	7.20		488.7	273.1	133,479		3.064	811,037	18.619
	7.30		489.5	273.9	134,089		3.078	824,415	18.926
	7.40		490.3	274.7	134,700		3.092	837,855	19.234
	7.50		491.1	275.5	135,313		3.106	851,355	19.544
	7.60		491.9	276.3	135,927		3.120	864,917	19.856
	7.70		492.7	277.1	136,542		3.135	878,541	20.169
	7.80		493.5	277.9	137,158		3.149	892,226	20.483
	7.90		494.3	278.7	137,776		3.163	905,973	20.798
	8.00		495.1	279.5	138,395		3.177	919,781	21.115
	8.10		495.9	280.3	139,016		3.191	933,652	21.434
	8.20		496.7	281.1	139,637		3.206	947,584	21.754
	8.30		497.5	281.9	140,260		3.220	961,579	22.075
	8.40		498.3	282.7	140,884		3.234	975,636	22.398
	8.50		499.1	283.5	141,510		3.249	989,756	22.722
	8.60		499.9	284.3	142,136		3.263	1,003,938	23.047
	8.70		500.7	285.1	142,764		3.277	1,018,183	23.374
	8.80		501.5	285.9	143,394		3.292	1,032,491	23.703
	8.90		502.3	286.7	144,024		3.306	1,046,862	24.033
	9.00		503.1	287.5	144,656		3.321	1,061,296	24.364
	9.10		503.9	288.3	145,289		3.335	1,075,793	24.697
	9.20		504.7	289.1	145,924		3.350	1,090,354	25.031
	9.30		505.5	289.9	146,559		3.365	1,104,978	25.367
	9.40		506.3	290.7	147,196		3.379	1,119,666	25.704
	9.50		507.1	291.5	147,835		3.394	1,134,417	26.043
	9.60		507.9	292.3	148,474		3.408	1,149,233	26.383
	9.70		508.7	293.1	149,115		3.423	1,164,112	26.724
	9.80		509.5	293.9	149,757		3.438	1,179,056	27.067

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)



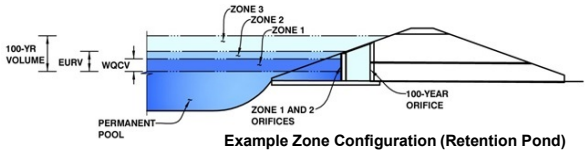


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **Dawson Trails**

Basin ID: **Pond E1 (Stage 0.00 = 6535.00)**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (User)	7.00	18.000	Weir&Pipe (Rect.)
Zone 2			
Zone 3			
Total (all zones)		18.000	

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

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

Underdrain Orifice Diameter = inches

Calculated Parameters for Underdrain

Underdrain Orifice Area = ft^2

Underdrain Orifice Centroid = feet

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

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

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

Orifice Plate: Orifice Vertical Spacing = inches

Orifice Plate: Orifice Area per Row = sq. inches

Calculated Parameters for Plate

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

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

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

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

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

	Zone 1 Weir	Not Selected			Zone 1 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	0.00		ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	4.00		feet
Overflow Weir Front Edge Length =	12.00		feet	Overflow Weir Slope Length =	16.49		feet
Overflow Weir Grate Slope =	4.00		H:V	Grate Open Area / 100-yr Orifice Area =	25.83		
Horiz. Length of Weir Sides =	16.00		feet	Overflow Grate Open Area w/o Debris =	137.74		ft^2
Overflow Grate Type =	Type C Grate			Overflow Grate Open Area w/ Debris =	68.87		ft^2
Debris Clogging % =	50%		%				

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

	Zone 1 Rectangular	Not Selected			Zone 1 Rectangular	Not Selected	
Depth to Invert of Outlet Pipe =	0.00		ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	5.33		ft^2
Rectangular Orifice Width =	96.00		inches	Outlet Orifice Centroid =	0.33		feet
Rectangular Orifice Height =	8.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	7.00	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	1.04	feet
Spillway Crest Length =	160.00	feet	Stage at Top of Freeboard =	9.04	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	3.33	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	24.50	acre-ft

Calculated Parameters for Spillway

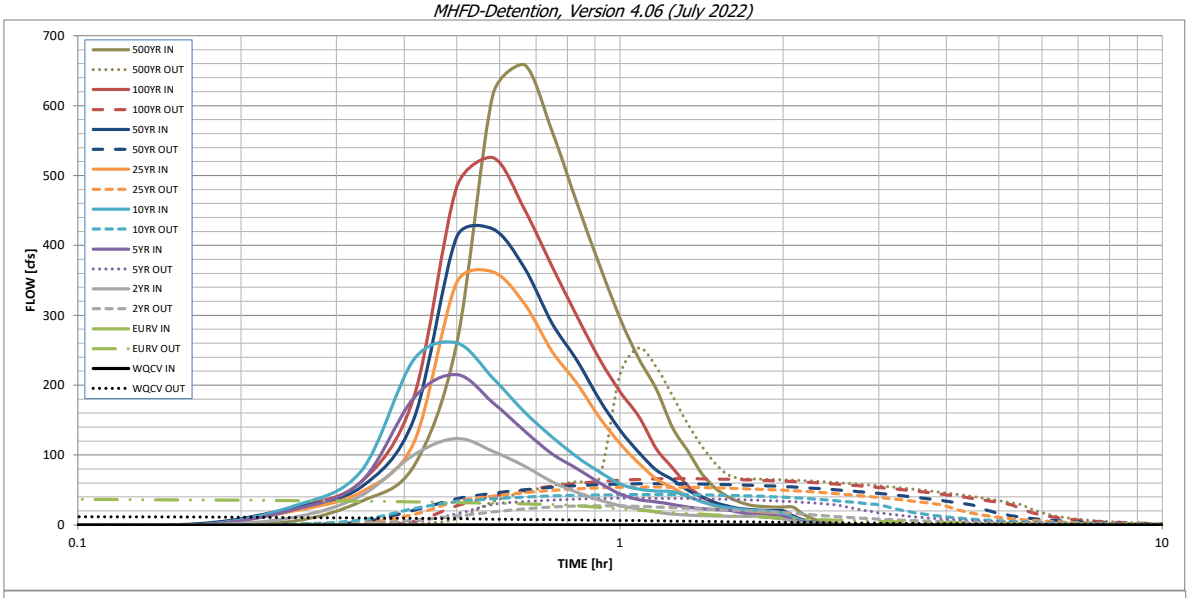
Routed Hydrograph Results

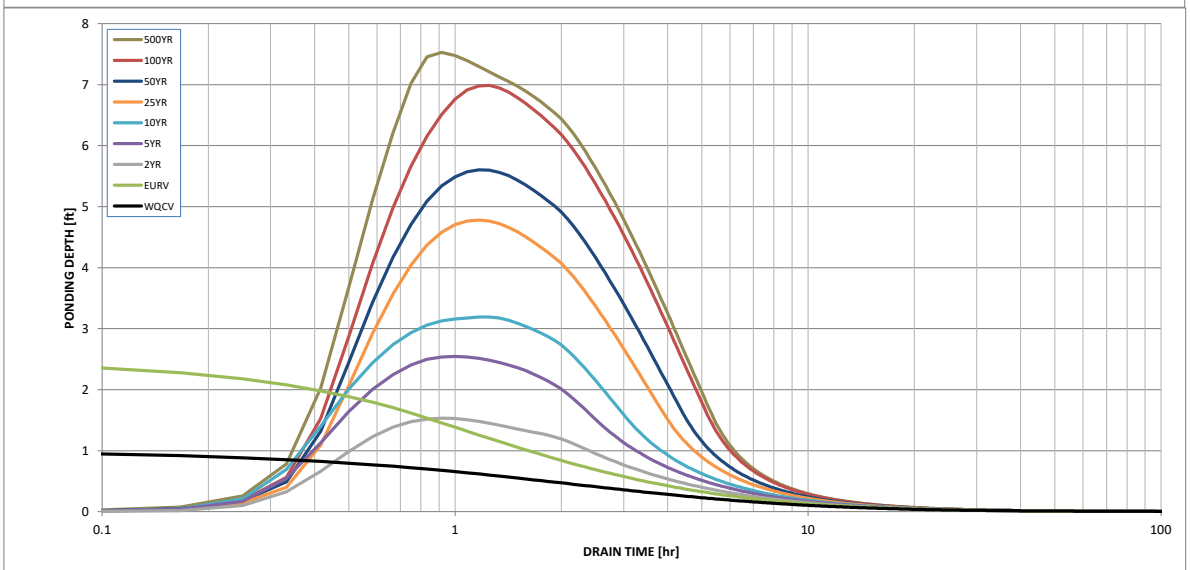
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

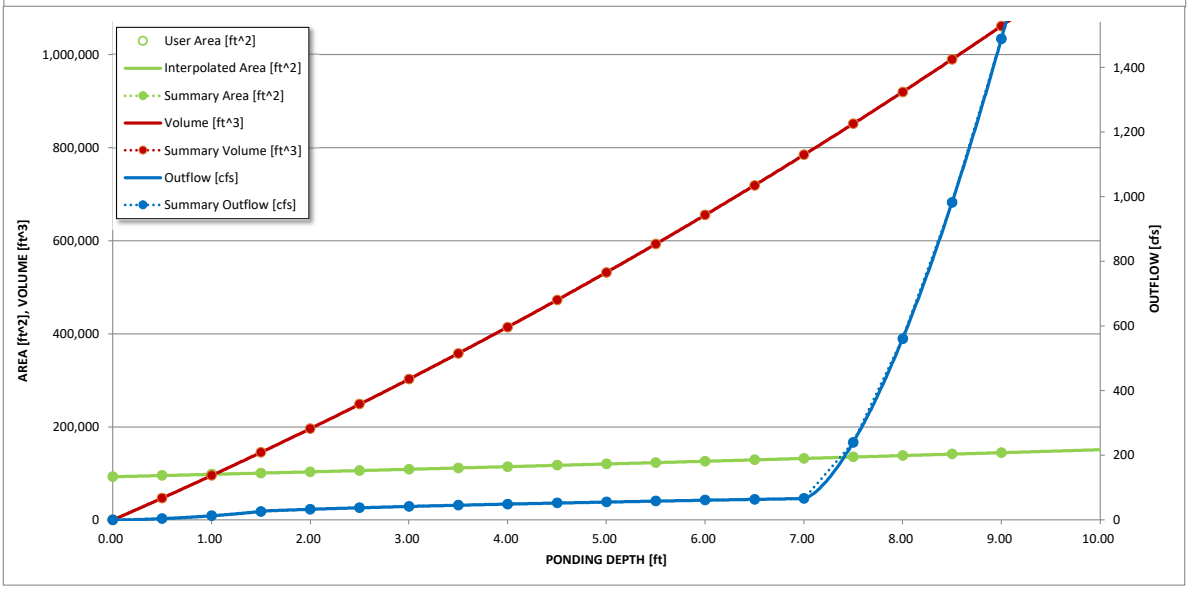
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.06	1.43	1.66	2.01	2.26	2.60	3.14
CUHP Runoff Volume (acre-ft) =	2.214	5.802	5.608	9.351	11.892	16.379	19.325	23.805	30.259
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	5.608	9.351	11.892	16.379	19.325	23.805	30.259
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	22.4	83.6	114.9	200.0	244.6	313.5	409.8
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.16	0.61	0.83	1.45	1.77	2.27	2.97
Peak Inflow Q (cfs) =	N/A	N/A	123.7	214.9	260.4	362.2	423.6	525.7	658.4
Peak Outflow Q (cfs) =	12.8	37.7	27.4	38.2	43.4	54.1	58.9	66.2	252.9
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.5	0.4	0.3	0.2	0.2	0.6
Structure Controlling Flow =	Overflow Weir 1	Outlet Plate 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	0.10	0.28	0.20	0.3	0.3	0.4	0.4	0.5	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) =	23	14	15	12	11	10	10	9	9
Time to Drain 99% of Inflow Volume (hours) =	**47**	27	28	22	19	17	16	16	14
Maximum Ponding Depth (ft) =	1.01	2.54	1.53	2.54	3.19	4.78	5.60	6.98	7.52
Area at Maximum Ponding Depth (acres) =	2.25	2.44	2.32	2.44	2.53	2.73	2.84	3.03	3.11
Maximum Volume Stored (acre-ft) =	2.215	5.809	3.404	5.809	7.399	11.579	13.865	17.948	19.607

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	1.75	0.83	5.31
	0:15:00	0.00	0.00	10.67	21.65	26.82	19.98	24.56	25.33	33.71
	0:20:00	0.00	0.00	41.98	61.95	77.25	47.24	54.57	61.76	84.26
	0:25:00	0.00	0.00	100.16	181.88	236.39	117.71	151.47	182.74	259.67
	0:30:00	0.00	0.00	123.69	214.92	260.41	347.16	412.12	483.40	615.26
	0:35:00	0.00	0.00	105.39	174.96	209.98	362.21	423.58	525.69	658.36
	0:40:00	0.00	0.00	84.26	134.51	161.68	316.13	367.57	451.51	562.93
	0:45:00	0.00	0.00	61.65	101.58	125.57	248.20	288.25	369.84	460.43
	0:50:00	0.00	0.00	46.53	80.66	97.20	202.49	235.37	298.39	372.13
	0:55:00	0.00	0.00	35.78	60.50	75.84	153.73	179.19	237.42	296.23
	1:00:00	0.00	0.00	27.56	44.50	58.79	116.48	135.89	190.71	237.81
	1:05:00	0.00	0.00	22.87	36.10	50.98	88.27	103.67	155.27	194.78
	1:10:00	0.00	0.00	18.16	33.01	48.54	65.82	78.57	109.23	139.39
	1:15:00	0.00	0.00	15.50	29.28	47.67	53.49	64.75	81.67	106.24
	1:20:00	0.00	0.00	14.11	25.56	40.80	41.30	49.74	56.15	73.20
	1:25:00	0.00	0.00	13.30	23.18	32.99	33.59	40.15	40.37	52.65
	1:30:00	0.00	0.00	12.79	21.82	27.80	26.86	32.00	31.00	40.36
	1:35:00	0.00	0.00	12.45	21.00	24.53	22.42	26.65	24.94	32.46
	1:40:00	0.00	0.00	12.25	17.74	22.48	19.75	23.42	21.54	28.00
	1:45:00	0.00	0.00	12.22	15.49	21.14	18.33	21.68	20.35	26.37
	1:50:00	0.00	0.00	12.22	14.15	20.35	17.54	20.72	19.79	25.57
	1:55:00	0.00	0.00	10.07	13.36	19.04	17.21	20.35	19.76	25.54
	2:00:00	0.00	0.00	8.54	12.30	16.61	17.05	20.17	19.76	25.54
	2:05:00	0.00	0.00	5.41	7.76	10.52	10.94	12.93	12.66	16.33
	2:10:00	0.00	0.00	3.25	4.62	6.33	6.64	7.83	7.66	9.86
	2:15:00	0.00	0.00	1.89	2.71	3.68	3.90	4.59	4.48	5.75
	2:20:00	0.00	0.00	1.00	1.52	2.01	2.19	2.58	2.51	3.21
	2:25:00	0.00	0.00	0.47	0.78	0.97	1.13	1.32	1.28	1.63
	2:30:00	0.00	0.00	0.17	0.28	0.32	0.41	0.47	0.45	0.56
	2:35:00	0.00	0.00	0.03	0.03	0.03	0.03	0.03	0.02	0.02
	2:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

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

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

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]
	0.00	92,915	2.133	0	0.000	0.00
	0.50	95,518	2.193	47,107	1.081	4.11
	1.00	98,152	2.253	95,523	2.193	13.01
	1.50	100,819	2.314	145,265	3.335	26.41
	2.00	103,517	2.376	196,347	4.508	33.15
	2.50	106,248	2.439	248,787	5.711	37.80
	3.00	109,010	2.503	302,601	6.947	41.94
	3.50	111,805	2.567	357,803	8.214	45.70
	4.00	114,631	2.632	414,411	9.514	49.17
	4.50	117,490	2.697	472,440	10.846	52.42
	5.00	120,380	2.764	531,906	12.211	55.47
	5.50	123,303	2.831	592,825	13.609	58.37
	6.00	126,257	2.898	655,214	15.042	61.13
	6.50	129,244	2.967	719,088	16.508	63.77
	7.00	132,262	3.036	784,463	18.009	66.31
	7.50	135,313	3.106	851,355	19.544	240.15
	8.00	138,395	3.177	919,781	21.115	560.70
	8.50	141,510	3.249	989,756	22.722	981.66
	9.00	144,656	3.321	1,061,296	24.364	1,487.55

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

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

Dawson Trails Infrastructure 1

CORE Project #: 20-224

Prepared By: LCC

CULVERT DESIGN SUMMARY

-REFERENCE Town of Castle Rock Storm Drainage Design and Technical Criteria Sections 11.2, 11.3

SUB-BASIN DATA					CROSSING TOPOGRPAHY						CULVERT DESIGN							HYDRAULIC PROPERTIES			
Road Crossing	Tributary Basins	Design Pt.	AREA ac.	Q100 cfs	Road Sta.	Length (ft.)	Entrance Invert	Exit Invert	Slope	Road CL Elev.	Span (ft.)	Rise (ft.)	Dia. (in.)	Entrance WSE	Q100 HW/D	Allowable HW/D	In/Out Control	Outlet velocity (ft/s)	Outlet depth (ft.)	Froude Number	Tailwater depth (ft.)
DTB	C1	C1	36.5	141.0	161+60	163	6405.87	6405.05	0.50%	6414.89	8	6	NA	6410.01	0.69	1.2	Inlet	10.49	2.38	1.20	2.07
Coll. D	C1-C2	C2	85.2	300.0	26+40	163	6370.43	6370.00	0.26%	6470.74	8	6	NA	6466.92	16.08	1.5	Inlet	11.70	3.45	1.11	2.73
Coll. B	D9.1	D9.1	10.5	9.0	12+40	288	6538.00	6533.00	1.74%	6550.00	NA	NA	24	6540.02	1.01	1.5	Inlet	8.35	0.88	1.57	0.15
Coll. B	D9.2	D9.2	13.3	110.0	18+25	268	6508.50	6504.00	1.68%	6520.00	NA	NA	48	6516.65	2.04	1.5	Inlet	14.69	2.30	1.71	0.71
Coll. B	D10.2	D10.2	10.5	100.0	22+70	289	6496.00	6491.00	1.73%	6505.00	NA	NA	48	6501.17	1.29	1.5	Inlet	14.91	2.11	1.81	0.67

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 156.00 cfs

Design Flow: 640.00 cfs

Maximum Flow: 1050.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: Culvert 7 (Existing Triple 6' x 9' CMP)

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 7 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
6347.16	156.00	156.00	0.00	1
6347.80	245.40	245.40	0.00	1
6348.34	334.80	334.80	0.00	1
6348.80	424.20	424.20	0.00	1
6349.22	513.60	513.60	0.00	1
6349.80	640.00	640.00	0.00	1
6350.04	692.40	692.40	0.00	1
6350.48	781.80	781.80	0.00	1
6350.96	871.20	871.20	0.00	1
6351.48	960.60	960.60	0.00	1
6352.04	1050.00	1050.00	0.00	1
6356.51	1599.83	1599.83	0.00	Overtopping

Culvert Data: Culvert 7

Table 2 - Culvert Summary Table: Culvert 7

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
156.00 cfs	156.00 cfs	6347.16	2.10	0.691	1-S2n	1.15	1.30	1.15	0.74	6.74	5.57
245.40 cfs	245.40 cfs	6347.80	2.74	1.131	1-S2n	1.46	1.67	1.47	0.97	7.79	6.56
334.80 cfs	334.80 cfs	6348.34	3.28	1.550	1-S2n	1.74	1.99	1.75	1.16	8.61	7.32
424.20 cfs	424.20 cfs	6348.80	3.74	1.967	1-S2n	1.99	2.28	2.01	1.33	9.26	7.95
513.60 cfs	513.60 cfs	6349.22	4.16	2.392	1-S2n	2.24	2.54	2.26	1.48	9.81	8.49
640.00 cfs	640.00 cfs	6349.80	4.74	3.018	1-S2n	2.57	2.89	2.60	1.68	10.47	9.14
692.40 cfs	692.40 cfs	6350.04	4.98	3.287	1-S2n	2.70	3.03	2.73	1.76	10.71	9.38
781.80 cfs	781.80 cfs	6350.48	5.42	3.760	1-S2n	2.93	3.25	2.96	1.89	11.09	9.77
871.20 cfs	871.20 cfs	6350.96	5.90	4.254	1-S2n	3.16	3.46	3.19	2.01	11.43	10.12
960.60 cfs	960.60 cfs	6351.48	6.42	4.768	5-S2n	3.39	3.67	3.42	2.12	11.73	10.45
1050.00 cfs	1050.00 cfs	6352.04	6.98	5.303	5-S2n	3.63	3.86	3.65	2.23	12.01	10.75

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

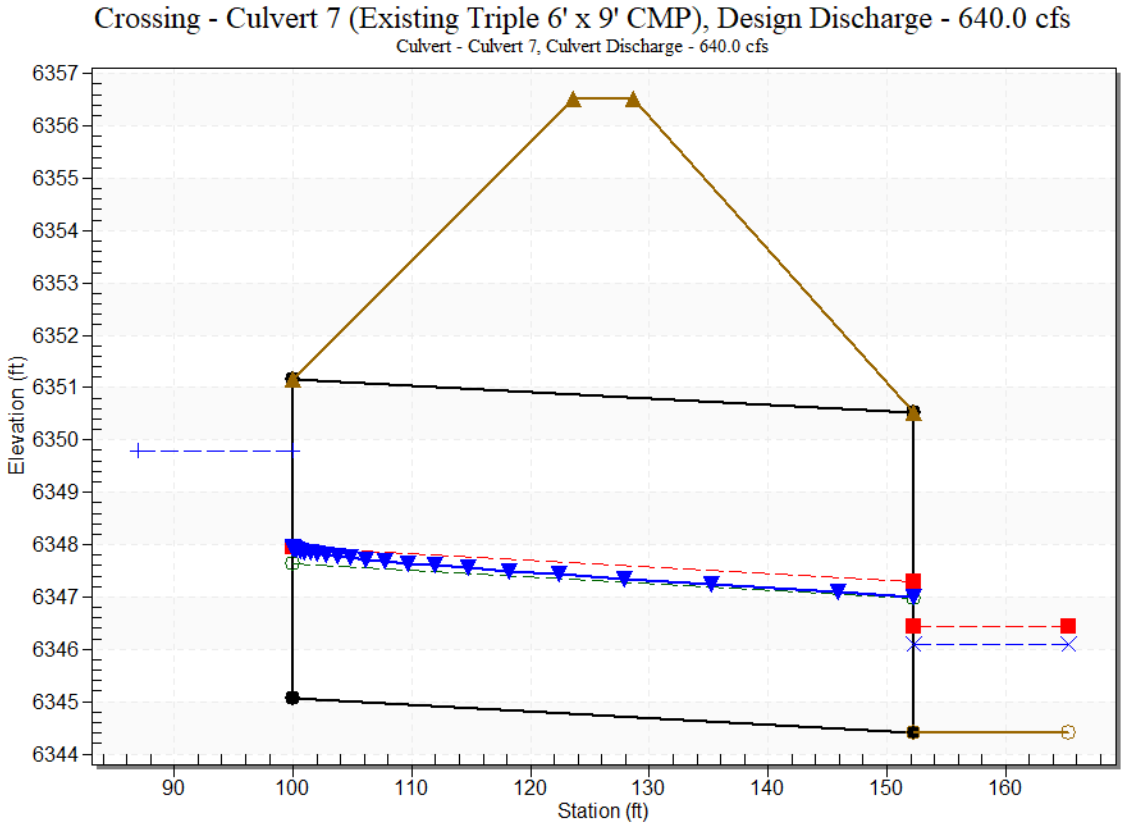
Inlet Elevation (invert): 6345.06 ft,

Outlet Elevation (invert): 6344.41 ft

Culvert Length: 52.26 ft,

Culvert Slope: 0.0124

Water Surface Profile Plot for Culvert: Culvert 7



Site Data - Culvert 7

Site Data Option: Culvert Invert Data

Inlet Station: 100.00 ft

Inlet Elevation: 6345.06 ft

Outlet Station: 152.26 ft

Outlet Elevation: 6344.41 ft

Number of Barrels: 3

Culvert Data Summary - Culvert 7

Barrel Shape: Pipe Arch

Barrel Span: 106.00 in

Barrel Rise: 73.30 in

Barrel Material: Steel Structural Plate

Embedment: 0.00 in

Barrel Manning's n: 0.0220

Culvert Type: Straight

Inlet Configuration: Mitered (Ke=0.7)

Inlet Depression: None

Tailwater Data for Crossing: Culvert 7 (Existing Triple 6' x 9' CMP)

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 7 (Existing Triple 6' x 9' CMP))

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
156.00	6345.15	0.74	5.57	1.32	1.18
245.40	6345.38	0.97	6.56	1.72	1.23
334.80	6345.57	1.16	7.32	2.07	1.27
424.20	6345.74	1.33	7.95	2.37	1.29
513.60	6345.89	1.48	8.49	2.65	1.31
640.00	6346.09	1.68	9.14	3.00	1.34
692.40	6346.17	1.76	9.38	3.14	1.35
781.80	6346.30	1.89	9.77	3.37	1.36
871.20	6346.42	2.01	10.12	3.58	1.37
960.60	6346.53	2.12	10.45	3.78	1.38
1050.00	6346.64	2.23	10.75	3.98	1.39

Tailwater Channel Data - Culvert 7 (Existing Triple 6' x 9' CMP)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 34.89 ft

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0286

Channel Manning's n: 0.0350

Channel Invert Elevation: 6344.41 ft

Roadway Data for Crossing: Culvert 7 (Existing Triple 6' x 9' CMP)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 6356.51 ft

Roadway Surface: Gravel

Roadway Top Width: 5.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 56.00 cfs

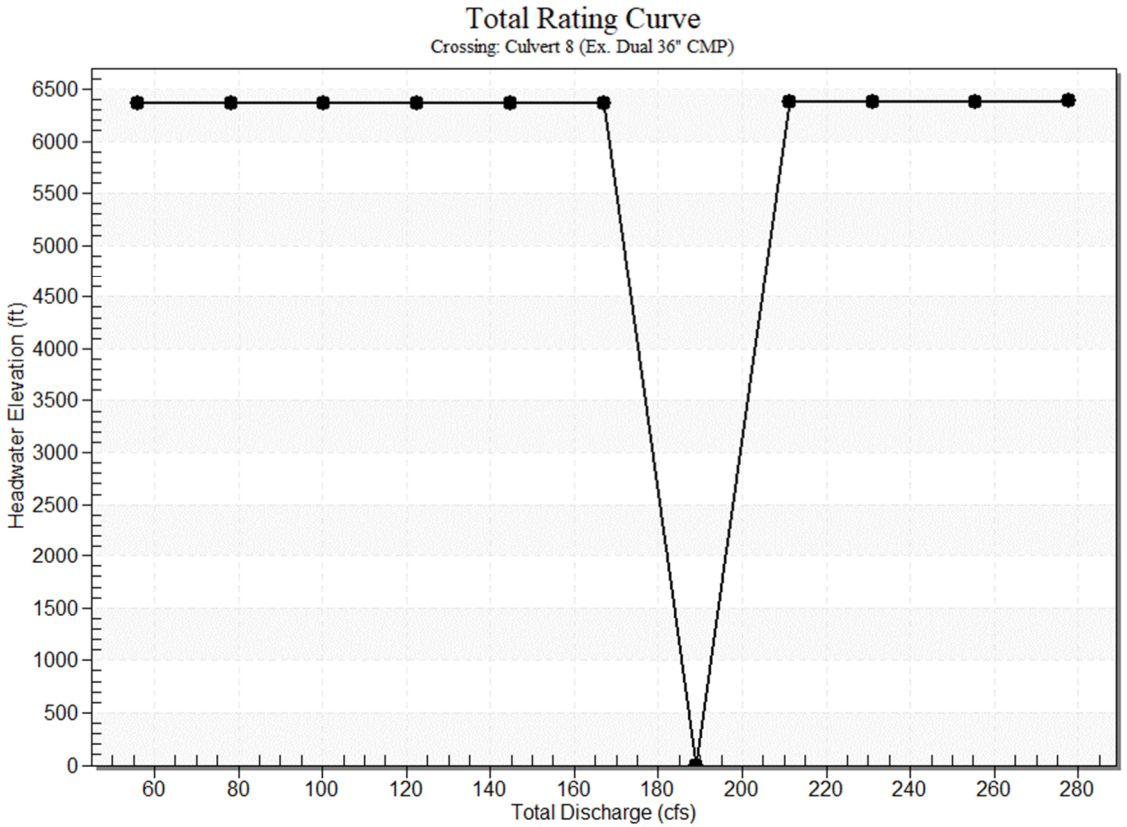
Design Flow: 231.00 cfs

Maximum Flow: 277.80 cfs

Table 1 - Summary of Culvert Flows at Crossing: Culvert 8 (Ex. Dual 36" CMP)

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 8 (1.18 Hw/D ratio @ 75 CFS) Discharge (cfs)	Roadway Discharge (cfs)	Iterations
6363.75	56.00	56.00	0.00	1
6364.41	78.18	78.18	0.00	1
6365.39	100.36	100.36	0.00	1
6366.69	122.54	122.54	0.00	1
6368.31	144.72	144.72	0.00	1
6370.27	166.90	166.90	0.00	1
0.00	189.08	0.00	0.00	1000
6375.09	211.26	0.00	0.00	0
6377.60	231.00	0.00	0.00	0
6381.04	255.62	0.00	0.00	0
6384.43	277.80	0.00	0.00	0
6371.17	176.07	176.07	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 8 (Ex. Dual 36" CMP)



Culvert Data: Culvert 8 (1.18 Hw/D ratio @ 75 CFS)

Table 1 - Culvert Summary Table: Culvert 8 (1.18 Hw/D ratio @ 75 CFS)

Total Discharge	Culvert Discharge	Headwater Elevation	Inlet Control	Outlet Control	Flow Type	Normal Depth	Critical Depth	Outlet Depth	Tailwater Depth	Outlet Velocity	Tailwater Velocity

(cfs)	(cfs)	(ft)	Depth (ft)	Depth (ft)		(ft)	(ft)	(ft)	(ft)	(ft/s)	(ft/s)
56.00 cfs	56.00 cfs	6363.75	2.76	2.978	2-M2c	1.80	1.71	1.71	0.90	6.72	4.85
78.18 cfs	78.18 cfs	6364.41	3.60	3.638	7-M2c	2.31	2.03	2.03	1.12	7.66	5.47
100.36 cfs	100.36 cfs	6365.39	4.62	4.373	7-M2c	3.00	2.31	2.31	1.31	8.61	5.99
122.54 cfs	122.54 cfs	6366.69	5.92	5.547	7-M2c	3.00	2.52	2.52	1.49	9.65	6.43
144.72 cfs	144.72 cfs	6368.31	7.54	6.946	7-M2c	3.00	2.69	2.69	1.66	10.83	6.81
166.90 cfs	166.90 cfs	6370.27	9.50	8.512	7-M2c	3.00	2.80	2.80	1.82	12.15	7.15
189.08 cfs	0.00 cfs	0.00	0.00	1.490	0-NF	0.00	0.00	1.98	1.98	12.15	7.46
211.26 cfs	0.00 cfs	6375.09	14.32	12.254	6-FFc	3.00	3.00	3.00	2.13	14.94	7.74
231.00 cfs	0.00 cfs	6377.60	16.83	14.160	6-FFc	3.00	3.00	3.00	2.26	16.34	7.98
255.62 cfs	0.00 cfs	6381.04	20.27	16.776	6-FFc	3.00	3.00	3.00	2.42	18.08	8.25
277.80 cfs	0.00 cfs	6384.43	23.66	19.359	6-FFc	3.00	3.00	3.00	2.56	19.65	8.47

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

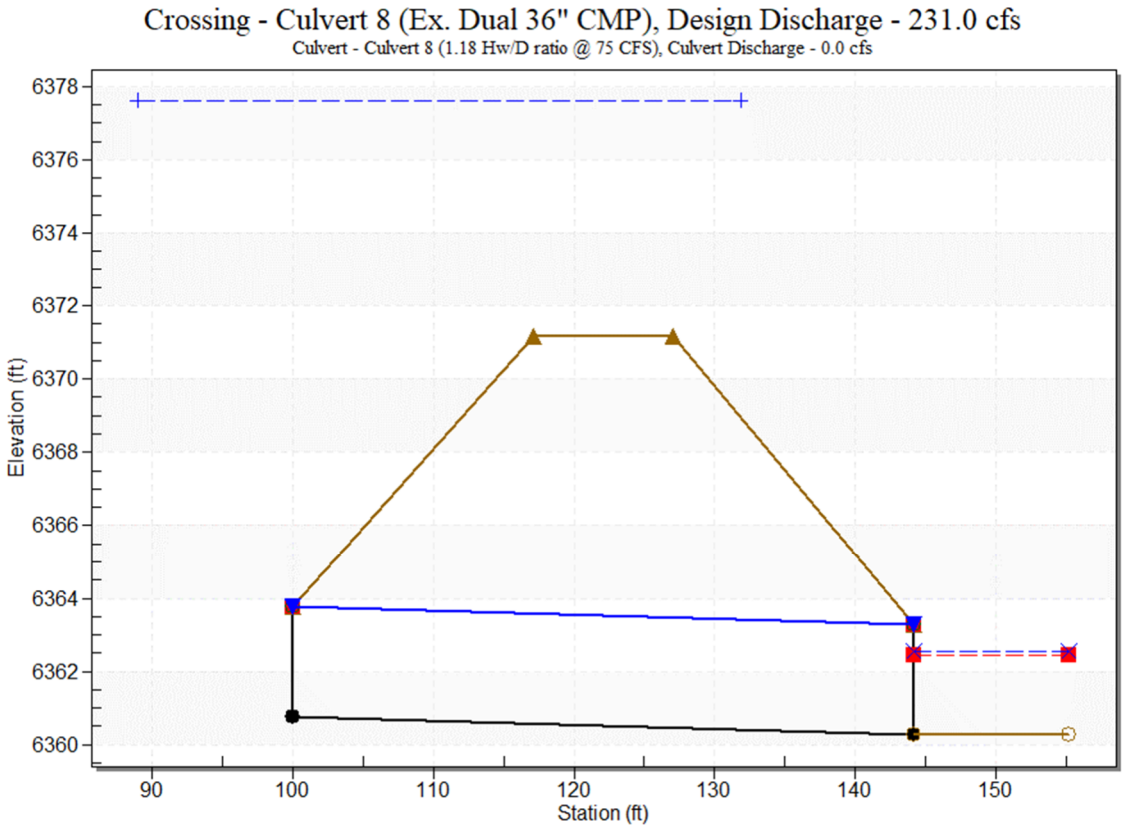
Inlet Elevation (invert): 6360.77 ft,

Outlet Elevation (invert): 6360.28 ft

Culvert Length: 44.17 ft,

Culvert Slope: 0.0111

Water Surface Profile Plot for Culvert: Culvert 8 (1.18 Hw/D ratio @ 75 CFS)



Site Data - Culvert 8 (1.18 Hw/D ratio @ 75 CFS)

Site Data Option: Culvert Invert Data

Inlet Station: 100.00 ft

Inlet Elevation: 6360.77 ft

Outlet Station: 144.17 ft

Outlet Elevation: 6360.28 ft

Number of Barrels: 2

Culvert Data Summary - Culvert 8 (1.18 Hw/D ratio @ 75 CFS)

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0220

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting (Ke=0.9)

Inlet Depression: None

Tailwater Data for Crossing: Culvert 8 (Ex. Dual 36" CMP)

Table 2 - Downstream Channel Rating Curve (Crossing: Culvert 8 (Ex. Dual 36" CMP))

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
56.00	6361.18	0.90	4.85	1.00	0.90
78.18	6361.40	1.12	5.47	1.24	0.91

100.36	6361.59	1.31	5.99	1.45	0.92
122.54	6361.77	1.49	6.43	1.65	0.93
144.72	6361.94	1.66	6.81	1.84	0.93
166.90	6362.10	1.82	7.15	2.02	0.93
189.08	6362.26	1.98	7.46	2.20	0.93
211.26	6362.41	2.13	7.74	2.37	0.93
231.00	6362.54	2.26	7.98	2.51	0.93
255.62	6362.70	2.42	8.25	2.69	0.93
277.80	6362.84	2.56	8.47	2.85	0.93

Tailwater Channel Data - Culvert 8 (Ex. Dual 36" CMP)

Tailwater Channel Option: Rectangular Channel

Bottom Width: 12.80 ft

Channel Slope: 0.0178

Channel Manning's n: 0.0350

Channel Invert Elevation: 6360.28 ft

Roadway Data for Crossing: Culvert 8 (Ex. Dual 36" CMP)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 6371.17 ft

Roadway Surface: Gravel

Roadway Top Width: 10.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 225.00 cfs

Design Flow: 225.00 cfs

Maximum Flow: 225.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: Culvert 9 (6' CMP)

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 9 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
6380.79	225.00	225.00	0.00	1
6380.79	225.00	225.00	0.00	1
6380.79	225.00	225.00	0.00	1
6380.79	225.00	225.00	0.00	1
6380.79	225.00	225.00	0.00	1
6380.79	225.00	225.00	0.00	1
6380.79	225.00	225.00	0.00	1
6380.79	225.00	225.00	0.00	1
6380.79	225.00	225.00	0.00	1
6380.79	225.00	225.00	0.00	1
6380.79	225.00	225.00	0.00	1
6384.88	386.87	386.87	0.00	Overtopping

Culvert Data: Culvert 9

Table 2 - Culvert Summary Table: Culvert 9

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
225.00 cfs	225.00 cfs	6380.79	6.85	7.086	7-M2c	6.00	4.11	4.11	1.15	10.91	12.17
225.00 cfs	225.00 cfs	6380.79	6.85	7.086	7-M2c	6.00	4.11	4.11	1.15	10.91	12.17
225.00 cfs	225.00 cfs	6380.79	6.85	7.086	7-M2c	6.00	4.11	4.11	1.15	10.91	12.17
225.00 cfs	225.00 cfs	6380.79	6.85	7.086	7-M2c	6.00	4.11	4.11	1.15	10.91	12.17
225.00 cfs	225.00 cfs	6380.79	6.85	7.086	7-M2c	6.00	4.11	4.11	1.15	10.91	12.17
225.00 cfs	225.00 cfs	6380.79	6.85	7.086	7-M2c	6.00	4.11	4.11	1.15	10.91	12.17
225.00 cfs	225.00 cfs	6380.79	6.85	7.086	7-M2c	6.00	4.11	4.11	1.15	10.91	12.17
225.00 cfs	225.00 cfs	6380.79	6.85	7.086	7-M2c	6.00	4.11	4.11	1.15	10.91	12.17
225.00 cfs	225.00 cfs	6380.79	6.85	7.086	7-M2c	6.00	4.11	4.11	1.15	10.91	12.17
225.00 cfs	225.00 cfs	6380.79	6.85	7.086	7-M2c	6.00	4.11	4.11	1.15	10.91	12.17
225.00 cfs	225.00 cfs	6380.79	6.85	7.086	7-M2c	6.00	4.11	4.11	1.15	10.91	12.17

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

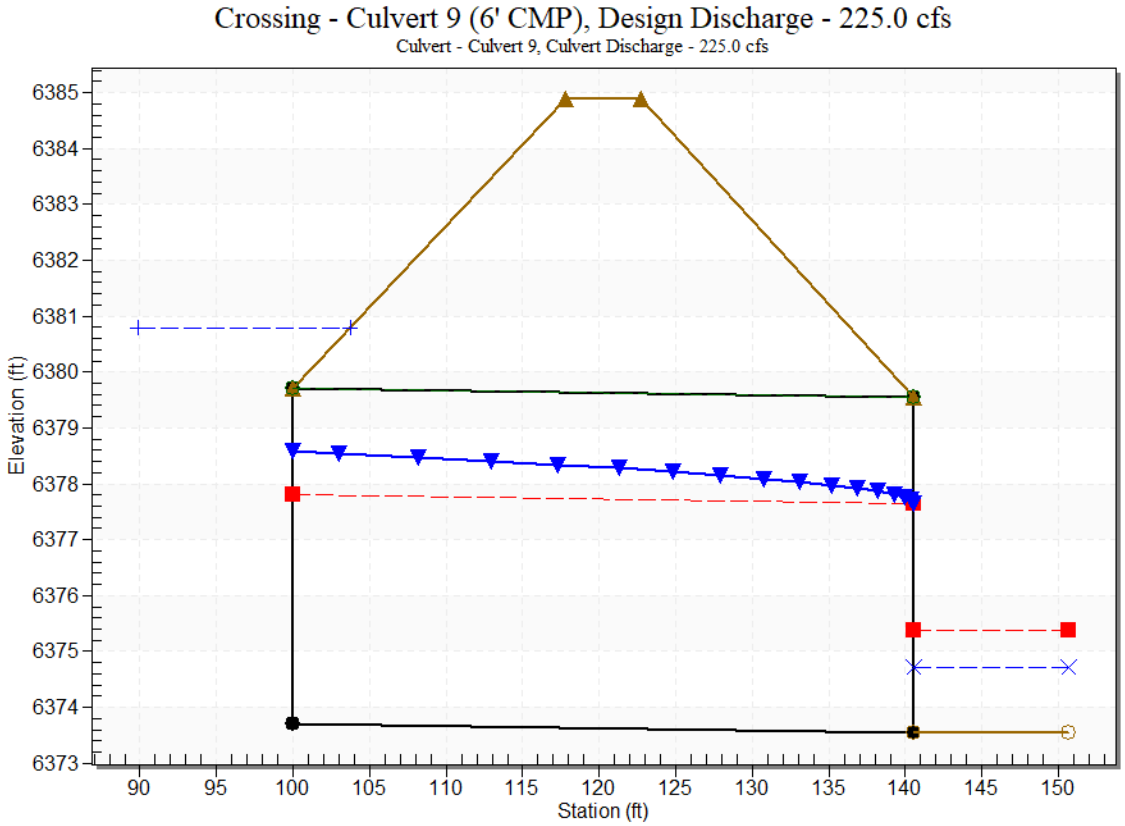
Inlet Elevation (invert): 6373.70 ft,

Outlet Elevation (invert): 6373.55 ft

Culvert Length: 40.54 ft,

Culvert Slope: 0.0037

Water Surface Profile Plot for Culvert: Culvert 9



Site Data - Culvert 9

Site Data Option: Culvert Invert Data

Inlet Station: 100.00 ft

Inlet Elevation: 6373.70 ft

Outlet Station: 140.54 ft

Outlet Elevation: 6373.55 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 9

Barrel Shape: Circular

Barrel Diameter: 6.00 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0220

Culvert Type: Straight

Inlet Configuration: Mitered to Conform to Slope (Ke=0.7)

Inlet Depression: None

Tailwater Data for Crossing: Culvert 9 (6' CMP)

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 9 (6' CMP))

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
225.00	6374.70	1.15	12.17	6.98	2.27
225.00	6374.70	1.15	12.17	6.98	2.27
225.00	6374.70	1.15	12.17	6.98	2.27
225.00	6374.70	1.15	12.17	6.98	2.27
225.00	6374.70	1.15	12.17	6.98	2.27
225.00	6374.70	1.15	12.17	6.98	2.27
225.00	6374.70	1.15	12.17	6.98	2.27
225.00	6374.70	1.15	12.17	6.98	2.27
225.00	6374.70	1.15	12.17	6.98	2.27
225.00	6374.70	1.15	12.17	6.98	2.27
225.00	6374.70	1.15	12.17	6.98	2.27

Tailwater Channel Data - Culvert 9 (6' CMP)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 11.41 ft

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0969

Channel Manning's n: 0.0350

Channel Invert Elevation: 6373.55 ft

Roadway Data for Crossing: Culvert 9 (6' CMP)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 6384.88 ft

Roadway Surface: Gravel

Roadway Top Width: 5.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 7.00 cfs

Design Flow: 35.00 cfs

Maximum Flow: 69.50 cfs

Table 1 - Summary of Culvert Flows at Crossing: Culvert 11 (Ex. 24" Steel Pipe)

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 11 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
6394.43	7.00	7.00	0.00	1
6395.25	13.25	13.25	0.00	1
6396.33	19.50	19.50	0.00	1
6398.08	25.75	25.75	0.00	1
6399.13	35.00	28.72	6.25	8
6399.17	38.25	28.84	9.39	6
6399.24	44.50	29.02	15.47	6
6399.30	50.75	29.17	21.57	5
6399.35	57.00	29.31	27.69	5
6399.40	63.25	29.44	33.80	4
6399.45	69.50	29.56	39.94	4
6399.00	28.36	28.36	0.00	Overtopping

Culvert Data: Culvert 11

Table 1 - Culvert Summary Table: Culvert 11

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
7.00 cfs	7.00 cfs	6394.43	1.43	0.247	1-S2n	0.88	0.94	0.88	0.13	5.23	13.04
13.25 cfs	13.25 cfs	6395.25	2.25	1.416	5-S2n	1.31	1.31	1.31	0.20	6.09	16.64
19.50 cfs	19.50 cfs	6396.33	3.33	3.088	7-M2c	2.00	1.59	1.59	0.25	7.29	19.24
25.75 cfs	25.75 cfs	6398.08	4.87	5.075	7-M2c	2.00	1.78	1.78	0.30	8.72	21.31
35.00 cfs	28.72 cfs	6399.13	5.79	6.134	7-M2c	2.00	1.84	1.84	0.37	9.49	23.83
38.25 cfs	28.84 cfs	6399.17	5.83	6.173	7-M2c	2.00	1.84	1.84	0.39	9.52	24.60
44.50 cfs	29.02 cfs	6399.24	5.89	6.240	7-M2c	2.00	1.85	1.85	0.43	9.57	25.97
50.75 cfs	29.17 cfs	6399.30	5.94	6.300	7-M2c	2.00	1.85	1.85	0.47	9.61	27.20
57.00 cfs	29.31 cfs	6399.35	5.99	6.352	7-M2c	2.00	1.85	1.85	0.50	9.65	28.33
63.25 cfs	29.44 cfs	6399.40	6.03	6.402	7-M2c	2.00	1.85	1.85	0.54	9.69	29.36
69.50 cfs	29.56 cfs	6399.45	6.07	6.446	7-M2c	2.00	1.86	1.86	0.57	9.72	30.33

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

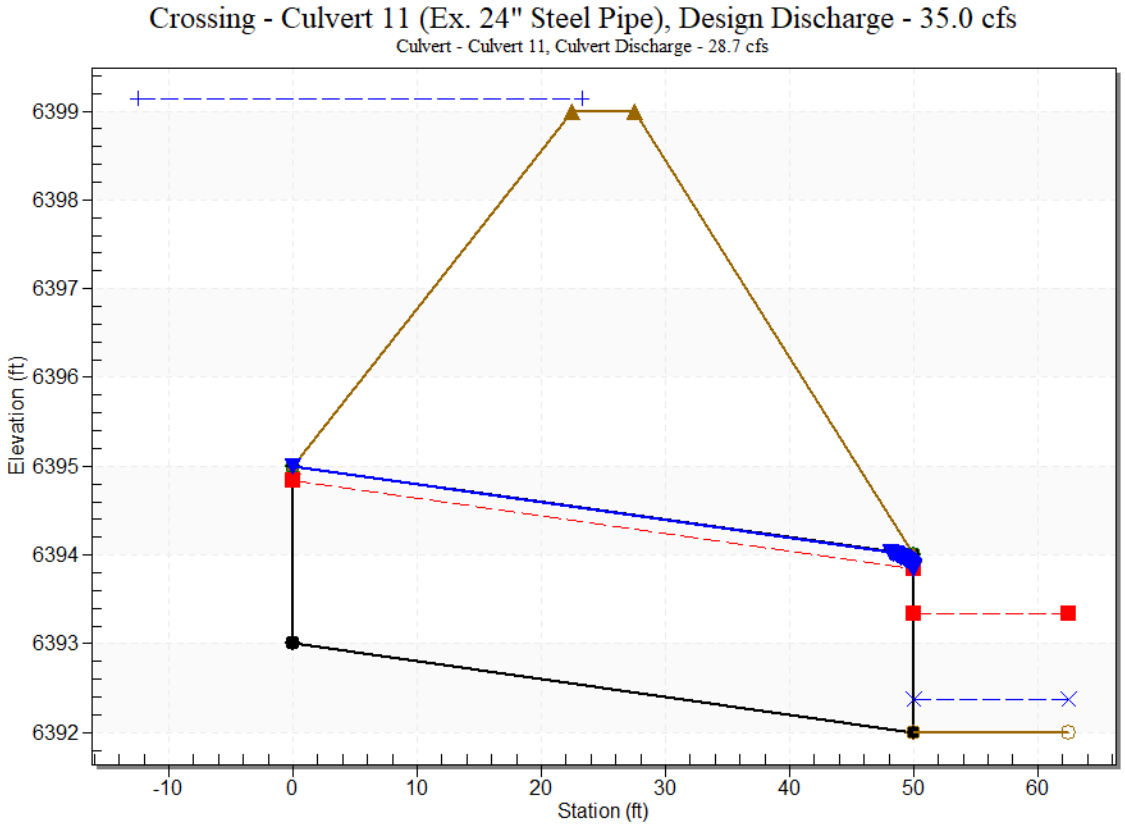
Inlet Elevation (invert): 6393.00 ft,

Outlet Elevation (invert): 6392.00 ft

Culvert Length: 50.01 ft,

Culvert Slope: 0.0200

Water Surface Profile Plot for Culvert: Culvert 11



Site Data - Culvert 11

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 6393.00 ft

Outlet Station: 50.00 ft

Outlet Elevation: 6392.00 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 11

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting

Inlet Depression: None

Tailwater Data for Crossing: Culvert 11 (Ex. 24" Steel Pipe)

Table 2 - Downstream Channel Rating Curve (Crossing: Culvert 11 (Ex. 24" Steel Pipe))

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
7.00	6392.13	0.13	13.04	12.56	6.27
13.25	6392.20	0.20	16.64	18.63	6.57
19.50	6392.25	0.25	19.24	23.72	6.73
25.75	6392.30	0.30	21.31	28.27	6.83
35.00	6392.37	0.37	23.83	34.37	6.93
38.25	6392.39	0.39	24.60	36.38	6.95
44.50	6392.43	0.43	25.97	40.10	6.99
50.75	6392.47	0.47	27.20	43.66	7.02
57.00	6392.50	0.50	28.33	47.09	7.04
63.25	6392.54	0.54	29.36	50.41	7.05
69.50	6392.57	0.57	30.33	53.63	7.06

Tailwater Channel Data - Culvert 11 (Ex. 24" Steel Pipe)

Tailwater Channel Option: Rectangular Channel

Bottom Width: 4.00 ft

Channel Slope: 1.5000

Channel Manning's n: 0.0350

Channel Invert Elevation: 6392.00 ft

Roadway Data for Crossing: Culvert 11 (Ex. 24" Steel Pipe)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 6399.00 ft

Roadway Surface: Gravel

Roadway Top Width: 5.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 50.00 cfs

Design Flow: 110.00 cfs

Maximum Flow: 220.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: DTB Culvert 4

Headwater Elevation (ft)	Total Discharge (cfs)	DTB Culvert 4 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
6424.99	50.00	50.00	0.00	1
6425.48	67.00	67.00	0.00	1
6426.01	84.00	84.00	0.00	1
6426.62	101.00	101.00	0.00	1
6426.98	110.00	110.00	0.00	1
6427.61	135.00	123.83	10.99	10
6427.70	152.00	125.58	26.09	5
6427.77	169.00	127.04	41.85	5
6427.83	186.00	128.27	57.53	4
6427.89	203.00	129.41	73.48	4
6427.94	220.00	130.45	89.20	3
6427.50	121.50	121.50	0.00	Overtopping

Culvert Data: DTB Culvert 4

Table 2 - Culvert Summary Table: DTB Culvert 4

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
50.00 cfs	50.00 cfs	6424.99	2.39	0.910	1-JS1f	1.08	1.61	3.00	3.25	3.54	0.00
67.00 cfs	67.00 cfs	6425.48	2.88	1.316	1-JS1f	1.27	1.88	3.00	3.25	4.74	0.00
84.00 cfs	84.00 cfs	6426.01	3.41	1.840	5-JS1f	1.44	2.11	3.00	3.25	5.94	0.00
101.00 cfs	101.00 cfs	6426.62	4.02	2.483	5-JS1f	1.61	2.31	3.00	3.25	7.14	0.00
110.00 cfs	110.00 cfs	6426.98	4.38	2.870	5-JS1f	1.69	2.41	3.00	3.25	7.78	0.00
135.00 cfs	123.83 cfs	6427.61	5.01	3.530	5-S2n	1.83	2.53	1.88	3.25	13.27	0.00
152.00 cfs	125.58 cfs	6427.70	5.10	3.620	5-S2n	1.84	2.55	1.90	3.25	13.32	0.00
169.00 cfs	127.04 cfs	6427.77	5.17	3.695	5-S2n	1.86	2.56	1.91	3.25	13.37	0.00
186.00 cfs	128.27 cfs	6427.83	5.23	3.759	5-S2n	1.87	2.57	1.92	3.25	13.39	0.00
203.00 cfs	129.41 cfs	6427.89	5.29	3.819	5-S2n	1.88	2.58	1.94	3.25	13.41	0.00
220.00 cfs	130.45 cfs	6427.94	5.34	3.874	5-S2n	1.89	2.59	1.95	3.25	13.42	0.00

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

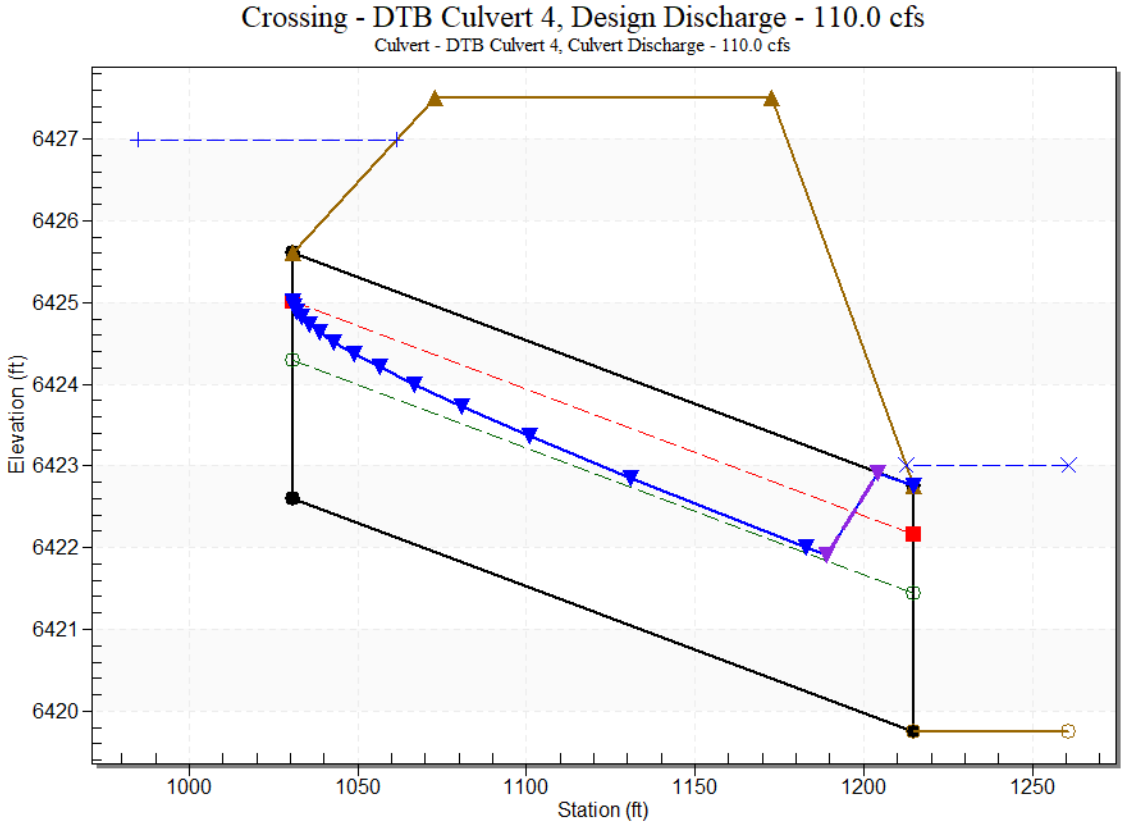
Inlet Elevation (invert): 6422.60 ft,

Outlet Elevation (invert): 6419.75 ft

Culvert Length: 184.07 ft,

Culvert Slope: 0.0155

Water Surface Profile Plot for Culvert: DTB Culvert 4



Site Data - DTB Culvert 4

Site Data Option: Culvert Invert Data

Inlet Station: 1030.79 ft

Inlet Elevation: 6422.60 ft

Outlet Station: 1214.84 ft

Outlet Elevation: 6419.75 ft

Number of Barrels: 2

Culvert Data Summary - DTB Culvert 4

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Tailwater Data for Crossing: DTB Culvert 4

Table 3 - Downstream Channel Rating Curve (Crossing: DTB Culvert 4)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
50.00	6423.00	3.25
67.00	6423.00	3.25
84.00	6423.00	3.25
101.00	6423.00	3.25
110.00	6423.00	3.25
135.00	6423.00	3.25
152.00	6423.00	3.25
169.00	6423.00	3.25
186.00	6423.00	3.25
203.00	6423.00	3.25
220.00	6423.00	3.25

Tailwater Channel Data - DTB Culvert 4

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 6423.00 ft

Roadway Data for Crossing: DTB Culvert 4

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 6427.50 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 95.00 cfs

Design Flow: 141.00 cfs

Maximum Flow: 200.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: Culvert C1

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert C1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
6403.50	95.00	95.00	0.00	1
6403.68	105.50	105.50	0.00	1
6403.86	116.00	116.00	0.00	1
6404.03	126.50	126.50	0.00	1
6404.26	141.00	141.00	0.00	1
6404.37	147.50	147.50	0.00	1
6404.53	158.00	158.00	0.00	1
6404.69	168.50	168.50	0.00	1
6404.84	179.00	179.00	0.00	1
6404.99	189.50	189.50	0.00	1
6405.14	200.00	200.00	0.00	1
6414.89	774.25	774.25	0.00	Overtopping

Culvert Data: Culvert C1

Table 1 - Culvert Summary Table: Culvert C1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
95.00 cfs	95.00 cfs	6403.50	2.50	0.746	1-S2n	1.34	1.64	1.34	1.49	8.85	5.56
105.50 cfs	105.50 cfs	6403.68	2.68	0.890	1-S2n	1.44	1.75	1.45	1.56	9.08	5.71
116.00 cfs	116.00 cfs	6403.86	2.86	1.033	1-S2n	1.54	1.87	1.55	1.63	9.35	5.85
126.50 cfs	126.50 cfs	6404.03	3.03	1.175	1-S2n	1.63	1.98	1.64	1.70	9.61	5.98
141.00 cfs	141.00 cfs	6404.26	3.26	1.370	1-S2n	1.75	2.13	1.77	1.78	9.93	6.15
147.50 cfs	147.50 cfs	6404.37	3.37	1.458	1-S2n	1.81	2.19	1.83	1.81	10.08	6.22
158.00 cfs	158.00 cfs	6404.53	3.53	1.600	1-S2n	1.90	2.30	1.92	1.87	10.29	6.33
168.50 cfs	168.50 cfs	6404.69	3.69	1.742	1-S2n	1.98	2.40	2.01	1.92	10.48	6.43
179.00 cfs	179.00 cfs	6404.84	3.84	1.885	1-S2n	2.07	2.50	2.10	1.97	10.68	6.53
189.50 cfs	189.50 cfs	6404.99	3.99	2.029	1-S2n	2.15	2.59	2.19	2.02	10.83	6.63
200.00 cfs	200.00 cfs	6405.14	4.14	2.174	1-S2n	2.23	2.69	2.27	2.07	10.99	6.72

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

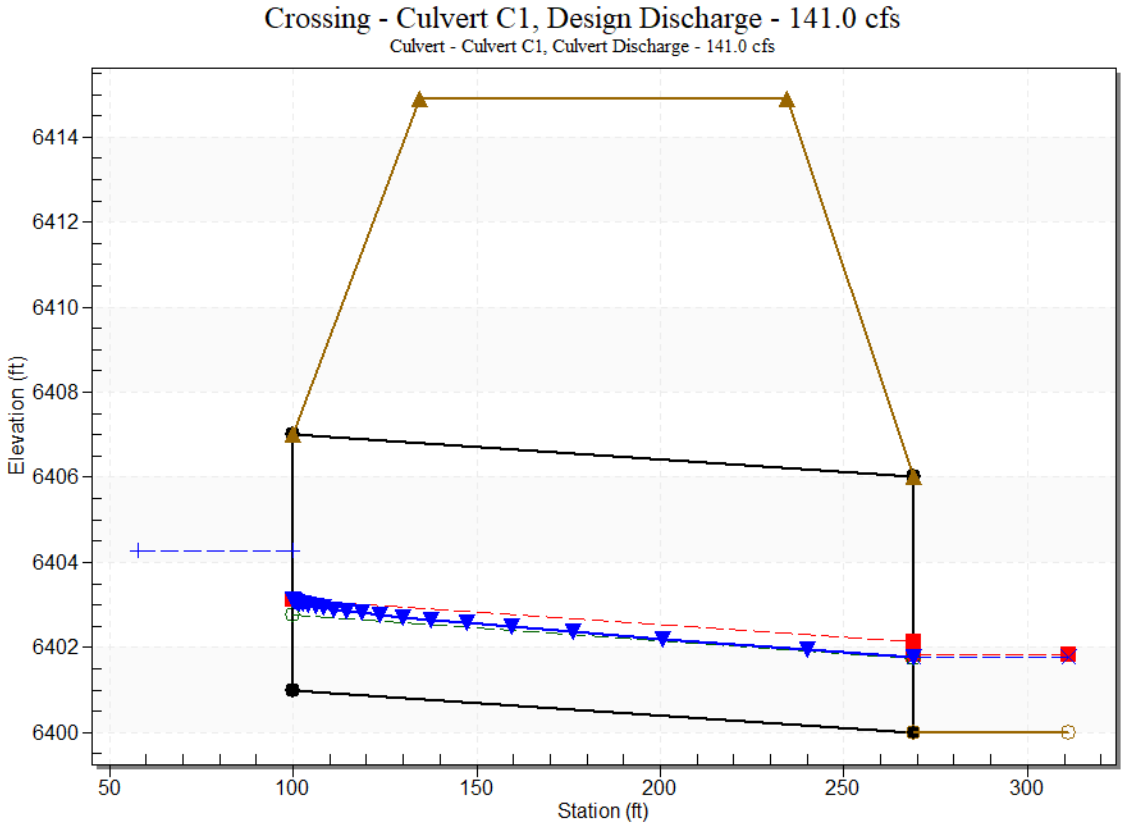
Inlet Elevation (invert): 6401.00 ft,

Outlet Elevation (invert): 6400.00 ft

Culvert Length: 169.00 ft,

Culvert Slope: 0.0059

Water Surface Profile Plot for Culvert: Culvert C1



Site Data - Culvert C1

Site Data Option: Culvert Invert Data

Inlet Station: 100.00 ft

Inlet Elevation: 6401.00 ft

Outlet Station: 269.00 ft

Outlet Elevation: 6400.00 ft

Number of Barrels: 1

Culvert Data Summary - Culvert C1

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 6.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130

Culvert Type: Straight

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

Inlet Depression: None

Tailwater Data for Crossing: Culvert C1

Table 2 - Downstream Channel Rating Curve (Crossing: Culvert C1)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
95.00	6401.49	1.49	5.56	1.86	1.03
105.50	6401.56	1.56	5.71	1.95	1.04
116.00	6401.63	1.63	5.85	2.04	1.04
126.50	6401.70	1.70	5.98	2.12	1.05
141.00	6401.78	1.78	6.15	2.22	1.06
147.50	6401.81	1.81	6.22	2.26	1.06
158.00	6401.87	1.87	6.33	2.33	1.06
168.50	6401.92	1.92	6.43	2.40	1.07
179.00	6401.97	1.97	6.53	2.46	1.07
189.50	6402.02	2.02	6.63	2.53	1.08
200.00	6402.07	2.07	6.72	2.59	1.08

Tailwater Channel Data - Culvert C1

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 4.00 ft

Side Slope (H:V): 5.00 (_:1)

Channel Slope: 0.0200

Channel Manning's n: 0.0350

Channel Invert Elevation: 6400.00 ft

Roadway Data for Crossing: Culvert C1

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 6414.89 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 170.00 cfs

Design Flow: 300.00 cfs

Maximum Flow: 450.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: Culvert C2

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert C2 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
6372.68	170.00	170.00	0.00	1
6373.08	198.00	198.00	0.00	1
6373.46	226.00	226.00	0.00	1
6373.83	254.00	254.00	0.00	1
6374.19	282.00	282.00	0.00	1
6374.42	300.00	300.00	0.00	1
6374.91	338.00	338.00	0.00	1
6375.27	366.00	366.00	0.00	1
6375.65	394.00	394.00	0.00	1
6376.03	422.00	422.00	0.00	1
6376.44	450.00	450.00	0.00	1
6379.42	623.10	623.10	0.00	Overtopping

Culvert Data: Culvert C2

Table 1 - Culvert Summary Table: Culvert C2

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
170.00 cfs	170.00 cfs	6372.68	3.71	2.493	1-JS1t	2.14	2.41	2.80	1.13	7.59	9.63
198.00 cfs	198.00 cfs	6373.08	4.11	2.705	1-S2n	2.38	2.67	2.40	1.22	10.29	10.06
226.00 cfs	226.00 cfs	6373.46	4.49	2.929	1-S2n	2.62	2.92	2.64	1.31	10.70	10.45
254.00 cfs	254.00 cfs	6373.83	4.86	3.259	1-S2n	2.85	3.15	2.87	1.39	11.06	10.80
282.00 cfs	282.00 cfs	6374.19	5.22	3.660	1-S2n	3.07	3.38	3.10	1.46	11.39	11.12
300.00 cfs	300.00 cfs	6374.42	5.45	3.923	1-S2n	3.21	3.52	3.24	1.51	11.58	11.31
338.00 cfs	338.00 cfs	6374.91	5.94	4.496	1-S2n	3.51	3.81	3.53	1.60	11.97	11.69
366.00 cfs	366.00 cfs	6375.27	6.30	4.932	5-S2n	3.72	4.02	3.74	1.67	12.22	11.95
394.00 cfs	394.00 cfs	6375.65	6.68	5.380	5-S2n	3.93	4.22	3.95	1.73	12.46	12.19
422.00 cfs	422.00 cfs	6376.03	7.06	5.843	5-S2n	4.14	4.42	4.16	1.79	12.68	12.42
450.00 cfs	450.00 cfs	6376.44	7.47	7.012	5-S2n	4.34	4.61	4.36	1.85	12.89	12.64

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

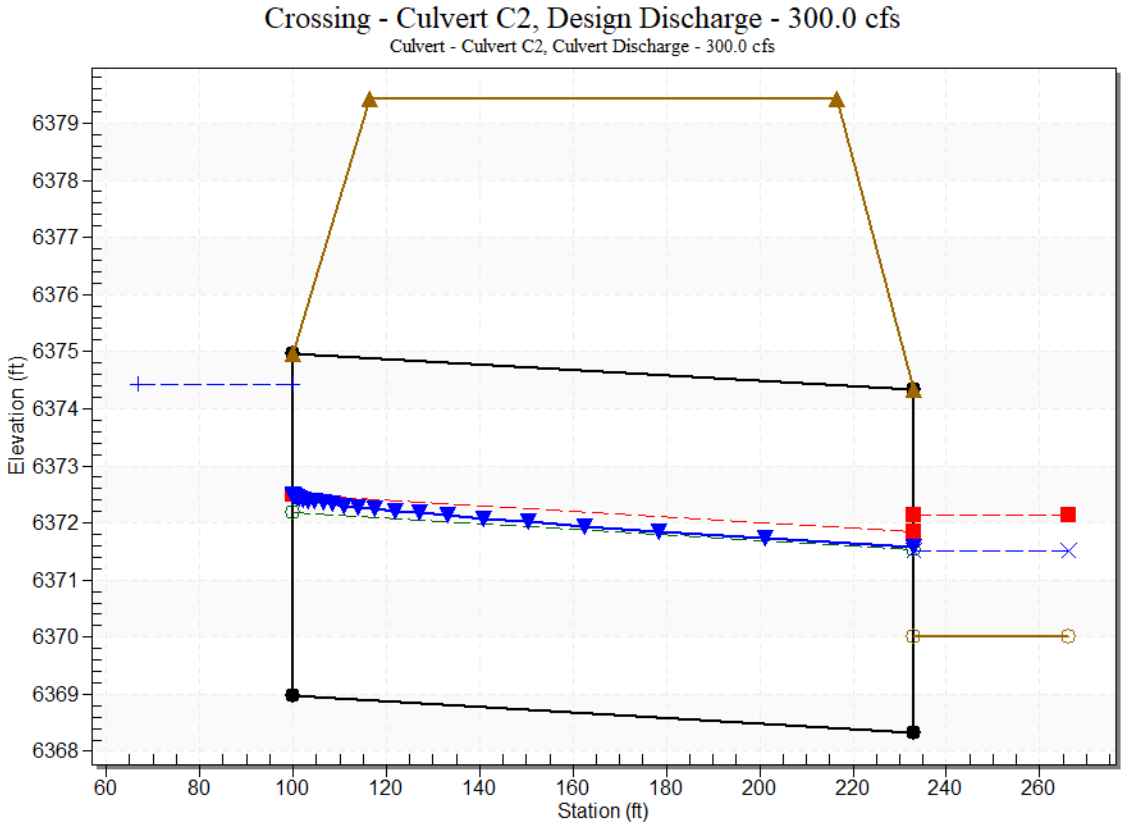
Inlet Elevation (invert): 6368.97 ft,

Outlet Elevation (invert): 6368.33 ft

Culvert Length: 133.00 ft,

Culvert Slope: 0.0048

Water Surface Profile Plot for Culvert: Culvert C2



Site Data - Culvert C2

Site Data Option: Culvert Invert Data

Inlet Station: 100.00 ft

Inlet Elevation: 6368.97 ft

Outlet Station: 233.00 ft

Outlet Elevation: 6368.33 ft

Number of Barrels: 1

Culvert Data Summary - Culvert C2

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 6.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130

Culvert Type: Straight

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

Inlet Depression: None

Tailwater Data for Crossing: Culvert C2

Table 2 - Downstream Channel Rating Curve (Crossing: Culvert C2)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
170.00	6371.13	1.13	9.63	4.72	1.86
198.00	6371.22	1.22	10.06	5.11	1.88
226.00	6371.31	1.31	10.45	5.47	1.90
254.00	6371.39	1.39	10.80	5.81	1.92
282.00	6371.46	1.46	11.12	6.12	1.93
300.00	6371.51	1.51	11.31	6.32	1.94
338.00	6371.60	1.60	11.69	6.71	1.95
366.00	6371.67	1.67	11.95	6.98	1.97
394.00	6371.73	1.73	12.19	7.24	1.98
422.00	6371.79	1.79	12.42	7.49	1.98
450.00	6371.85	1.85	12.64	7.73	1.99

Tailwater Channel Data - Culvert C2

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 10.00 ft

Side Slope (H:V): 5.00 (_:1)

Channel Slope: 0.0670

Channel Manning's n: 0.0350

Channel Invert Elevation: 6370.00 ft

Roadway Data for Crossing: Culvert C2

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 6379.42 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 0.00 cfs

Design Flow: 6.60 cfs

Maximum Flow: 9.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: Culvert D9.1

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert D9.1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
6538.00	0.00	0.00	0.00	1
6538.48	0.90	0.90	0.00	1
6538.69	1.80	1.80	0.00	1
6538.88	2.70	2.70	0.00	1
6539.05	3.60	3.60	0.00	1
6539.21	4.50	4.50	0.00	1
6539.35	5.40	5.40	0.00	1
6539.55	6.60	6.60	0.00	1
6539.66	7.20	7.20	0.00	1
6539.83	8.10	8.10	0.00	1
6540.02	9.00	9.00	0.00	1
6550.00	21.54	21.54	0.00	Overtopping

Culvert Data: Culvert D9.1

Table 1 - Culvert Summary Table: Culvert D9.1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00 cfs	0.00 cfs	6538.00	0.00	0.000	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
0.90 cfs	0.90 cfs	6538.48	0.48	0.0*	1-S2n	0.26	0.35	0.26	0.04	4.43	1.67
1.80 cfs	1.80 cfs	6538.69	0.69	0.0*	1-S2n	0.36	0.50	0.36	0.06	5.42	2.21
2.70 cfs	2.70 cfs	6538.88	0.88	0.0*	1-S2n	0.45	0.62	0.45	0.07	6.08	2.59
3.60 cfs	3.60 cfs	6539.05	1.05	0.0*	1-S2n	0.52	0.72	0.52	0.09	6.59	2.91
4.50 cfs	4.50 cfs	6539.21	1.21	0.0*	1-S2n	0.59	0.81	0.59	0.10	7.01	3.18
5.40 cfs	5.40 cfs	6539.35	1.35	0.0*	1-S2n	0.65	0.90	0.65	0.11	7.36	3.41
6.60 cfs	6.60 cfs	6539.55	1.55	0.0*	5-S2n	0.73	0.99	0.73	0.13	7.75	3.70
7.20 cfs	7.20 cfs	6539.66	1.66	0.0*	5-S2n	0.77	1.04	0.77	0.13	7.92	3.83
8.10 cfs	8.10 cfs	6539.83	1.83	0.0*	5-S2n	0.82	1.10	0.82	0.14	8.15	4.01
9.00 cfs	9.00 cfs	6540.02	2.02	0.0*	5-S2n	0.88	1.16	0.88	0.15	8.35	4.18

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

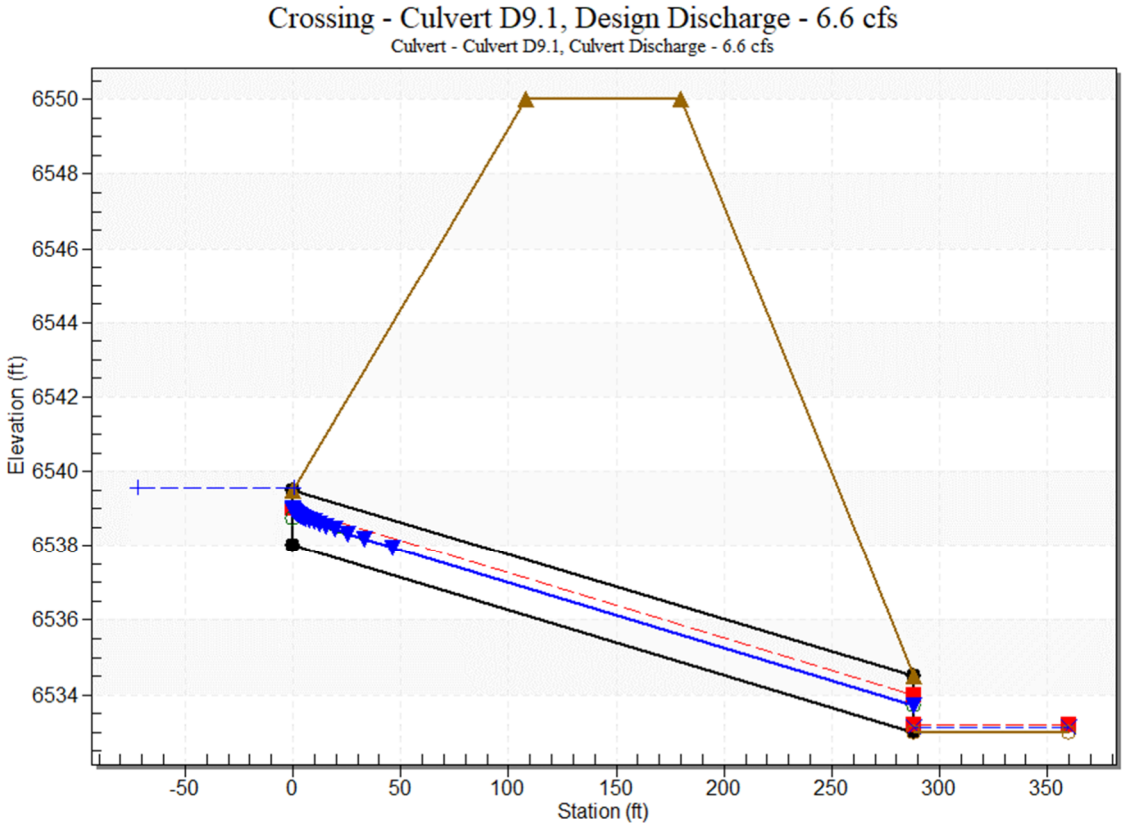
Inlet Elevation (invert): 6538.00 ft,

Outlet Elevation (invert): 6533.00 ft

Culvert Length: 288.04 ft,

Culvert Slope: 0.0174

Water Surface Profile Plot for Culvert: Culvert D9.1



Site Data - Culvert D9.1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 6538.00 ft

Outlet Station: 288.00 ft

Outlet Elevation: 6533.00 ft

Number of Barrels: 1

Culvert Data Summary - Culvert D9.1

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Tailwater Data for Crossing: Culvert D9.1

Table 2 - Downstream Channel Rating Curve (Crossing: Culvert D9.1)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.00	6533.00	0.00	0.00	0.00	0.00
0.90	6533.04	0.04	1.67	0.48	1.50
1.80	6533.06	0.06	2.21	0.73	1.61
2.70	6533.07	0.07	2.59	0.93	1.68
3.60	6533.09	0.09	2.91	1.10	1.72
4.50	6533.10	0.10	3.18	1.26	1.76
5.40	6533.11	0.11	3.41	1.41	1.79
6.60	6533.13	0.13	3.70	1.59	1.82
7.20	6533.13	0.13	3.83	1.68	1.84
8.10	6533.14	0.14	4.01	1.80	1.86
9.00	6533.15	0.15	4.18	1.92	1.88

Tailwater Channel Data - Culvert D9.1

Tailwater Channel Option: Rectangular Channel

Bottom Width: 14.00 ft

Channel Slope: 0.2000

Channel Manning's n: 0.0450

Channel Invert Elevation: 6533.00 ft

Roadway Data for Crossing: Culvert D9.1

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 6550.00 ft

Roadway Surface: Paved

Roadway Top Width: 72.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 0.00 cfs

Design Flow: 19.40 cfs

Maximum Flow: 110.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: Culvert D9.2

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert D9.2 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
6508.50	0.00	0.00	0.00	1
6509.81	11.00	11.00	0.00	1
6510.26	19.40	19.40	0.00	1
6510.92	33.00	33.00	0.00	1
6511.39	44.00	44.00	0.00	1
6511.82	55.00	55.00	0.00	1
6512.24	66.00	66.00	0.00	1
6512.66	77.00	77.00	0.00	1
6513.12	88.00	88.00	0.00	1
6513.62	99.00	99.00	0.00	1
6514.18	110.00	110.00	0.00	1
6520.00	187.57	187.57	0.00	Overtopping

Culvert Data: Culvert D9.2

Table 1 - Culvert Summary Table: Culvert D9.2

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00 cfs	0.00 cfs	6508.50	0.00	0.000	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
11.00 cfs	11.00 cfs	6509.81	1.31	0.0*	1-S2n	0.67	0.97	0.67	0.17	7.94	4.52
19.40 cfs	19.40 cfs	6510.26	1.76	0.0*	1-S2n	0.89	1.30	0.89	0.25	9.37	5.65
33.00 cfs	33.00 cfs	6510.92	2.42	0.0*	1-S2n	1.16	1.71	1.16	0.34	10.91	6.96
44.00 cfs	44.00 cfs	6511.39	2.89	0.0*	1-S2n	1.35	1.98	1.37	0.40	11.60	7.78
55.00 cfs	55.00 cfs	6511.82	3.32	0.0*	1-S2n	1.52	2.23	1.52	0.46	12.58	8.47
66.00 cfs	66.00 cfs	6512.24	3.74	0.0*	1-S2n	1.68	2.45	1.68	0.52	13.22	9.09
77.00 cfs	77.00 cfs	6512.66	4.16	0.0*	5-S2n	1.83	2.66	1.86	0.57	13.49	9.64
88.00 cfs	88.00 cfs	6513.12	4.62	0.561	5-S2n	1.97	2.84	2.00	0.62	14.00	10.14
99.00 cfs	99.00 cfs	6513.62	5.12	1.814	5-S2n	2.12	3.01	2.16	0.67	14.33	10.61
110.00 cfs	110.00 cfs	6514.18	5.68	2.550	5-S2n	2.26	3.17	2.30	0.71	14.69	11.04

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

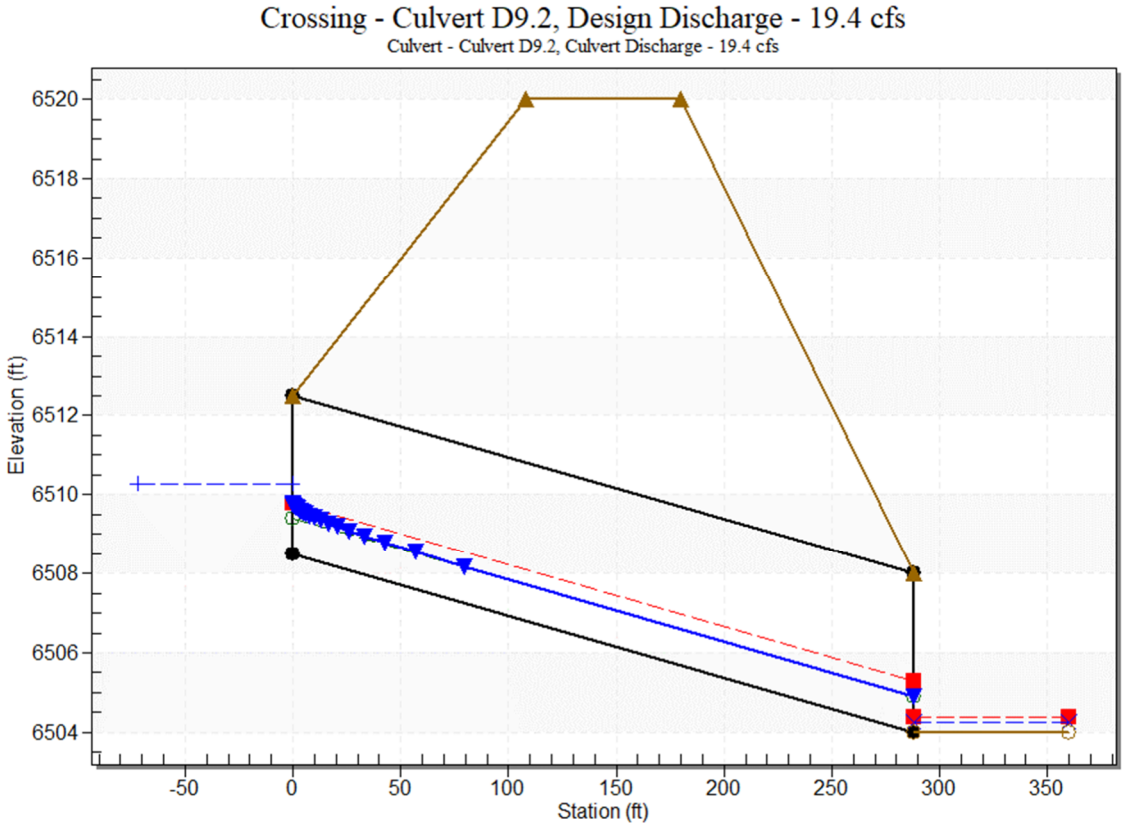
Inlet Elevation (invert): 6508.50 ft,

Outlet Elevation (invert): 6504.00 ft

Culvert Length: 288.04 ft,

Culvert Slope: 0.0156

Water Surface Profile Plot for Culvert: Culvert D9.2



Site Data - Culvert D9.2

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 6508.50 ft

Outlet Station: 288.00 ft

Outlet Elevation: 6504.00 ft

Number of Barrels: 1

Culvert Data Summary - Culvert D9.2

Barrel Shape: Circular

Barrel Diameter: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall (Ke=0.5)

Inlet Depression: None

Tailwater Data for Crossing: Culvert D9.2

Table 2 - Downstream Channel Rating Curve (Crossing: Culvert D9.2)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.00	6504.00	0.00	0.00	0.00	0.00
11.00	6504.17	0.17	4.52	2.17	1.91
19.40	6504.25	0.25	5.65	3.06	2.01
33.00	6504.34	0.34	6.96	4.23	2.11
44.00	6504.40	0.40	7.78	5.04	2.16
55.00	6504.46	0.46	8.47	5.79	2.19
66.00	6504.52	0.52	9.09	6.47	2.22
77.00	6504.57	0.57	9.64	7.12	2.25
88.00	6504.62	0.62	10.14	7.73	2.27
99.00	6504.67	0.67	10.61	8.32	2.29
110.00	6504.71	0.71	11.04	8.88	2.31

Tailwater Channel Data - Culvert D9.2

Tailwater Channel Option: Rectangular Channel

Bottom Width: 14.00 ft

Channel Slope: 0.2000

Channel Manning's n: 0.0450

Channel Invert Elevation: 6504.00 ft

Roadway Data for Crossing: Culvert D9.2

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 6520.00 ft

Roadway Surface: Paved

Roadway Top Width: 72.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 0.00 cfs

Design Flow: 51.20 cfs

Maximum Flow: 100.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: Culvert D10.2

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert D10.2 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
6496.00	0.00	0.00	0.00	1
6497.24	10.00	10.00	0.00	1
6497.79	20.00	20.00	0.00	1
6498.27	30.00	30.00	0.00	1
6498.72	40.00	40.00	0.00	1
6499.17	51.20	51.20	0.00	1
6499.51	60.00	60.00	0.00	1
6499.89	70.00	70.00	0.00	1
6500.28	80.00	80.00	0.00	1
6500.71	90.00	90.00	0.00	1
6501.17	100.00	100.00	0.00	1
6505.00	159.28	159.28	0.00	Overtopping

Culvert Data: Culvert D10.2

Table 1 - Culvert Summary Table: Culvert D10.2

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00 cfs	0.00 cfs	6496.00	0.00	0.000	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
10.00 cfs	10.00 cfs	6497.24	1.24	0.0*	1-S2n	0.62	0.92	0.62	0.16	7.99	4.36
20.00 cfs	20.00 cfs	6497.79	1.79	0.0*	1-S2n	0.88	1.32	0.87	0.25	9.94	5.72
30.00 cfs	30.00 cfs	6498.27	2.27	0.0*	1-S2n	1.08	1.62	1.08	0.32	11.02	6.70
40.00 cfs	40.00 cfs	6498.72	2.72	0.0*	1-S2n	1.25	1.89	1.26	0.38	11.78	7.49
51.20 cfs	51.20 cfs	6499.17	3.17	0.0*	1-S2n	1.42	2.15	1.42	0.44	12.80	8.24
60.00 cfs	60.00 cfs	6499.51	3.51	0.0*	1-S2n	1.55	2.33	1.57	0.49	13.06	8.76
70.00 cfs	70.00 cfs	6499.89	3.89	0.0*	1-S2n	1.68	2.53	1.71	0.54	13.63	9.30
80.00 cfs	80.00 cfs	6500.28	4.28	0.0*	5-S2n	1.81	2.71	1.85	0.58	14.10	9.78
90.00 cfs	90.00 cfs	6500.71	4.71	0.199	5-S2n	1.94	2.88	1.97	0.63	14.56	10.23
100.00 cfs	100.00 cfs	6501.17	5.17	1.383	5-S2n	2.07	3.03	2.11	0.67	14.91	10.65

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

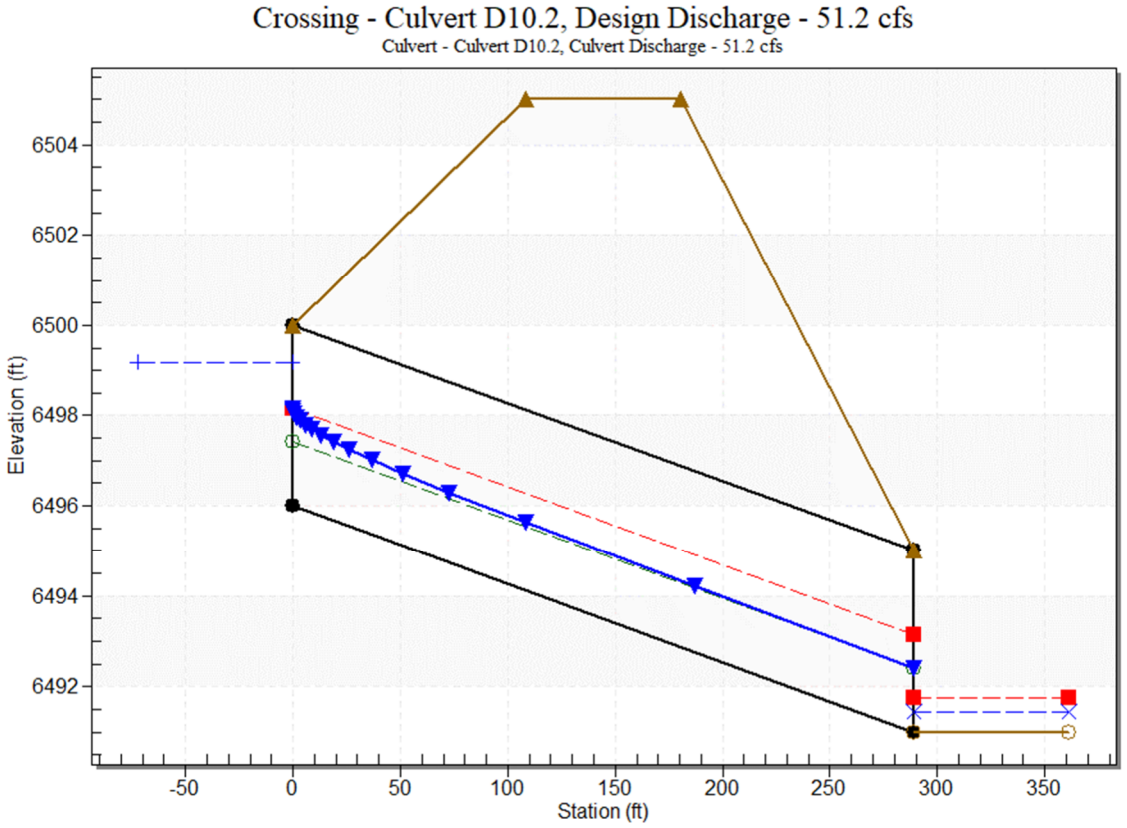
Inlet Elevation (invert): 6496.00 ft,

Outlet Elevation (invert): 6491.00 ft

Culvert Length: 289.04 ft,

Culvert Slope: 0.0173

Water Surface Profile Plot for Culvert: Culvert D10.2



Site Data - Culvert D10.2

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 6496.00 ft

Outlet Station: 289.00 ft

Outlet Elevation: 6491.00 ft

Number of Barrels: 1

Culvert Data Summary - Culvert D10.2

Barrel Shape: Circular

Barrel Diameter: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall (Ke=0.5)

Inlet Depression: None

Tailwater Data for Crossing: Culvert D10.2

Table 2 - Downstream Channel Rating Curve (Crossing: Culvert D10.2)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.00	6491.00	0.00	0.00	0.00	0.00
10.00	6491.16	0.16	4.36	2.05	1.90
20.00	6491.25	0.25	5.72	3.12	2.02
30.00	6491.32	0.32	6.70	3.99	2.09
40.00	6491.38	0.38	7.49	4.76	2.14
51.20	6491.44	0.44	8.24	5.54	2.18
60.00	6491.49	0.49	8.76	6.10	2.21
70.00	6491.54	0.54	9.30	6.71	2.23
80.00	6491.58	0.58	9.78	7.29	2.26
90.00	6491.63	0.63	10.23	7.84	2.27
100.00	6491.67	0.67	10.65	8.37	2.29

Tailwater Channel Data - Culvert D10.2

Tailwater Channel Option: Rectangular Channel

Bottom Width: 14.00 ft

Channel Slope: 0.2000

Channel Manning's n: 0.0450

Channel Invert Elevation: 6491.00 ft

Roadway Data for Crossing: Culvert D10.2

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 6505.00 ft

Roadway Surface: Paved

Roadway Top Width: 72.00 ft

HY-8 Culvert Analysis Report

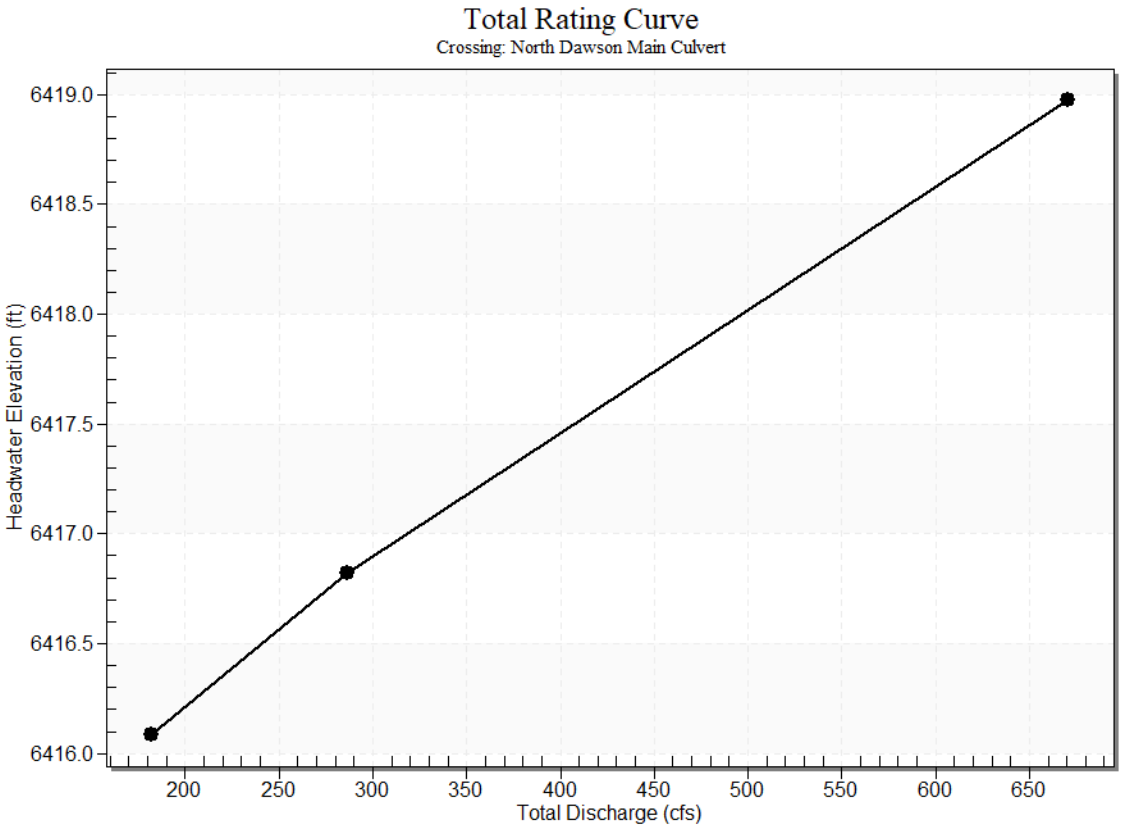
Crossing Discharge Data

Discharge Selection Method: User Defined

Table 1 - Summary of Culvert Flows at Crossing: North Dawson Main Culvert

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	North Dawson Main Culvert Discharge (cfs)	Roadway Discharge (cfs)	Iterations
6416.09	2-year	182.16	182.16	0.00	1
6416.82	5-year	286.43	286.43	0.00	1
6418.97	100-year	670.37	670.37	0.00	1
6435.42	Overtopping	3942.05	3942.05	0.00	Overtopping

Rating Curve Plot for Crossing: North Dawson Main Culvert



Culvert Data: North Dawson Main Culvert

Table 2 - Culvert Summary Table: North Dawson Main Culvert

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
2-year	182.16 cfs	182.16 cfs	6416.09	2.09	0.0*	1-S2n	0.93	1.37	0.95	0.63	9.60	5.68
5-year	286.43 cfs	286.43 cfs	6416.82	2.82	0.0*	1-S2n	1.24	1.85	1.28	0.82	11.18	6.71
100-year	670.37 cfs	670.37 cfs	6418.97	4.97	1.562	1-S2n	2.20	3.27	2.33	1.35	14.36	9.10

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

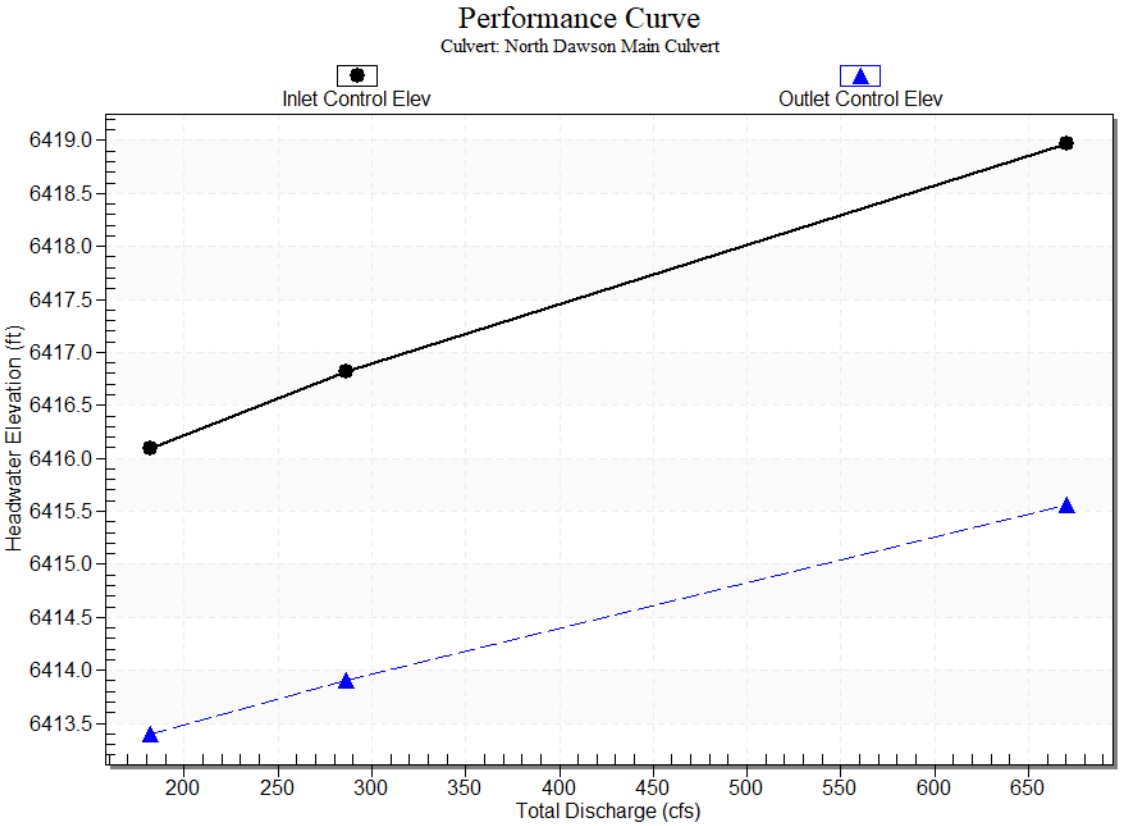
Inlet Elevation (invert): 6414.00 ft,

Outlet Elevation (invert): 6412.00 ft

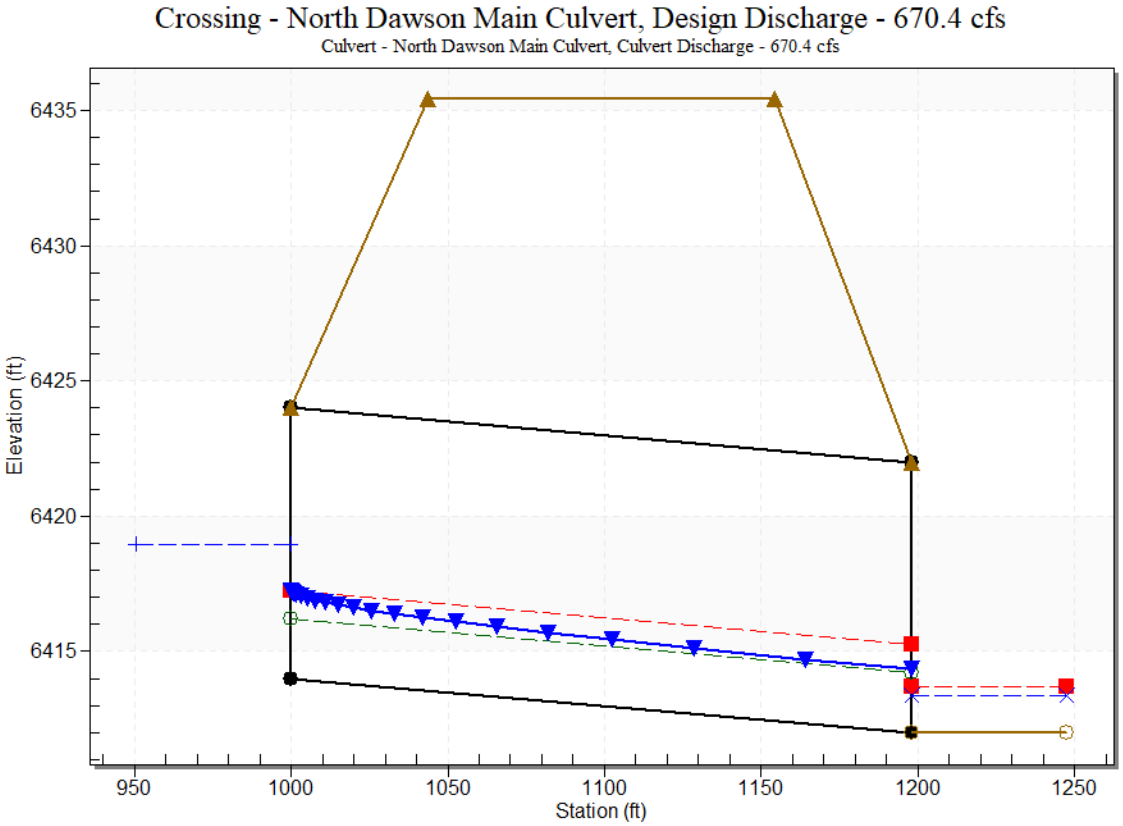
Culvert Length: 198.01 ft,

Culvert Slope: 0.0101

Culvert Performance Curve Plot: North Dawson Main Culvert



Water Surface Profile Plot for Culvert: North Dawson Main Culvert



Site Data - North Dawson Main Culvert

Site Data Option: Culvert Invert Data

Inlet Station: 1000.00 ft

Inlet Elevation: 6414.00 ft

Outlet Station: 1198.00 ft

Outlet Elevation: 6412.00 ft

Number of Barrels: 2

Culvert Data Summary - North Dawson Main Culvert

Barrel Shape: Concrete Box

Barrel Span: 10.00 ft

Barrel Rise: 10.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130

Culvert Type: Straight

Inlet Configuration: Square Edge (30-75º flare) Wingwall (Ke=0.4)

Inlet Depression: None

Tailwater Data for Crossing: North Dawson Main Culvert

Table 3 - Downstream Channel Rating Curve (Crossing: North Dawson Main Culvert)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
182.16	6412.63	0.63	5.68	0.20	1.30
286.43	6412.82	0.82	6.71	0.26	1.36
670.37	6413.35	1.35	9.10	0.42	1.46

Tailwater Channel Data - North Dawson Main Culvert

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 48.00 ft

Side Slope (H:V): 5.00 (_:1)

Channel Slope: 0.0050

Channel Manning's n: 0.0130

Channel Invert Elevation: 6412.00 ft

Roadway Data for Crossing: North Dawson Main Culvert

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 6435.42 ft

Roadway Surface: Paved

Roadway Top Width: 111.00 ft

Dawson Trails Filing 2
Riprap Sizing and Shear Stress Calculations - Channel to Pond C1

	Channel Information						USACE *Stability Thresholds for Stream Restoration Materials* (Fischenich 2001) Shear Stress and Riprap Size Calculation				USACE EM 1110-2-1601 *Hydraulic Design of Flood Control Channels* (1994) Steep Slope Riprap Size Calculation					*USDCM* Section 8.1.1 for slopes less than 2%			Selected Lining
Reach	Channel Bottom Width (ft)	Side Slopes	Manning's n	Q100 (cfs)	Max Reach Slope (S)	Normal Depth d100 (ft)	τ100 $\tau = \Upsilon dS$ (lbs/ft^2)	Factor of Safety (FS)	τ100 x FS (lbs/ft^2)	D50 Riprap Size per Table 2 (in)	q100 (cfs/ft)	Flow Concentration Factor (FC)	q100 x FC (cfs/ft)	D30 (ft)	D50 (in)	V (ft/sec)	Gs	d50>= (ft)	
A - C4 to C3 @ 1%	10	4H:1V	0.05	137	0.010	2.04	1.3	1.5	1.9	6						3.7	2.6	0.2	Use Type M (D50 = 12")
B - C4 to C3@ 4.1%	10	4H:1V	0.05	137	0.041	1.43	3.7	1.5	5.5	18	13.7	1.25	17.1	0.69	13.8				Use Type H (D50 = 18")
B - C4 to C3 @ 4.3%	10	4H:1V	0.05	137	0.043	1.41	3.8	1.5	5.7	18	13.7	1.25	17.1	0.71	14.2				Use Type H (D50 = 18")
C - C4 to C3@ 8.8%	10	4H:1V	0.05	137	0.088	1.17	6.4	1.5	9.6	24	13.7	1.25	17.1	1.06	21.1				Use Type VH (D50 = 24")
D - C2 to C1 @ 0.5%	10	4H:1V	0.05	382	0.005	3.94	1.2	1.5	1.8	6						3.8	2.6	0.2	Use Type M (D50 = 12")
D - C2 to C1 @ 0.66%	10	4H:1V	0.05	382	0.007	3.70	1.5	1.5	2.3	6						4.2	2.6	0.2	Use Type M (D50 = 12")
D - C2 to C1 @ 1%	10	4H:1V	0.05	382	0.010	3.40	2.1	1.5	3.2	9						4.9	2.6	0.4	Use Type M (D50 = 12")

Table 8-5. Recommended roughness values

Location and Cover	When Assessing Velocity, Froude No., Shear Stress	When Assessing Water Surface Elevation and Water Depth
Main Channel (bankfull channel)		
Sand or clay bed	0.03	0.04
Gravel or cobble bed	0.035	0.07
Vegetated Overbanks		
Turfgrass sod	0.03	0.04
Native grasses	0.032	0.05
Herbaceous wetlands (few or no willows)	0.06	0.12
Willow stands, woody shrubs	0.07	0.16

(Source: Chow 1959, USDA 1954, Barnes 1967, Arcement and Schneider 1989, Jarrett 1985)

Table 2. Permissible Shear and Velocity for Selected Lining Materials[1]

Boundary Category	Boundary Type	Permissible Shear Stress (lb/sq ft)	Permissible Velocity (ft/sec)	Citation(s)
Riprap	6 – in. d_{50}	2.5	5 – 10	H
	9 – in. d_{50}	3.8	7 – 11	H
	12 – in. d_{50}	5.1	10 – 13	H
	18 – in. d_{50}	7.6	12 – 16	H
	24 – in. d_{50}	10.1	14 – 18	E

Υ = unit weight of water (62.4 lbs/ft^3)
d = depth (ft)
S = longitudinal channel slope
τ = shear stress exerted by flowing water (lbs/ft^2)

e. Steep slope riprap design.

In cases where unit discharge is low, riprap can be used on steep slopes ranging from 2 to 20 percent. A typical application is a rock-lined chute. The stone size equation is

$$D_{50} = \frac{1.95\ S^{0.555}\ q^{2/3}}{g^{1/3}} \qquad (3\text{-}5)$$

where

S = slope of bed

q = unit discharge

8.1.1 Mild Slope Conditions

When subcritical flow conditions occur and/or slopes are mild (less than 2 percent), UDFCD recommends the following equation (Hughes, et al, 1983):

$$d_m \geq \left[\frac{VS^{0.17}}{4.5(G_s - 1)^{0.66}}\right]^2 \qquad \text{Equation 8-11}$$

Where:

V = mean channel velocity (ft/sec)

S = longitudinal channel slope (ft/ft)

d_{50} = mean rock size (ft)

Gs = specific gravity of stone (minimum = 2.50, typically 2.5 to 2.7), Note: In this equation (Gs -1) considers the buoyancy of the water, in that the specific gravity of water is subtracted from the specific gravity of the rock.

Table 2. Permissible Shear and Velocity for Selected Lining Materials[1]

Boundary Category	Boundary Type	Permissible Shear Stress (lb/sq ft)	Permissible Velocity (ft/sec)	Citation(s)
Soils	Fine colloidal sand	0.02 - 0.03	1.5	A
	Sandy loam (noncolloidal)	0.03 - 0.04	1.75	A
	Alluvial silt (noncolloidal)	0.045 - 0.05	2	A
	Silty loam (noncolloidal)	0.045 - 0.05	1.75 – 2.25	A
	Firm loam	0.075	2.5	A
	Fine gravels	0.075	2.5	A
	Stiff clay	0.26	3 – 4.5	A, F
	Alluvial silt (colloidal)	0.26	3.75	A
	Graded loam to cobbles	0.38	3.75	A
	Graded silts to cobbles	0.43	4	A
	Shales and hardpan	0.67	6	A
Gravel/Cobble	1-in.	0.33	2.5 – 5	A
	2-in.	0.67	3 – 6	A
	6-in.	2.0	4 – 7.5	A
	12-in.	4.0	5.5 – 12	A
Vegetation	Class A turf	3.7	6 – 8	E, N
	Class B turf	2.1	4 - 7	E, N
	Class C turf	1.0	3.5	E, N
	Long native grasses	1.2 – 1.7	4 – 6	G, H, L, N
	Short native and bunch grass	0.7 - 0.95	3 – 4	G, H, L, N
	Reed plantings	0.1-0.6	N/A	E, N
	Hardwood tree plantings	0.41-2.5	N/A	E, N
Temporary Degradable RECPs	Jute net	0.45	1 – 2.5	E, H, M
	Straw with net	1.5 – 1.65	1 – 3	E, H, M
	Coconut fiber with net	2.25	3 – 4	E, M
	Fiberglass roving	2.00	2.5 – 7	E, H, M
Non-Degradable RECPs	Unvegetated	3.00	5 – 7	E, G, M
	Partially established	4.0-6.0	7.5 – 15	E, G, M
	Fully vegetated	8.00	8 – 21	F, L, M
Riprap	6 – in. d_{50}	2.5	5 – 10	H
	9 – in. d_{50}	3.8	7 – 11	H
	12 – in. d_{50}	5.1	10 – 13	H
	18 – in. d_{50}	7.6	12 – 16	H
	24 – in. d_{50}	10.1	14 – 18	E
Soil Bioengineering	Wattles	0.2 – 1.0	3	C, I, J, N
	Reed fascine	0.6-1.25	5	E
	Coir roll	3 - 5	8	E, M, N
	Vegetated coir mat	4 - 8	9.5	E, M, N
	Live brush mattress (initial)	0.4 – 4.1	4	B, E, I
	Live brush mattress (grown)	3.90-8.2	12	B, C, E, I, N
	Brush layering (initial/grown)	0.4 – 6.25	12	E, I, N
	Live fascine	1.25-3.10	6 – 8	C, E, I, J
	Live willow stakes	2.10-3.10	3 – 10	E, N, O
Hard Surfacing	Gabions	10	14 – 19	D
	Concrete	12.5	>18	H

[1] Ranges of values generally reflect multiple sources of data or different testing conditions.

A. Chang, H.H. (1988).
B. Florineth. (1982)
C. Gerstgraser, C. (1998).
D. Goff, K. (1999).
E. Gray, D.H., and Sotir, R.B. (1996).
F. Julien, P.Y. (1995).
G. Kouwen, N.; Li, R. M.; and Simons, D.B., (1980).
H. Norman, J. N. (1975).
I. Schiechtl, H. M. and R. Stern. (1996).
J. Schoklitsch, A. (1937).
K. Sprague, C.J. (1999).
L. Temple, D.M. (1980).
M. TXDOT (1999)
N. Data from Author (2001)
O. USACE (1997).

Dawson Trails Filing 2
Tabulation of All Project Inlets

INLET/DISCHARGE POINT	HYDRAULIC CONDITION	CAPACITY (CFS)		DESIGN FLOWRATE (CFS)		BYPASS FLOWS (CFS)		PONDING DEPTH (IN)	
		5YR	100YR	5YR	100YR	5YR	100YR	5YR	100YR
B6.11	On Grade	17.2	45.6	2.7	4.9	0.0	0.4	N/A	N/A
B6.12	On Grade	17.2	45.6	3.1	5.4	0.0	0.8	N/A	N/A
B6.21	On Grade	5.0	63.0	4.5	6.9	0.4	3.3	N/A	N/A
B6.22	On Grade	4.7	59.5	2.7	3.8	2.0	6.3	N/A	N/A
B6.31	On Grade	4.9	61.6	4.4	7.5	0.3	4.6	N/A	N/A
B6.32	On Grade	4.2	53.2	3.3	5.6	0.0	0.9	N/A	N/A
B6.41	On Grade	15.7	52.7	3.2	7.2	0.0	3.1	N/A	N/A
B6.42	On Grade	15.8	52.6	2.2	4.9	0.0	0.4	N/A	N/A
B6.51	On Grade	4.5	57.0	2.4	4.9	0.0	0.2	N/A	N/A
B6.52	On Grade	4.5	56.7	2.4	4.8	0.0	0.4	N/A	N/A
C5.01	On Grade	14.8	78.7	7.9	12.5	0.3	4.3	N/A	N/A
C5.02	On Grade	15.6	82.7	6.8	11.2	0.0	2.6	N/A	N/A
C5.03	On Grade	18.5	141.6	5.3	13.5	0.0	0.8	N/A	N/A
C5.04	On Grade	19.8	128.4	4.5	11.5	0.0	0.1	N/A	N/A
C5.11	On Grade	19.5	130.0	4.5	6.9	0.3	2.7	N/A	N/A
C.12	On Grade	19.5	103.4	4.5	6.9	0.3	2.7	N/A	N/A
C5.13	In Sump	8.3	22.3	7.1	17.2	N/A	N/A	6	10.6
C5.14	In Sump	5.4	8.6	2.9	5.7	N/A	N/A	6	#NAME?
C5.15	On Grade	19.5	103.4	5.7	11.3	0.0	0.1	N/A	N/A
C5.16	On Grade	19.5	103.4	5.2	10.3	0.0	0.0	N/A	N/A
C6.01	In Sump	7.7	17.2	6.9	16.1	N/A	N/A	6	10.6
C6.02	On Grade	18.1	20.9	4.1	6.4	0.1	1.9	N/A	N/A
C6.03	On Grade	7.3	7.3	3.3	6.7	0.0	0.0	N/A	N/A
C6.04	On Grade	13.7	87.7	3.4	8.2	0.0	0.4	N/A	N/A

INLET/DISCHARGE POINT	HYDRAULIC CONDITION	CAPACITY (CFS)		DESIGN FLOWRATE (CFS)		BYPASS FLOWS (CFS)		PONDING DEPTH (IN)	
		5YR	100YR	5YR	100YR	5YR	100YR	5YR	100YR
2D1	In Sump	8.3	25.5	4.5	9.4	N/A	N/A	6	10.3
3D1	In Sump	3.4	6.9	2.5	5.3	N/A	N/A	6	10.3
4D1	On Grade	13.8	43.6	3.4	5.9	0.0	1.5	N/A	N/A
5D1	On Grade	15.8	51.3	1.3	2.9	0.0	0.0	N/A	N/A
8D1	In Sump	8.3	21.6	5.2	11.5	N/A	N/A	6	11.0
9D1	In Sump	8.3	22.3	5.1	11.5	N/A	N/A	6	10.9
D3.10	On Grade	15.4	92.0	1.8	4.2	0.0	0.1	N/A	N/A
D3.11	On Grade	15.4	15.4	1.7	4.1	0.0	0.1	N/A	N/A
D3.12	On Grade	16.6	21.1	1.2	9.0	0.0	9.0	N/A	N/A
D3.13	On Grade	16.0	73.6	1.4	3.7	0.0	0.0	N/A	N/A
D3.15	On Grade	15.2	79.6	1.1	4.1	0.0	0.1	N/A	N/A
D3.16	On Grade	15.2	24.3	0.6	2.1	0.0	0.0	N/A	N/A
D3.18	On Grade	15.2	24.3	0.9	2.2	0.0	0.0	N/A	N/A
D3.19	On Grade	15.2	81.3	0.8	4.1	0.0	0.0	N/A	N/A
D3.21	In Sump	4.6	4.6	0.9	2.8	N/A	N/A	6	10.56
D3.22	In Sump	4.6	4.6	1.0	2.0	N/A	N/A	6	8.4
D3.20	On Grade	17.3	19.6	1.2	2.2	0.0	0.7	N/A	N/A
D4.1	In Sump	4.6	4.6	2.9	6.5	N/A	N/A	6	10.6
D4.2	In Sump	4.6	4.6	2.6	5.9	N/A	N/A	6	11.0
D5.1	On Grade	16.8	16.8	2.8	8.5	0.0	0.5	N/A	N/A
D5.2	On Grade	15.2	15.2	1.7	2.5	1.1	6.2	N/A	N/A

MHFD-Inlet, Version 5.02 (August 2022)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	B6.11	B6.12	B6.21	B6.22	B6.31
Site Type (Urban or Rural)	URBAN	URBAN	URBAN	URBAN	URBAN
Inlet Application (Street or Area)	STREET	STREET	STREET	STREET	STREET
Hydraulic Condition	On Grade	On Grade	On Grade	On Grade	On Grade
Inlet Type	CDOT Type R Curb Opening	CDOT Type R Curb Opening	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)	2.7	3.1	4.9	4.6	4.4
Major Q_{known} (cfs)	5.3	6.1	9.8	9.3	8.8

Bypass (Carry-Over) Flow from Upstream Inlets must be organized from upstream (left) to downstream (right) in order for bypass flows to be linked.

Receive Bypass Flow from:	No Bypass Flow Received	No Bypass Flow Received	B6.11	B6.12	B6.21
Minor Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.0	0.0	0.4
Major Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.4	0.8	3.3

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)	**2.7**	**3.1**	**4.9**	**4.6**	**4.8**
Major Total Design Peak Flow, Q (cfs)	**5.3**	**6.1**	**10.3**	**10.1**	**12.1**
Minor Flow Bypassed Downstream, Q_b (cfs)	0.0	0.0	0.4	2.0	0.3
Major Flow Bypassed Downstream, Q_b (cfs)	0.4	0.8	3.3	6.3	4.6

MHFD-Inlet, Version 5.02 (August 2022)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	B6.32	B6.41	B6.42	B6.51	B6.52
Site Type (Urban or Rural)	URBAN	URBAN	URBAN	URBAN	URBAN
Inlet Application (Street or Area)	STREET	STREET	STREET	STREET	STREET
Hydraulic Condition	On Grade	On Grade	On Grade	On Grade	On Grade
Inlet Type	CDOT Type R Curb Opening	CDOT Type R Curb Opening	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)	3.3	2.9	2.2	2.4	2.4
Major Q_{Known} (cfs)	6.5	5.7	4.4	4.9	4.8

Bypass (Carry-Over) Flow from Upstream

Receive Bypass Flow from:	No Bypass Flow Received	B6.31	B6.32	B6.41	B6.42
Minor Bypass Flow Received, Q_b (cfs)	0.0	0.3	0.0	0.0	0.0
Major Bypass Flow Received, Q_b (cfs)	0.0	4.6	0.9	3.1	0.4

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)	**3.3**	**3.2**	**2.2**	**2.4**	**2.4**
Major Total Design Peak Flow, Q (cfs)	**6.5**	**10.3**	**5.4**	**8.0**	**5.2**
Minor Flow Bypassed Downstream, Q_b (cfs)	0.0	0.0	0.0	0.0	0.0
Major Flow Bypassed Downstream, Q_b (cfs)	0.9	3.1	0.4	0.2	0.4

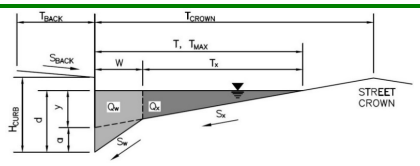
MHFD-Inlet, Version 5.02 (August 2022)

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

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

Project: Dawson Trails Infrastructure 1: Watershed B

Inlet ID: B6.11



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	20.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	23.5	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 =	0.034	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	18.5	23.5	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	10.8	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	4.44	5.64	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	5.95	7.15	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	16.5	21.5	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.321	0.251	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	16.7	33.8	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	7.9	11.3	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.5	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**24.6**	**45.6**	**cfs**
Flow Velocity within the Gutter Section	V =	9.6	11.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	4.7	6.6	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	38.7	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	36.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.148	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	17.2	140.6	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	17.2	127.2	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	8.0	24.5	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	22.3	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	25.2	174.0	cfs
Average Flow Velocity Within the Gutter Section	V =	9.6	15.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	4.8	13.5	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	0.68	0.55	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**17.2**	**95.8**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.35	8.94	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	1.79	inches

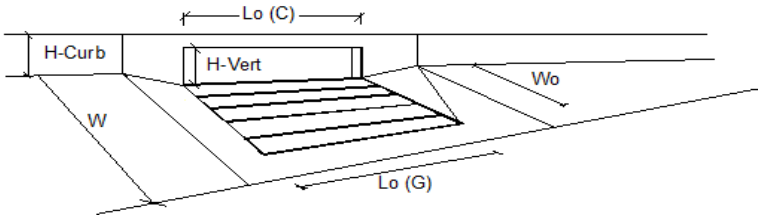
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**17.2**	**45.6**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 2.65 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 5.31 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



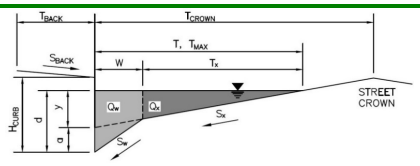
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	10.00	10.00	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	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	2.7	5.3	cfs
Water Spread Width	T =	6.8	9.7	ft
Water Depth at Flowline (outside of local depression)	d =	3.1	3.8	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.765	0.594	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.6	2.2	cfs
Discharge within the Gutter Section W	Q_w =	2.0	3.2	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.36	0.47	sq ft
Velocity within the Gutter Section W	V_W =	5.7	6.7	fps
Water Depth for Design Condition	d_{LOCAL} =	6.1	6.8	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoeff =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**
Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e	S_e =	0.164	0.132	ft/ft
Required Length L_T to Have 100% Interception	L_T =	7.90	12.45	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	7.90	10.00	ft
Interception Capacity	Q_i =	2.7	5.0	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoeff =	1.25	1.25	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.06	0.06	
Effective (Unclogged) Length	L_e =	7.90	9.38	ft
Actual Interception Capacity	**Q_a =**	**2.7**	**4.9**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.0**	**0.4**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**2.7**	**4.9**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.4**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**92**	**%**

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

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

Project: Dawson Trails Infrastructure 1: Watershed B

Inlet ID: B6.12



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	20.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	23.5	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 =	0.034	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	18.5	23.5	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	10.8	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	4.44	5.64	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	5.95	7.15	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	16.5	21.5	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.321	0.251	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	16.7	33.8	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	7.9	11.3	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.5	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**24.6**	**45.6**	**cfs**
Flow Velocity within the Gutter Section	V =	9.6	11.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	4.7	6.6	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	38.7	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	36.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.148	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	17.2	140.6	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	17.2	127.2	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	8.0	24.5	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	22.3	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	25.2	174.0	cfs
Average Flow Velocity Within the Gutter Section	V =	9.6	15.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	4.8	13.5	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	0.68	0.55	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**17.2**	**95.8**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.35	8.94	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	1.79	inches

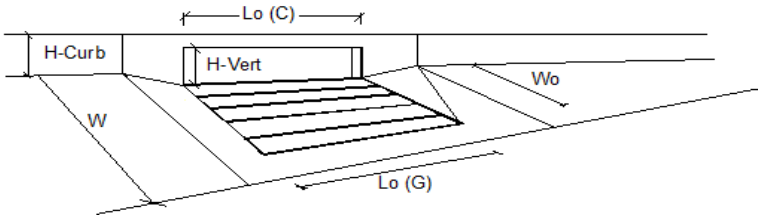
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**17.2**	**45.6**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 3.05 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 6.12 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



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 =	10.00	10.00	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	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	3.1	6.1	cfs
Water Spread Width	T =	7.3	10.3	ft
Water Depth at Flowline (outside of local depression)	d =	3.3	4.0	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.729	0.562	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.8	2.7	cfs
Discharge within the Gutter Section W	Q_w =	2.2	3.4	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.38	0.50	sq ft
Velocity within the Gutter Section W	V_W =	5.8	6.9	fps
Water Depth for Design Condition	d_{LOCAL} =	6.3	7.0	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoeff =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**
Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e	S_e =	0.157	0.126	ft/ft
Required Length L_T to Have 100% Interception	L_T =	8.66	13.68	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	8.66	10.00	ft
Interception Capacity	Q_i =	3.1	5.5	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoeff =	1.25	1.25	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.06	0.06	
Effective (Unclogged) Length	L_e =	8.66	9.38	ft
Actual Interception Capacity	**Q_a =**	**3.1**	**5.4**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.0**	**0.8**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**3.1**	**5.4**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.8**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**88**	**%**

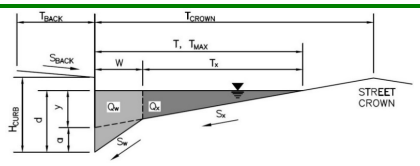
MHFD-Inlet, Version 5.02 (August 2022)

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

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

Project: Dawson Trails Infrastructure 1: Watershed B

Inlet ID: B6.21



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	20.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	23.5	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 =	0.046	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.014	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	8.0	23.5	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	10.3	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	1.92	5.64	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	3.43	7.15	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	6.0	21.5	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.688	0.251	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	1.6	46.8	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	3.4	15.7	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.6	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**5.0**	**63.0**	**cfs**
Flow Velocity within the Gutter Section	V =	8.4	15.3	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	2.4	9.1	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	36.6	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	34.6	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.157	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	23.9	166.7	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	23.9	154.2	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	11.1	31.1	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	19.4	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	35.0	204.7	cfs
Average Flow Velocity Within the Gutter Section	V =	13.3	20.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	6.7	17.2	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	0.53	0.43	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**18.5**	**87.8**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	4.98	7.90	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	0.74	inches

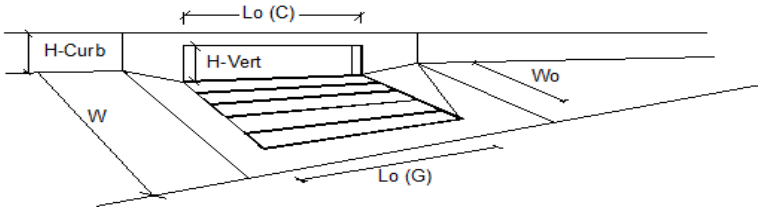
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**5.0**	**63.0**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 4.90 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 10.26 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



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 =	10.00	10.00	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	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	4.9	10.3	cfs
Water Spread Width	T =	7.9	11.2	ft
Water Depth at Flowline (outside of local depression)	d =	3.4	4.2	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.691	0.521	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	1.5	4.9	cfs
Discharge within the Gutter Section W	Q_w =	3.4	5.3	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.40	0.54	sq ft
Velocity within the Gutter Section W	V_W =	8.4	10.0	fps
Water Depth for Design Condition	d_{LOCAL} =	6.4	7.2	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoeff =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**
Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e	S_e =	0.150	0.118	ft/ft
Required Length L_T to Have 100% Interception	L_T =	12.40	20.17	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	10.00	10.00	ft
Interception Capacity	Q_i =	4.6	7.3	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoeff =	1.25	1.25	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.06	0.06	
Effective (Unclogged) Length	L_e =	9.38	9.38	ft
Actual Interception Capacity	**Q_a =**	**4.5**	**6.9**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.4**	**3.3**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**4.5**	**6.9**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.4**	**3.3**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**92**	**68**	**%**

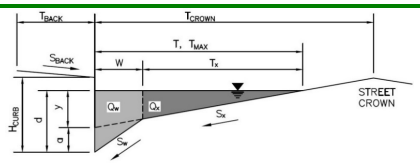
MHFD-Inlet, Version 5.02 (August 2022)

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

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

Project: Dawson Trails Infrastructure 1: Watershed B

Inlet ID: B6.22



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	20.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	23.5	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 =	0.044	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.014	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	8.0	23.5	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	10.8	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	1.92	5.64	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	3.43	7.15	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	6.0	21.5	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.688	0.251	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	1.5	44.2	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	3.2	14.8	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.6	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**4.7**	**59.5**	**cfs**
Flow Velocity within the Gutter Section	V =	8.0	14.4	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	2.3	8.6	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	38.7	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	36.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.148	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	22.5	183.9	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	22.5	166.4	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	10.5	32.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	25.5	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	33.0	223.9	cfs
Average Flow Velocity Within the Gutter Section	V =	12.6	19.6	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	6.3	17.6	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	0.55	0.44	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**18.1**	**99.4**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.03	8.34	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	1.19	inches

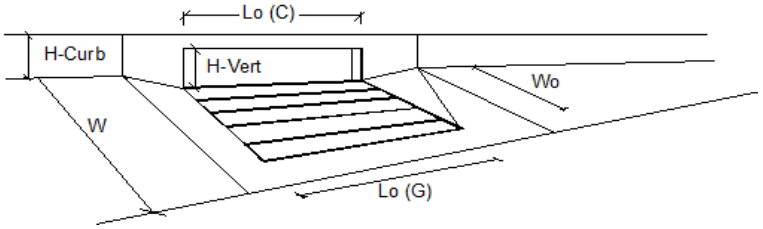
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**4.7**	**59.5**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 4.63 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 10.06 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



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	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	4.6	10.1	cfs
Water Spread Width	T =	7.9	11.4	ft
Water Depth at Flowline (outside of local depression)	d =	3.4	4.3	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.691	0.514	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	1.4	4.9	cfs
Discharge within the Gutter Section W	Q_w =	3.2	5.2	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.40	0.54	sq ft
Velocity within the Gutter Section W	V_W =	7.9	9.5	fps
Water Depth for Design Condition	d_{LOCAL} =	6.4	7.3	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoeff =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**
Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e	S_e =	0.150	0.117	ft/ft
Required Length L_T to Have 100% Interception	L_T =	11.82	19.71	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	5.00	5.00	ft
Interception Capacity	Q_i =	2.9	4.1	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoeff =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.10	0.10	
Effective (Unclogged) Length	L_e =	4.50	4.50	ft
Actual Interception Capacity	**Q_a =**	**2.7**	**3.8**	**cfs**
Carry-Over Flow = $Q_{o(GRATE)}$-Q_a	**Q_b =**	**2.0**	**6.3**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**2.7**	**3.8**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**2.0**	**6.3**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**58**	**37**	**%**

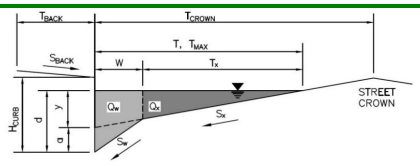
MHFD-Inlet, Version 5.02 (August 2022)

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

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

Project: Dawson Trails Infrastructure 1: Watershed B

Inlet ID: B6.31



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	20.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	23.5	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 =	0.044	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.014	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	8.0	23.5	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	10.8	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	1.92	5.64	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	3.43	7.15	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	6.0	21.5	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.688	0.251	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	1.5	45.7	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	3.3	15.3	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.6	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**4.9**	**61.6**	**cfs**
Flow Velocity within the Gutter Section	V =	8.2	14.9	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	2.4	8.9	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	38.7	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	36.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.148	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	23.3	190.3	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	23.3	172.2	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	10.9	33.1	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	25.5	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	34.2	230.7	cfs
Average Flow Velocity Within the Gutter Section	V =	13.0	20.3	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	6.5	18.2	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	0.55	0.45	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**18.8**	**102.8**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.04	8.34	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	1.19	inches

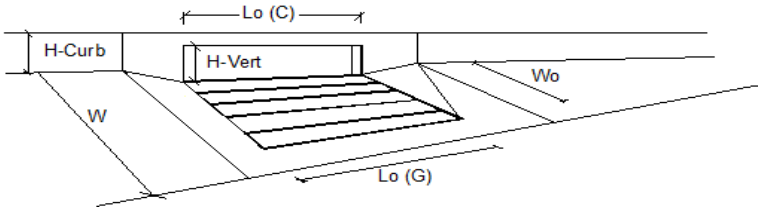
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**4.9**	**61.6**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 4.78 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 12.14 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



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 =	10.00	10.00	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	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	4.8	12.1	cfs
Water Spread Width	T =	7.9	12.2	ft
Water Depth at Flowline (outside of local depression)	d =	3.4	4.4	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.691	0.483	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	1.5	6.3	cfs
Discharge within the Gutter Section W	Q_w =	3.3	5.9	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.40	0.57	sq ft
Velocity within the Gutter Section W	V_W =	8.2	10.2	fps
Water Depth for Design Condition	d_{LOCAL} =	6.4	7.4	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoeff =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**
Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e	S_e =	0.150	0.111	ft/ft
Required Length L_T to Have 100% Interception	L_T =	12.20	22.57	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	10.00	10.00	ft
Interception Capacity	Q_i =	4.6	7.9	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoeff =	1.25	1.25	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.06	0.06	
Effective (Unclogged) Length	L_e =	9.38	9.38	ft
Actual Interception Capacity	**Q_a =**	**4.4**	**7.5**	**cfs**
Carry-Over Flow = $Q_{o(GRATE)}$-Q_a	**Q_b =**	**0.3**	**4.6**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**4.4**	**7.5**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.3**	**4.6**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**93**	**62**	**%**

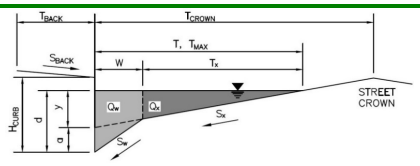
MHFD-Inlet, Version 5.02 (August 2022)

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

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

Project: Dawson Trails Infrastructure 1: Watershed B

Inlet ID: B6.32



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	20.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	23.5	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 =	0.046	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	8.0	23.5	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	10.8	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	1.92	5.64	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	3.43	7.15	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	6.0	21.5	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.688	0.251	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	1.3	39.5	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	2.9	13.2	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.6	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**4.2**	**53.2**	**cfs**
Flow Velocity within the Gutter Section	V =	7.1	12.9	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	2.0	7.7	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	38.7	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	36.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.148	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	20.1	164.2	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	20.1	148.5	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	9.4	28.6	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	26.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	29.5	203.1	cfs
Average Flow Velocity Within the Gutter Section	V =	11.2	17.5	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	5.6	15.7	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	0.53	0.43	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**15.6**	**87.3**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	4.98	8.28	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	1.13	inches

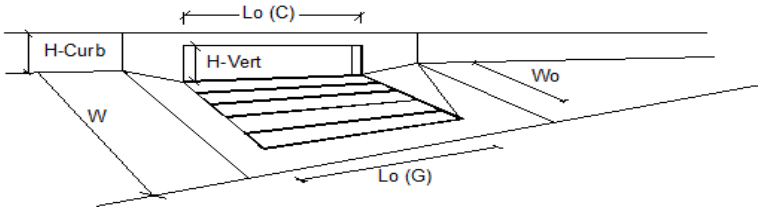
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**4.2**	**53.2**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 3.26 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 6.54 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



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 =	10.00	10.00	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	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	3.3	6.5	cfs
Water Spread Width	T =	7.0	9.9	ft
Water Depth at Flowline (outside of local depression)	d =	3.2	3.9	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.751	0.582	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.8	2.7	cfs
Discharge within the Gutter Section W	Q_w =	2.4	3.8	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.37	0.48	sq ft
Velocity within the Gutter Section W	V_W =	6.7	7.9	fps
Water Depth for Design Condition	d_{LOCAL} =	6.2	6.9	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoeff =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**
Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e	S_e =	0.161	0.129	ft/ft
Required Length L_T to Have 100% Interception	L_T =	9.01	14.21	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	9.01	10.00	ft
Interception Capacity	Q_i =	3.3	5.8	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoeff =	1.25	1.25	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.06	0.06	
Effective (Unclogged) Length	L_e =	9.01	9.38	ft
Actual Interception Capacity	**Q_a =**	**3.3**	**5.6**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.0**	**0.9**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**3.3**	**5.6**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.9**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**86**	**%**

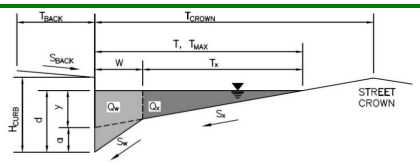
MHFD-Inlet, Version 5.02 (August 2022)

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

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

Project: Dawson Trails Infrastructure 1: Watershed B

Inlet ID: B6.41



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	20.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	23.5	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 =	0.045	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	18.5	23.5	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	10.8	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	4.44	5.64	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	5.95	7.15	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	16.5	21.5	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.321	0.251	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	19.3	39.1	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	9.1	13.1	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.6	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**28.4**	**52.7**	**cfs**
Flow Velocity within the Gutter Section	V =	11.1	12.7	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	5.5	7.6	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	38.7	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	36.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.148	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	19.9	162.6	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	19.9	147.1	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	9.3	28.3	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	25.8	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	29.2	201.1	cfs
Average Flow Velocity Within the Gutter Section	V =	11.1	17.3	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	5.6	15.6	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	0.54	0.44	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**15.7**	**87.9**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.01	8.33	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	1.17	inches

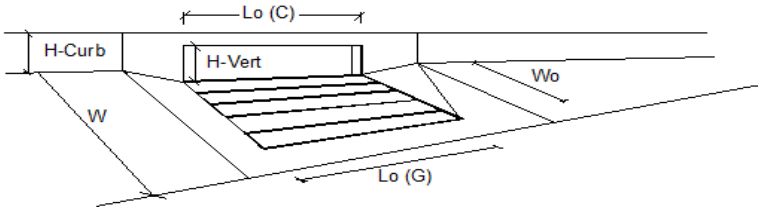
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**15.7**	**52.7**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 3.19 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 10.34 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



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 =	10.00	10.00	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	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	3.2	10.3	cfs
Water Spread Width	T =	7.0	12.2	ft
Water Depth at Flowline (outside of local depression)	d =	3.2	4.4	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.754	0.484	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.8	5.3	cfs
Discharge within the Gutter Section W	Q_w =	2.4	5.0	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.36	0.57	sq ft
Velocity within the Gutter Section W	V_W =	6.6	8.7	fps
Water Depth for Design Condition	d_{LOCAL} =	6.2	7.4	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoeff =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**
Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e	S_e =	0.162	0.111	ft/ft
Required Length L_T to Have 100% Interception	L_T =	8.89	19.24	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	8.89	10.00	ft
Interception Capacity	Q_i =	3.2	7.6	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoeff =	1.25	1.25	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.06	0.06	
Effective (Unclogged) Length	L_e =	8.89	9.38	ft
Actual Interception Capacity	**Q_a =**	**3.2**	**7.2**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.0**	**3.1**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**3.2**	**7.2**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**3.1**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**70**	**%**

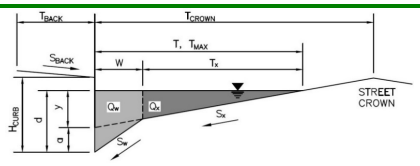
MHFD-Inlet, Version 5.02 (August 2022)

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

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

Project: Dawson Trails Infrastructure 1: Watershed B

Inlet ID: B6.42



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	20.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	23.5	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 =	0.045	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	18.5	23.5	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	10.8	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	4.44	5.64	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	5.95	7.15	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	16.5	21.5	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.321	0.251	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	19.2	39.0	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	9.1	13.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.6	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**28.3**	**52.6**	**cfs**
Flow Velocity within the Gutter Section	V =	11.0	12.7	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	5.5	7.6	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	38.7	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	36.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.148	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	19.9	162.2	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	19.9	146.7	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	9.3	28.2	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	25.7	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	29.1	200.7	cfs
Average Flow Velocity Within the Gutter Section	V =	11.1	17.3	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	5.5	15.6	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	0.54	0.44	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**15.8**	**88.0**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.01	8.34	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	1.18	inches

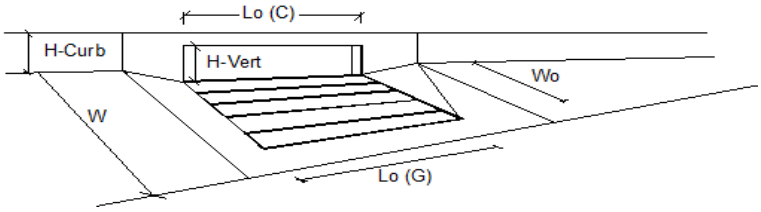
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**15.8**	**52.6**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 2.20 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 5.36 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



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 =	10.00	10.00	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	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	2.2	5.4	cfs
Water Spread Width	T =	5.6	9.1	ft
Water Depth at Flowline (outside of local depression)	d =	2.9	3.7	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.847	0.625	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.3	2.0	cfs
Discharge within the Gutter Section W	Q_w =	1.9	3.4	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.31	0.45	sq ft
Velocity within the Gutter Section W	V_W =	6.0	7.5	fps
Water Depth for Design Condition	d_{LOCAL} =	5.9	6.7	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoeff =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**
Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e	S_e =	0.179	0.138	ft/ft
Required Length L_T to Have 100% Interception	L_T =	7.01	12.47	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	7.01	10.00	ft
Interception Capacity	Q_i =	2.2	5.1	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoeff =	1.25	1.25	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.06	0.06	
Effective (Unclogged) Length	L_e =	7.01	9.38	ft
Actual Interception Capacity	**Q_a =**	**2.2**	**4.9**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.0**	**0.4**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**2.2**	**4.9**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.4**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**92**	**%**

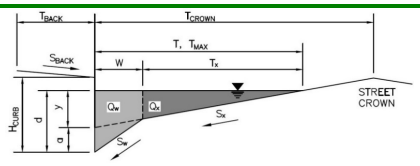
MHFD-Inlet, Version 5.02 (August 2022)

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

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

Project: Dawson Trails Infrastructure 1: Watershed B

Inlet ID: B6.51



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	20.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	23.5	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 =	0.053	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	8.0	23.5	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	10.8	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	1.92	5.64	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	3.43	7.15	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	6.0	21.5	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.688	0.251	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	1.4	42.2	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	3.1	14.1	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.6	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**4.5**	**57.0**	**cfs**
Flow Velocity within the Gutter Section	V =	7.6	13.8	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	2.2	8.2	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	38.7	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	36.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.148	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	21.5	175.8	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	21.5	159.0	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	10.0	30.6	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	27.9	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	31.6	217.5	cfs
Average Flow Velocity Within the Gutter Section	V =	12.0	18.7	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	6.0	16.9	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	0.48	0.39	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**15.0**	**83.8**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	4.83	8.02	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	0.87	inches

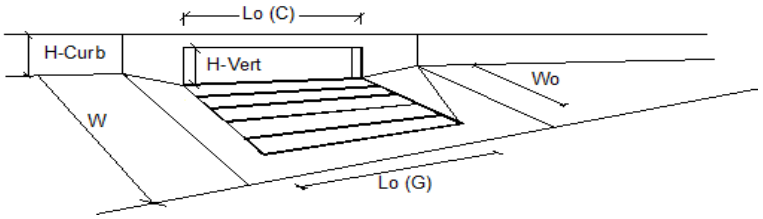
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**4.5**	**57.0**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 2.44 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 8.01 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet (CDOT Type R Curb Opening)	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 =	15.00	15.00	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	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	2.4	8.0	cfs
Water Spread Width	T =	5.7	10.5	ft
Water Depth at Flowline (outside of local depression)	d =	2.9	4.0	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.841	0.552	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.4	3.6	cfs
Discharge within the Gutter Section W	Q_w =	2.1	4.4	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.31	0.51	sq ft
Velocity within the Gutter Section W	V_W =	6.5	8.7	fps
Water Depth for Design Condition	d_{LOCAL} =	5.9	7.0	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoeff =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**
Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e	S_e =	0.178	0.124	ft/ft
Required Length L_T to Have 100% Interception	L_T =	7.48	16.21	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	7.48	15.00	ft
Interception Capacity	Q_i =	2.4	7.9	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoeff =	1.31	1.31	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.04	0.04	
Effective (Unclogged) Length	L_e =	7.48	14.35	ft
Actual Interception Capacity	**Q_a =**	**2.4**	**7.8**	**cfs**
Carry-Over Flow = $Q_{o(GRATE)}$-Q_a	**Q_b =**	**0.0**	**0.2**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**2.4**	**7.8**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.2**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**98**	**%**

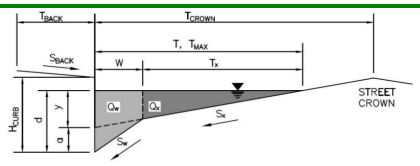
MHFD-Inlet, Version 5.02 (August 2022)

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

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

Project: Dawson Trails Infrastructure 1: Watershed B

Inlet ID: B6.52



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	20.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	23.5	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 =	0.052	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	8.0	23.5	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	10.8	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	1.92	5.64	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	3.43	7.15	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	6.0	21.5	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.688	0.251	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	1.4	42.0	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	3.1	14.1	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.6	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**4.5**	**56.7**	**cfs**
Flow Velocity within the Gutter Section	V =	7.6	13.7	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	2.2	8.2	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	38.7	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	36.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.148	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	21.4	174.9	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	21.4	158.3	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	10.0	30.5	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	27.7	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	31.4	216.5	cfs
Average Flow Velocity Within the Gutter Section	V =	12.0	18.6	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	6.0	16.8	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	0.48	0.39	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**15.1**	**84.1**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	4.84	8.04	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	0.89	inches

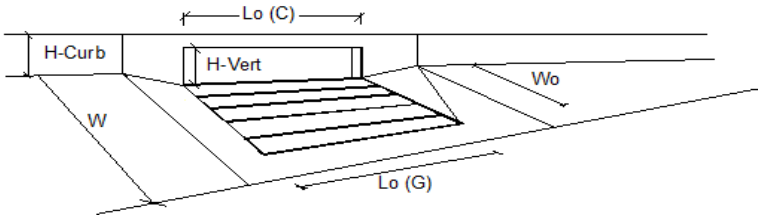
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**4.5**	**56.7**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 2.37 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 5.19 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet (CDOT Type R Curb Opening)	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 =	10.00	10.00	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	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	2.4	5.2	cfs
Water Spread Width	T =	5.6	8.6	ft
Water Depth at Flowline (outside of local depression)	d =	2.9	3.6	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.848	0.651	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.4	1.8	cfs
Discharge within the Gutter Section W	Q_w =	2.0	3.4	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.31	0.43	sq ft
Velocity within the Gutter Section W	V_W =	6.5	7.8	fps
Water Depth for Design Condition	d_{LOCAL} =	5.9	6.6	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoeff =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**
Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e	S_e =	0.179	0.142	ft/ft
Required Length L_T to Have 100% Interception	L_T =	7.34	12.17	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	7.34	10.00	ft
Interception Capacity	Q_i =	2.4	5.0	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoeff =	1.25	1.25	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.06	0.06	
Effective (Unclogged) Length	L_e =	7.34	9.38	ft
Actual Interception Capacity	**Q_a =**	**2.4**	**4.8**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.0**	**0.4**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**2.4**	**4.8**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.4**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**93**	**%**

MHFD-Inlet, Version 5.02 (August 2022)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	C5.01	C5.02	C5.03	C5.04	C5.11
Site Type (Urban or Rural)	URBAN	URBAN	URBAN	URBAN	URBAN
Inlet Application (Street or Area)	STREET	STREET	STREET	STREET	STREET
Hydraulic Condition	On Grade	On Grade	On Grade	On Grade	On Grade
Inlet Type	CDOT Type R Curb Opening	CDOT Type R Curb Opening	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)	8.2	6.8	5.0	4.5	4.8
Major Q_{known} (cfs)	16.3	13.7	10.1	9.0	9.6

Bypass (Carry-Over) Flow from Upstream Inlets must be organized from upstream (left) to downstream (right) in order for bypass flows to be linked.

Receive Bypass Flow from:	User-Defined	No Bypass Flow Received	C5.01	C5.02	No Bypass Flow Received
Minor Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.3	0.0	0.0
Major Bypass Flow Received, Q_b (cfs)	0.4	0.0	4.3	2.6	0.0

bypass from b6.52

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)	**8.2**	**6.8**	**5.3**	**4.5**	**4.8**
Major Total Design Peak Flow, Q (cfs)	**16.7**	**13.7**	**14.4**	**11.6**	**9.6**
Minor Flow Bypassed Downstream, Q_b (cfs)	0.3	0.0	0.0	0.0	0.3
Major Flow Bypassed Downstream, Q_b (cfs)	4.3	2.6	0.8	0.1	2.7

MHFD-Inlet, Version 5.02 (August 2022)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	C5.12	C5.13	C5.14	C5.15	C5.16
Site Type (Urban or Rural)	URBAN	URBAN	URBAN	URBAN	URBAN
Inlet Application (Street or Area)	STREET	STREET	STREET	STREET	STREET
Hydraulic Condition	On Grade	In Sump	In Sump	On Grade	On Grade
Inlet Type	CDOT Type R Curb Opening	CDOT Type R Curb Opening	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)	4.8	6.8	2.9	5.7	5.2
Major Q_{Known} (cfs)	9.6	13.7	5.7	11.3	10.3

Bypass (Carry-Over) Flow from Upstream

Receive Bypass Flow from:	No Bypass Flow Received	User-Defined	No Bypass Flow Received	No Bypass Flow Received	No Bypass Flow Received
Minor Bypass Flow Received, Q_b (cfs)	0.0	0.3	0.0	0.0	0.0
Major Bypass Flow Received, Q_b (cfs)	0.0	3.5	0.0	0.0	0.0

bypass from C5.11 and the B6.51

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)	**4.8**	**7.1**	**2.9**	**5.7**	**5.2**
Major Total Design Peak Flow, Q (cfs)	**9.6**	**17.2**	**5.7**	**11.3**	**10.3**
Minor Flow Bypassed Downstream, Q_b (cfs)	0.3	N/A	N/A	0.0	0.0
Major Flow Bypassed Downstream, Q_b (cfs)	2.7	N/A	N/A	0.1	0.0

MHFD-Inlet, Version 5.02 (August 2022)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	C6.01	C6.02	C6.03	C6.04
Site Type (Urban or Rural)	URBAN	URBAN	URBAN	URBAN
Inlet Application (Street or Area)	STREET	STREET	STREET	STREET
Hydraulic Condition	In Sump	On Grade	On Grade	On Grade
Inlet Type	CDOT Type R Curb Opening	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)	6.7	4.2	3.3	3.3
Major Q_{Known} (cfs)	13.3	8.3	6.7	6.6

Bypass (Carry-Over) Flow from Upstream

Receive Bypass Flow from:	C5.12	No Bypass Flow Received	No Bypass Flow Received	C6.02
Minor Bypass Flow Received, Q_b (cfs)	0.3	0.0	0.0	0.1
Major Bypass Flow Received, Q_b (cfs)	2.7	0.0	0.0	1.9

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

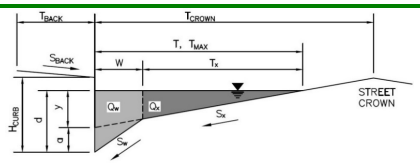
Minor Total Design Peak Flow, Q (cfs)	**6.9**	**4.2**	**3.3**	**3.4**
Major Total Design Peak Flow, Q (cfs)	**16.1**	**8.3**	**6.7**	**8.6**
Minor Flow Bypassed Downstream, Q_b (cfs)	N/A	0.1	0.0	0.0
Major Flow Bypassed Downstream, Q_b (cfs)	N/A	1.9	0.0	0.4

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

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

Project: **Dawson Trails Infrastructure 1: Watershed C**

Inlet ID: **C5.01**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	21.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	34.5	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 =	0.012	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	18.7	34.5	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	11.1	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	4.49	8.28	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	6.00	9.79	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	16.7	32.5	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.167	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	10.1	59.8	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	4.7	12.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	7.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**14.8**	**78.7**	**cfs**
Flow Velocity within the Gutter Section	V =	5.7	8.2	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	2.8	6.7	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	39.9	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	37.9	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.144	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	10.1	89.8	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	10.1	89.3	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	4.7	15.1	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	15.2	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	14.8	119.6	cfs
Average Flow Velocity Within the Gutter Section	V =	5.7	9.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.8	8.3	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	1.00	1.00	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**14.8**	**119.6**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	11.08	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	1.29	inches

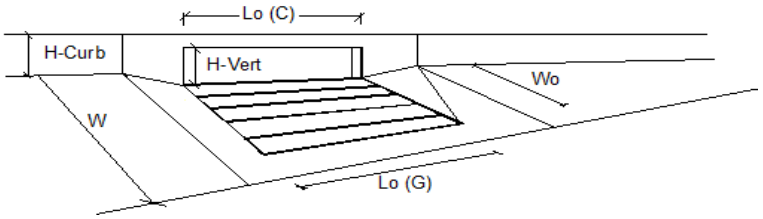
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**14.8**	**78.7**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 8.15 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 16.74 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



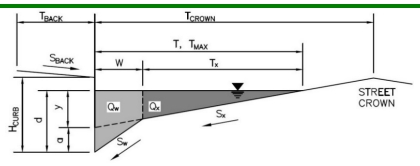
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	15.00	15.00	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	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	8.2	16.7	cfs
Water Spread Width	T =	14.7	19.6	ft
Water Depth at Flowline (outside of local depression)	d =	5.0	6.2	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.405	0.302	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	4.8	11.7	cfs
Discharge within the Gutter Section W	Q_w =	3.3	5.1	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.67	0.87	sq ft
Velocity within the Gutter Section W	V_W =	4.9	5.8	fps
Water Depth for Design Condition	d_{LOCAL} =	8.0	9.2	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoeff =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**
Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e	S_e =	0.096	0.077	ft/ft
Required Length L_T to Have 100% Interception	L_T =	16.83	26.94	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	15.00	15.00	ft
Interception Capacity	Q_i =	8.0	12.9	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoeff =	1.31	1.31	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.04	0.04	
Effective (Unclogged) Length	L_e =	14.35	14.35	ft
Actual Interception Capacity	**Q_a =**	**7.9**	**12.5**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.3**	**4.3**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**7.9**	**12.5**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.3**	**4.3**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**97**	**75**	**%**

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

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

Project: **Dawson Trails Infrastructure 1: Watershed C**

Inlet ID: **C5.02**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	21.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	34.5	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 =	0.013	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	18.7	34.5	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	11.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	4.49	8.28	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	6.00	9.79	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	16.7	32.5	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.167	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	10.6	62.8	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	5.0	12.6	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	7.3	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**15.6**	**82.7**	**cfs**
Flow Velocity within the Gutter Section	V =	5.9	8.6	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	3.0	7.0	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	39.7	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	37.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.144	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	10.6	93.2	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	10.6	92.8	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	5.0	15.7	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	15.7	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	15.6	124.2	cfs
Average Flow Velocity Within the Gutter Section	V =	5.9	9.4	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	3.0	8.6	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	1.00	1.00	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**15.6**	**124.2**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	11.04	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	1.25	inches

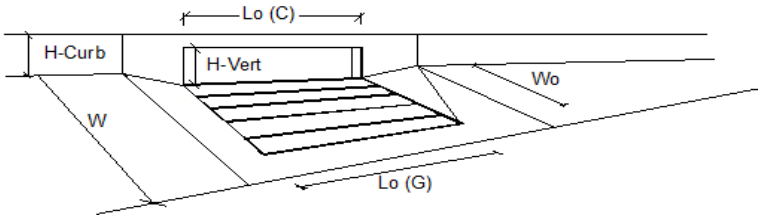
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**15.6**	**82.7**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 6.84 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 13.72 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



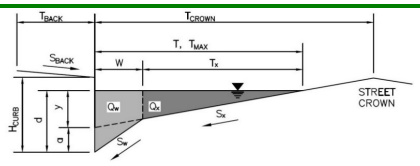
Design Information (Input)		MINOR	MAJOR	
Type of Inlet (CDOT Type R Curb Opening)	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	15.00	15.00	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	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	6.8	13.7	cfs
Water Spread Width	T =	13.4	17.8	ft
Water Depth at Flowline (outside of local depression)	d =	4.7	5.8	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.444	0.334	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	3.8	9.1	cfs
Discharge within the Gutter Section W	Q_w =	3.0	4.6	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.62	0.80	sq ft
Velocity within the Gutter Section W	V_W =	4.9	5.7	fps
Water Depth for Design Condition	d_{LOCAL} =	7.7	8.8	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoeff =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**
Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e	S_e =	0.103	0.083	ft/ft
Required Length L_T to Have 100% Interception	L_T =	14.97	23.66	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	14.97	15.00	ft
Interception Capacity	Q_i =	6.8	11.5	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoeff =	1.31	1.31	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.04	0.04	
Effective (Unclogged) Length	L_e =	14.35	14.35	ft
Actual Interception Capacity	**Q_a =**	**6.8**	**11.2**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.0**	**2.6**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**6.8**	**11.2**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**2.6**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**81**	**%**

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

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

Project: Dawson Trails Infrastructure 1: Watershed C

Inlet ID: C5.03



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	22.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	31.0	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 =	0.018	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	18.7	31.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	11.3	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☑	

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression ($T * S_x * 12$)	y =	4.49	7.44	inches
Vertical Depth between Gutter Lip and Gutter Flowline ($W * S_w * 12$)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - ($W * S_x * 12$))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	6.00	8.95	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	16.7	29.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.187	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	12.6	54.9	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	5.9	12.7	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	4.5	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**18.5**	**72.1**	**cfs**
Flow Velocity within the Gutter Section	V =	7.0	9.5	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	3.5	7.1	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	40.7	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	38.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.141	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	12.6	118.6	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	12.6	115.6	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	5.9	19.4	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	21.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	18.5	156.0	cfs
Average Flow Velocity Within the Gutter Section	V =	7.0	11.3	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	3.5	10.6	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	1.00	0.91	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**18.5**	**141.6**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	10.95	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	1.99	inches

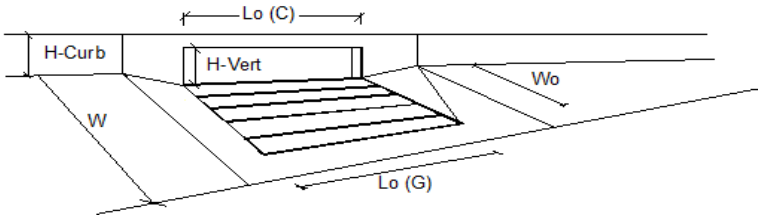
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**18.5**	**141.6**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 5.29 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 14.36 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet (CDOT Type R Curb Opening)	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 =	2	2	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	10.00	10.00	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	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	5.3	14.4	cfs
Water Spread Width	T =	11.1	16.9	ft
Water Depth at Flowline (outside of local depression)	d =	4.2	5.6	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.526	0.351	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	2.5	9.3	cfs
Discharge within the Gutter Section W	Q_w =	2.8	5.0	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.53	0.76	sq ft
Velocity within the Gutter Section W	V_W =	5.3	6.6	fps
Water Depth for Design Condition	d_{LOCAL} =	7.2	8.6	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoeff =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**
Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e	S_e =	0.119	0.086	ft/ft
Required Length L_T to Have 100% Interception	L_T =	12.56	24.26	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	12.56	20.00	ft
Interception Capacity	Q_i =	5.3	13.7	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoeff =	1.33	1.33	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.03	0.03	
Effective (Unclogged) Length	L_e =	12.56	19.34	ft
Actual Interception Capacity	**Q_a =**	**5.3**	**13.5**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.0**	**0.8**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**5.3**	**13.5**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.8**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**94**	**%**

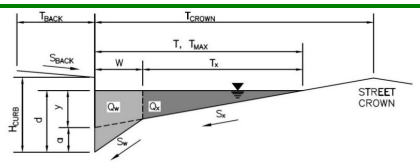
MHFD-Inlet, Version 5.02 (August 2022)

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

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

Project: **Dawson Trails Infrastructure 1: Watershed C**

Inlet ID: **C5.04**



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	21.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	62.0	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 =	0.021	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	18.7	39.7	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	11.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	4.49	9.53	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	6.00	11.04	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	16.7	37.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.144	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	13.6	118.9	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	6.3	20.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	20.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**19.9**	**158.9**	**cfs**
Flow Velocity within the Gutter Section	V =	7.6	12.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	3.8	11.0	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	39.7	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	37.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.144	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	13.6	118.9	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	13.6	118.9	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	6.3	20.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	20.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	19.9	158.9	cfs
Average Flow Velocity Within the Gutter Section	V =	7.6	12.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	3.8	11.0	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	1.00	0.81	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**19.8**	**128.4**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	10.37	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	0.00	inches

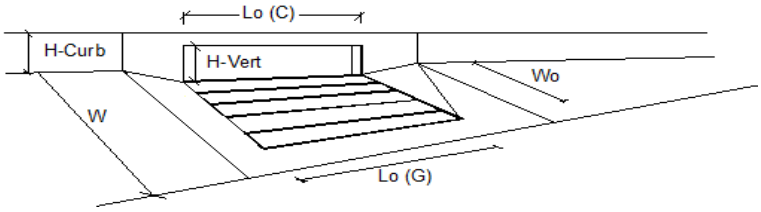
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**19.8**	**128.4**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 4.52 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 11.60 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



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 =	2	2	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	10.00	10.00	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	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	4.5	11.6	cfs
Water Spread Width	T =	10.0	15.0	ft
Water Depth at Flowline (outside of local depression)	d =	3.9	5.1	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.576	0.395	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	1.9	7.0	cfs
Discharge within the Gutter Section W	Q_w =	2.6	4.6	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.49	0.69	sq ft
Velocity within the Gutter Section W	V_W =	5.4	6.7	fps
Water Depth for Design Condition	d_{LOCAL} =	6.9	8.1	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoeff =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**
Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e	S_e =	0.128	0.094	ft/ft
Required Length L_T to Have 100% Interception	L_T =	11.29	21.04	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	11.29	20.00	ft
Interception Capacity	Q_i =	4.5	11.6	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoeff =	1.33	1.33	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.03	0.03	
Effective (Unclogged) Length	L_e =	11.29	19.34	ft
Actual Interception Capacity	**Q_a =**	**4.5**	**11.5**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.0**	**0.1**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**4.5**	**11.5**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.1**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**99**	**%**

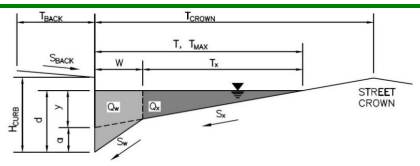
MHFD-Inlet, Version 5.02 (August 2022)

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

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

Project: **Dawson Trails Infrastructure 1: Watershed C**

Inlet ID: **C5.11**



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	21.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	45.5	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 =	0.020	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	18.7	37.7	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	11.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	4.49	9.05	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	6.00	10.56	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	16.7	35.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.152	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	13.3	100.8	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	6.2	18.1	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	15.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**19.5**	**133.9**	**cfs**
Flow Velocity within the Gutter Section	V =	7.4	11.4	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	3.7	10.0	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	39.7	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	37.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.144	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	13.3	116.6	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	13.3	116.6	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	6.2	19.7	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	19.6	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	19.5	155.8	cfs
Average Flow Velocity Within the Gutter Section	V =	7.4	11.7	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	3.7	10.8	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	1.00	0.83	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**19.5**	**130.0**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	10.47	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	0.00	inches

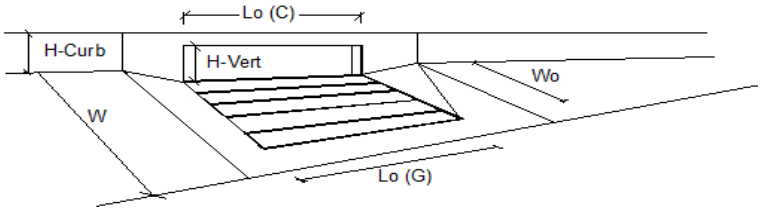
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**19.5**	**130.0**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 4.80 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 9.63 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



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 =	10.00	10.00	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	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	4.8	9.6	cfs
Water Spread Width	T =	10.4	14.0	ft
Water Depth at Flowline (outside of local depression)	d =	4.0	4.9	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.558	0.423	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	2.1	5.6	cfs
Discharge within the Gutter Section W	Q_w =	2.7	4.1	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.50	0.65	sq ft
Velocity within the Gutter Section W	V_W =	5.3	6.3	fps
Water Depth for Design Condition	d_{LOCAL} =	7.0	7.9	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoeff =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**
Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e	S_e =	0.125	0.100	ft/ft
Required Length L_T to Have 100% Interception	L_T =	11.76	18.62	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	10.00	10.00	ft
Interception Capacity	Q_i =	4.6	7.2	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoeff =	1.25	1.25	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.06	0.06	
Effective (Unclogged) Length	L_e =	9.38	9.38	ft
Actual Interception Capacity	**Q_a =**	**4.5**	**6.9**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.3**	**2.7**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**4.5**	**6.9**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.3**	**2.7**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**94**	**72**	**%**

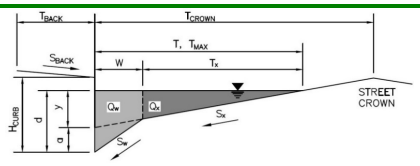
MHFD-Inlet, Version 5.02 (August 2022)

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

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

Project: **Dawson Trails Infrastructure 1: Watershed C**

Inlet ID: **C5.12**



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	32.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	34.5	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 =	0.020	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	18.7	34.5	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	13.7	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	4.49	8.28	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	6.00	9.79	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	16.7	32.5	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.167	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	13.3	78.5	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	6.2	15.8	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	9.2	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**19.5**	**103.4**	**cfs**
Flow Velocity within the Gutter Section	V =	7.4	10.8	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	3.7	8.8	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	50.7	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	48.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.112	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	13.3	230.7	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	13.3	218.4	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	6.2	29.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	60.2	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	19.5	307.7	cfs
Average Flow Velocity Within the Gutter Section	V =	7.4	13.7	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	3.7	15.6	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	1.00	0.83	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**19.5**	**256.6**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	12.90	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	3.11	inches

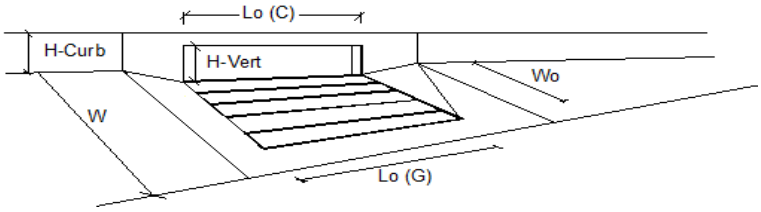
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**19.5**	**103.4**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 4.80 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 9.64 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



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 =	10.00	10.00	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	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	4.8	9.6	cfs
Water Spread Width	T =	10.4	14.0	ft
Water Depth at Flowline (outside of local depression)	d =	4.0	4.9	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.558	0.423	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	2.1	5.6	cfs
Discharge within the Gutter Section W	Q_w =	2.7	4.1	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.50	0.65	sq ft
Velocity within the Gutter Section W	V_W =	5.3	6.3	fps
Water Depth for Design Condition	d_{LOCAL} =	7.0	7.9	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoeff =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**
Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e	S_e =	0.125	0.099	ft/ft
Required Length L_T to Have 100% Interception	L_T =	11.76	18.64	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	10.00	10.00	ft
Interception Capacity	Q_i =	4.6	7.2	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoeff =	1.25	1.25	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.06	0.06	
Effective (Unclogged) Length	L_e =	9.38	9.38	ft
Actual Interception Capacity	**Q_a =**	**4.5**	**6.9**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.3**	**2.7**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**4.5**	**6.9**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.3**	**2.7**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**94**	**72**	**%**

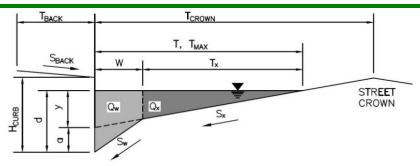
MHFD-Inlet, Version 5.02 (August 2022)

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

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

Project: **Dawson Trails Infrastructure 1: Watershed C**

Inlet ID: **C5.13**



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	21.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	35.0	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 =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	18.7	35.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	10.6	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

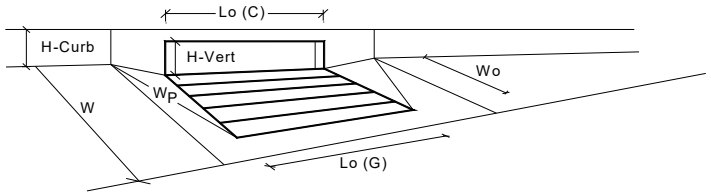
Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	4.49	8.40	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	6.00	9.91	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	16.7	33.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.165	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**SUMP**	**SUMP**	**cfs**
Flow Velocity within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	0.0	0.0	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	37.7	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	35.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.152	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	0.0	0.0	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	SUMP	SUMP	cfs
Average Flow Velocity Within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.0	0.0	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	SUMP	SUMP	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**SUMP**	**SUMP**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =			inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =			inches

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is not applicable to Sump Condition				
MAJOR STORM Allowable Capacity is not applicable to Sump Condition	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.02 (August 2022)



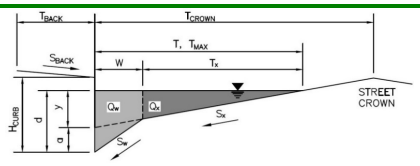
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	9.9	inches
Grate Information		MINOR	MAJOR	Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	10.00	10.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
Grate Flow Analysis (Calculated)		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	N/A	N/A	
Clogging Factor for Multiple Units	Clog =	N/A	N/A	
Grate Capacity as a Weir (based on MHFD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	N/A	N/A	cfs
Interception with Clogging	Q_{wa} =	N/A	N/A	cfs
Grate Capacity as an Orifice (based on MHFD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	N/A	N/A	cfs
Interception with Clogging	Q_{oa} =	N/A	N/A	cfs
Grate Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	N/A	N/A	cfs
Interception with Clogging	Q_{ma} =	N/A	N/A	cfs
Resulting Grate Capacity (assumes clogged condition)	**Q_{Grate} =**	**N/A**	**N/A**	**cfs**
Curb Opening Flow Analysis (Calculated)		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	1.25	1.25	
Clogging Factor for Multiple Units	Clog =	0.06	0.06	
Curb Capacity as a Weir (based on MHFD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	8.8	26.3	cfs
Interception with Clogging	Q_{wa} =	8.3	24.6	cfs
Curb Capacity as an Orifice (based on MHFD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	19.5	24.8	cfs
Interception with Clogging	Q_{oa} =	18.3	23.3	cfs
Curb Opening Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	12.2	23.7	cfs
Interception with Clogging	Q_{ma} =	11.4	22.3	cfs
Resulting Curb Opening Capacity (assumes clogged condition)	**Q_{Curb} =**	**8.3**	**22.3**	**cfs**
Resultant Street Conditions		MINOR	MAJOR	
Total Inlet Length	L =	10.00	10.00	feet
Resultant Street Flow Spread (based on street geometry from above)	T =	18.7	35.0	ft
Resultant Flow Depth at Street Crown	d_{CROWN} =	0.0	0.0	inches
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.33	0.66	ft
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	0.93	1.00	
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	N/A	N/A	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**8.3**	**22.3**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms (>Q Peak)	$Q_{PEAK\ REQUIRED}$ =	7.1	17.2	cfs

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

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

Project: **Dawson Trails Infrastructure 1: Watershed C**

Inlet ID: **C5.14**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	20.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	25.0	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 =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	18.7	25.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	10.6	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	4.49	6.00	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	6.00	7.51	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	16.7	23.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.235	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**SUMP**	**SUMP**	**cfs**
Flow Velocity within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	0.0	0.0	

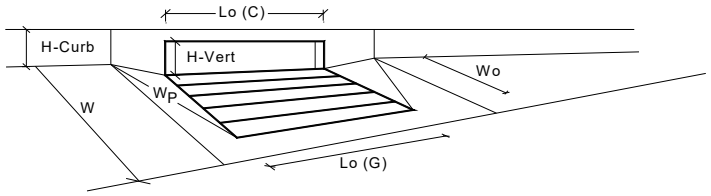
Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	37.7	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	35.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.152	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	0.0	0.0	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	SUMP	SUMP	cfs
Average Flow Velocity Within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.0	0.0	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	SUMP	SUMP	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**SUMP**	**SUMP**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =			inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =			inches

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is not applicable to Sump Condition				
MAJOR STORM Allowable Capacity is not applicable to Sump Condition	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.02 (August 2022)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	7.5	inches
Grate Information		MINOR	MAJOR	Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
Grate Flow Analysis (Calculated)		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	N/A	N/A	
Clogging Factor for Multiple Units	Clog =	N/A	N/A	
Grate Capacity as a Weir (based on MHFD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	N/A	N/A	cfs
Interception with Clogging	Q_{wa} =	N/A	N/A	cfs
Grate Capacity as an Orifice (based on MHFD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	N/A	N/A	cfs
Interception with Clogging	Q_{oa} =	N/A	N/A	cfs
Grate Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	N/A	N/A	cfs
Interception with Clogging	Q_{ma} =	N/A	N/A	cfs
Resulting Grate Capacity (assumes clogged condition)	**Q_{Grate} =**	**N/A**	**N/A**	**cfs**
Curb Opening Flow Analysis (Calculated)		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	1.00	1.00	
Clogging Factor for Multiple Units	Clog =	0.10	0.10	
Curb Capacity as a Weir (based on MHFD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	6.0	9.7	cfs
Interception with Clogging	Q_{wa} =	5.4	8.7	cfs
Curb Capacity as an Orifice (based on MHFD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	9.8	10.9	cfs
Interception with Clogging	Q_{oa} =	8.8	9.8	cfs
Curb Opening Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	7.1	9.5	cfs
Interception with Clogging	Q_{ma} =	6.4	8.6	cfs
Resulting Curb Opening Capacity (assumes clogged condition)	**Q_{Curb} =**	**5.4**	**8.6**	**cfs**
Resultant Street Conditions		MINOR	MAJOR	
Total Inlet Length	L =	5.00	5.00	feet
Resultant Street Flow Spread (based on street geometry from above)	T =	18.7	25.0	ft
Resultant Flow Depth at Street Crown	d_{CROWN} =	0.0	0.0	inches
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.33	0.46	ft
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	N/A	N/A	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**5.4**	**8.6**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms (>Q Peak)	$Q_{PEAK\ REQUIRED}$ =	2.9	5.7	cfs

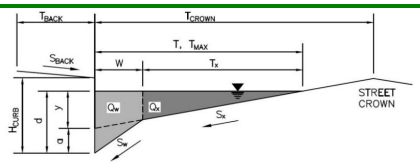
MHFD-Inlet, Version 5.02 (August 2022)

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

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

Project: **Dawson Trails Infrastructure 1: Watershed C**

Inlet ID: **C5.15**



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	21.5	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	34.5	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 =	0.020	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	18.7	34.5	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	11.2	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	4.49	8.28	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	6.00	9.79	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	16.7	32.5	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.167	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	13.3	78.5	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	6.2	15.8	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	9.2	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**19.5**	**103.4**	**cfs**
Flow Velocity within the Gutter Section	V =	7.4	10.8	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	3.7	8.8	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	40.2	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	38.2	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.142	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	13.3	120.7	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	13.3	120.0	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	6.2	20.1	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	20.9	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	19.5	160.9	cfs
Average Flow Velocity Within the Gutter Section	V =	7.4	11.8	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	3.7	11.0	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	1.00	0.83	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**19.5**	**134.2**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	10.57	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	0.78	inches

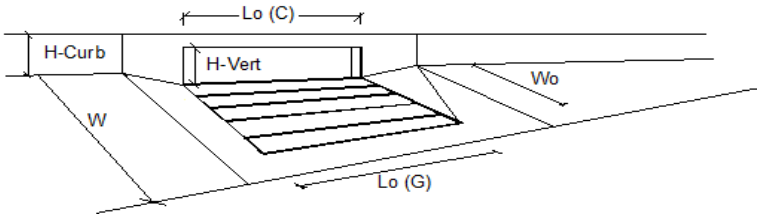
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**19.5**	**103.4**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 5.65 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 11.34 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



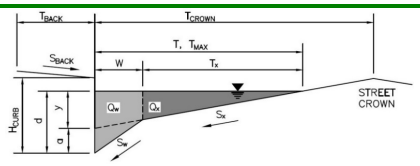
Design Information (Input)		MINOR	MAJOR	
Type of Inlet (CDOT Type R Curb Opening)	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	2	2	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	10.00	10.00	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	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	5.7	11.3	cfs
Water Spread Width	T =	11.2	15.0	ft
Water Depth at Flowline (outside of local depression)	d =	4.2	5.1	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.524	0.395	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	2.7	6.9	cfs
Discharge within the Gutter Section W	Q_w =	3.0	4.5	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.53	0.69	sq ft
Velocity within the Gutter Section W	V_W =	5.6	6.5	fps
Water Depth for Design Condition	d_{LOCAL} =	7.2	8.1	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoeff =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**
Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e	S_e =	0.119	0.094	ft/ft
Required Length L_T to Have 100% Interception	L_T =	13.09	20.74	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	13.09	20.00	ft
Interception Capacity	Q_i =	5.7	11.3	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoeff =	1.33	1.33	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.03	0.03	
Effective (Unclogged) Length	L_e =	13.09	19.34	ft
Actual Interception Capacity	**Q_a =**	**5.7**	**11.3**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.0**	**0.1**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**5.7**	**11.3**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.1**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**99**	**%**

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

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

Project: **Dawson Trails Infrastructure 1: Watershed C**

Inlet ID: **C5.16**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	25.3	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	34.5	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 =	0.020	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	18.7	34.5	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.1	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	4.49	8.28	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	6.00	9.79	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	16.7	32.5	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.167	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	13.3	78.5	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	6.2	15.8	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	9.2	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**19.5**	**103.4**	**cfs**
Flow Velocity within the Gutter Section	V =	7.4	10.8	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	3.7	8.8	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	44.0	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	42.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.130	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	13.3	155.0	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	13.3	152.1	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	6.2	23.1	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	32.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	19.5	207.2	cfs
Average Flow Velocity Within the Gutter Section	V =	7.4	12.5	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	3.7	12.6	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	1.00	0.83	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**19.5**	**172.8**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	11.41	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	1.62	inches

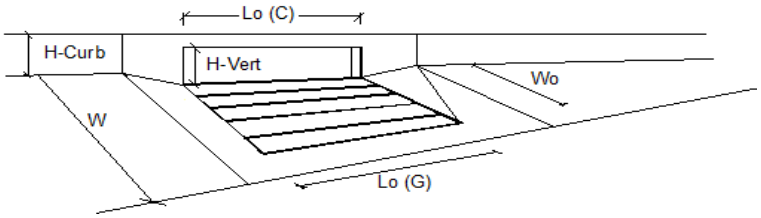
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**19.5**	**103.4**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 5.15 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 10.32 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet (CDOT Type R Curb Opening)	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 =	2	2	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	10.00	10.00	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	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	5.2	10.3	cfs
Water Spread Width	T =	10.7	14.4	ft
Water Depth at Flowline (outside of local depression)	d =	4.1	5.0	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.544	0.412	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	2.3	6.1	cfs
Discharge within the Gutter Section W	Q_w =	2.8	4.2	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.51	0.66	sq ft
Velocity within the Gutter Section W	V_W =	5.4	6.4	fps
Water Depth for Design Condition	d_{LOCAL} =	7.1	8.0	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoeff =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**
Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e	S_e =	0.122	0.097	ft/ft
Required Length L_T to Have 100% Interception	L_T =	12.31	19.48	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	12.31	19.48	ft
Interception Capacity	Q_i =	5.2	10.3	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoeff =	1.33	1.33	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.03	0.03	
Effective (Unclogged) Length	L_e =	12.31	19.34	ft
Actual Interception Capacity	**Q_a =**	**5.2**	**10.3**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.0**	**0.0**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**5.2**	**10.3**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**100**	**%**

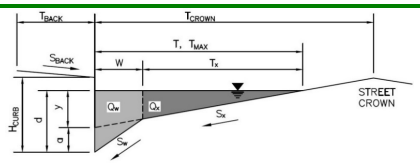
MHFD-Inlet, Version 5.02 (August 2022)

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

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

Project: **Dawson Trails Infrastructure 1: Watershed C**

Inlet ID: **C6.01**



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	19.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	28.0	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 =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	18.0	28.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	10.6	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

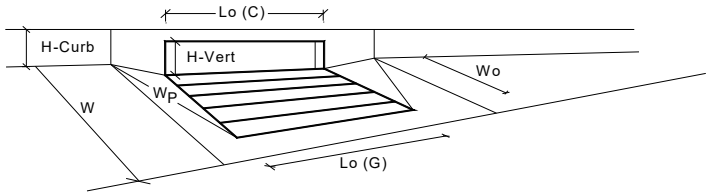
Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	4.32	6.72	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	5.83	8.23	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	16.0	26.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.330	0.209	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**SUMP**	**SUMP**	**cfs**
Flow Velocity within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	0.0	0.0	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	37.7	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	35.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.152	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	0.0	0.0	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	SUMP	SUMP	cfs
Average Flow Velocity Within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.0	0.0	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	SUMP	SUMP	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**SUMP**	**SUMP**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =			inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =			inches

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is not applicable to Sump Condition				
MAJOR STORM Allowable Capacity is not applicable to Sump Condition	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.02 (August 2022)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	5.8	8.2	inches
Grate Information		MINOR	MAJOR	☐ Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	10.00	10.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
Grate Flow Analysis (Calculated)		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	N/A	N/A	
Clogging Factor for Multiple Units	Clog =	N/A	N/A	
Grate Capacity as a Weir (based on MHFD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	N/A	N/A	cfs
Interception with Clogging	Q_{wa} =	N/A	N/A	cfs
Grate Capacity as an Orifice (based on MHFD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	N/A	N/A	cfs
Interception with Clogging	Q_{oa} =	N/A	N/A	cfs
Grate Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	N/A	N/A	cfs
Interception with Clogging	Q_{ma} =	N/A	N/A	cfs
Resulting Grate Capacity (assumes clogged condition)	**Q_{Grate} =**	**N/A**	**N/A**	**cfs**
Curb Opening Flow Analysis (Calculated)		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	1.25	1.25	
Clogging Factor for Multiple Units	Clog =	0.06	0.06	
Curb Capacity as a Weir (based on MHFD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	8.2	18.4	cfs
Interception with Clogging	Q_{wa} =	7.7	17.2	cfs
Curb Capacity as an Orifice (based on MHFD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	19.2	22.7	cfs
Interception with Clogging	Q_{oa} =	18.0	21.3	cfs
Curb Opening Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	11.7	19.0	cfs
Interception with Clogging	Q_{ma} =	10.9	17.8	cfs
Resulting Curb Opening Capacity (assumes clogged condition)	**Q_{Curb} =**	**7.7**	**17.2**	**cfs**
Resultant Street Conditions		MINOR	MAJOR	
Total Inlet Length	L =	10.00	10.00	feet
Resultant Street Flow Spread (based on street geometry from above)	T =	18.0	28.0	ft
Resultant Flow Depth at Street Crown	d_{CROWN} =	0.0	0.0	inches
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.32	0.52	ft
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	0.92	1.00	
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	N/A	N/A	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**7.7**	**17.2**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms (>Q Peak)	$Q_{PEAK\ REQUIRED}$ =	6.9	16.1	cfs

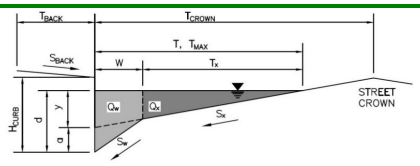
MHFD-Inlet, Version 5.02 (August 2022)

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

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

Project: **Dawson Trails Infrastructure 1: Watershed C**

Inlet ID: **C6.02**



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	19.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	18.0	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 =	0.028	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	18.0	18.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	10.6	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	4.32	4.32	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	5.83	5.83	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	16.0	16.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.330	0.330	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	14.0	14.0	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	6.9	6.9	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**20.9**	**20.9**	**cfs**
Flow Velocity within the Gutter Section	V =	8.6	8.6	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	4.2	4.2	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	37.9	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	35.9	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.152	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	15.7	120.5	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	15.7	95.6	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	7.3	21.6	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	18.1	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	23.0	135.3	cfs
Average Flow Velocity Within the Gutter Section	V =	8.8	13.5	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	4.4	11.9	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	0.79	0.64	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**18.1**	**86.5**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.59	9.12	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	3.29	inches

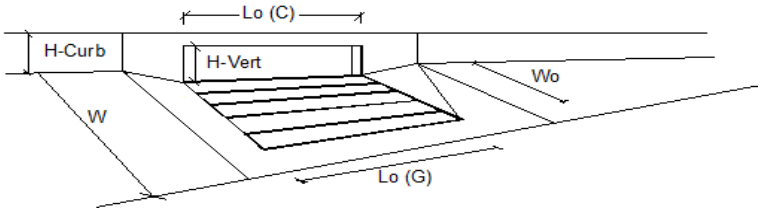
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**18.1**	**20.9**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 4.15 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 8.33 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



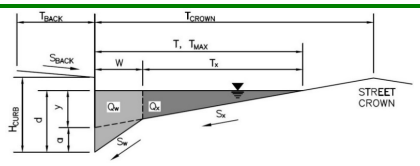
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	10.00	10.00	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	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	4.2	8.3	cfs
Water Spread Width	T =	9.0	12.3	ft
Water Depth at Flowline (outside of local depression)	d =	3.7	4.5	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.629	0.479	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	1.5	4.3	cfs
Discharge within the Gutter Section W	Q_w =	2.6	4.0	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.45	0.58	sq ft
Velocity within the Gutter Section W	V_W =	5.9	6.9	fps
Water Depth for Design Condition	d_{LOCAL} =	6.7	7.5	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoeff =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**
Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e	S_e =	0.138	0.110	ft/ft
Required Length L_T to Have 100% Interception	L_T =	10.62	16.83	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	10.00	10.00	ft
Interception Capacity	Q_i =	4.1	6.7	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoeff =	1.25	1.25	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.06	0.06	
Effective (Unclogged) Length	L_e =	9.38	9.38	ft
Actual Interception Capacity	**Q_a =**	**4.1**	**6.4**	**cfs**
Carry-Over Flow = $Q_{o(GRATE)}$-Q_a	**Q_b =**	**0.1**	**1.9**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**4.1**	**6.4**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.1**	**1.9**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**98**	**77**	**%**

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

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

Project: Dawson Trails Infrastructure 1: Watershed C

Inlet ID: C6.03



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	23.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	14.0	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 =	0.012	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	14.0	14.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	11.5	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	3.36	3.36	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	4.87	4.87	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	12.0	12.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.425	0.425	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	4.2	4.2	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	3.1	3.1	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**7.3**	**7.3**	**cfs**
Flow Velocity within the Gutter Section	V =	4.8	4.8	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	2.0	2.0	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	41.7	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	39.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.137	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	10.2	102.8	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	9.9	63.4	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	4.8	16.3	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	19.2	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	14.6	98.9	cfs
Average Flow Velocity Within the Gutter Section	V =	5.7	9.3	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.9	8.9	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	1.00	1.00	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**14.6**	**98.9**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	11.52	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	1.13	6.65	inches

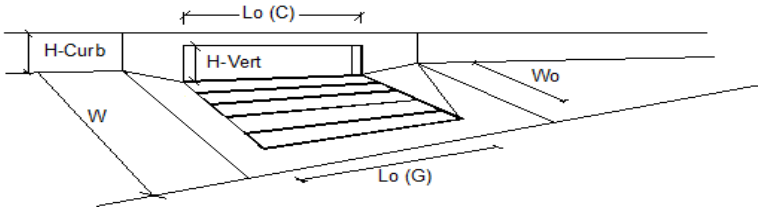
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**7.3**	**7.3**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 3.32 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 6.67 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



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 =	15.00	15.00	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	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	3.3	6.7	cfs
Water Spread Width	T =	9.9	13.4	ft
Water Depth at Flowline (outside of local depression)	d =	3.9	4.7	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.582	0.441	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	1.4	3.7	cfs
Discharge within the Gutter Section W	Q_w =	1.9	2.9	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.48	0.62	sq ft
Velocity within the Gutter Section W	V_W =	4.0	4.7	fps
Water Depth for Design Condition	d_{LOCAL} =	6.9	7.7	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoeff =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**
Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e	S_e =	0.129	0.103	ft/ft
Required Length L_T to Have 100% Interception	L_T =	9.30	14.75	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	9.30	14.75	ft
Interception Capacity	Q_i =	3.3	6.7	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoeff =	1.31	1.31	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.04	0.04	
Effective (Unclogged) Length	L_e =	9.30	14.35	ft
Actual Interception Capacity	**Q_a =**	**3.3**	**6.7**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.0**	**0.0**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**3.3**	**6.7**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**100**	**%**

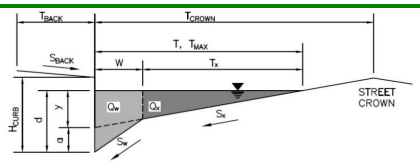
MHFD-Inlet, Version 5.02 (August 2022)

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

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

Project: **Dawson Trails Infrastructure 1: Watershed C**

Inlet ID: **C6.04**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	19.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	18.0	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 =	0.012	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	18.0	18.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	10.6	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☑	

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	4.32	4.32	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	5.83	5.83	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	16.0	16.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.330	0.330	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	9.2	9.2	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	4.5	4.5	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**13.7**	**13.7**	**cfs**
Flow Velocity within the Gutter Section	V =	5.6	5.6	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	2.7	2.7	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	37.7	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	35.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.152	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	10.3	78.1	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	10.3	62.1	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	4.8	14.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	11.6	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	15.1	87.7	cfs
Average Flow Velocity Within the Gutter Section	V =	5.7	8.8	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.9	7.7	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	1.00	1.00	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**15.1**	**87.7**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	10.56	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.17	4.73	inches

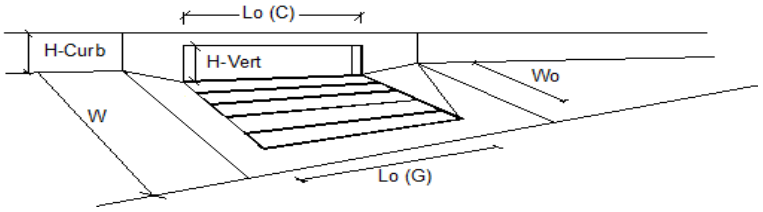
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**13.7**	**87.7**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 3.40 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 8.55 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



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 =	15.00	15.00	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	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	3.4	8.6	cfs
Water Spread Width	T =	10.0	14.9	ft
Water Depth at Flowline (outside of local depression)	d =	3.9	5.1	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.579	0.400	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	1.4	5.1	cfs
Discharge within the Gutter Section W	Q_w =	2.0	3.4	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.48	0.68	sq ft
Velocity within the Gutter Section W	V_W =	4.1	5.0	fps
Water Depth for Design Condition	d_{LOCAL} =	6.9	8.1	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoeff =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**
Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e	S_e =	0.129	0.095	ft/ft
Required Length L_T to Have 100% Interception	L_T =	9.44	17.36	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	9.44	15.00	ft
Interception Capacity	Q_i =	3.4	8.3	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoeff =	1.31	1.31	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.04	0.04	
Effective (Unclogged) Length	L_e =	9.44	14.35	ft
Actual Interception Capacity	**Q_a =**	**3.4**	**8.2**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.0**	**0.4**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**3.4**	**8.2**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.4**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**96**	**%**

MHFD-Inlet, Version 5.02 (August 2022)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	INLET 2D1-Sump	INLET 3D1-Sump	INLET 4D1	INLET 5D1	INLET 8D1-Sump
Site Type (Urban or Rural)	URBAN	URBAN	URBAN	URBAN	URBAN
Inlet Application (Street or Area)	STREET	STREET	STREET	STREET	STREET
Hydraulic Condition	In Sump	In Sump	On Grade	On Grade	In Sump
Inlet Type	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening

USER-DEFINED INPUT

	D1-2	D1-3	D1-4	D1-5	
User-Defined Design Flows					D1-8a + D1-8b
Minor Q_{Known} (cfs)	4.5	2.5	3.4	1.3	5.2
Major Q_{Known} (cfs)	9.4	5.3	7.4	2.9	11.5

Bypass (Carry-Over) Flow from Upstream Inlets must be organized from upstream (left) to downstream (right) in order for bypass flows to be linked.

Receive Bypass Flow from:	No Bypass Flow Received	No Bypass Flow Received	No Bypass Flow Received	No Bypass Flow Received	No Bypass Flow Received
Minor Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.0	0.0	0.0
Major Bypass Flow Received, Q_b (cfs)	0.0	0.0	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)	**4.5**	**2.5**	**3.4**	**1.3**	**5.2**
Major Total Design Peak Flow, Q (cfs)	**9.4**	**5.3**	**7.4**	**2.9**	**11.5**
Minor Flow Bypassed Downstream, Q_b (cfs)	N/A	N/A	0.0	0.0	N/A
Major Flow Bypassed Downstream, Q_b (cfs)	N/A	N/A	1.5	0.0	N/A

MHFD-Inlet, Version 5.02 (August 2022)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	INLET 9D1-Sump
Site Type (Urban or Rural)	URBAN
Inlet Application (Street or Area)	STREET
Hydraulic Condition	In Sump
Inlet Type	CDOT Type R Curb Opening

USER-DEFINED INPUT

User-Defined Design Flows	D1-9a + D1-9b
Minor Q_{Known} (cfs)	5.1
Major Q_{Known} (cfs)	11.5

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

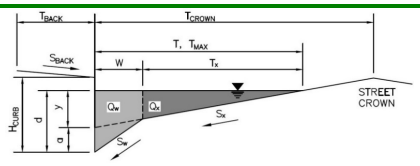
Minor Total Design Peak Flow, Q (cfs)	**5.1**
Major Total Design Peak Flow, Q (cfs)	**11.5**
Minor Flow Bypassed Downstream, Q_b (cfs)	N/A
Major Flow Bypassed Downstream, Q_b (cfs)	N/A

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

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

Project:

Inlet ID: INLET 2D1-Sump



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	18.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	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 =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	12.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	10.3	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	2.88	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	4.39	5.59	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	10.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.491	0.350	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**SUMP**	**SUMP**	**cfs**
Flow Velocity within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	0.0	0.0	

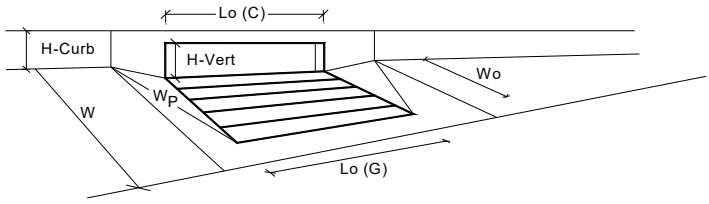
Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	36.6	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	34.6	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.157	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	0.0	0.0	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	SUMP	SUMP	cfs
Average Flow Velocity Within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.0	0.0	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	SUMP	SUMP	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**SUMP**	**SUMP**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =			inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =			inches

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is not applicable to Sump Condition				
MAJOR STORM Allowable Capacity is not applicable to Sump Condition	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

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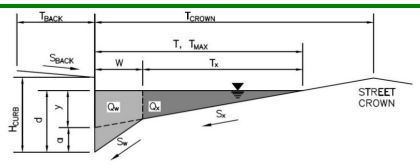
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	12.0	inches
Grate Information		MINOR	MAJOR	☑ Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	10.00	10.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.33	0.83	ft
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	0.93	1.00	
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	N/A	N/A	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**8.3**	**25.5**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms (>Q Peak)	$Q_{PEAK\ REQUIRED}$ =	4.5	9.4	cfs

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

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

Project:

Inlet ID: INLET 3D1-Sump



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	18.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	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 =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	12.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	10.3	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	2.88	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	4.39	5.59	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	10.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.491	0.350	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**SUMP**	**SUMP**	**cfs**
Flow Velocity within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	0.0	0.0	

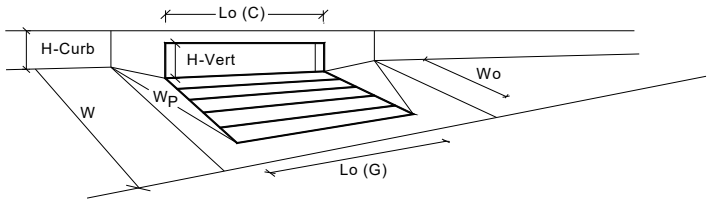
Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	36.6	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	34.6	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.157	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	0.0	0.0	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	SUMP	SUMP	cfs
Average Flow Velocity Within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.0	0.0	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	SUMP	SUMP	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**SUMP**	**SUMP**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =			inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =			inches

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is not applicable to Sump Condition				
MAJOR STORM Allowable Capacity is not applicable to Sump Condition	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.02 (August 2022)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	4.4	5.6	inches
Grate Information		MINOR	MAJOR	Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	10.00	10.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.20	0.30	ft
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	0.82	0.91	
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	N/A	N/A	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**3.4**	**6.9**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms (>Q Peak)	$Q_{PEAK\ REQUIRED}$ =	2.5	5.3	cfs

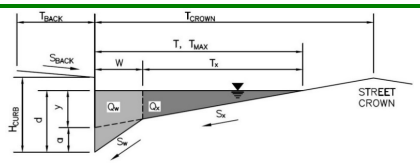
MHFD-Inlet, Version 5.02 (August 2022)

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

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

Project:

Inlet ID: **INLET 4D1**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	21.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	28.8	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 =	0.010	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	18.7	28.8	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	11.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	4.49	6.91	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	6.00	8.42	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	16.7	26.8	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.202	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	9.4	33.2	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	4.4	8.4	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	2.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**13.8**	**43.6**	**cfs**
Flow Velocity within the Gutter Section	V =	5.2	6.8	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	2.6	4.8	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	39.7	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	37.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.144	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	9.4	82.4	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	9.4	79.4	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	4.4	13.9	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	13.9	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	13.8	107.2	cfs
Average Flow Velocity Within the Gutter Section	V =	5.2	8.3	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.6	7.6	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	1.00	1.00	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**13.8**	**107.2**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	11.04	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	2.62	inches

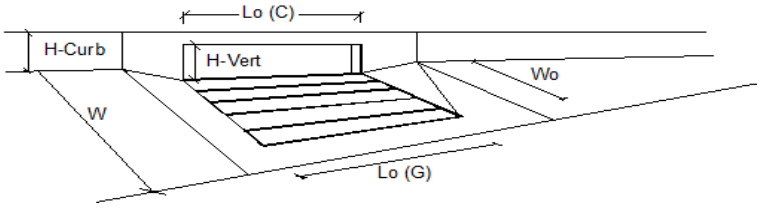
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**13.8**	**43.6**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 3.44 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 7.42 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



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 =	10.00	10.00	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	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	3.4	7.4	cfs
Water Spread Width	T =	10.4	14.5	ft
Water Depth at Flowline (outside of local depression)	d =	4.0	5.0	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.556	0.408	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	1.5	4.4	cfs
Discharge within the Gutter Section W	Q_w =	1.9	3.0	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.50	0.67	sq ft
Velocity within the Gutter Section W	V_W =	3.8	4.5	fps
Water Depth for Design Condition	d_{LOCAL} =	7.0	8.0	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoeff =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**
Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e	S_e =	0.125	0.097	ft/ft
Required Length L_T to Have 100% Interception	L_T =	9.55	15.86	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	9.55	10.00	ft
Interception Capacity	Q_i =	3.4	6.2	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoeff =	1.25	1.25	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.06	0.06	
Effective (Unclogged) Length	L_e =	9.38	9.38	ft
Actual Interception Capacity	**Q_a =**	**3.4**	**5.9**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.0**	**1.5**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**3.4**	**5.9**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**1.5**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**80**	**%**

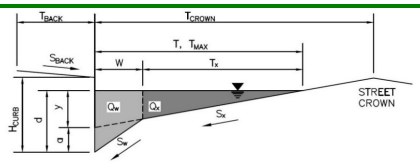
MHFD-Inlet, Version 5.02 (August 2022)

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

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

Project:

Inlet ID: **INLET 5D1**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	21.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	29.1	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 =	0.013	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	18.7	29.1	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	11.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	4.49	6.98	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	6.00	8.50	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	16.7	27.1	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.200	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	10.8	39.1	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	5.0	9.8	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	2.4	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**15.8**	**51.3**	**cfs**
Flow Velocity within the Gutter Section	V =	6.0	7.8	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	3.0	5.5	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	39.7	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	37.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.144	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	10.8	94.3	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	10.8	91.1	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	5.0	15.9	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	15.9	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	15.8	122.9	cfs
Average Flow Velocity Within the Gutter Section	V =	6.0	9.5	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	3.0	8.7	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	1.00	1.00	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**15.8**	**122.9**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	11.04	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	2.54	inches

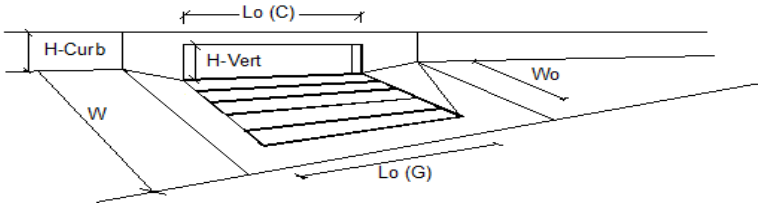
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**15.8**	**51.3**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 1.30 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 2.88 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



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 =	10.00	10.00	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	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	1.3	2.9	cfs
Water Spread Width	T =	5.9	9.0	ft
Water Depth at Flowline (outside of local depression)	d =	2.9	3.7	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.825	0.626	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.2	1.1	cfs
Discharge within the Gutter Section W	Q_w =	1.1	1.8	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.32	0.45	sq ft
Velocity within the Gutter Section W	V_W =	3.3	4.0	fps
Water Depth for Design Condition	d_{LOCAL} =	5.9	6.7	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoeff =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**
Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e	S_e =	0.175	0.138	ft/ft
Required Length L_T to Have 100% Interception	L_T =	5.05	8.45	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	5.05	8.45	ft
Interception Capacity	Q_i =	1.3	2.9	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoeff =	1.25	1.25	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.06	0.06	
Effective (Unclogged) Length	L_e =	5.05	8.45	ft
Actual Interception Capacity	**Q_a =**	**1.3**	**2.9**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.0**	**0.0**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.3**	**2.9**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**100**	**%**

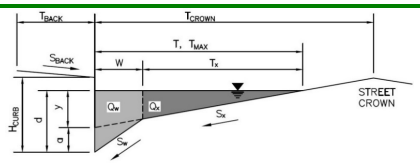
MHFD-Inlet, Version 5.02 (August 2022)

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

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

Project:

Inlet ID: INLET 8D1-Sump



Gutter Geometry:

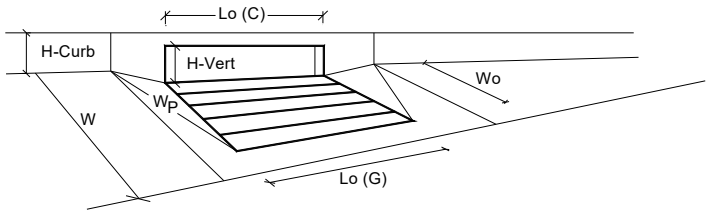
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	21.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	34.0	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 =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	18.7	34.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	11.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is not applicable to Sump Condition				
MAJOR STORM Allowable Capacity is not applicable to Sump Condition	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.02 (August 2022)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	9.7	inches
Grate Information		MINOR	MAJOR	☐ Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	10.00	10.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.33	0.64	ft
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	0.93	1.00	
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	N/A	N/A	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**8.3**	**21.6**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms (>Q Peak)	$Q_{PEAK\ REQUIRED}$ =	5.2	11.5	cfs

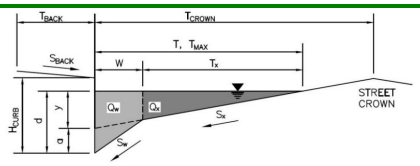
MHFD-Inlet, Version 5.02 (August 2022)

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

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

Project:

Inlet ID: INLET 9D1-Sump



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	20.6	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	35.0	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 =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	18.7	35.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	10.9	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

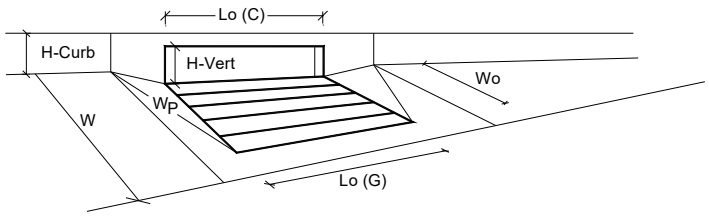
MINOR STORM Allowable Capacity is not applicable to Sump Condition

MAJOR STORM Allowable Capacity is not applicable to Sump Condition

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

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.02 (August 2022)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	9.9	inches
Grate Information		MINOR	MAJOR	Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	10.00	10.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.33	0.66	ft
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	0.93	1.00	
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	N/A	N/A	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**8.3**	**22.3**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms (>Q Peak)	$Q_{PEAK\ REQUIRED}$ =	5.1	11.5	cfs

MHFD-Inlet, Version 5.02 (August 2022)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	D3.10	D3.11	D3.12	D3.13	D3.15
Site Type (Urban or Rural)	URBAN	URBAN	URBAN	URBAN	URBAN
Inlet Application (Street or Area)	STREET	STREET	STREET	STREET	STREET
Hydraulic Condition	On Grade	On Grade	On Grade	On Grade	On Grade
Inlet Type	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening

USER-DEFINED INPUT

	D3.10	D3.11	D3.12	D3.13	D3.15
User-Defined Design Flows					
Minor Q_{Known} (cfs)	1.8	1.7	1.2	1.4	1.1
Major Q_{Known} (cfs)	4.3	4.2	9.5	3.6	3.6

Bypass (Carry-Over) Flow from Upstream Inlets must be organized from upstream (left) to downstream (right) in order for bypass flows to be linked.

Receive Bypass Flow from:	No Bypass Flow Received	No Bypass Flow Received	D3.10	D3.11	D3.12
Minor Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.0	0.0	0.0
Major Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.1	0.1	0.6

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)	**1.8**	**1.7**	**1.2**	**1.4**	**1.1**
Major Total Design Peak Flow, Q (cfs)	**4.3**	**4.2**	**9.6**	**3.7**	**4.2**
Minor Flow Bypassed Downstream, Q_b (cfs)	0.0	0.0	0.0	0.0	0.0
Major Flow Bypassed Downstream, Q_b (cfs)	0.1	0.1	0.6	0.0	0.1

MHFD-Inlet, Version 5.02 (August 2022)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	D3.16	D3.18	D3.19	D3.21	D3.22
Site Type (Urban or Rural)	URBAN	URBAN	URBAN	URBAN	URBAN
Inlet Application (Street or Area)	STREET	STREET	STREET	STREET	STREET
Hydraulic Condition	On Grade	On Grade	On Grade	In Sump	In Sump
Inlet Type	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening

USER-DEFINED INPUT

	D3.16	D3.18	D3.19	D3.21	D3.22
User-Defined Design Flows					
Minor Q_{Known} (cfs)	0.6	0.9	0.8	0.9	1.0
Major Q_{Known} (cfs)	2.1	2.1	4.1	2.8	2.0
Bypass (Carry-Over) Flow from Upstream					
Receive Bypass Flow from:	D3.13	D3.15	D3.16	No Bypass Flow Received	No Bypass Flow Received
Minor Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.0	0.0	0.0
Major Bypass Flow Received, Q_b (cfs)	0.0	0.1	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)	**0.6**	**0.9**	**0.8**	**0.9**	**1.0**
Major Total Design Peak Flow, Q (cfs)	**2.1**	**2.2**	**4.1**	**2.8**	**2.0**
Minor Flow Bypassed Downstream, Q_b (cfs)	0.0	0.0	0.0	N/A	N/A
Major Flow Bypassed Downstream, Q_b (cfs)	0.0	0.0	0.0	N/A	N/A

MHFD-Inlet, Version 5.02 (August 2022)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	D3.20
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 D3.20

User-Defined Design Flows

Minor Q_{Known} (cfs)	1.2
Major Q_{Known} (cfs)	2.9

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)	**1.2**
Major Total Design Peak Flow, Q (cfs)	**2.9**
Minor Flow Bypassed Downstream, Q_b (cfs)	0.0
Major Flow Bypassed Downstream, Q_b (cfs)	0.7

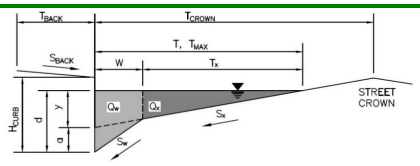
MHFD-Inlet, Version 5.02 (August 2022)

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

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

Project:

Inlet ID: **D3.10**



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	19.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	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 =	0.020	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	10.6	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☑	

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	4.08	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	5.59	5.59	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	15.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.350	0.350	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	10.0	10.0	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	5.4	5.4	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**15.4**	**15.4**	**cfs**
Flow Velocity within the Gutter Section	V =	7.0	7.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	3.3	3.3	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	37.7	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	35.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.152	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	13.3	100.8	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	13.3	77.2	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	6.2	18.1	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	15.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	19.5	110.3	cfs
Average Flow Velocity Within the Gutter Section	V =	7.4	11.4	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	3.7	10.0	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	1.00	0.83	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**19.5**	**92.0**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	9.93	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.41	4.34	inches

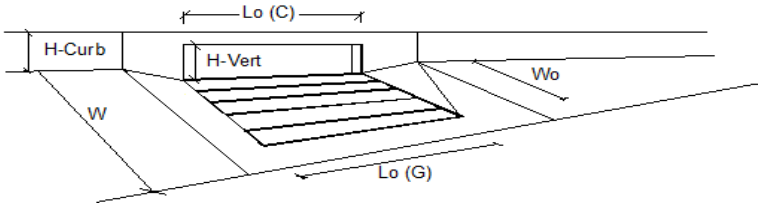
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**15.4**	**92.0**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 1.75 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 4.34 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



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 =	10.00	10.00	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	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	1.8	4.3	cfs
Water Spread Width	T =	6.2	9.9	ft
Water Depth at Flowline (outside of local depression)	d =	3.0	3.9	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.804	0.580	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.3	1.8	cfs
Discharge within the Gutter Section W	Q_w =	1.4	2.5	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.34	0.48	sq ft
Velocity within the Gutter Section W	V_W =	4.2	5.2	fps
Water Depth for Design Condition	d_{LOCAL} =	6.0	6.9	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoeff =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**
Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e	S_e =	0.171	0.129	ft/ft
Required Length L_T to Have 100% Interception	L_T =	6.08	11.01	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	6.08	10.00	ft
Interception Capacity	Q_i =	1.8	4.3	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoeff =	1.25	1.25	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.06	0.06	
Effective (Unclogged) Length	L_e =	6.08	9.38	ft
Actual Interception Capacity	**Q_a =**	**1.8**	**4.2**	**cfs**
Carry-Over Flow = $Q_{o(GRATE)}$-Q_a	**Q_b =**	**0.0**	**0.1**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.8**	**4.2**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.1**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**97**	**%**

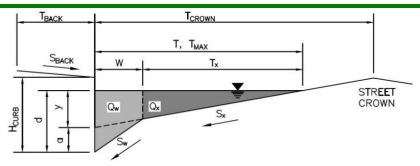
MHFD-Inlet, Version 5.02 (August 2022)

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

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

Project:

Inlet ID: **D3.11**



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	19.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	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 =	0.020	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	10.6	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	4.08	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	5.59	5.59	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	15.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.350	0.350	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	10.0	10.0	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	5.4	5.4	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**15.4**	**15.4**	**cfs**
Flow Velocity within the Gutter Section	V =	7.0	7.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	3.3	3.3	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	37.7	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	35.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.152	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	13.3	100.8	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	13.3	77.2	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	6.2	18.1	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	15.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	19.5	110.3	cfs
Average Flow Velocity Within the Gutter Section	V =	7.4	11.4	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	3.7	10.0	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	1.00	0.83	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**19.5**	**92.0**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	9.93	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.41	4.34	inches

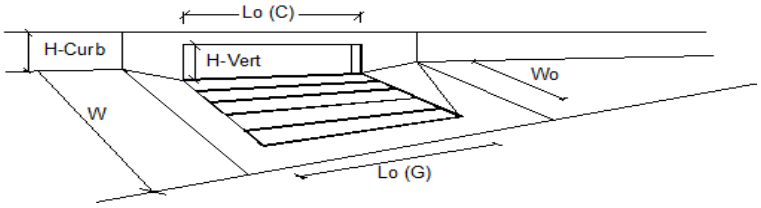
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**15.4**	**15.4**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 1.73 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 4.22 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



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 =	10.00	10.00	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	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	1.7	4.2	cfs
Water Spread Width	T =	6.2	9.8	ft
Water Depth at Flowline (outside of local depression)	d =	3.0	3.9	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.806	0.587	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.3	1.7	cfs
Discharge within the Gutter Section W	Q_w =	1.4	2.5	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.33	0.48	sq ft
Velocity within the Gutter Section W	V_W =	4.2	5.2	fps
Water Depth for Design Condition	d_{LOCAL} =	6.0	6.9	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoeff =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**
Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e	S_e =	0.171	0.130	ft/ft
Required Length L_T to Have 100% Interception	L_T =	6.05	10.79	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	6.05	10.00	ft
Interception Capacity	Q_i =	1.7	4.2	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoeff =	1.25	1.25	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.06	0.06	
Effective (Unclogged) Length	L_e =	6.05	9.38	ft
Actual Interception Capacity	**Q_a =**	**1.7**	**4.1**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.0**	**0.1**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.7**	**4.1**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.1**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**97**	**%**

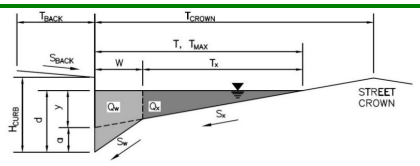
MHFD-Inlet, Version 5.02 (August 2022)

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

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

Project:

Inlet ID: **D3.12**



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	19.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	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 =	0.038	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	10.6	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	4.08	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	5.59	5.59	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	15.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.350	0.350	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	13.7	13.7	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	7.4	7.4	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**21.1**	**21.1**	**cfs**
Flow Velocity within the Gutter Section	V =	9.6	9.6	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	4.5	4.5	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	37.7	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	35.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.152	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	18.2	138.4	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	18.2	106.0	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	8.5	24.9	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	20.6	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	26.7	151.5	cfs
Average Flow Velocity Within the Gutter Section	V =	10.2	15.6	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	5.1	13.7	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	0.62	0.50	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**16.6**	**76.1**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.21	8.38	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	2.79	inches

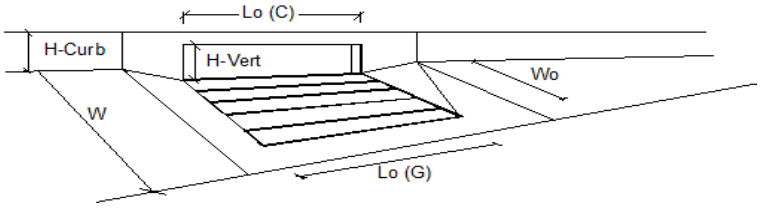
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**16.6**	**21.1**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 1.17 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 9.59 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



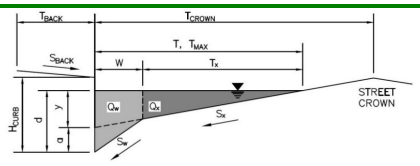
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	15.00	15.00	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	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	1.2	9.6	cfs
Water Spread Width	T =	3.8	12.3	ft
Water Depth at Flowline (outside of local depression)	d =	2.4	4.5	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.961	0.481	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.0	5.0	cfs
Discharge within the Gutter Section W	Q_w =	1.1	4.6	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.24	0.58	sq ft
Velocity within the Gutter Section W	V_W =	4.8	8.0	fps
Water Depth for Design Condition	d_{LOCAL} =	5.4	7.5	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoeff =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**
Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e	S_e =	0.201	0.110	ft/ft
Required Length L_T to Have 100% Interception	L_T =	4.78	18.38	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	4.78	15.00	ft
Interception Capacity	Q_i =	1.2	9.1	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoeff =	1.31	1.31	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.04	0.04	
Effective (Unclogged) Length	L_e =	4.78	14.35	ft
Actual Interception Capacity	**Q_a =**	**1.2**	**9.0**	**cfs**
Carry-Over Flow = $Q_{o(GRATE)}$-Q_a	**Q_b =**	**0.0**	**0.6**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.2**	**9.0**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.6**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**93**	**%**

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

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

Project:

Inlet ID: **D3.13**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	19.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	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} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	10.6	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☑	

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	4.08	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	5.59	5.59	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	15.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.350	0.350	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	14.5	14.5	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	7.8	7.8	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**22.3**	**22.3**	**cfs**
Flow Velocity within the Gutter Section	V =	10.2	10.2	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	4.8	4.8	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	37.7	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	35.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.152	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	19.3	146.4	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	19.3	112.2	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	9.0	26.3	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	21.8	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	28.3	160.3	cfs
Average Flow Velocity Within the Gutter Section	V =	10.8	16.5	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	5.4	14.5	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	0.57	0.46	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**16.0**	**73.6**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.08	8.13	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	2.54	inches

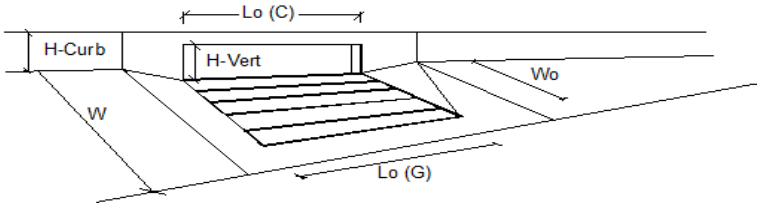
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**16.0**	**73.6**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 1.44 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 3.69 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



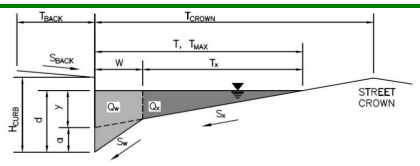
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	10.00	10.00	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	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	1.4	3.7	cfs
Water Spread Width	T =	4.3	7.6	ft
Water Depth at Flowline (outside of local depression)	d =	2.5	3.3	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.935	0.709	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.1	1.1	cfs
Discharge within the Gutter Section W	Q_w =	1.4	2.6	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.26	0.39	sq ft
Velocity within the Gutter Section W	V_W =	5.3	6.7	fps
Water Depth for Design Condition	d_{LOCAL} =	5.5	6.3	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoeff =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**
Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e	S_e =	0.196	0.153	ft/ft
Required Length L_T to Have 100% Interception	L_T =	5.41	9.77	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	5.41	9.77	ft
Interception Capacity	Q_i =	1.4	3.7	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoeff =	1.25	1.25	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.06	0.06	
Effective (Unclogged) Length	L_e =	5.41	9.38	ft
Actual Interception Capacity	**Q_a =**	**1.4**	**3.7**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.0**	**0.0**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.4**	**3.7**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**100**	**%**

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

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

Project:

Inlet ID: **D3.15**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	21.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	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 =	0.050	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	11.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☑	

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	4.08	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	5.59	5.59	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	15.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.350	0.350	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	15.8	15.8	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	8.5	8.5	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**24.3**	**24.3**	**cfs**
Flow Velocity within the Gutter Section	V =	11.1	11.1	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	5.2	5.2	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	39.7	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	37.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.144	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	21.0	184.3	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	21.0	136.7	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	9.8	31.1	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	31.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	30.8	198.7	cfs
Average Flow Velocity Within the Gutter Section	V =	11.7	18.6	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	5.9	17.1	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	0.49	0.40	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**15.2**	**79.6**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	4.88	8.12	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	2.53	inches

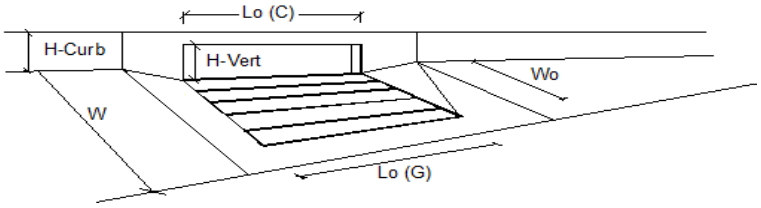
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**15.2**	**79.6**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 1.06 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 4.18 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



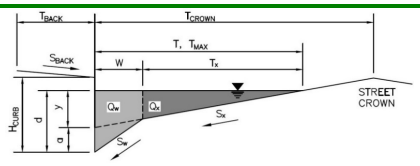
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	10.00	10.00	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	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	1.1	4.2	cfs
Water Spread Width	T =	2.2	7.8	ft
Water Depth at Flowline (outside of local depression)	d =	2.0	3.4	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	1.000	0.699	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.0	1.3	cfs
Discharge within the Gutter Section W	Q_w =	1.1	2.9	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.18	0.40	sq ft
Velocity within the Gutter Section W	V_W =	6.0	7.3	fps
Water Depth for Design Condition	d_{LOCAL} =	5.0	6.4	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoeff =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**
Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e	S_e =	0.208	0.151	ft/ft
Required Length L_T to Have 100% Interception	L_T =	4.54	10.58	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	4.54	10.00	ft
Interception Capacity	Q_i =	1.1	4.2	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoeff =	1.25	1.25	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.06	0.06	
Effective (Unclogged) Length	L_e =	4.54	9.38	ft
Actual Interception Capacity	**Q_a =**	**1.1**	**4.1**	**cfs**
Carry-Over Flow = $Q_{o(GRATE)}$-Q_a	**Q_b =**	**0.0**	**0.1**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.1**	**4.1**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.1**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**98**	**%**

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

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

Project:

Inlet ID: **D3.16**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	19.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	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 =	0.050	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	10.6	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	4.08	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	5.59	5.59	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	15.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.350	0.350	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	15.8	15.8	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	8.5	8.5	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**24.3**	**24.3**	**cfs**
Flow Velocity within the Gutter Section	V =	11.1	11.1	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	5.2	5.2	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	37.7	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	35.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.152	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	21.0	159.4	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	21.0	122.1	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	9.8	28.7	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	23.7	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	30.8	174.5	cfs
Average Flow Velocity Within the Gutter Section	V =	11.7	18.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	5.9	15.8	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	0.49	0.40	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**15.2**	**69.9**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	4.88	7.78	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	2.19	inches

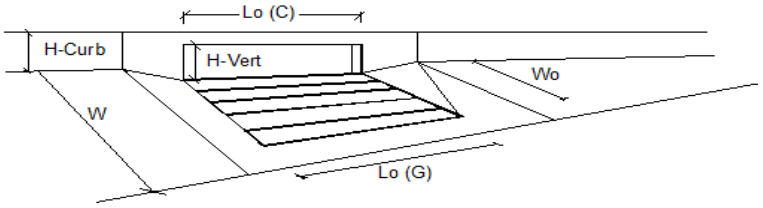
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**15.2**	**24.3**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 0.62 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 2.13 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



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 =	10.00	10.00	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	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	0.6	2.1	cfs
Water Spread Width	T =	1.8	5.3	ft
Water Depth at Flowline (outside of local depression)	d =	2.0	2.8	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	1.000	0.867	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.0	0.3	cfs
Discharge within the Gutter Section W	Q_w =	0.6	1.9	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.00	0.30	sq ft
Velocity within the Gutter Section W	V_W =	0.0	6.2	fps
Water Depth for Design Condition	d_{LOCAL} =	5.0	5.8	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoeff =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**
Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e	S_e =	0.208	0.183	ft/ft
Required Length L_T to Have 100% Interception	L_T =	3.46	6.88	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	3.46	6.88	ft
Interception Capacity	Q_i =	0.6	2.1	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoeff =	1.25	1.25	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.06	0.06	
Effective (Unclogged) Length	L_e =	3.46	6.88	ft
Actual Interception Capacity	**Q_a =**	**0.6**	**2.1**	**cfs**
Carry-Over Flow = $Q_{o(GRATE)}$-Q_a	**Q_b =**	**0.0**	**0.0**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.6**	**2.1**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**100**	**%**

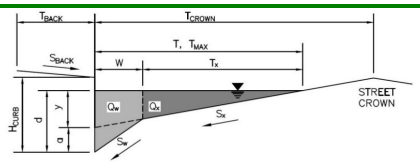
MHFD-Inlet, Version 5.02 (August 2022)

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

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

Project:

Inlet ID: **D3.18**



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	21.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	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 =	0.050	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	11.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	4.08	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	5.59	5.59	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	15.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.350	0.350	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	15.8	15.8	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	8.5	8.5	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**24.3**	**24.3**	**cfs**
Flow Velocity within the Gutter Section	V =	11.1	11.1	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	5.2	5.2	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	39.7	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	37.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.144	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	21.0	184.3	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	21.0	136.7	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	9.8	31.1	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	31.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	30.8	198.7	cfs
Average Flow Velocity Within the Gutter Section	V =	11.7	18.6	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	5.9	17.1	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	0.49	0.40	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**15.2**	**79.6**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	4.88	8.12	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	2.53	inches

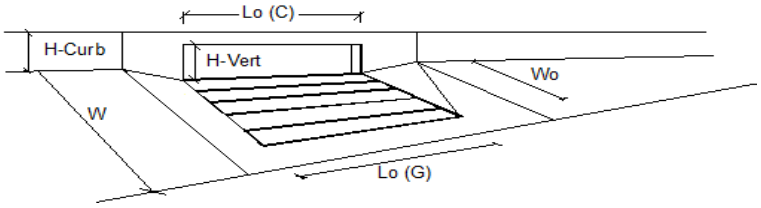
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**15.2**	**24.3**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 0.86 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 2.17 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



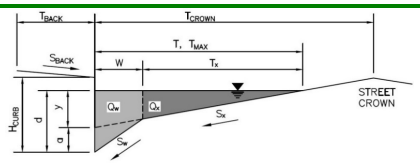
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	10.00	10.00	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	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	0.9	2.2	cfs
Water Spread Width	T =	2.1	5.4	ft
Water Depth at Flowline (outside of local depression)	d =	2.0	2.8	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	1.000	0.864	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.0	0.3	cfs
Discharge within the Gutter Section W	Q_w =	0.9	1.9	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.17	0.30	sq ft
Velocity within the Gutter Section W	V_W =	5.1	6.2	fps
Water Depth for Design Condition	d_{LOCAL} =	5.0	5.8	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoeff =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**
Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e	S_e =	0.208	0.182	ft/ft
Required Length L_T to Have 100% Interception	L_T =	4.09	6.94	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	4.09	6.94	ft
Interception Capacity	Q_i =	0.9	2.2	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoeff =	1.25	1.25	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.06	0.06	
Effective (Unclogged) Length	L_e =	4.09	6.94	ft
Actual Interception Capacity	**Q_a =**	**0.9**	**2.2**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.0**	**0.0**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.9**	**2.2**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**100**	**%**

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

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

Project:

Inlet ID: **D3.19**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	19.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	27.0	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 =	0.050	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	18.7	27.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	10.6	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	4.49	6.48	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	6.00	7.99	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	16.7	25.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.217	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	21.0	61.6	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	9.8	17.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	2.6	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**30.8**	**81.3**	**cfs**
Flow Velocity within the Gutter Section	V =	11.7	14.6	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	5.9	9.7	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	37.7	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	35.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.152	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	21.0	159.4	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	21.0	153.0	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	9.8	28.7	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	23.7	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	30.8	205.3	cfs
Average Flow Velocity Within the Gutter Section	V =	11.7	18.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	5.9	15.8	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	0.49	0.40	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**15.2**	**82.3**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	4.88	8.02	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	0.03	inches

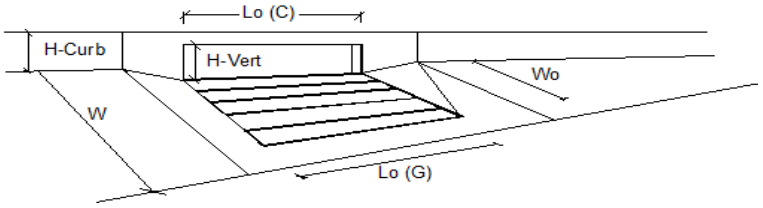
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**15.2**	**81.3**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 0.80 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 4.09 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



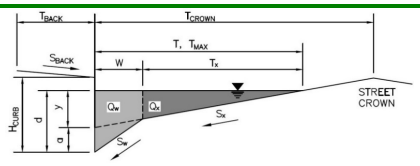
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	15.00	15.00	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	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	0.8	4.1	cfs
Water Spread Width	T =	2.0	7.7	ft
Water Depth at Flowline (outside of local depression)	d =	2.0	3.4	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	1.000	0.705	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.0	1.2	cfs
Discharge within the Gutter Section W	Q_w =	0.8	2.9	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.17	0.39	sq ft
Velocity within the Gutter Section W	V_W =	4.8	7.3	fps
Water Depth for Design Condition	d_{LOCAL} =	5.0	6.4	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoeff =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**
Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e	S_e =	0.208	0.152	ft/ft
Required Length L_T to Have 100% Interception	L_T =	3.94	10.42	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	3.94	10.42	ft
Interception Capacity	Q_i =	0.8	4.1	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoeff =	1.31	1.31	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.04	0.04	
Effective (Unclogged) Length	L_e =	3.94	10.42	ft
Actual Interception Capacity	**Q_a =**	**0.8**	**4.1**	**cfs**
Carry-Over Flow = $Q_{o(GRATE)}$-Q_a	**Q_b =**	**0.0**	**0.0**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.8**	**4.1**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**100**	**%**

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

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

Project:

Inlet ID: **D3.21**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	19.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	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 =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	10.6	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	4.08	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	5.59	5.59	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	15.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.350	0.350	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**SUMP**	**SUMP**	**cfs**
Flow Velocity within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	0.0	0.0	

Maximum Capacity for 1/2 Street based on Allowable Depth

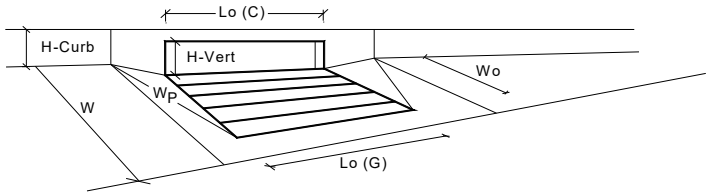
		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	37.7	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	35.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.152	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	0.0	0.0	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	SUMP	SUMP	cfs
Average Flow Velocity Within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.0	0.0	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	SUMP	SUMP	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**SUMP**	**SUMP**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =			inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =			inches

MINOR STORM Allowable Capacity is not applicable to Sump Condition
MAJOR STORM Allowable Capacity is not applicable to Sump Condition

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

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.02 (August 2022)



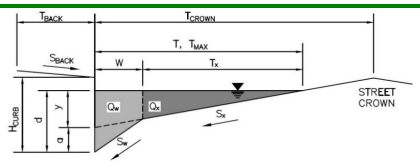
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	5.6	5.6	inches
Grate Information		MINOR	MAJOR	☐ Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
Grate Flow Analysis (Calculated)		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	N/A	N/A	
Clogging Factor for Multiple Units	Clog =	N/A	N/A	
Grate Capacity as a Weir (based on MHFD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	N/A	N/A	cfs
Interception with Clogging	Q_{wa} =	N/A	N/A	cfs
Grate Capacity as an Orifice (based on MHFD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	N/A	N/A	cfs
Interception with Clogging	Q_{oa} =	N/A	N/A	cfs
Grate Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	N/A	N/A	cfs
Interception with Clogging	Q_{ma} =	N/A	N/A	cfs
Resulting Grate Capacity (assumes clogged condition)	**Q_{Grate} =**	**N/A**	**N/A**	**cfs**
Curb Opening Flow Analysis (Calculated)		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	1.00	1.00	
Clogging Factor for Multiple Units	Clog =	0.10	0.10	
Curb Capacity as a Weir (based on MHFD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	5.1	5.1	cfs
Interception with Clogging	Q_{wa} =	4.6	4.6	cfs
Curb Capacity as an Orifice (based on MHFD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	9.4	9.4	cfs
Interception with Clogging	Q_{oa} =	8.5	8.5	cfs
Curb Opening Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	6.4	6.4	cfs
Interception with Clogging	Q_{ma} =	5.8	5.8	cfs
Resulting Curb Opening Capacity (assumes clogged condition)	**Q_{Curb} =**	**4.6**	**4.6**	**cfs**
Resultant Street Conditions		MINOR	MAJOR	
Total Inlet Length	L =	5.00	5.00	feet
Resultant Street Flow Spread (based on street geometry from above)	T =	17.0	17.0	ft
Resultant Flow Depth at Street Crown	d_{CROWN} =	0.0	0.0	inches
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.30	0.30	ft
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	N/A	N/A	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**4.6**	**4.6**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms (>Q Peak)	$Q_{PEAK\ REQUIRED}$ =	0.9	2.8	cfs

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

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

Project:

Inlet ID: **D3.22**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	10.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	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 =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	8.4	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	4.08	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline (y + a)	d =	5.59	5.59	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	15.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.350	0.350	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**SUMP**	**SUMP**	**cfs**
Flow Velocity within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	0.0	0.0	

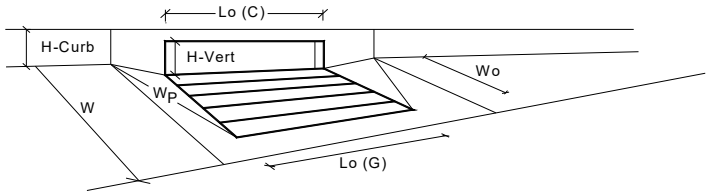
Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	28.7	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	16.7	26.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.318	0.203	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	0.0	0.0	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	SUMP	SUMP	cfs
Average Flow Velocity Within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.0	0.0	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	SUMP	SUMP	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**SUMP**	**SUMP**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =			inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =			inches

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is not applicable to Sump Condition				
MAJOR STORM Allowable Capacity is not applicable to Sump Condition	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.02 (August 2022)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	5.6	5.6	inches
Grate Information		MINOR	MAJOR	☐ Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
Grate Flow Analysis (Calculated)		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	N/A	N/A	
Clogging Factor for Multiple Units	Clog =	N/A	N/A	
Grate Capacity as a Weir (based on MHFD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	N/A	N/A	cfs
Interception with Clogging	Q_{wa} =	N/A	N/A	cfs
Grate Capacity as an Orifice (based on MHFD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	N/A	N/A	cfs
Interception with Clogging	Q_{oa} =	N/A	N/A	cfs
Grate Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	N/A	N/A	cfs
Interception with Clogging	Q_{ma} =	N/A	N/A	cfs
Resulting Grate Capacity (assumes clogged condition)	**Q_{Grate} =**	**N/A**	**N/A**	**cfs**
Curb Opening Flow Analysis (Calculated)		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	1.00	1.00	
Clogging Factor for Multiple Units	Clog =	0.10	0.10	
Curb Capacity as a Weir (based on MHFD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	5.1	5.1	cfs
Interception with Clogging	Q_{wa} =	4.6	4.6	cfs
Curb Capacity as an Orifice (based on MHFD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	9.4	9.4	cfs
Interception with Clogging	Q_{oa} =	8.5	8.5	cfs
Curb Opening Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	6.4	6.4	cfs
Interception with Clogging	Q_{ma} =	5.8	5.8	cfs
Resulting Curb Opening Capacity (assumes clogged condition)	**Q_{Curb} =**	**4.6**	**4.6**	**cfs**
Resultant Street Conditions		MINOR	MAJOR	
Total Inlet Length	L =	5.00	5.00	feet
Resultant Street Flow Spread (based on street geometry from above)	T =	17.0	17.0	ft
Resultant Flow Depth at Street Crown	d_{CROWN} =	0.0	0.0	inches
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.30	0.30	ft
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	N/A	N/A	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**4.6**	**4.6**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms (>Q Peak)	$Q_{PEAK\ REQUIRED}$ =	1.0	2.0	cfs

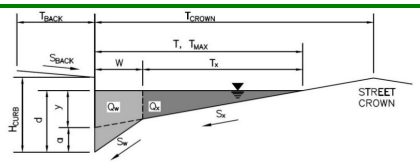
MHFD-Inlet, Version 5.02 (August 2022)

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

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

Project:

Inlet ID: **D3.20**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	19.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	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 =	0.033	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	10.6	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

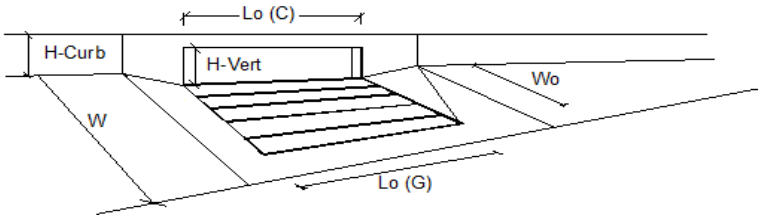
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**17.3**	**19.6**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 1.25 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 2.91 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



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**	**2.2**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.7**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**99**	**75**	**%**

MHFD-Inlet, Version 5.03 (August 2023)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	D4.1	D4.2
Site Type (Urban or Rural)		
Inlet Application (Street or Area)	STREET	STREET
Hydraulic Condition	In Sump	In Sump
Inlet Type	CDOT Type R Curb Opening	CDOT Type R Curb Opening

USER-DEFINED INPUT

User-Defined Design Flows

Minor Q_{Known} (cfs)	2.9	2.6
Major Q_{Known} (cfs)	6.5	5.9

Bypass (Carry-Over) Flow from Upstream Inlets must be organized from upstream (left) to downstream (right) in order for byp

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)	**2.9**	**2.6**
Major Total Design Peak Flow, Q (cfs)	**6.5**	**5.9**
Minor Flow Bypassed Downstream, Q_b (cfs)	N/A	N/A
Major Flow Bypassed Downstream, Q_b (cfs)	N/A	N/A

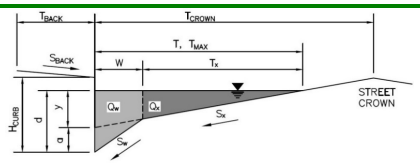
MHFD-Inlet, Version 5.03 (August 2023)

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

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

Project:

Inlet ID: **D4.1**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	19.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	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 =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.020	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	10.6	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

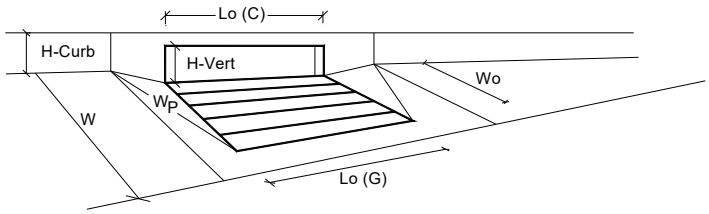
MINOR STORM Allowable Capacity is not applicable to Sump Condition

MAJOR STORM Allowable Capacity is not applicable to Sump Condition

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

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.03 (August 2023)



CDOT Type R Curb Opening

Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	5.6	5.6	☐ Override Depths
Grate Information		MINOR	MAJOR	
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	

Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.30	0.30	ft
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	N/A	N/A	

		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**4.6**	**4.6**	**cfs**
WARNING: Inlet Capacity < Q Peak for Major Storm	$Q_{PEAK\ REQUIRED}$ =	2.9	6.5	cfs

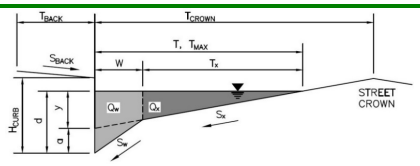
MHFD-Inlet, Version 5.03 (August 2023)

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

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

Project:

Inlet ID: **D4.2**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	19.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	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 =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	11.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

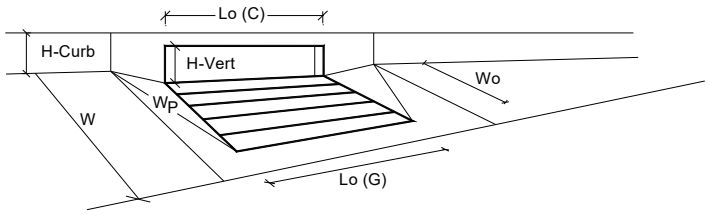
MINOR STORM Allowable Capacity is not applicable to Sump Condition

MAJOR STORM Allowable Capacity is not applicable to Sump Condition

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

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.03 (August 2023)



CDOT Type R Curb Opening

Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	5.6	5.6	☐ Override Depths
Grate Information		MINOR	MAJOR	
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.30	0.30	ft
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	N/A	N/A	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**4.6**	**4.6**	**cfs**
WARNING: Inlet Capacity < Q Peak for Major Storm	$Q_{PEAK\ REQUIRED}$ =	2.6	5.9	cfs

MHFD-Inlet, Version 5.03 (August 2023)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	D5.1	D5.2
Site Type (Urban or Rural)		
Inlet Application (Street or Area)	STREET	STREET
Hydraulic Condition	On Grade	On Grade
Inlet Type	CDOT Type R Curb Opening	CDOT Type R Curb Opening

USER-DEFINED INPUT

User-Defined Design Flows

Minor Q_{Known} (cfs)	2.8	2.8
Major Q_{Known} (cfs)	9.0	8.7

Bypass (Carry-Over) Flow from Upstream Inlets must be organized from upstream (left) to downstream (right) in order for byp

Receive Bypass Flow from:	No Bypass Flow Received	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)	**2.8**	**2.8**
Major Total Design Peak Flow, Q (cfs)	**9.0**	**8.7**
Minor Flow Bypassed Downstream, Q_b (cfs)	0.0	1.1
Major Flow Bypassed Downstream, Q_b (cfs)	0.5	6.2

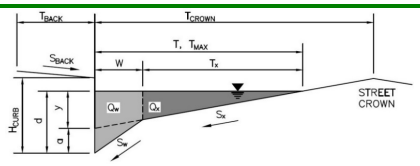
MHFD-Inlet, Version 5.03 (August 2023)

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

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

Project:

Inlet ID: **D5.1**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	19.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	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 =	0.024	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	10.6	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

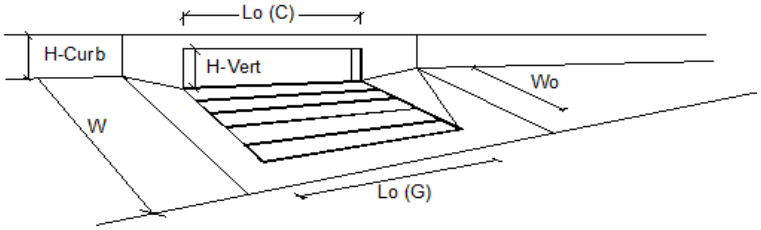
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**16.8**	**16.8**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 2.76 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 8.97 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.03 (August 2023)



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 =	15.00	15.00	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 =**	**2.8**	**8.5**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.5**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**95**	**%**

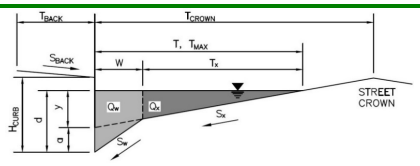
MHFD-Inlet, Version 5.03 (August 2023)

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

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

Project:

Inlet ID: **D5.2**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	19.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	ft
Gutter Width	W =	0.02	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 =	0.024	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	10.6	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

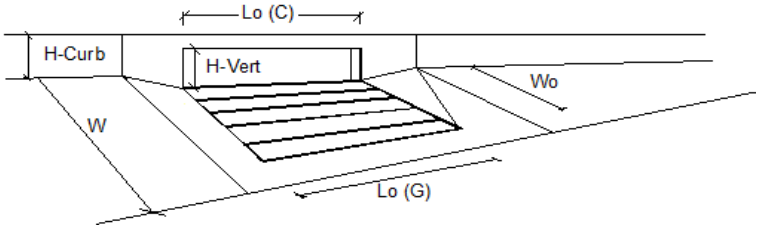
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**15.2**	**15.2**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 2.80 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 8.72 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.03 (August 2023)



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	

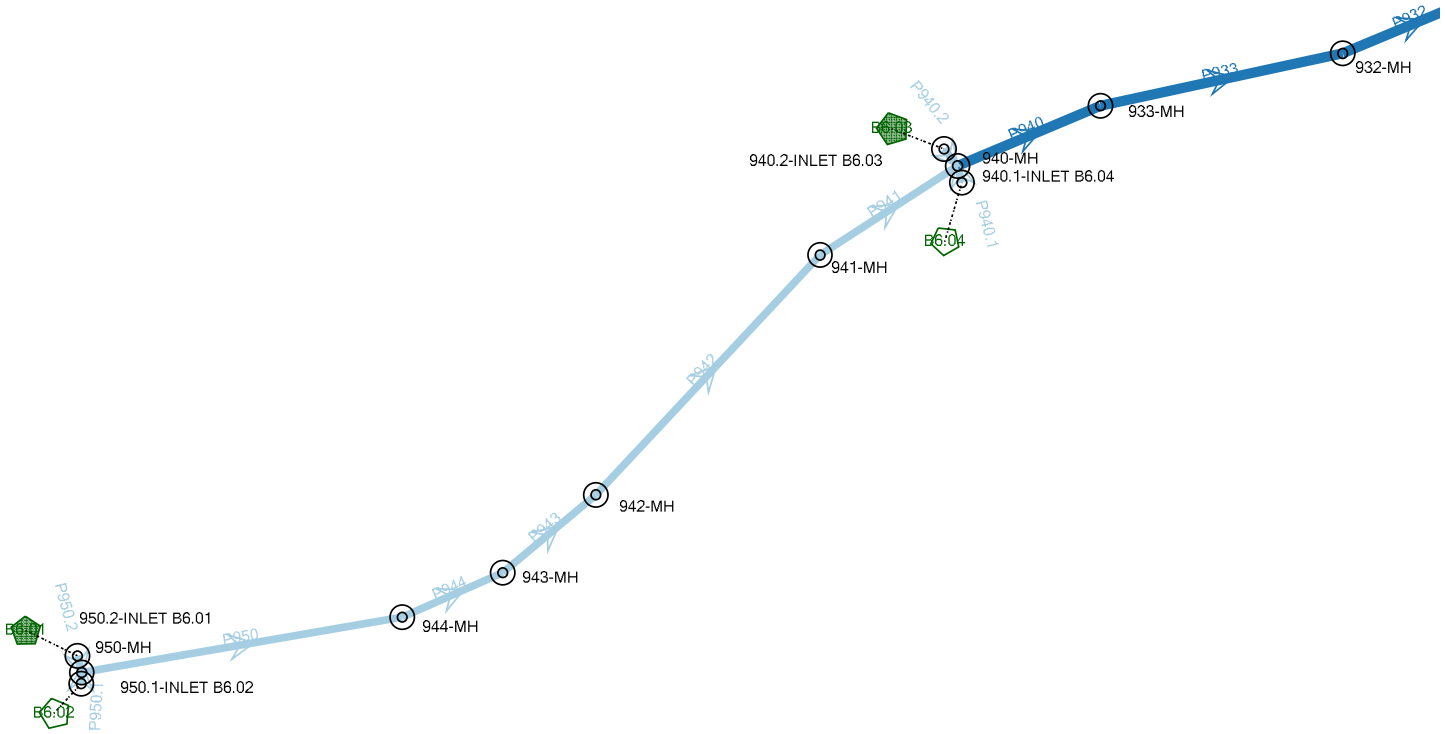
Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.7**	**2.5**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**1.1**	**6.2**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**61**	**29**	**%**

GAMBEL RIDGE STORM SEWER

Scenario: Major-100-yr



Scenario: Major-100-yr



Scenario: Major-100-yr
Current Time Step: 0.000 h
FlexTable: Conduit Table

Label	Start Node	Stop Node	Invert (Start) (ft)	Invert (Stop) (ft)	Slope (Calculated) (ft/ft)	Length (Scaled) (ft)	Manning's n	Flow (cfs)	Diameter (in)	Velocity (ft/s)
P090	010-OUTLET STR	OF-010	6,430.58	6,430.05	0.005	105.8	0.013	168.50	60.0	10.63
P901	901-INLET B6.52	O-900	6,433.60	6,432.82	0.009	92.7	0.013	53.93	42.0	5.61
P910	910-MH	901-INLET B6.52	6,435.52	6,435.35	0.005	32.9	0.013	51.61	42.0	8.06
P910.1	910.1-INLET B6.51	910-MH	6,437.78	6,437.52	0.010	25.8	0.013	5.65	18.0	6.05
P911	911-MH	910-MH	6,440.01	6,436.02	0.025	157.4	0.013	49.00	36.0	14.72
P912	912-MH	911-MH	6,444.75	6,441.51	0.035	93.2	0.013	49.10	36.0	16.54
P913	913-MH	912-MH	6,450.86	6,446.24	0.035	133.1	0.013	49.23	36.0	16.55
P920	922-MH	921-MH	6,471.86	6,468.90	0.035	85.7	0.013	42.17	30.0	15.92
P920	920-MH	913-MH	6,453.83	6,452.37	0.010	145.8	0.013	49.47	36.0	10.34
P920.1	920.1-INLET B6.42	920-MH	6,456.10	6,455.83	0.010	27.2	0.013	5.01	18.0	5.88
P920.2	920.2-INLET B6.41	920-MH	6,457.69	6,456.83	0.042	20.6	0.013	7.37	18.0	11.01
P920.3	920.3-INLET B6.40	920.2-INLET B6.41	6,462.00	6,460.69	0.023	57.0	0.013	2.66	18.0	6.69
P921	921-MH	920-MH	6,465.53	6,455.33	0.046	223.3	0.013	42.09	30.0	17.66
P930	930-MH	922-MH	6,476.63	6,473.86	0.014	194.8	0.013	42.43	30.0	11.22
P930.1	930.1-INLET B6.32	930-MH	6,478.06	6,477.86	0.008	25.4	0.013	5.70	18.0	3.23
P930.2	930.2-INLET B6.31	930-MH	6,480.19	6,480.01	0.008	22.3	0.013	14.76	18.0	8.35
P930.3	930.3-INLET B6.30	930.2-INLET B6.31	6,484.93	6,483.62	0.026	50.2	0.013	9.07	18.0	9.77
P931	931-MH	930-MH	6,488.13	6,480.02	0.050	162.8	0.013	26.85	24.0	16.31
P932	932-MH	931-MH	6,498.51	6,490.68	0.042	187.7	0.013	26.96	24.0	15.27
P933	933-MH	932-MH	6,512.16	6,498.76	0.044	307.1	0.013	27.15	24.0	15.56
P940	940-MH	933-MH	6,514.82	6,512.41	0.013	192.1	0.013	27.37	24.0	8.71
P940.1	940.1-INLET B6.22	940-MH	6,516.51	6,516.32	0.007	26.1	0.013	4.53	18.0	5.09
P940.2	940.2-INLET B6.21	940-MH	6,518.18	6,518.01	0.008	21.3	0.013	17.22	24.0	7.25
P940.3	940.3-INLET B6.20	940.2-INLET B6.21	6,522.89	6,521.58	0.051	26.0	0.013	14.63	18.0	14.07
P941	941-MH	940-MH	6,528.50	6,516.32	0.060	202.9	0.013	11.18	18.0	14.05
P942	942-MH	941-MH	6,552.51	6,533.10	0.048	406.0	0.013	11.39	18.0	12.97
P943	943-MH	942-MH	6,559.51	6,552.76	0.045	150.3	0.013	11.48	18.0	12.69
P944	944-MH	943-MH	6,565.91	6,559.76	0.045	136.2	0.013	11.55	18.0	12.74
P950	950-MH	944-MH	6,578.51	6,566.51	0.030	402.9	0.013	11.82	18.0	10.93
P950.1	950.1-INLET B6.12	950-MH	6,578.87	6,578.76	0.005	19.6	0.013	3.35	18.0	4.21
P950.2	950.2-INLET B6.11	950-MH	6,579.76	6,579.70	0.004	14.8	0.013	3.15	18.0	3.87
P950.3	951-MH	950-MH	6,580.59	6,579.01	0.036	44.2	0.013	6.48	18.0	10.05
P950.4	952-INLET B6.10	951-MH	6,583.22	6,581.34	0.013	140.5	0.013	6.56	18.0	7.00

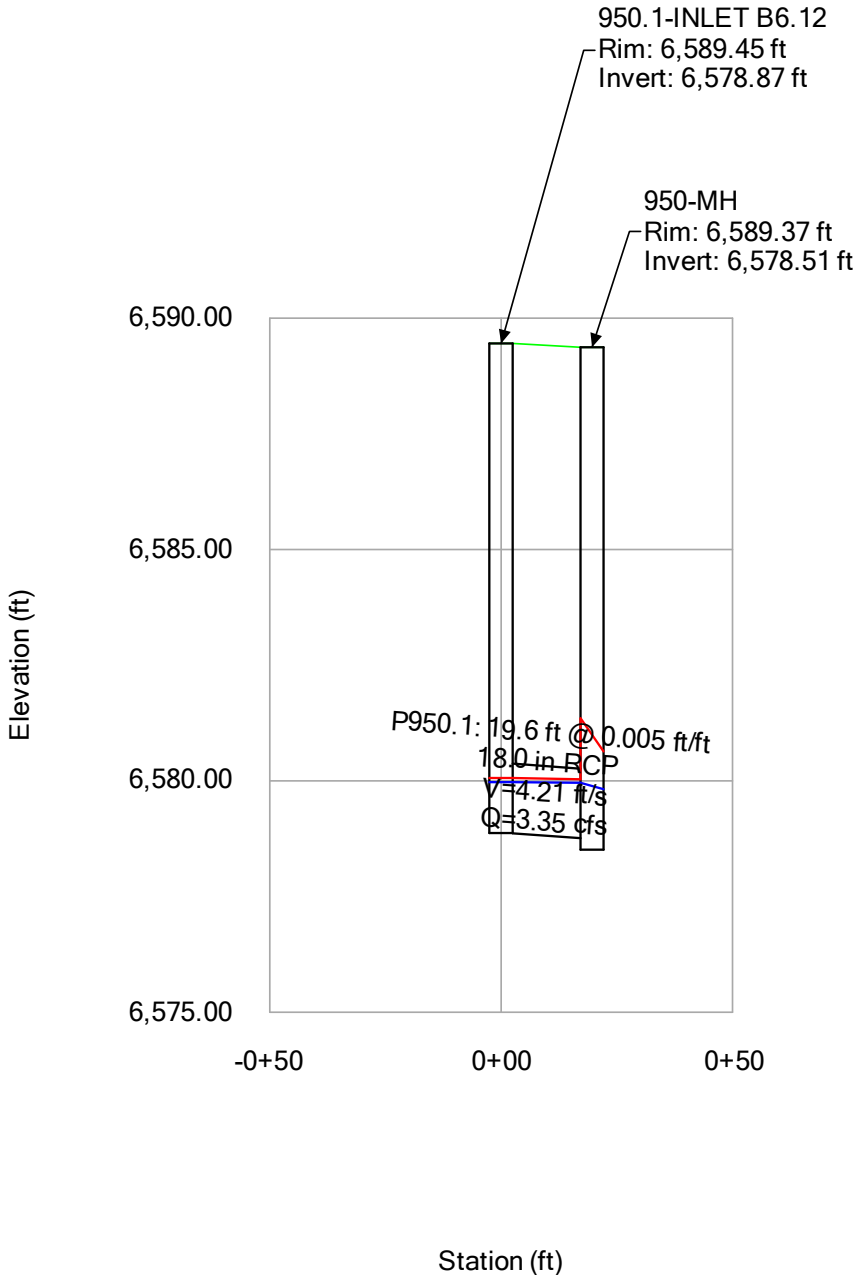
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Scenario: Major-100-yr
Current Time Step: 0.000 h
FlexTable: Manhole Table

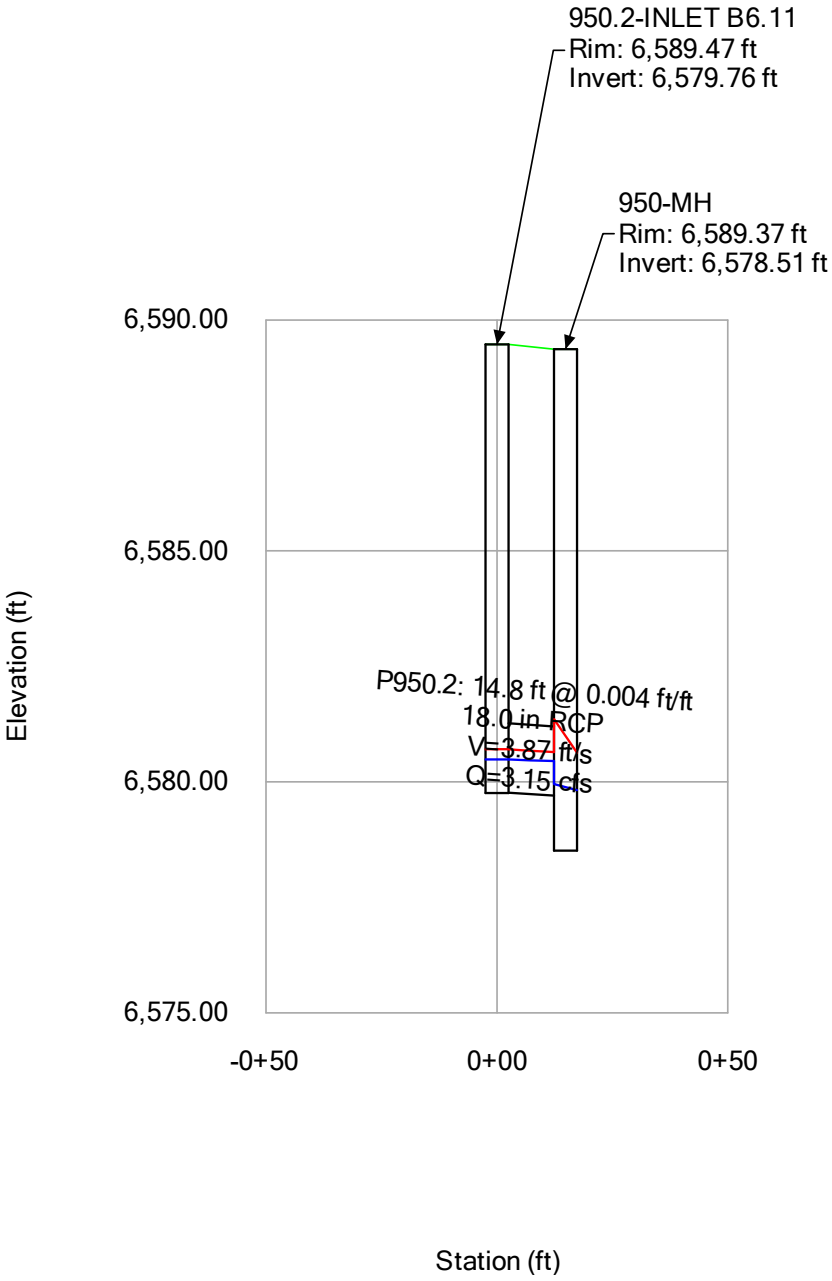
Label	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Headloss Method	Headloss (ft)	Velocity (Out) (ft/s)
010-OUTLET STR	6,436.75	6,430.08	6,434.34	6,434.34	HEC-22 Energy (Second Edition)	0.00	10.63
901-INLET B6.52	6,442.51	6,433.60	6,438.73	6,438.66	HEC-22 Energy (Second Edition)	0.07	5.61
910-MH	6,444.10	6,435.52	6,438.89	6,438.79	HEC-22 Energy (Second Edition)	0.10	5.52
910.1-INLET B6.51	6,442.76	6,437.78	6,438.88	6,438.88	HEC-22 Energy (Second Edition)	0.00	4.07
911-MH	6,451.36	6,440.01	6,442.48	6,442.29	HEC-22 Energy (Second Edition)	0.19	8.50
912-MH	6,455.54	6,444.75	6,447.24	6,447.03	HEC-22 Energy (Second Edition)	0.22	8.51
913-MH	6,461.50	6,450.86	6,453.42	6,453.15	HEC-22 Energy (Second Edition)	0.28	8.52
920-MH	6,466.66	6,453.83	6,456.24	6,456.12	HEC-22 Energy (Second Edition)	0.12	8.54
920.1-INLET B6.42	6,466.60	6,456.10	6,456.96	6,456.96	HEC-22 Energy (Second Edition)	0.00	4.77
920.2-INLET B6.41	6,466.63	6,457.69	6,458.91	6,458.74	HEC-22 Energy (Second Edition)	0.16	5.57
920.3-INLET B6.40	6,465.48	6,462.00	6,462.62	6,462.62	HEC-22 Energy (Second Edition)	0.00	3.87
921-MH	6,478.07	6,465.53	6,467.93	6,467.70	HEC-22 Energy (Second Edition)	0.23	9.29
922-MH	6,481.90	6,471.86	6,474.28	6,474.04	HEC-22 Energy (Second Edition)	0.25	9.30
930-MH	6,490.63	6,476.63	6,479.09	6,478.81	HEC-22 Energy (Second Edition)	0.28	9.35
930.1-INLET B6.32	6,489.19	6,478.06	6,479.86	6,479.86	HEC-22 Energy (Second Edition)	0.00	3.23
930.2-INLET B6.31	6,489.20	6,480.19	6,482.40	6,481.91	HEC-22 Energy (Second Edition)	0.49	8.35
930.3-INLET B6.30	6,489.18	6,484.72	6,486.10	6,486.10	HEC-22 Energy (Second Edition)	0.00	6.16
931-MH	6,497.92	6,488.13	6,490.23	6,489.94	HEC-22 Energy (Second Edition)	0.30	9.00
932-MH	6,506.33	6,498.51	6,500.62	6,500.32	HEC-22 Energy (Second Edition)	0.29	9.03
933-MH	6,520.09	6,512.16	6,514.28	6,513.97	HEC-22 Energy (Second Edition)	0.30	9.08
940-MH	6,527.33	6,514.82	6,517.10	6,516.82	HEC-22 Energy (Second Edition)	0.29	8.71
940.1-INLET B6.22	6,527.09	6,516.51	6,517.78	6,517.78	HEC-22 Energy (Second Edition)	0.00	2.84
940.2-INLET B6.21	6,527.47	6,518.18	6,519.75	6,519.68	HEC-22 Energy (Second Edition)	0.07	6.83
940.3-INLET B6.20	6,525.88	6,522.89	6,524.29	6,524.29	HEC-22 Energy (Second Edition)	0.00	8.53
941-MH	6,538.50	6,528.50	6,530.01	6,529.78	HEC-22 Energy (Second Edition)	0.23	6.97
942-MH	6,559.80	6,552.20	6,553.98	6,553.80	HEC-22 Energy (Second Edition)	0.18	7.05
943-MH	6,567.69	6,559.51	6,561.06	6,560.81	HEC-22 Energy (Second Edition)	0.25	7.09
944-MH	6,574.84	6,565.91	6,567.43	6,567.21	HEC-22 Energy (Second Edition)	0.22	7.12
950-MH	6,589.37	6,578.51	6,579.95	6,579.82	HEC-22 Energy (Second Edition)	0.13	7.23
950.1-INLET B6.12	6,589.45	6,578.87	6,579.97	6,579.97	HEC-22 Energy (Second Edition)	0.00	2.41
950.2-INLET B6.11	6,589.47	6,579.76	6,580.48	6,580.48	HEC-22 Energy (Second Edition)	0.00	3.77
951-MH	6,590.82	6,580.59	6,581.78	6,581.58	HEC-22 Energy (Second Edition)	0.20	5.27
952-INLET B6.10	6,586.01	6,582.97	6,584.21	6,584.21	HEC-22 Energy (Second Edition)	0.00	5.30

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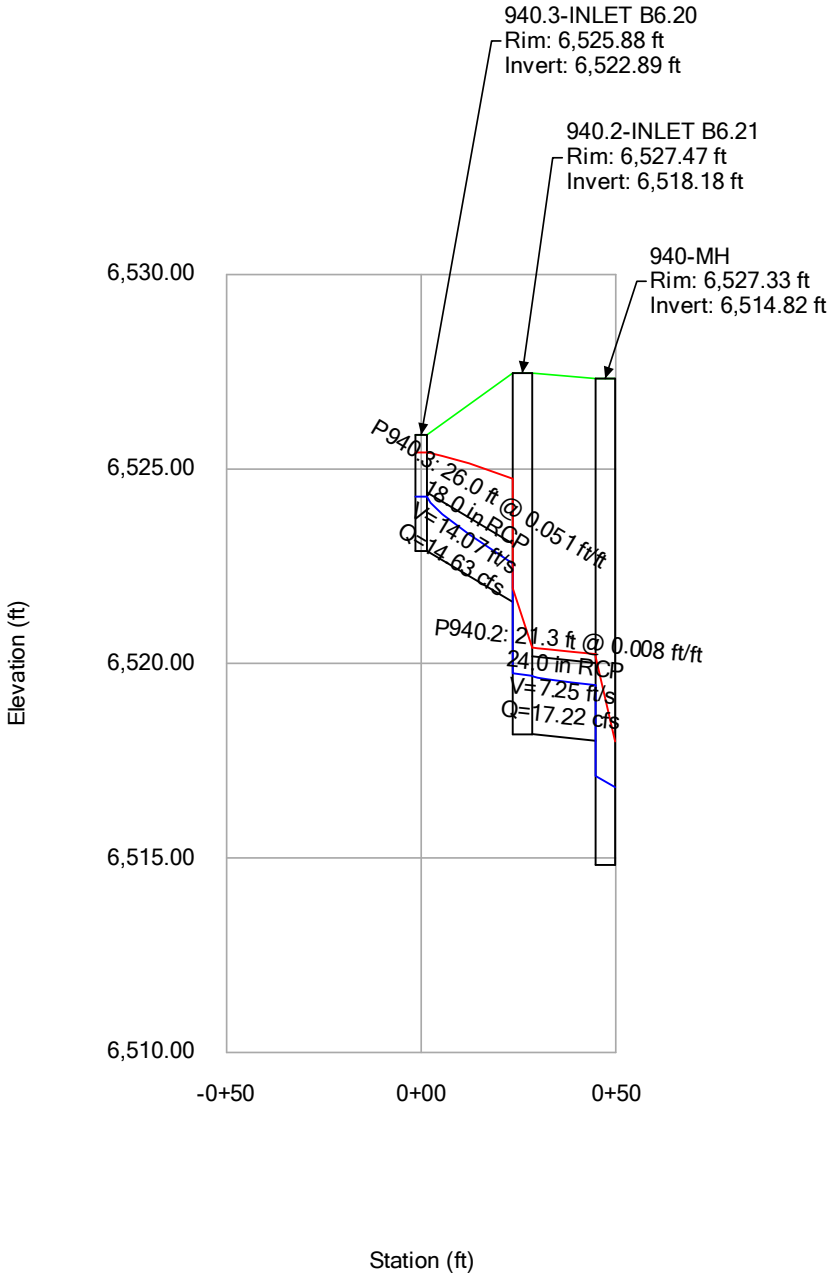
Active Scenario: Major-100-yr



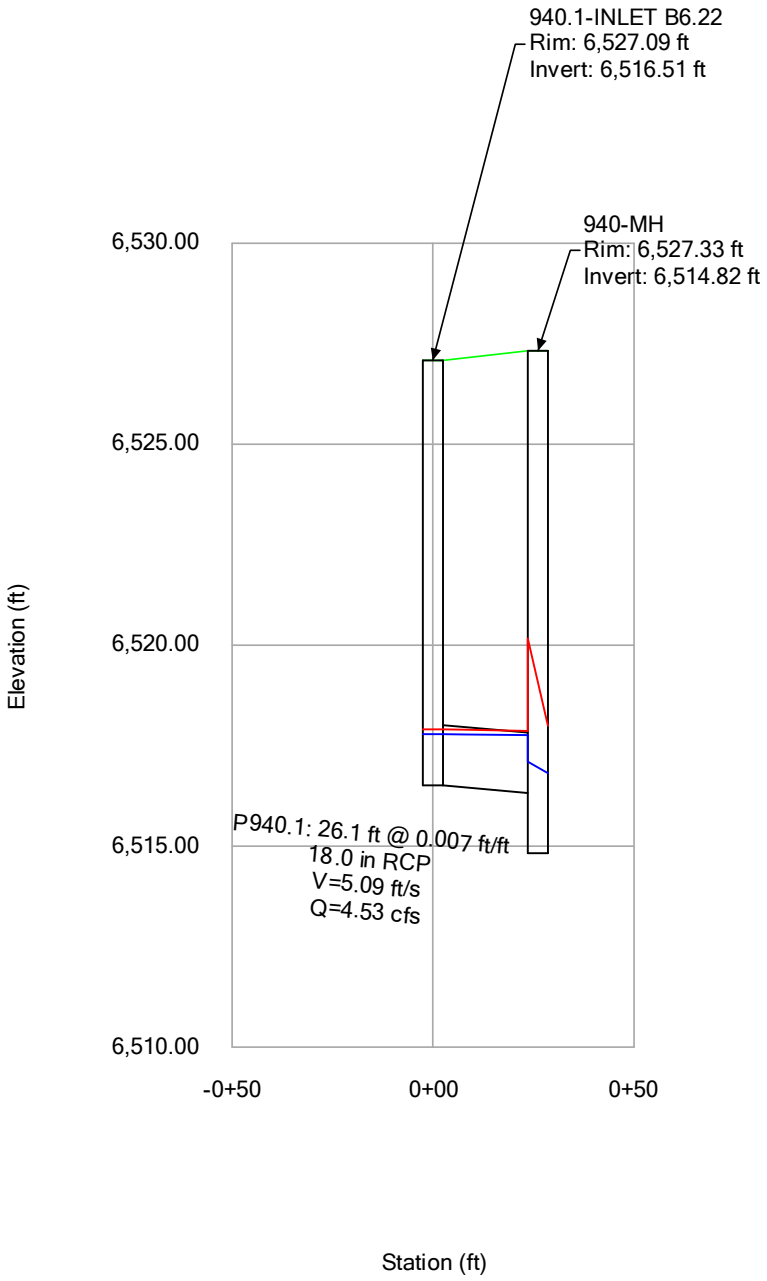
Active Scenario: Major-100-yr



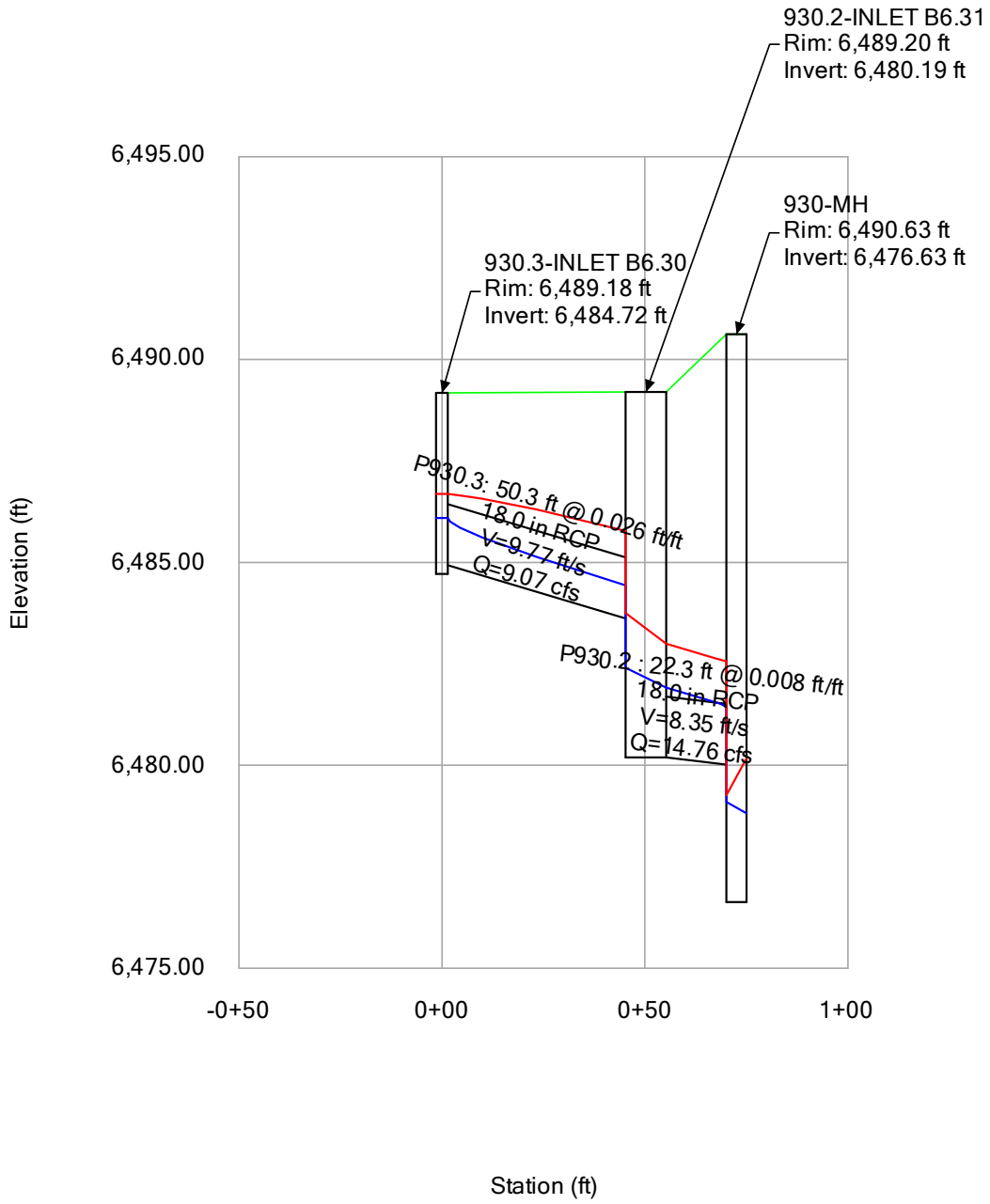
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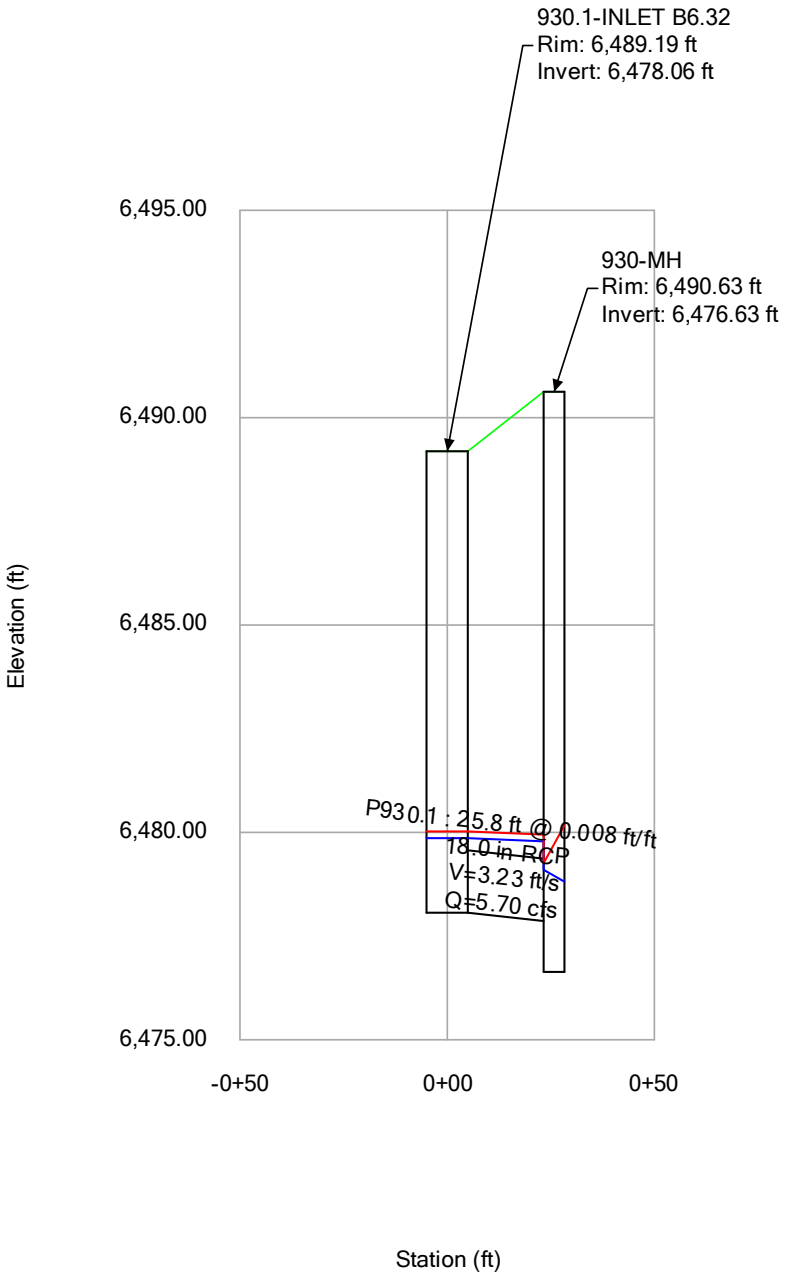
Active Scenario: Major-100-yr



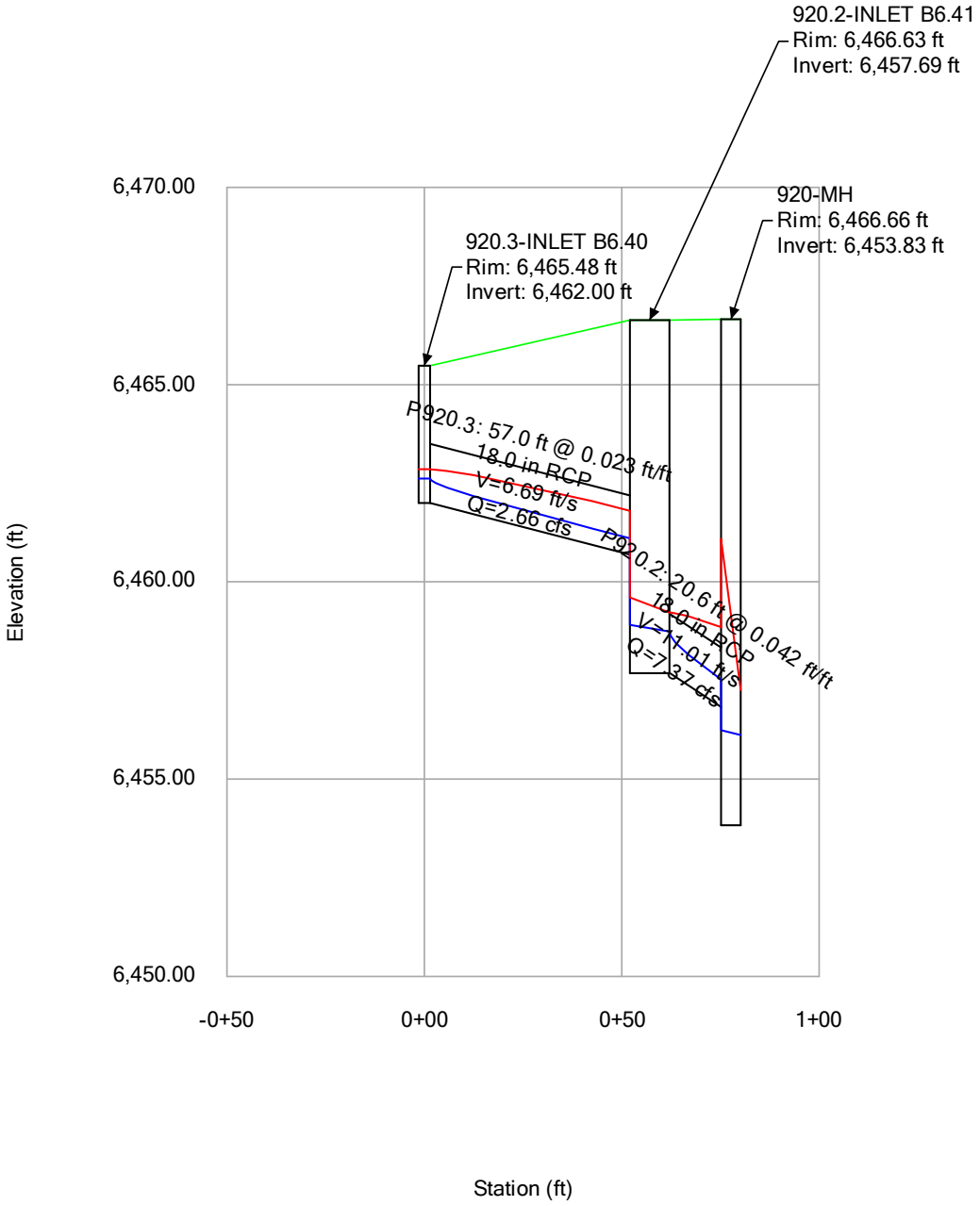
Active Scenario: Major-100-yr



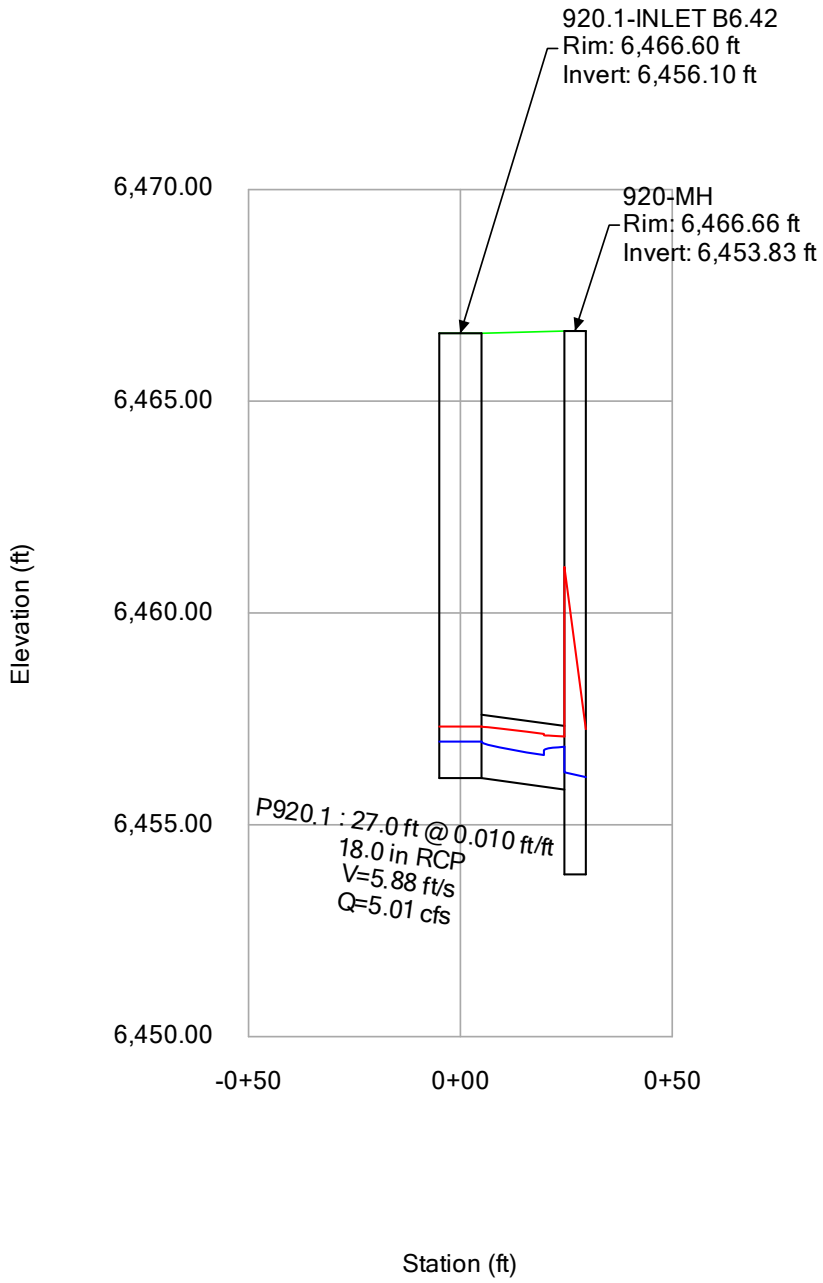
Active Scenario: Major-100-yr



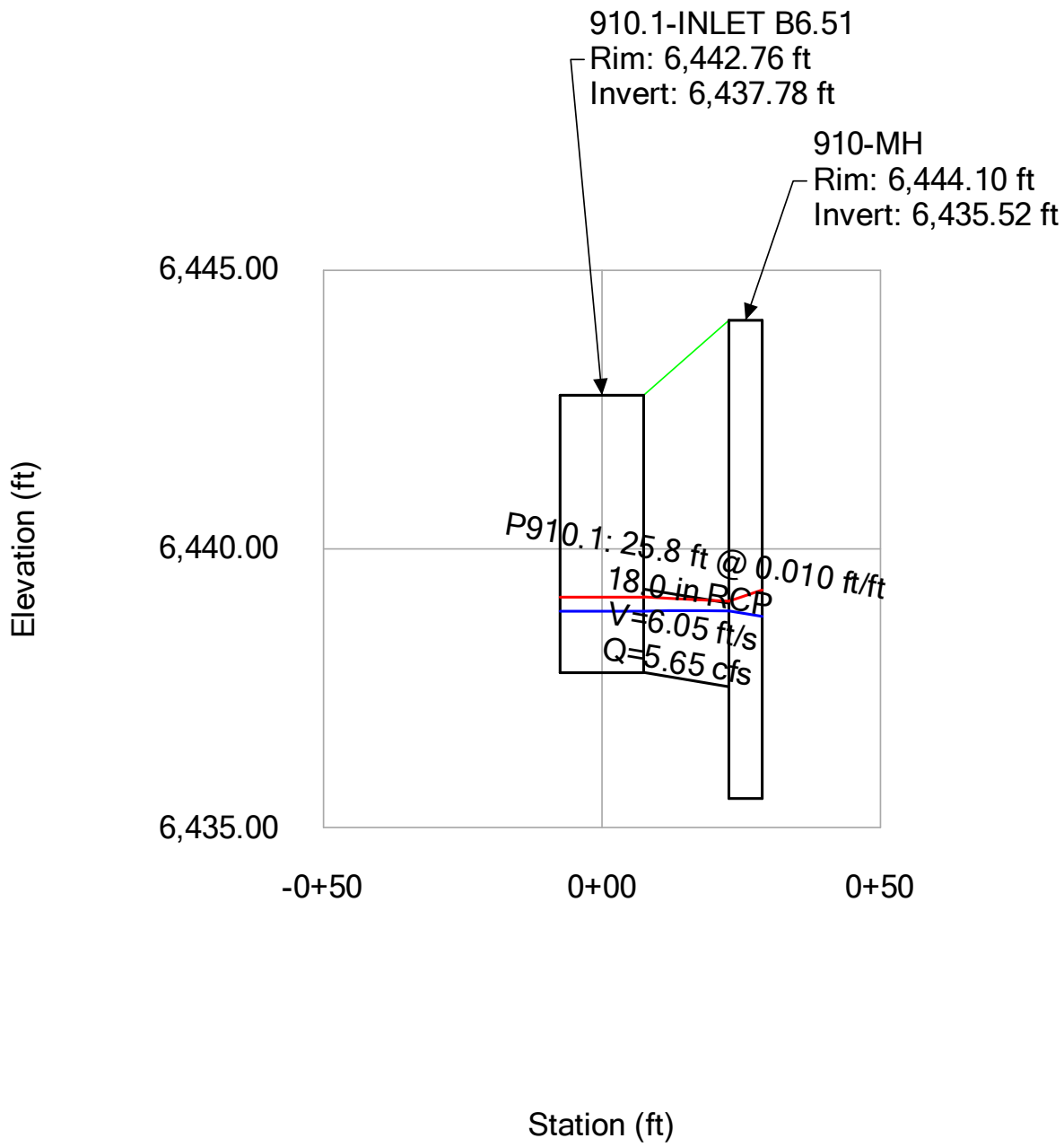
Active Scenario: Major-100-yr



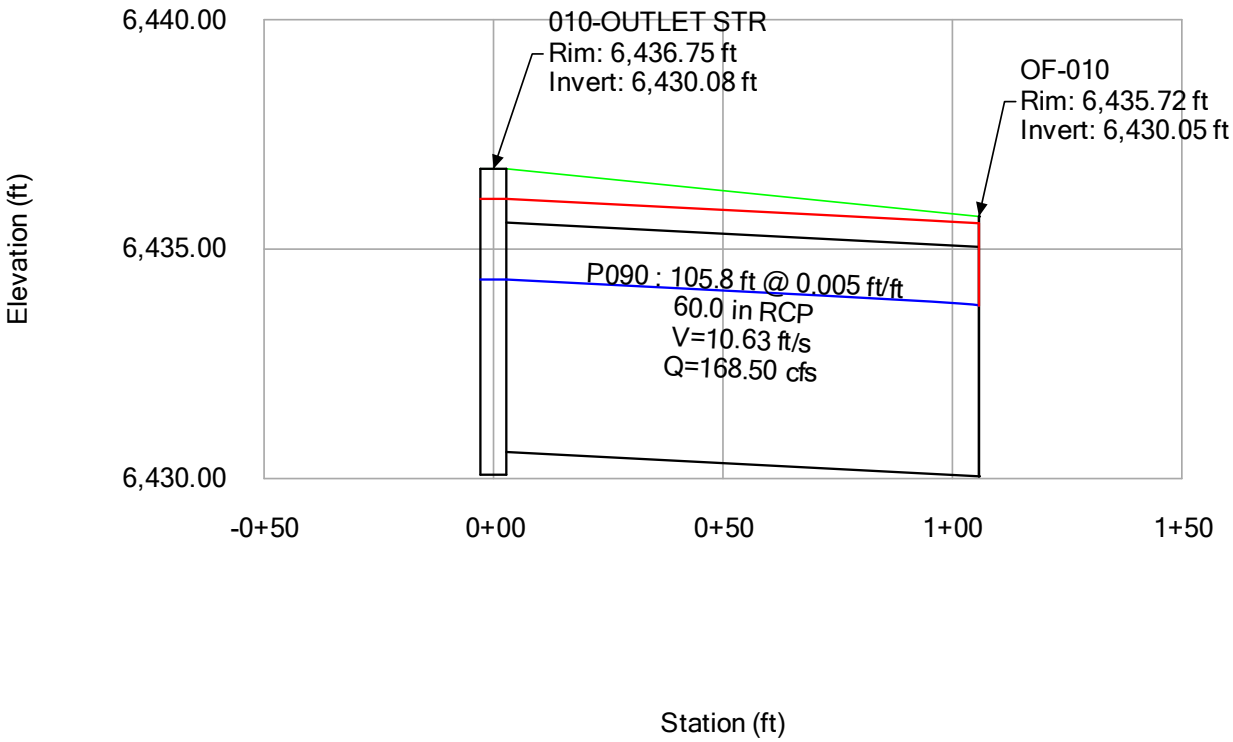
Active Scenario: Major-100-yr



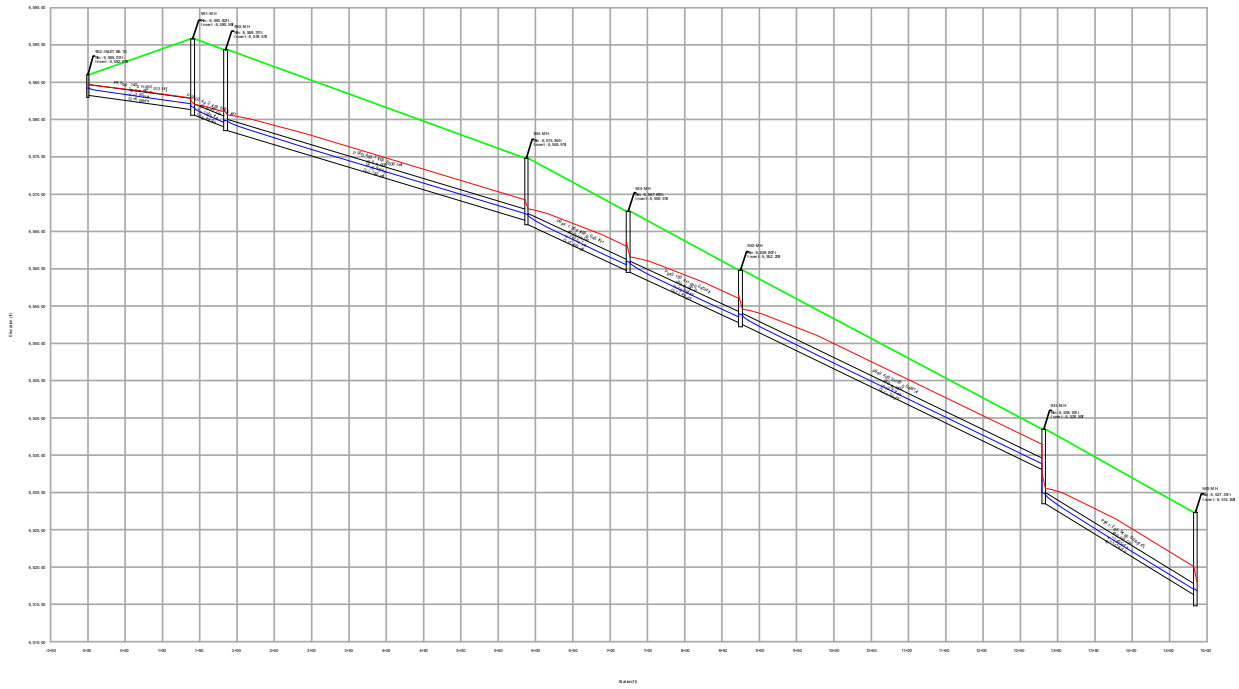
Active Scenario: Major-100-yr



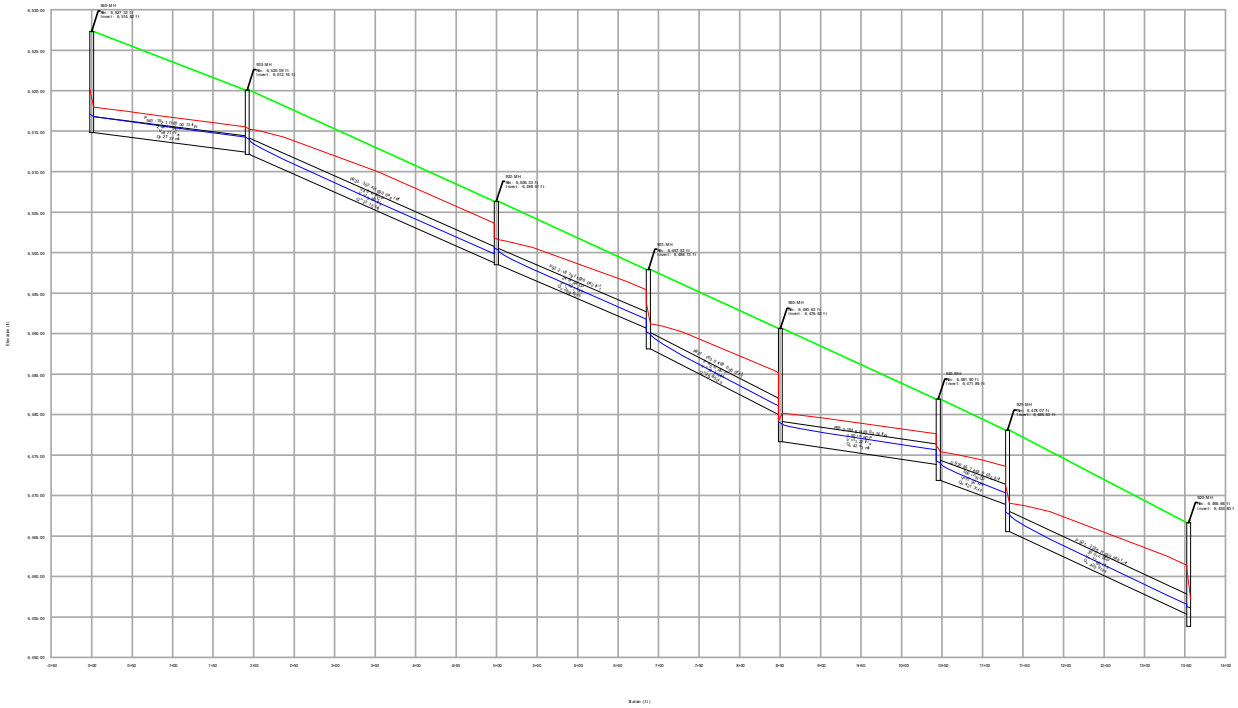
Active Scenario: Major-100-yr



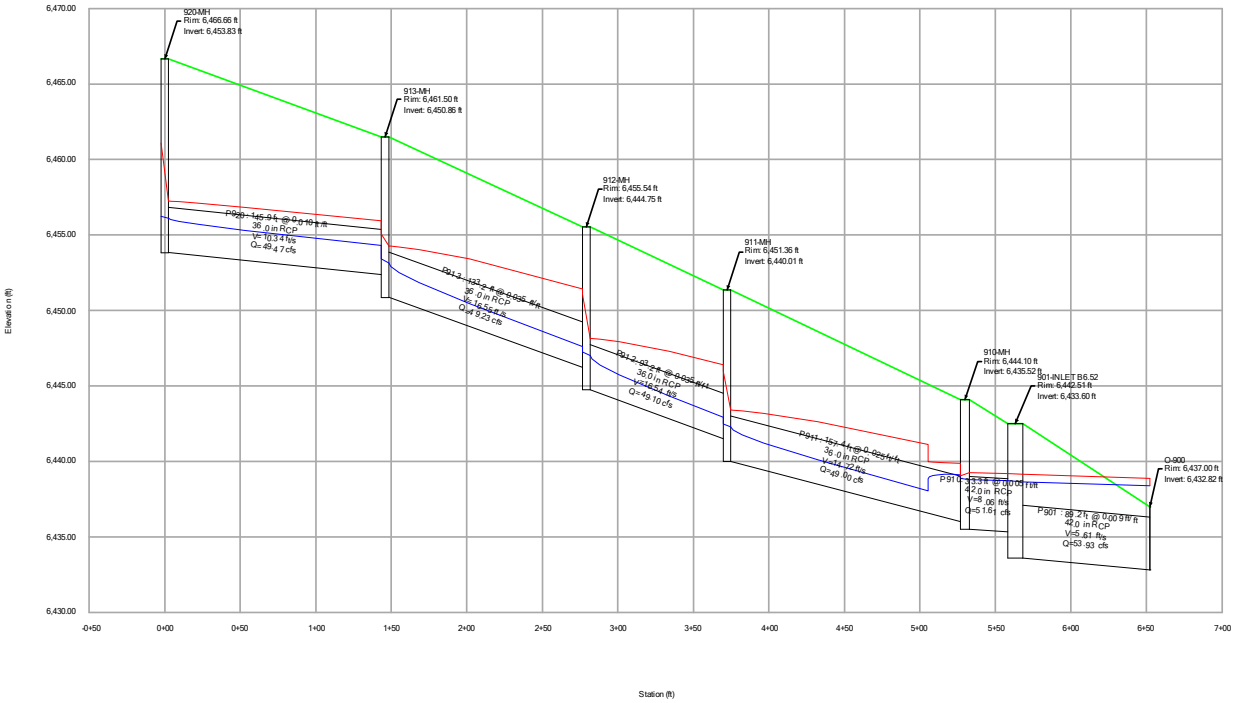
Active Scenario: Major-100-yr



Active Scenario: Major-100-yr



Active Scenario: Major-100-yr



Scenario: Minor-5-yr
Current Time Step: 0.000 h
FlexTable: Conduit Table

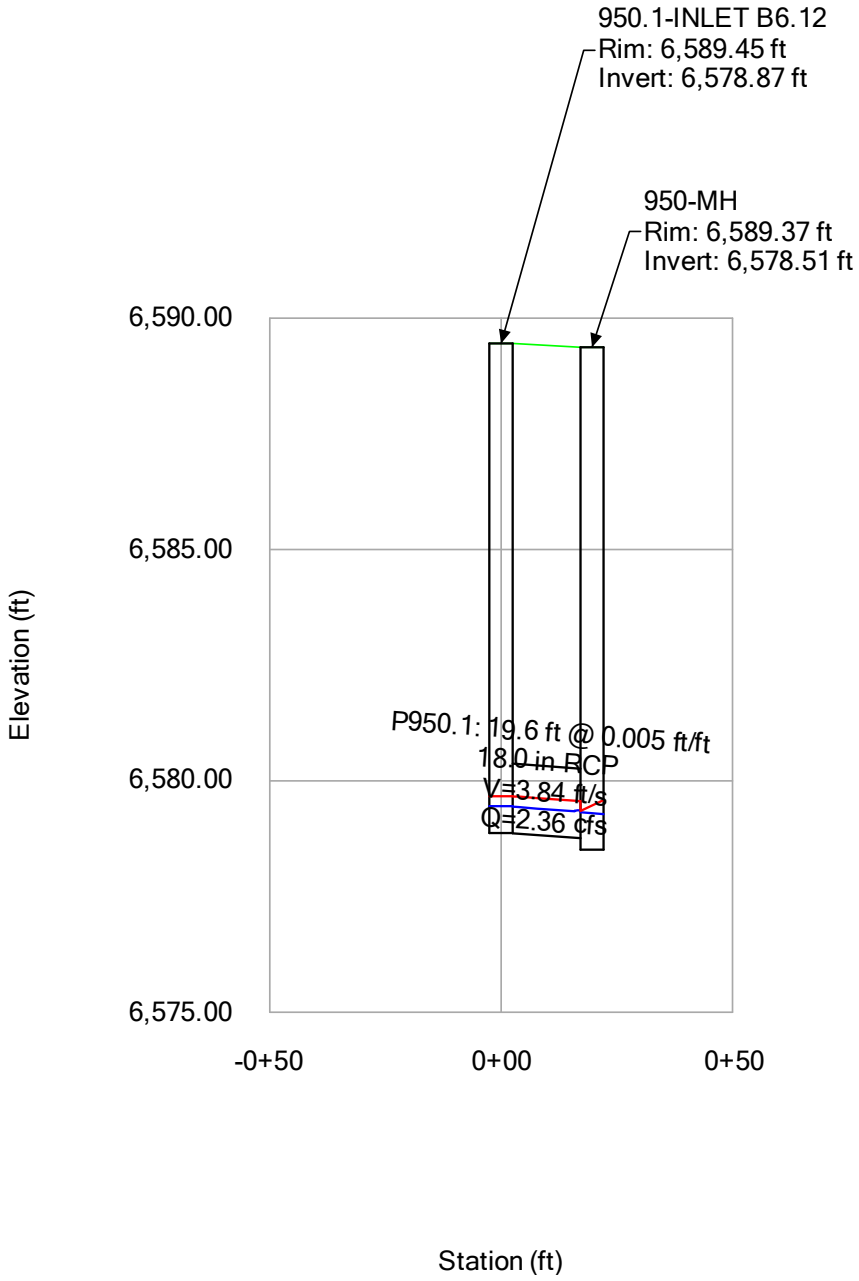
Label	Start Node	Stop Node	Invert (Start) (ft)	Invert (Stop) (ft)	Slope (Calculated) (ft/ft)	Length (Scaled) (ft)	Manning's n	Flow (cfs)	Diameter (in)	Velocity (ft/s)
P090	010-OUTLET STR	OF-010	6,430.58	6,430.05	0.005	105.8	0.013	35.00	60.0	7.22
P901	901-INLET B6.52	O-900	6,433.60	6,432.82	0.009	92.7	0.013	16.71	42.0	7.36
P910	910-MH	901-INLET B6.52	6,435.52	6,435.35	0.005	32.9	0.013	15.61	42.0	5.93
P910.1	910.1-INLET B6.51	910-MH	6,437.78	6,437.52	0.010	25.8	0.013	2.46	18.0	4.85
P911	911-MH	910-MH	6,440.01	6,436.02	0.025	157.4	0.013	14.50	36.0	10.51
P912	912-MH	911-MH	6,444.75	6,441.51	0.035	93.2	0.013	14.54	36.0	11.76
P913	913-MH	912-MH	6,450.86	6,446.24	0.035	133.1	0.013	14.59	36.0	11.78
P920	922-MH	921-MH	6,471.86	6,468.90	0.035	85.7	0.013	11.87	30.0	11.29
P920	920-MH	913-MH	6,453.83	6,452.37	0.010	145.8	0.013	14.69	36.0	7.57
P920.1	920.1-INLET B6.42	920-MH	6,456.10	6,455.83	0.010	27.2	0.013	2.16	18.0	4.68
P920.2	920.2-INLET B6.41	920-MH	6,457.69	6,456.83	0.042	20.6	0.013	2.73	18.0	8.33
P920.3	920.3-INLET B6.40	920.2-INLET B6.41	6,462.00	6,460.69	0.023	57.0	0.013	0.15	18.0	2.86
P921	921-MH	920-MH	6,465.53	6,455.33	0.046	223.3	0.013	11.83	30.0	12.45
P930	930-MH	922-MH	6,476.63	6,473.86	0.014	194.8	0.013	11.96	30.0	8.23
P930.1	930.1-INLET B6.32	930-MH	6,478.06	6,477.86	0.008	25.4	0.013	3.25	18.0	4.78
P930.2	930.2-INLET B6.31	930-MH	6,480.19	6,480.01	0.008	22.3	0.013	3.89	18.0	5.08
P930.3	930.3-INLET B6.30	930.2-INLET B6.31	6,484.93	6,483.62	0.026	50.2	0.013	0.52	18.0	4.32
P931	931-MH	930-MH	6,488.13	6,480.02	0.050	162.8	0.013	7.00	24.0	11.29
P932	932-MH	931-MH	6,498.51	6,490.68	0.042	187.7	0.013	7.05	24.0	10.63
P933	933-MH	932-MH	6,512.16	6,498.76	0.044	307.1	0.013	7.12	24.0	10.83
P940	940-MH	933-MH	6,514.82	6,512.41	0.013	192.1	0.013	7.19	24.0	6.94
P940.1	940.1-INLET B6.22	940-MH	6,516.51	6,516.32	0.007	26.1	0.013	3.25	18.0	4.67
P940.2	940.2-INLET B6.21	940-MH	6,518.18	6,518.01	0.008	21.3	0.013	2.70	24.0	4.49
P940.3	940.3-INLET B6.20	940.2-INLET B6.21	6,522.89	6,521.58	0.051	26.0	0.013	0.84	18.0	6.30
P941	941-MH	940-MH	6,528.50	6,516.32	0.060	202.9	0.013	3.75	18.0	10.38
P942	942-MH	941-MH	6,552.51	6,533.10	0.048	406.0	0.013	3.84	18.0	9.64
P943	943-MH	942-MH	6,559.51	6,552.76	0.045	150.3	0.013	3.88	18.0	9.46
P944	944-MH	943-MH	6,565.91	6,559.76	0.045	136.2	0.013	3.91	18.0	9.50
P950	950-MH	944-MH	6,578.51	6,566.51	0.030	402.9	0.013	4.03	18.0	8.25
P950.1	950.1-INLET B6.12	950-MH	6,578.87	6,578.76	0.005	19.6	0.013	2.36	18.0	3.84
P950.2	950.2-INLET B6.11	950-MH	6,579.76	6,579.70	0.004	14.8	0.013	2.16	18.0	3.51
P950.3	951-MH	950-MH	6,580.59	6,579.01	0.036	44.2	0.013	0.37	18.0	4.35
P950.4	952-INLET B6.10	951-MH	6,583.22	6,581.34	0.013	140.5	0.013	0.38	18.0	3.10

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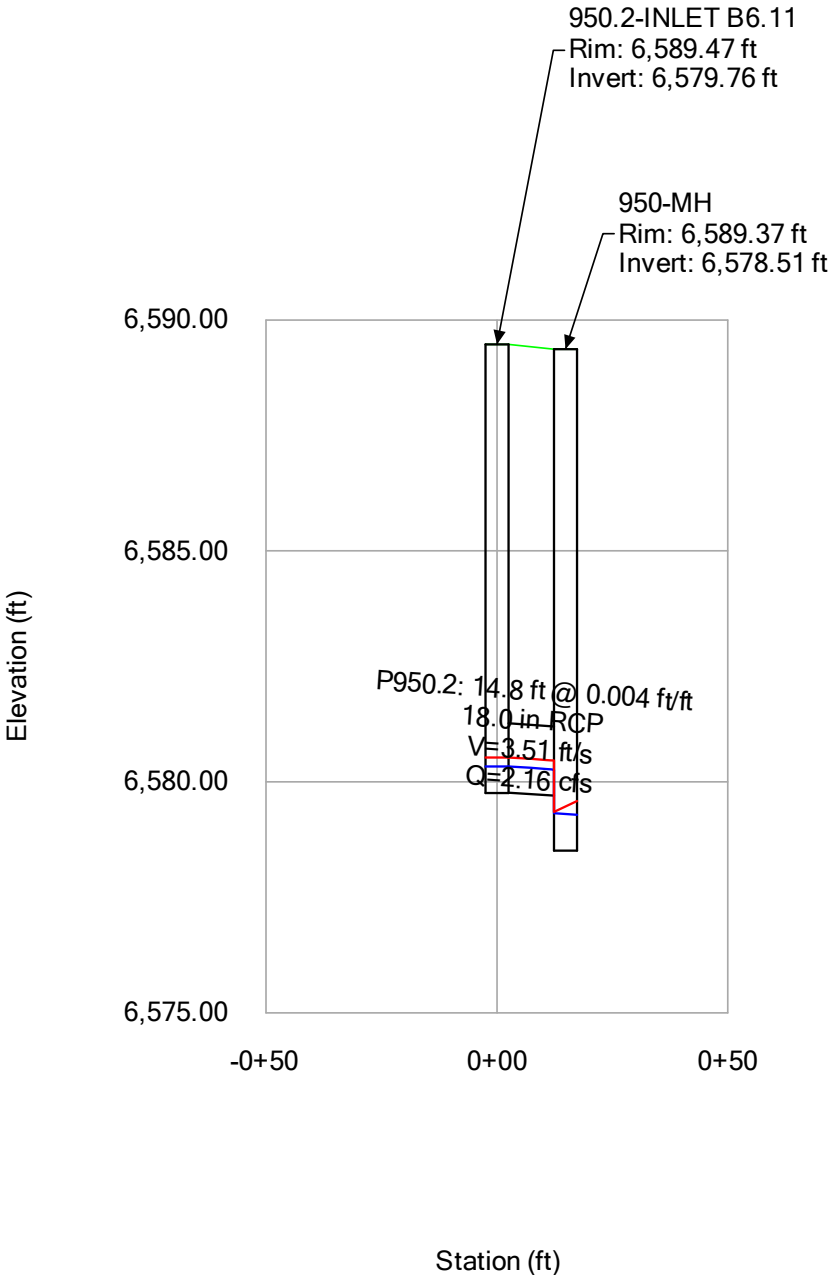
Scenario: Minor-5-yr
Current Time Step: 0.000 h
FlexTable: Manhole Table

Label	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Headloss Method	Headloss (ft)	Velocity (Out) (ft/s)
010-OUTLET STR	6,436.75	6,430.08	6,432.22	6,432.22	HEC-22 Energy (Second Edition)	0.00	6.21
901-INLET B6.52	6,442.51	6,433.60	6,434.88	6,434.85	HEC-22 Energy (Second Edition)	0.03	5.43
910-MH	6,444.10	6,435.52	6,436.77	6,436.72	HEC-22 Energy (Second Edition)	0.05	5.33
910.1-INLET B6.51	6,442.76	6,437.78	6,438.37	6,438.37	HEC-22 Energy (Second Edition)	0.00	3.78
911-MH	6,451.36	6,440.01	6,441.28	6,441.23	HEC-22 Energy (Second Edition)	0.05	5.41
912-MH	6,455.54	6,444.75	6,446.02	6,445.96	HEC-22 Energy (Second Edition)	0.06	5.41
913-MH	6,461.50	6,450.86	6,452.16	6,452.08	HEC-22 Energy (Second Edition)	0.08	5.42
920-MH	6,466.66	6,453.83	6,455.09	6,455.05	HEC-22 Energy (Second Edition)	0.03	5.43
920.1-INLET B6.42	6,466.60	6,456.10	6,456.66	6,456.66	HEC-22 Energy (Second Edition)	0.00	3.63
920.2-INLET B6.41	6,466.63	6,457.69	6,458.38	6,458.32	HEC-22 Energy (Second Edition)	0.06	3.90
920.3-INLET B6.40	6,465.48	6,462.00	6,462.15	6,462.15	HEC-22 Energy (Second Edition)	0.00	1.77
921-MH	6,478.07	6,465.53	6,466.73	6,466.68	HEC-22 Energy (Second Edition)	0.05	5.35
922-MH	6,481.90	6,471.86	6,473.07	6,473.02	HEC-22 Energy (Second Edition)	0.06	5.35
930-MH	6,490.63	6,476.63	6,477.86	6,477.79	HEC-22 Energy (Second Edition)	0.06	5.36
930.1-INLET B6.32	6,489.19	6,478.06	6,478.75	6,478.75	HEC-22 Energy (Second Edition)	0.00	4.12
930.2-INLET B6.31	6,489.20	6,480.19	6,481.03	6,480.95	HEC-22 Energy (Second Edition)	0.08	4.37
930.3-INLET B6.30	6,489.18	6,484.72	6,485.20	6,485.20	HEC-22 Energy (Second Edition)	0.00	2.44
931-MH	6,497.92	6,488.13	6,489.13	6,489.07	HEC-22 Energy (Second Edition)	0.06	4.83
932-MH	6,506.33	6,498.51	6,499.51	6,499.46	HEC-22 Energy (Second Edition)	0.06	4.84
933-MH	6,520.09	6,512.16	6,513.17	6,513.11	HEC-22 Energy (Second Edition)	0.06	4.86
940-MH	6,527.33	6,514.82	6,515.83	6,515.77	HEC-22 Energy (Second Edition)	0.06	4.87
940.1-INLET B6.22	6,527.09	6,516.51	6,517.20	6,517.20	HEC-22 Energy (Second Edition)	0.00	4.12
940.2-INLET B6.21	6,527.47	6,518.18	6,518.77	6,518.76	HEC-22 Energy (Second Edition)	0.01	3.64
940.3-INLET B6.20	6,525.88	6,522.89	6,523.23	6,523.23	HEC-22 Energy (Second Edition)	0.00	2.78
941-MH	6,538.50	6,528.50	6,529.31	6,529.24	HEC-22 Energy (Second Edition)	0.06	4.32
942-MH	6,559.80	6,552.20	6,553.31	6,553.26	HEC-22 Energy (Second Edition)	0.05	4.35
943-MH	6,567.69	6,559.51	6,560.34	6,560.27	HEC-22 Energy (Second Edition)	0.07	4.37
944-MH	6,574.84	6,565.91	6,566.73	6,566.67	HEC-22 Energy (Second Edition)	0.06	4.38
950-MH	6,589.37	6,578.51	6,579.32	6,579.28	HEC-22 Energy (Second Edition)	0.04	4.42
950.1-INLET B6.12	6,589.45	6,578.87	6,579.45	6,579.45	HEC-22 Energy (Second Edition)	0.00	3.73
950.2-INLET B6.11	6,589.47	6,579.76	6,580.33	6,580.33	HEC-22 Energy (Second Edition)	0.00	3.51
951-MH	6,590.82	6,580.59	6,580.83	6,580.82	HEC-22 Energy (Second Edition)	0.01	2.23
952-INLET B6.10	6,586.01	6,582.97	6,583.44	6,583.44	HEC-22 Energy (Second Edition)	0.00	2.24

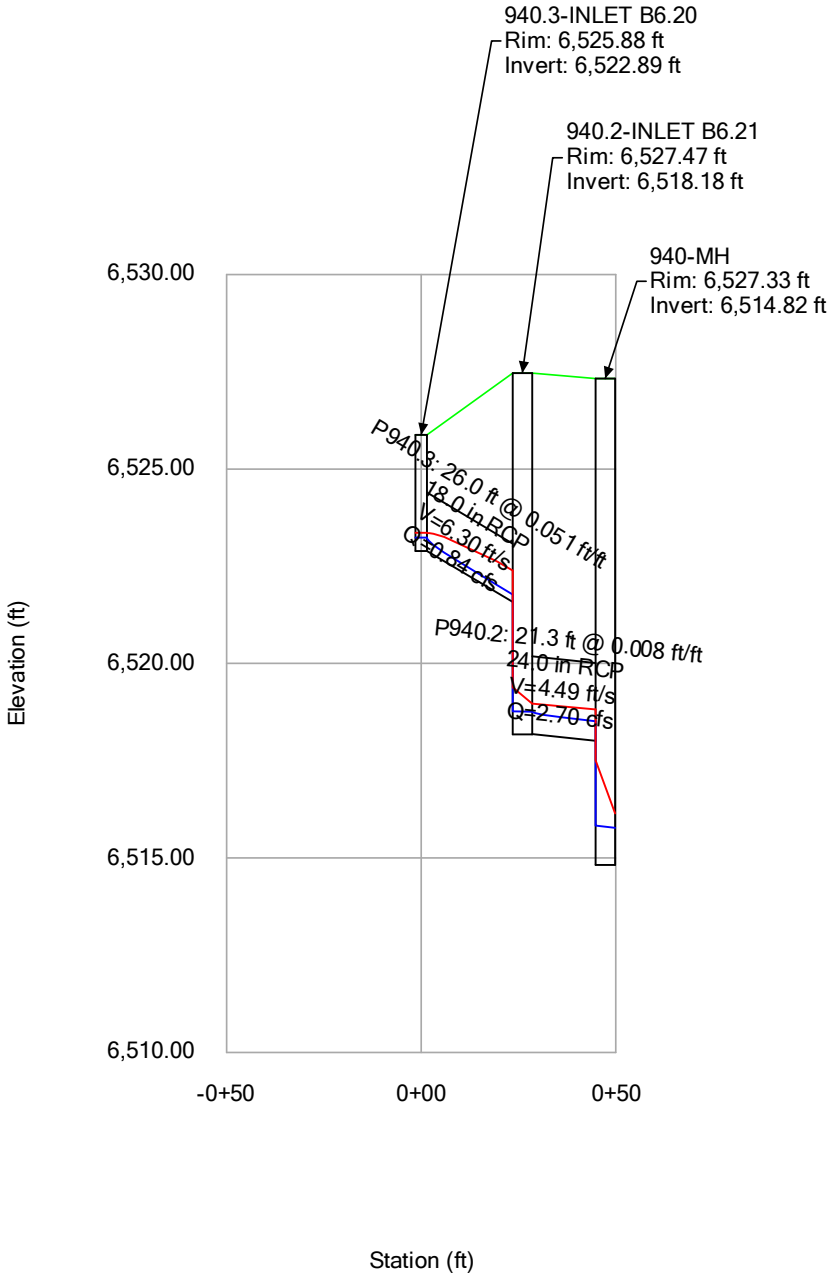
Active Scenario: Minor-5-yr



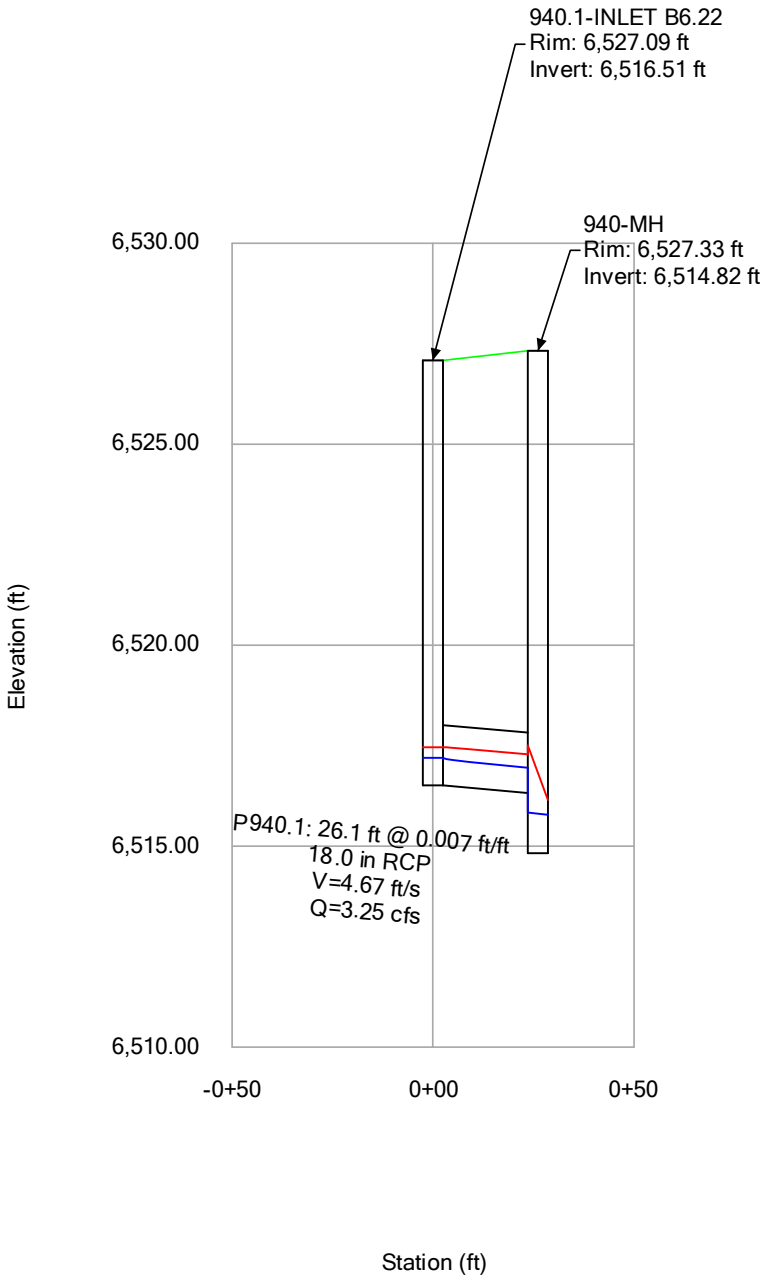
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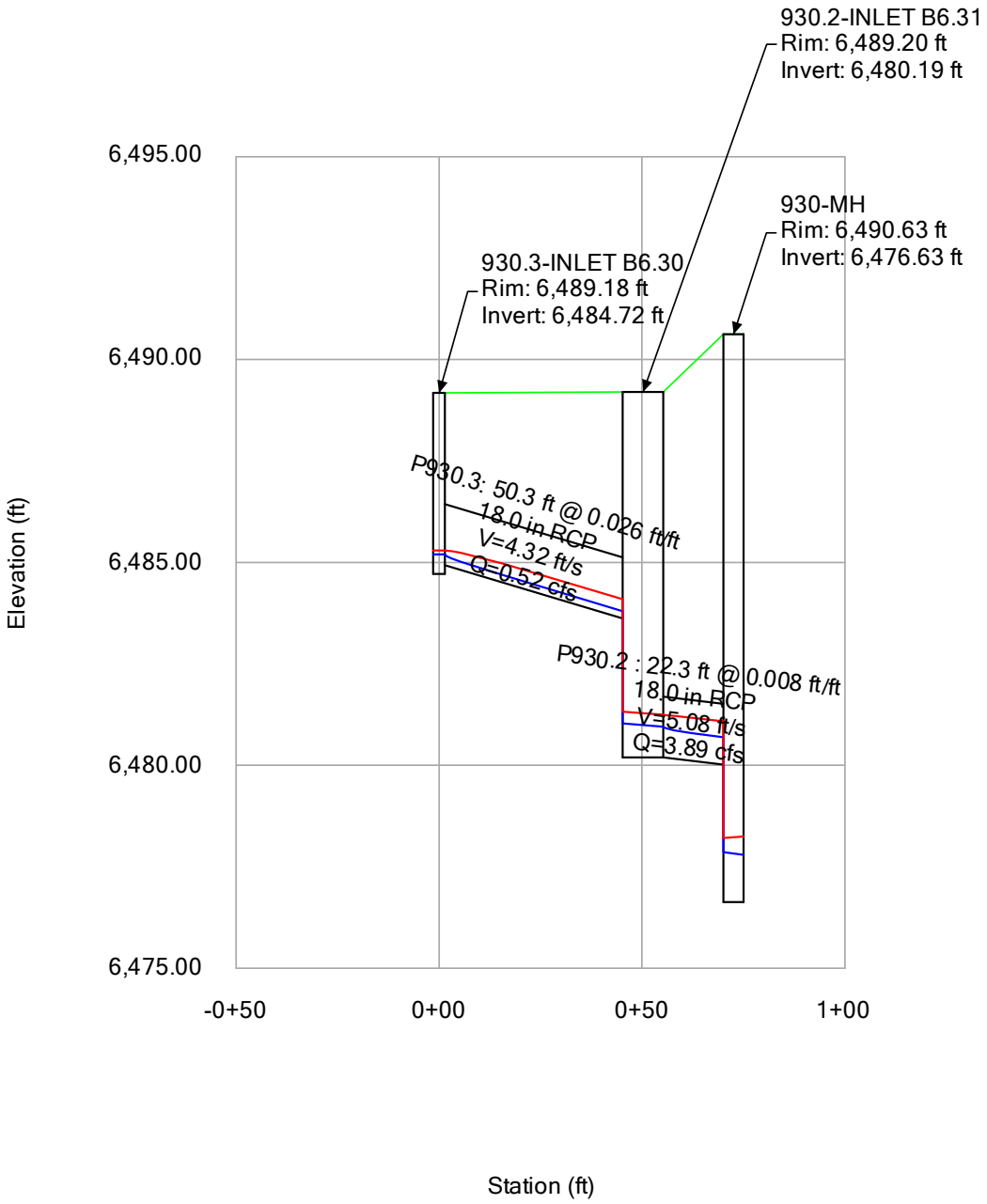
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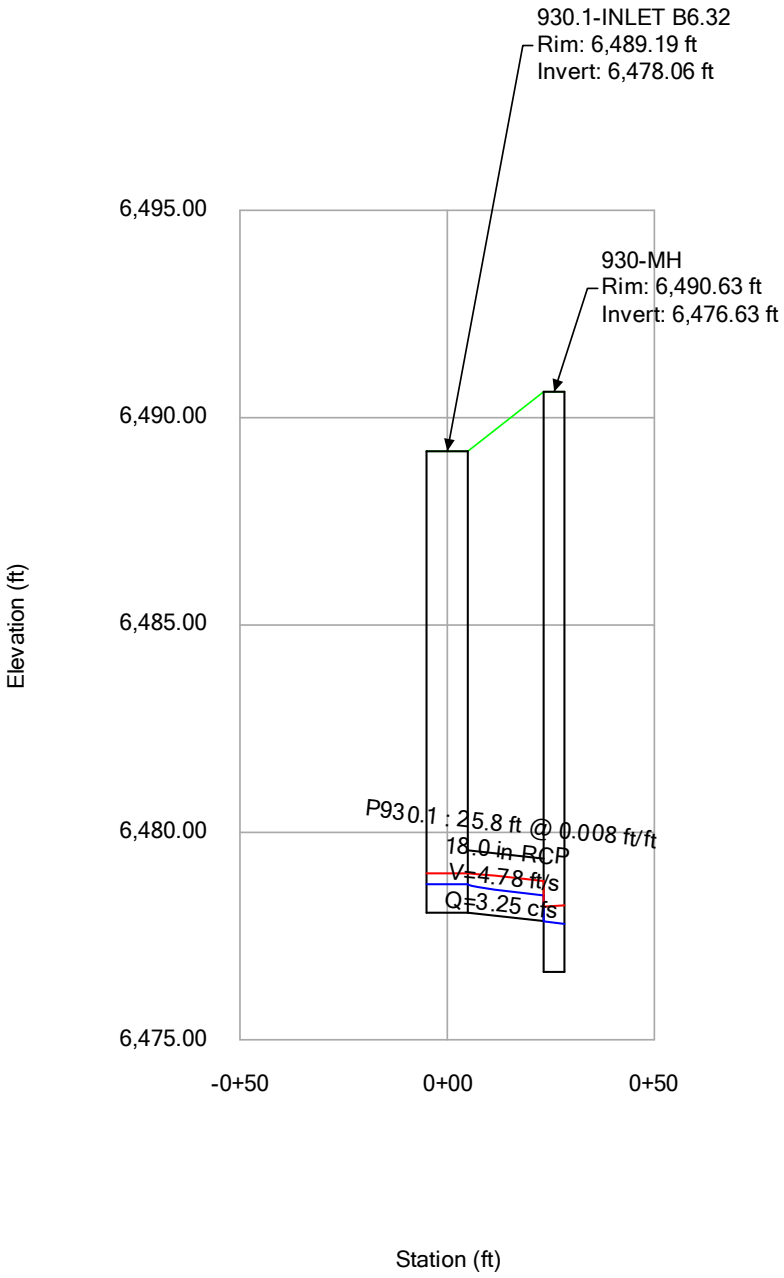
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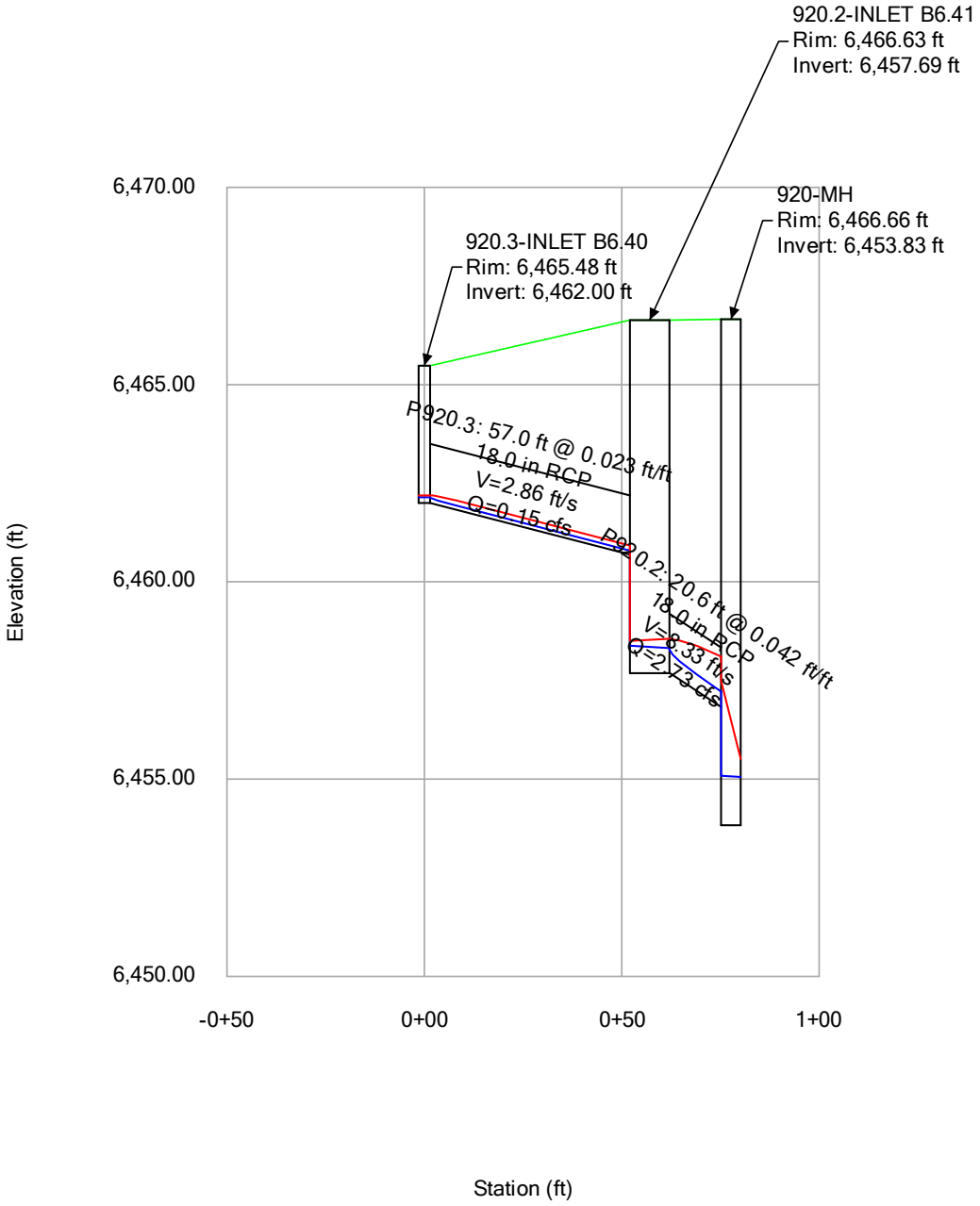
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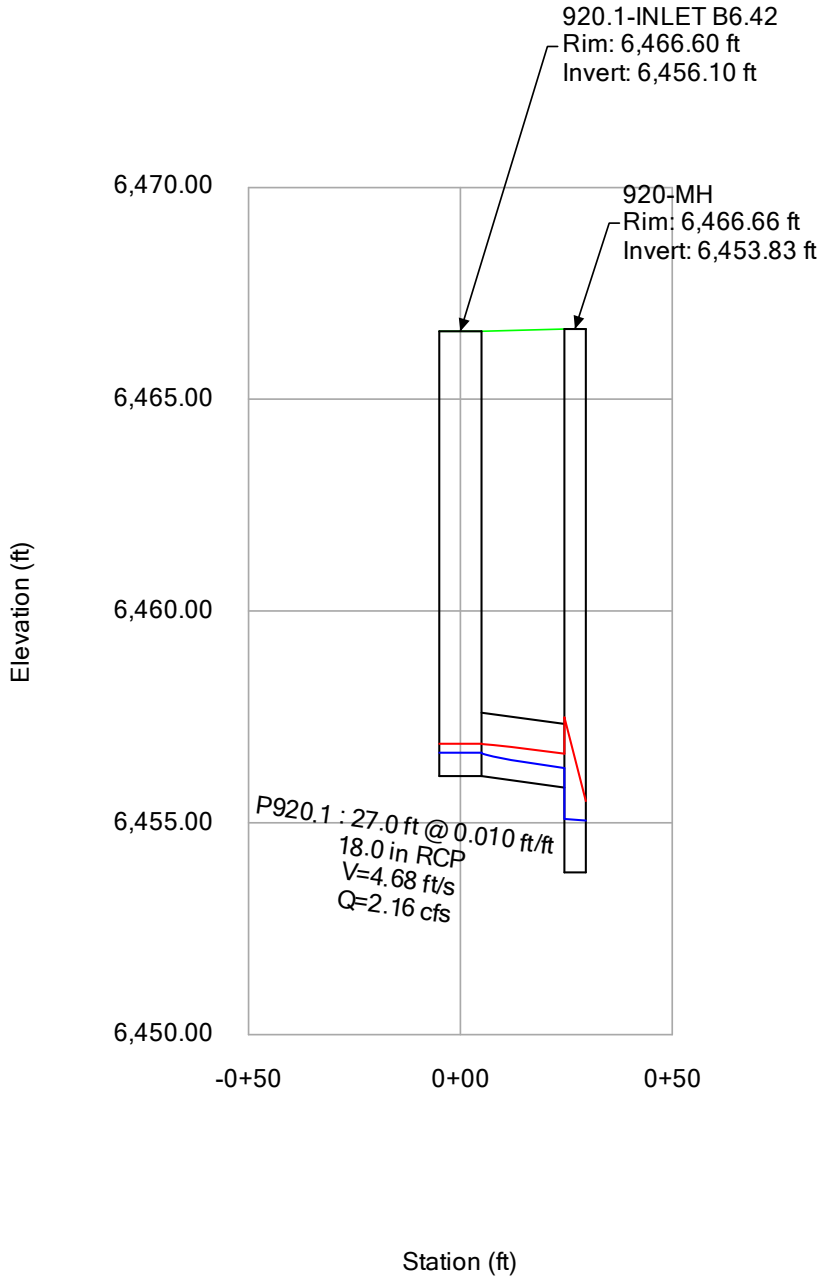
Active Scenario: Minor-5-yr



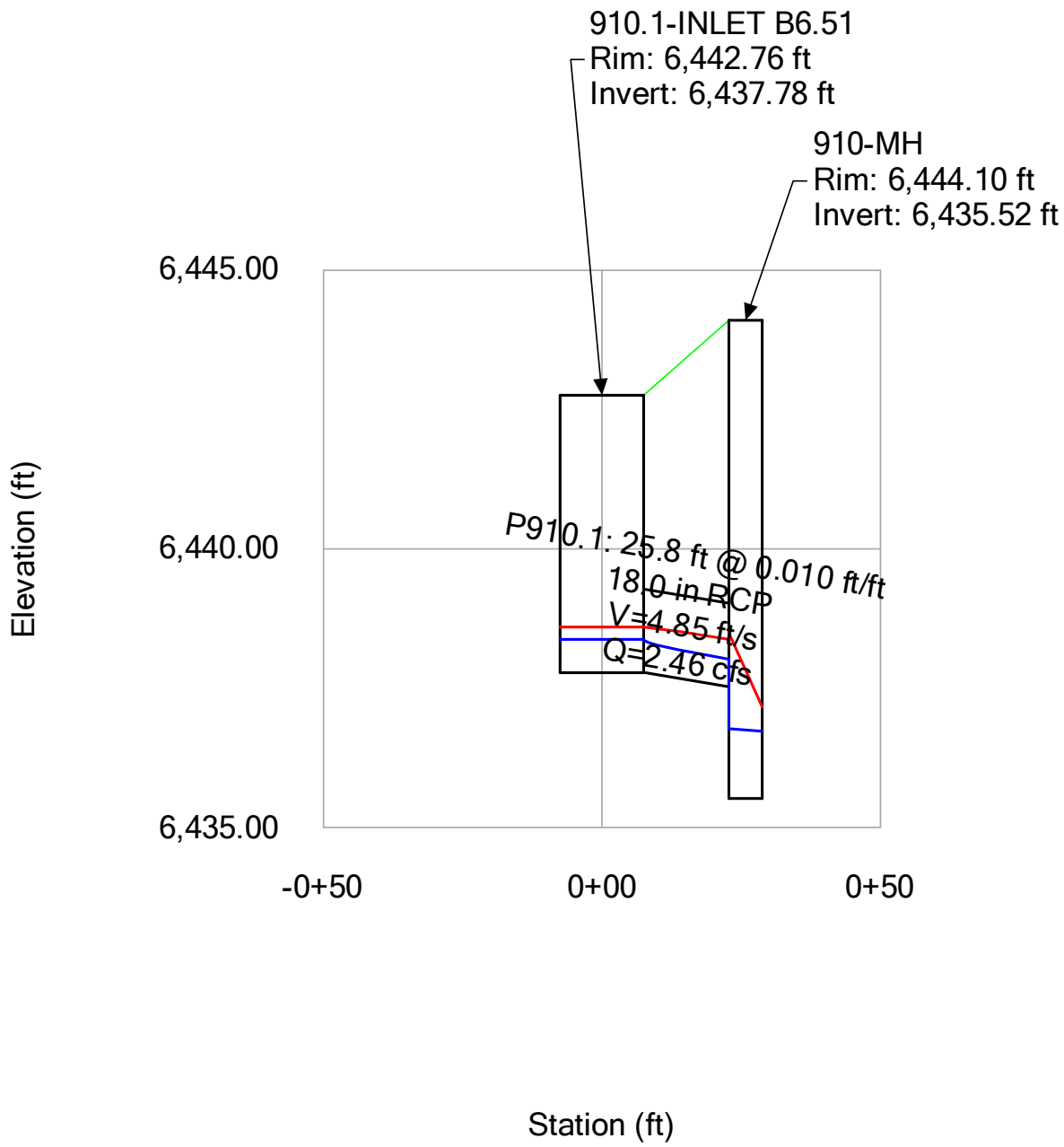
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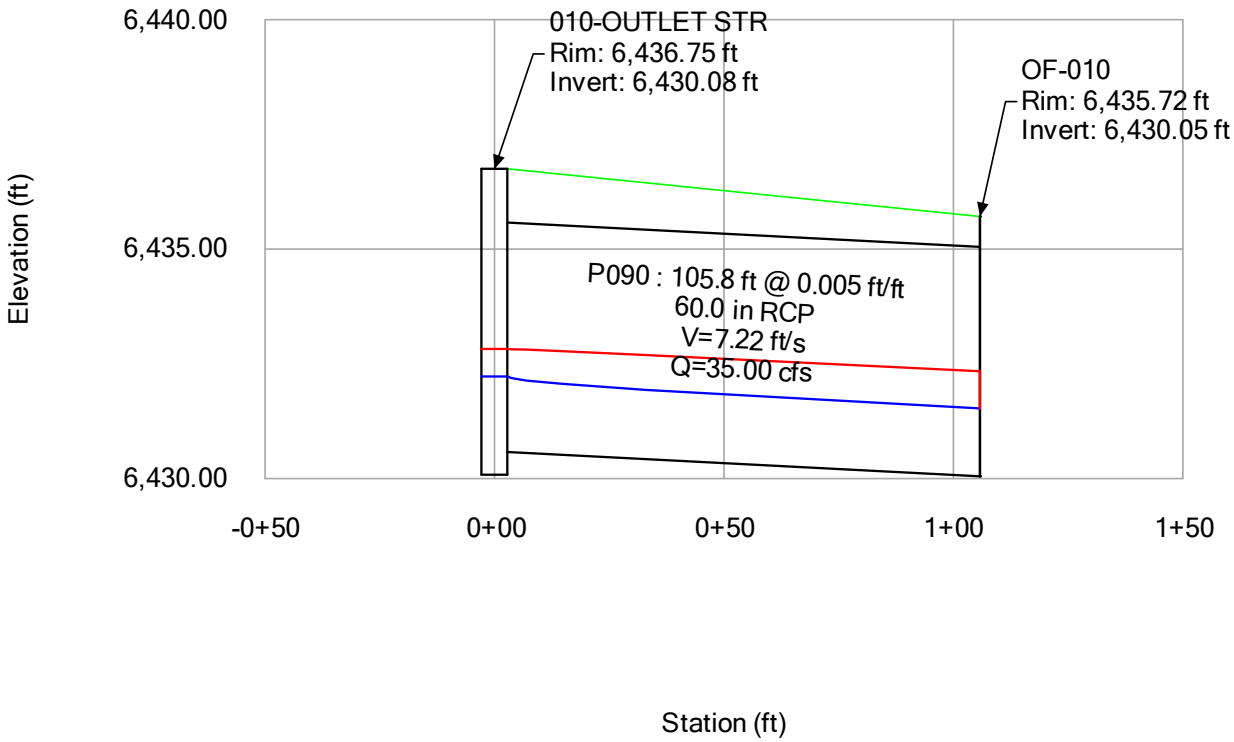
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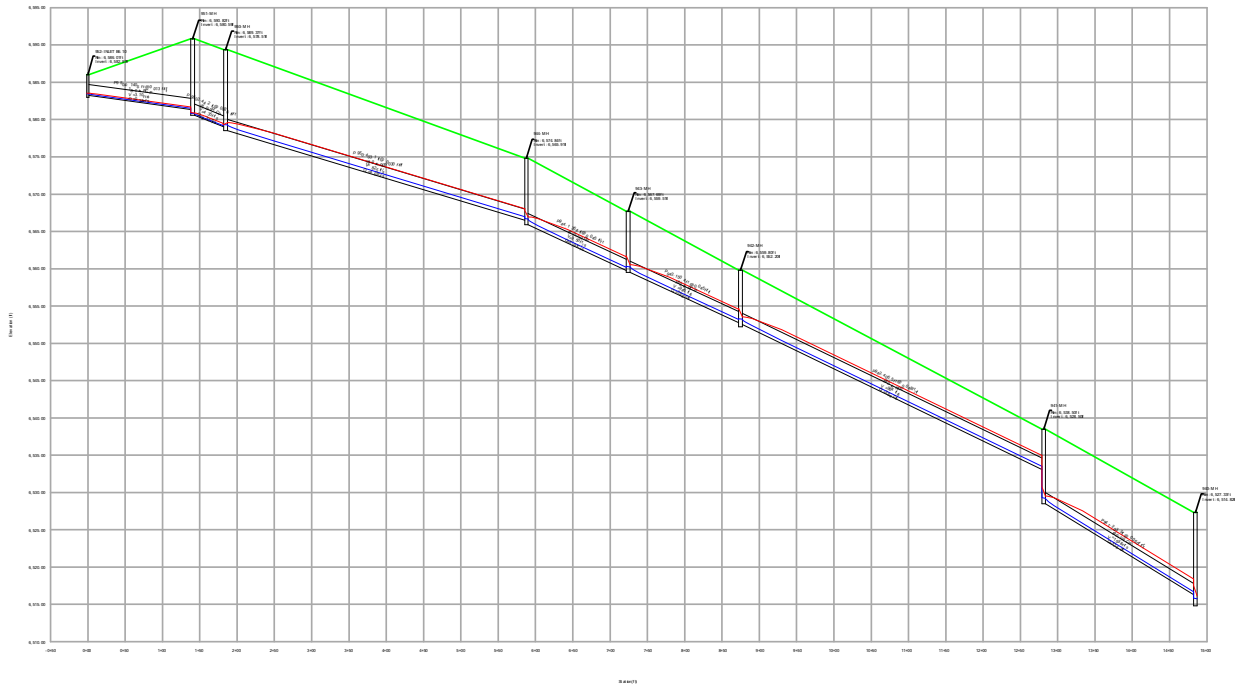
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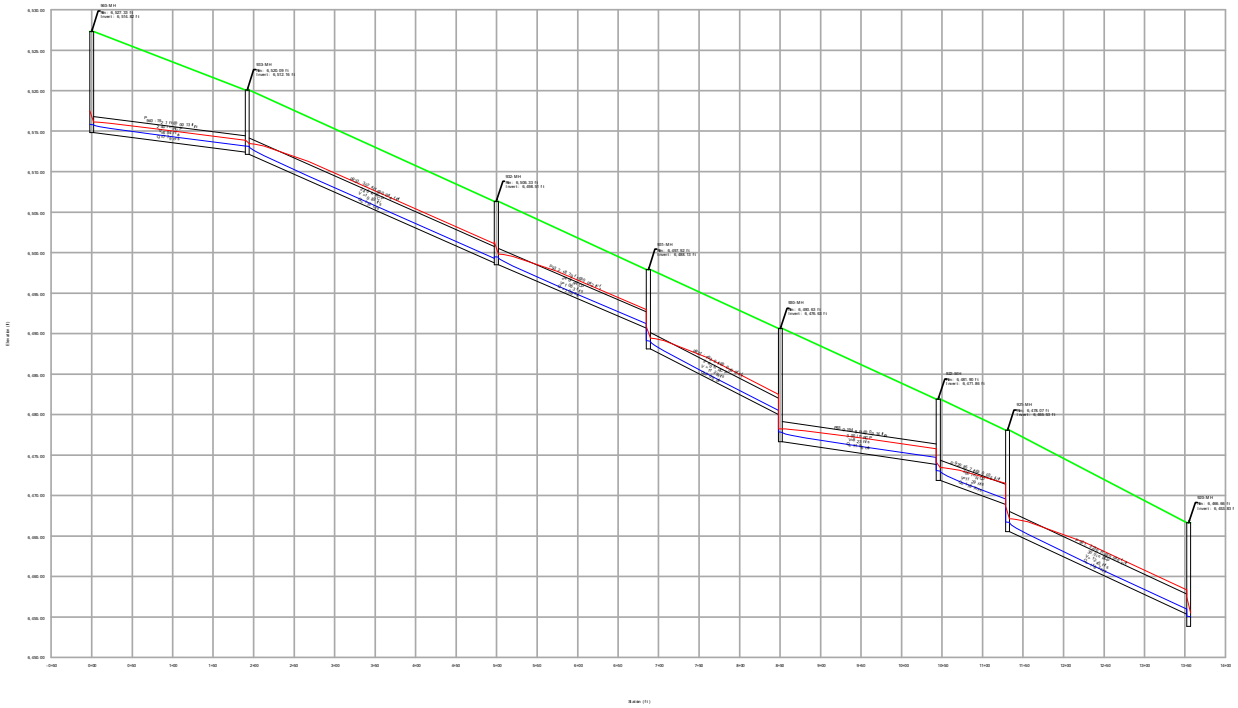
Active Scenario: Minor-5-yr



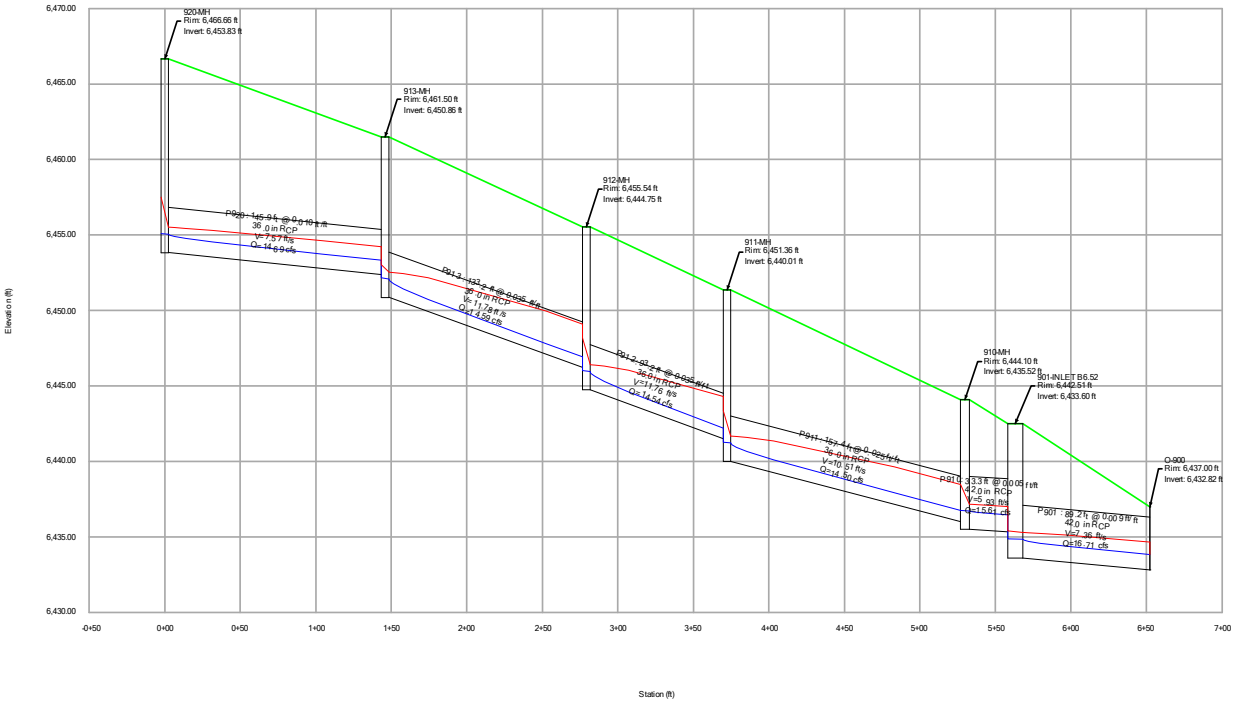
Active Scenario: Minor-5-yr



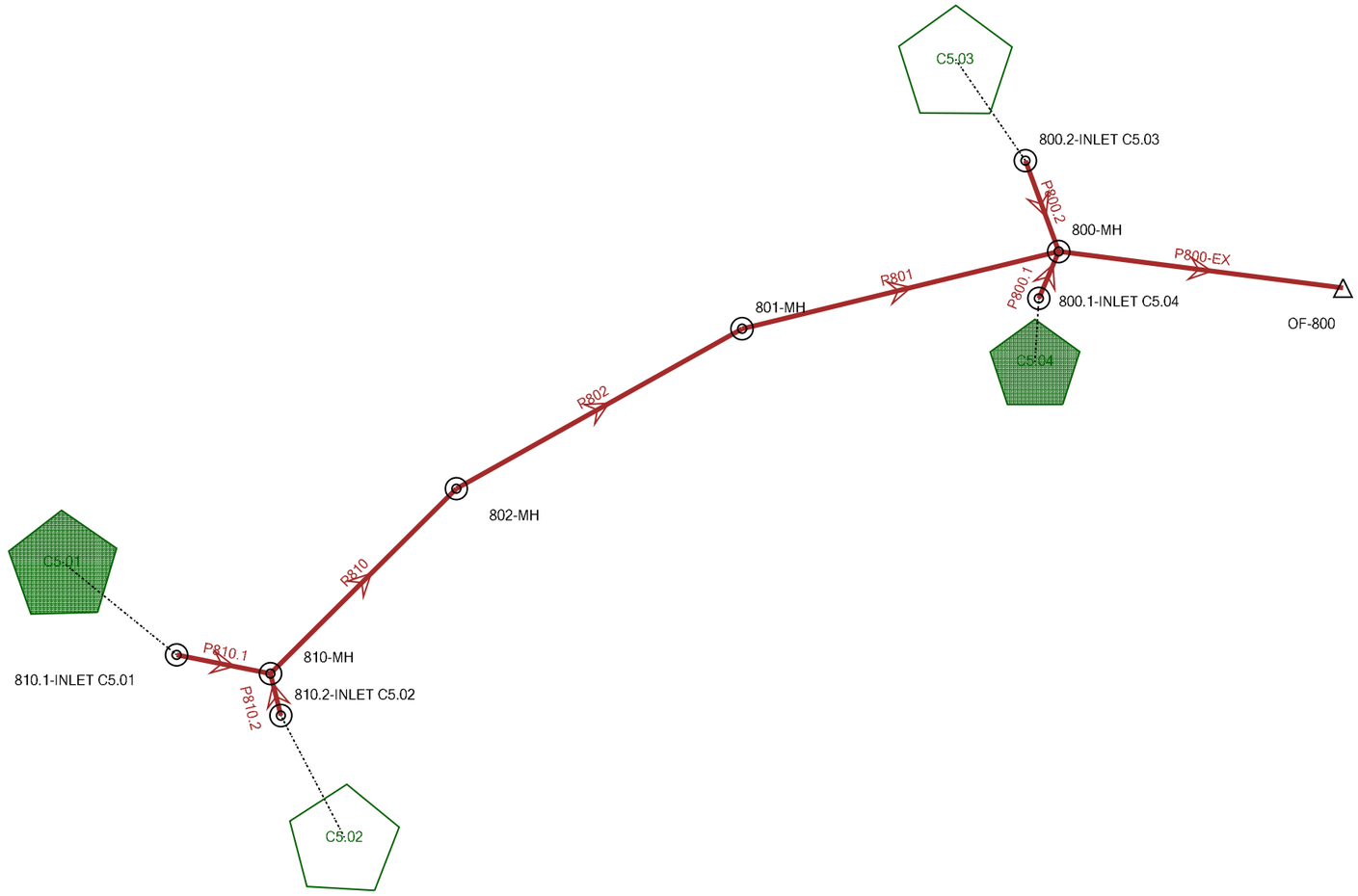
Active Scenario: Minor-5-yr



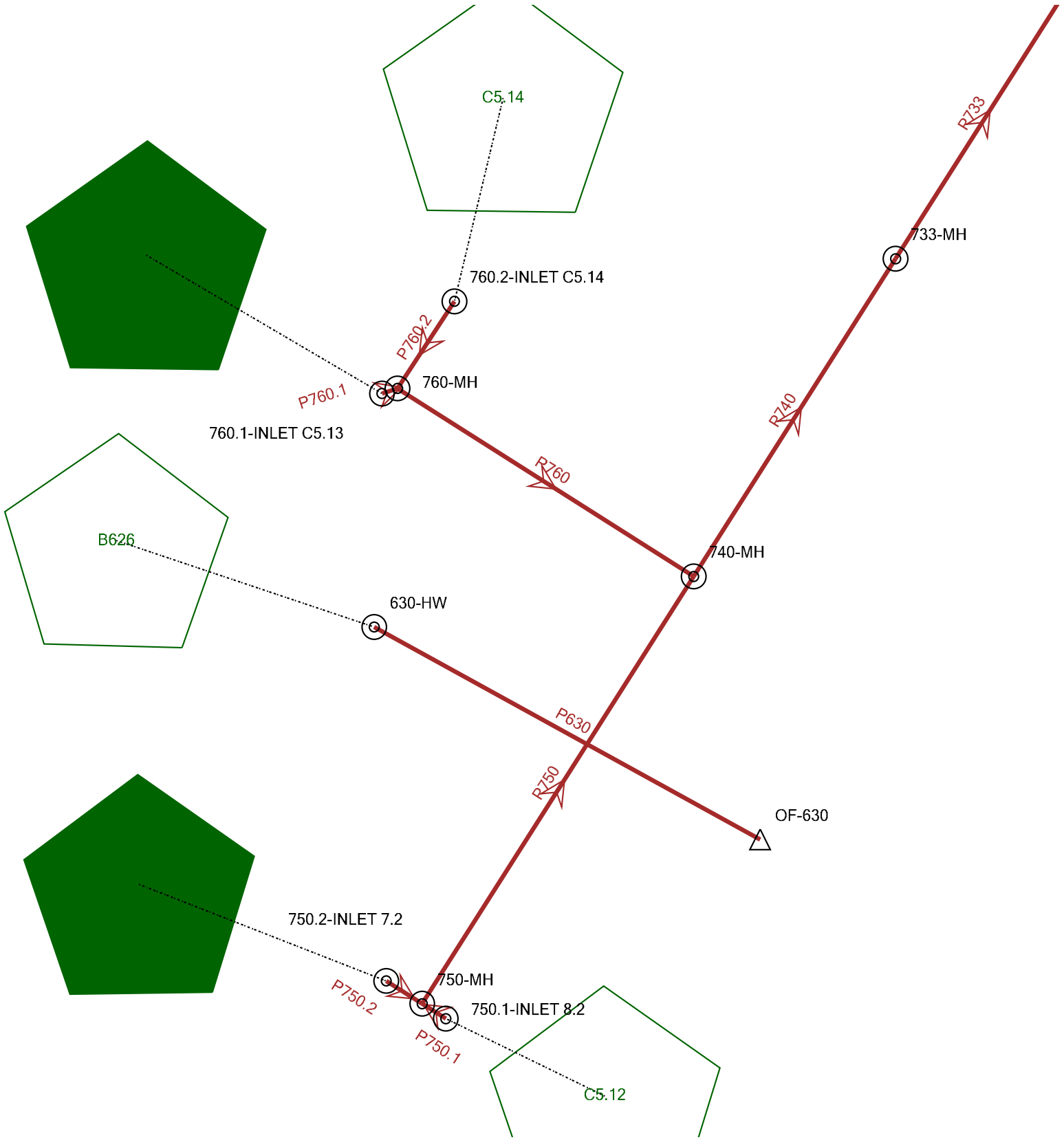
Active Scenario: Minor-5-yr



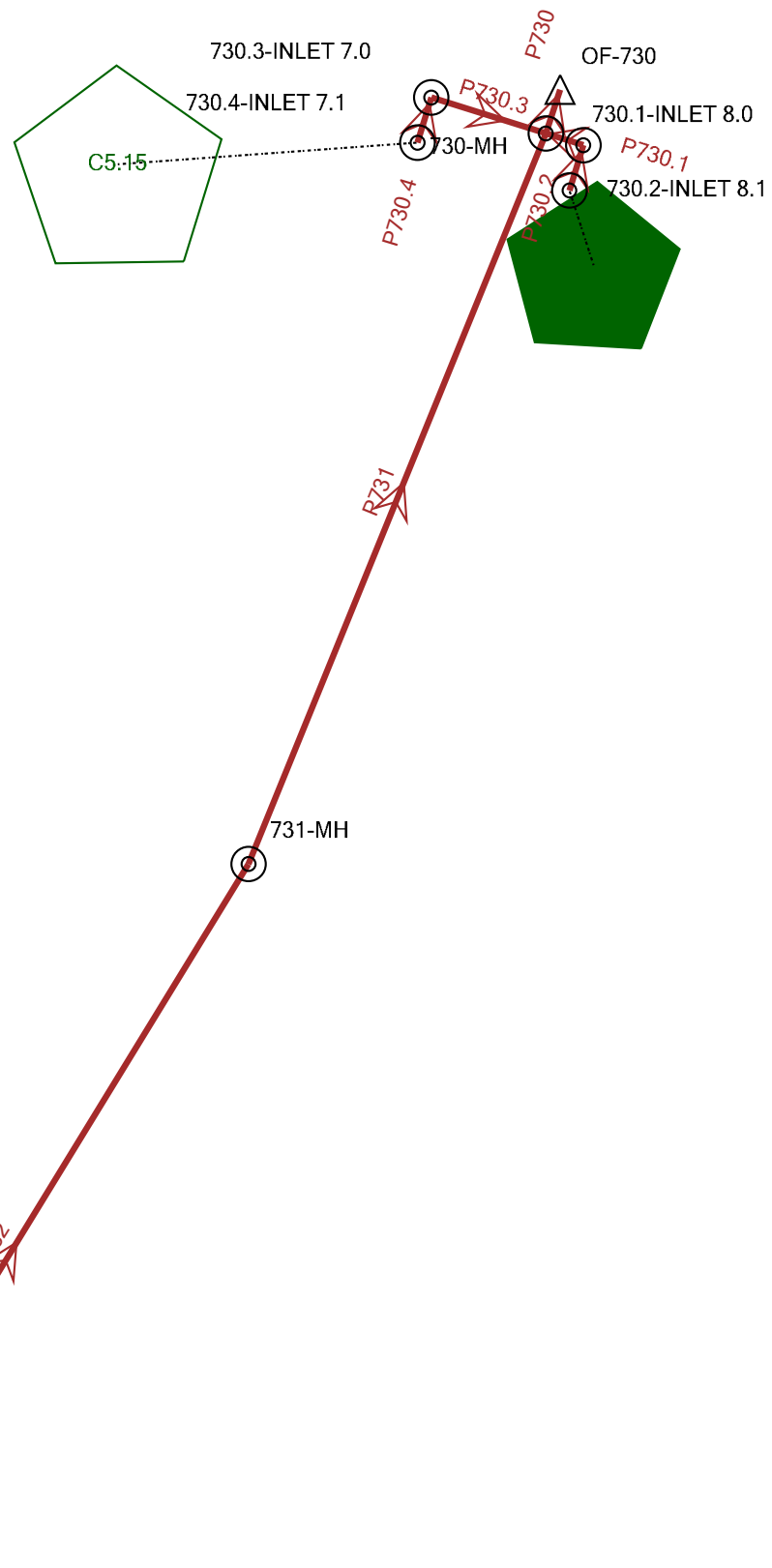
Scenario: Major-100-yr



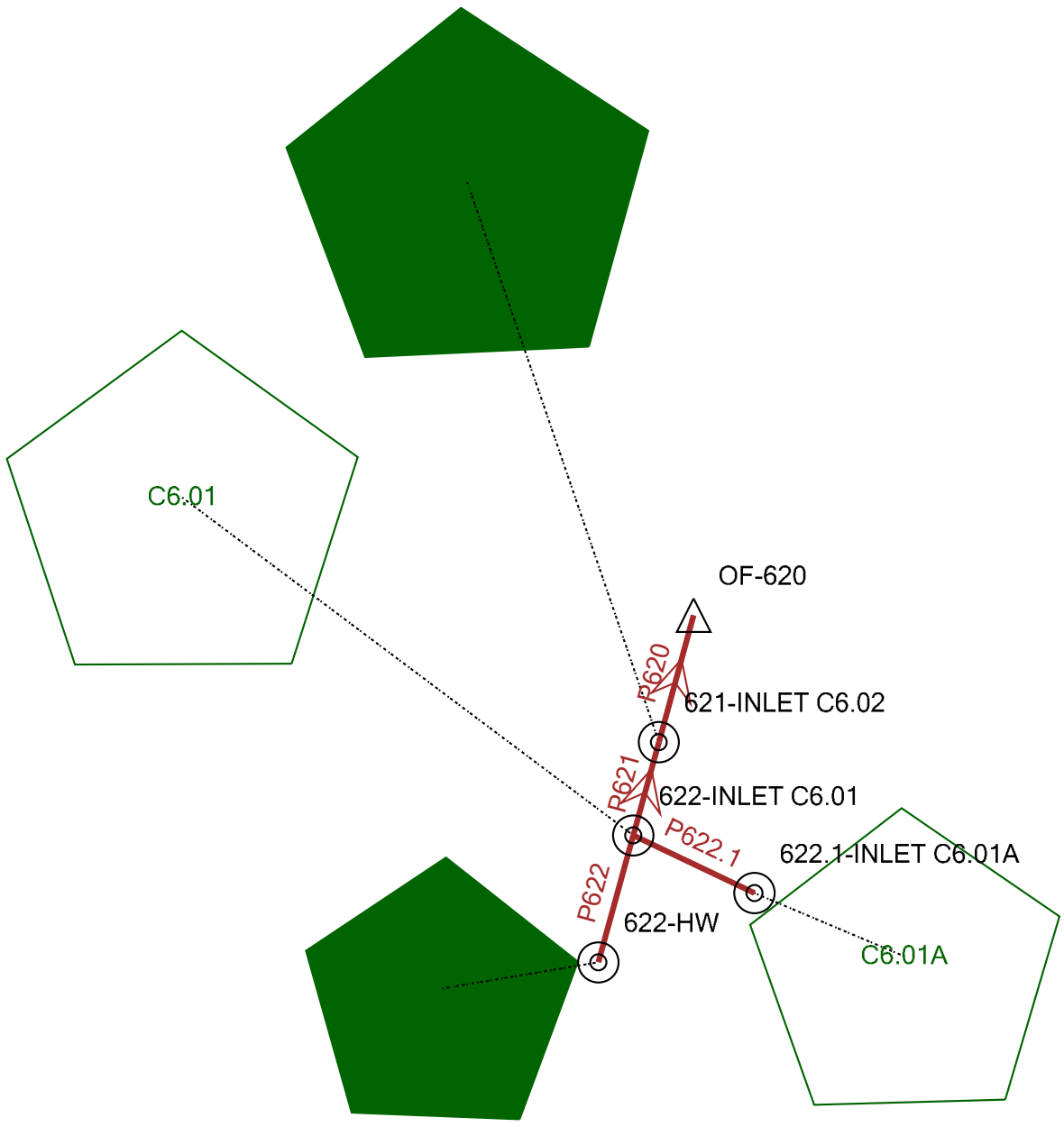
Scenario: Major-100-yr



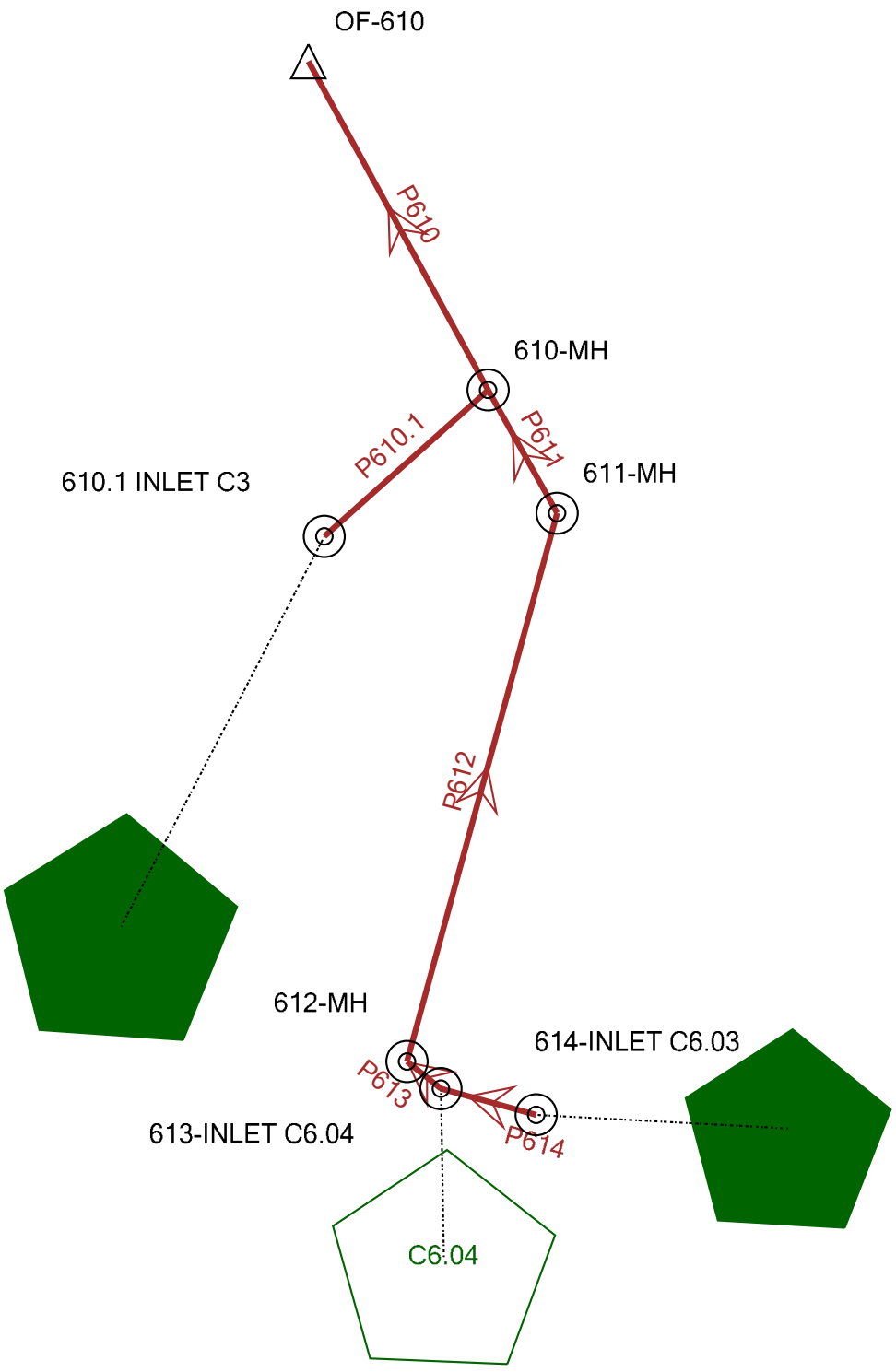
Scenario: Major-100-yr



Scenario: Major-100-yr



Scenario: Major-100-yr



Scenario: Major-100-yr
Current Time Step: 0.0 h
FlexTable: Conduit Table

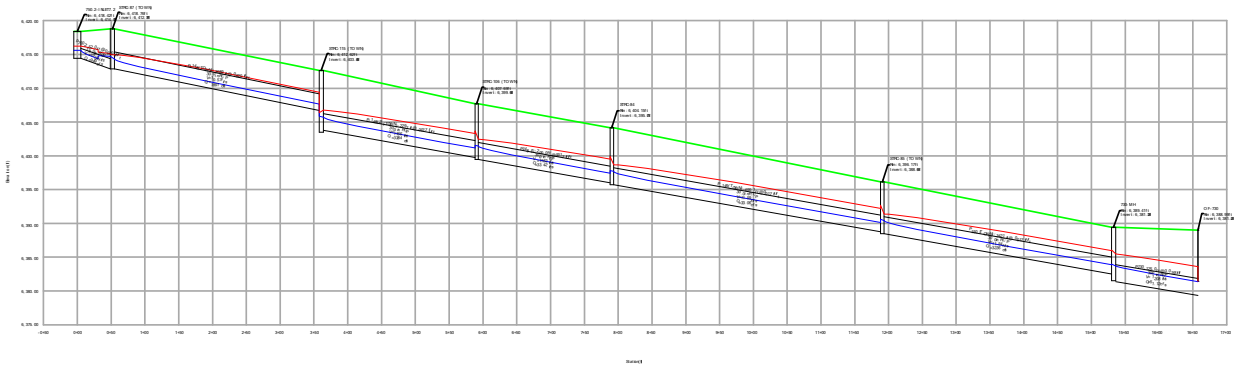
Label	Start Node	Stop Node	Invert (Start) (ft)	Invert (Stop) (ft)	Slope (Calculated) (ft/ft)	Length (Scaled) (ft)	Manning's n	Flow (cfs)	Diameter (in)	Velocity (ft/s)
P-147 (TOWN)	INLET 8.2 (TOWN)	STRC-87 (TOWN)	6,413.46	6,413.37	0.005	17.0	0.013	9.49	24.0	5.31
P-148 (1)	STRC-106 (TOWN)	STRC-84	6,399.49	6,395.99	0.017	200.0	0.013	33.42	30.0	11.62
P-148 (2) (TOWN)	STRC-115 (TOWN)	STRC-106 (TOWN)	6,403.76	6,399.74	0.017	229.6	0.013	33.84	30.0	11.66
P-148 (TOWN)	STRC-87 (TOWN)	STRC-115 (TOWN)	6,412.87	6,406.70	0.020	308.8	0.013	18.91	30.0	10.57
P-149 (TOWN)	STRC-84	STRC-85 (TOWN)	6,395.74	6,388.74	0.017	400.0	0.013	33.06	30.0	11.59
P-150 (TOWN)	STRC-85 (TOWN)	730-MH	6,388.49	6,382.51	0.017	342.0	0.013	32.36	30.0	11.54
P040	040-OUTLET STR	OUT-210	6,496.01	6,492.01	0.047	84.6	0.013	5.20	18.0	10.46
P050	050-OUTLET STR	OF-050	6,548.01	6,546.01	0.010	201.1	0.013	7.60	18.0	6.46
P401	401-INLET D4.02	OF-400	6,498.87	6,498.26	0.012	51.2	0.013	12.06	18.0	7.34
P402	402-INLET D4.01	401-INLET D4.02	6,499.41	6,499.07	0.010	34.0	0.013	6.38	18.0	6.23
P500	500-MH	OF-500	6,550.17	6,550.01	0.005	30.7	0.013	17.43	18.0	9.86
P501	501-INLET D5.02	500-MH	6,550.92	6,550.46	0.033	14.0	0.013	17.45	18.0	9.87
P502	502-INLET D5.01	501-INLET D5.02	6,551.76	6,551.42	0.010	34.0	0.013	8.94	18.0	5.06
P610	610-MH	OF-610	6,356.01	6,355.33	0.005	136.4	0.013	18.74	36.0	6.29
P610.1	610.1 INLET C3	610-MH	6,356.63	6,356.21	0.005	80.0	0.013	13.74	24.0	5.84
P611	611-MH	610-MH	6,356.55	6,356.21	0.006	56.4	0.013	12.64	24.0	6.09
P612	612-MH	611-MH	6,357.76	6,356.75	0.005	202.1	0.013	12.88	24.0	5.66
P613	613-INLET C6.04	612-MH	6,358.00	6,357.96	0.005	13.7	0.013	12.89	24.0	5.66
P614	614-INLET C6.03	613-INLET C6.04	6,358.66	6,358.50	0.005	32.0	0.013	6.60	18.0	4.75
P620	620-HW	OF-620	6,368.99	6,368.75	0.002	134.0	0.013	313.00	-	8.08
P621	621-INLET C6.02	OF-621	6,369.24	6,368.63	0.011	57.6	0.013	20.83	18.0	11.79
P622	622-INLET C6.01A	621-INLET C6.02	6,373.37	6,372.74	0.012	49.7	0.013	13.11	18.0	7.42
P730	730-MH	OF-730	6,381.38	6,379.37	0.016	105.8	0.013	51.12	30.0	12.08
P730.1	730.1-INLET 8.0	730-MH	6,382.84	6,382.50	0.020	17.0	0.013	10.16	30.0	8.88
P730.3	730.3-INLET 7.0	730-MH	6,382.89	6,382.50	0.007	52.1	0.013	11.15	30.0	6.40
P750.2	750.2-INLET 7.2	STRC-87 (TOWN)	6,414.41	6,412.87	0.030	52.0	0.013	9.49	18.0	10.36
P760	760-MH	STRC-115 (TOWN)	6,405.68	6,404.25	0.008	214.0	0.013	18.61	24.0	5.92
P760.1	760.1-INLET C5.13	760-MH	6,405.98	6,405.93	0.005	9.1	0.013	13.33	18.0	7.54
P760.2	760.2-INLET C5.14	760-MH	6,406.25	6,405.93	0.005	64.0	0.013	5.60	18.0	3.17
P800-EX	800-MH	OF-800	6,375.00	6,373.22	0.009	195.7	0.013	43.31	30.0	8.82
P800.1	800.1-INLET C5.04	800-MH	6,380.98	6,380.00	0.030	34.7	0.013	8.86	18.0	10.27
P800.2	800.2-INLET C5.03	800-MH	6,380.98	6,380.00	0.015	66.0	0.013	9.87	18.0	8.05
P801	801-MH	800-MH	6,384.73	6,379.50	0.024	222.4	0.013	28.33	24.0	12.31
P802	802-MH	801-MH	6,390.15	6,384.96	0.023	223.4	0.013	28.68	24.0	12.28
P810	810-MH	802-MH	6,393.87	6,390.40	0.019	178.8	0.013	28.98	24.0	11.38
P810.1	810.2-INLET C5.01	810-MH	6,395.01	6,394.37	0.010	65.4	0.013	16.11	24.0	7.84
P810.2	810.2-INLET C5.02	810-MH	6,394.64	6,394.37	0.010	29.4	0.013	13.50	18.0	7.64

Scenario: Major-100-yr
Current Time Step: 0.0 h
FlexTable: Manhole Table

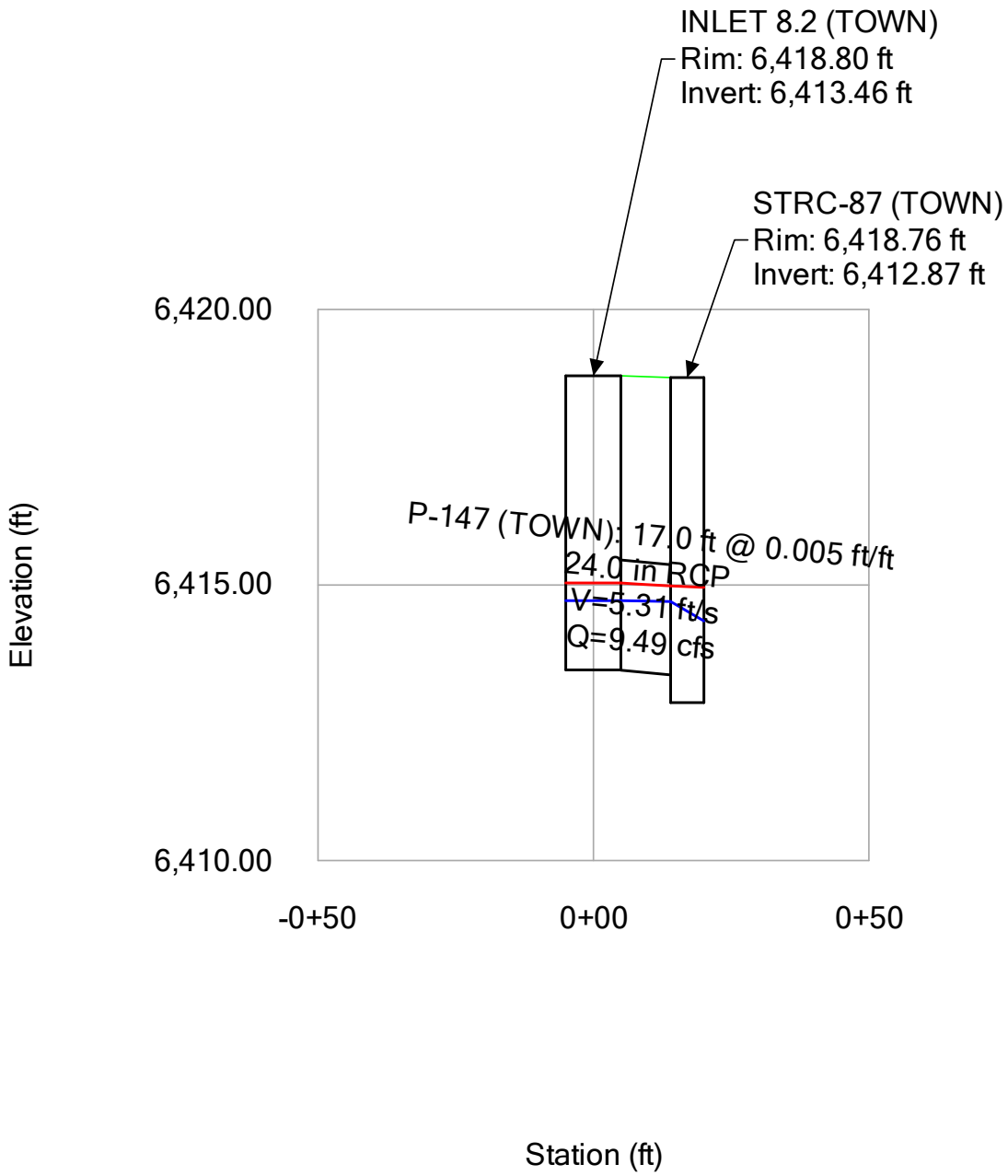
Label	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Headloss Method	Headloss (ft)	Velocity (Out) (ft/s)
040-OUTLET STR	6,499.51	6,496.01	6,496.89	6,496.89	HEC-22 Energy (Second Edition)	0.00	4.84
050-OUTLET STR	6,551.64	6,548.01	6,549.08	6,549.08	HEC-22 Energy (Second Edition)	0.00	5.65
401-INLET D4.02	6,504.67	6,498.87	6,500.71	6,500.19	HEC-22 Energy (Second Edition)	0.52	7.34
402-INLET D4.01	6,504.76	6,499.41	6,500.82	6,500.82	HEC-22 Energy (Second Edition)	0.00	3.70
500-MH	6,556.42	6,550.17	6,552.65	6,552.34	HEC-22 Energy (Second Edition)	0.31	9.86
501-INLET D5.02	6,556.15	6,550.92	6,553.51	6,553.04	HEC-22 Energy (Second Edition)	0.47	9.87
502-INLET D5.01	6,556.15	6,551.76	6,553.76	6,553.76	HEC-22 Energy (Second Edition)	0.00	5.06
610-MH	6,363.97	6,356.01	6,357.48	6,357.40	HEC-22 Energy (Second Edition)	0.07	5.86
610.1 INLET C3	6,360.14	6,356.63	6,358.03	6,358.03	HEC-22 Energy (Second Edition)	0.00	5.84
611-MH	6,363.76	6,356.55	6,358.10	6,357.83	HEC-22 Energy (Second Edition)	0.27	5.96
612-MH	6,363.09	6,357.76	6,359.32	6,359.12	HEC-22 Energy (Second Edition)	0.20	5.66
613-INLET C6.04	6,365.75	6,358.00	6,359.66	6,359.36	HEC-22 Energy (Second Edition)	0.29	5.66
614-INLET C6.03	6,366.36	6,358.66	6,359.79	6,359.79	HEC-22 Energy (Second Edition)	0.00	4.65
620-HW	6,376.20	6,368.99	6,373.26	6,373.26	HEC-22 Energy (Second Edition)	0.00	9.16
621-INLET C6.02	6,377.67	6,369.24	6,373.97	6,372.38	HEC-22 Energy (Second Edition)	1.59	11.79
622-INLET C6.01A	6,377.89	6,373.37	6,374.92	6,374.92	HEC-22 Energy (Second Edition)	0.00	7.42
730-MH	6,389.41	6,381.52	6,383.99	6,383.69	HEC-22 Energy (Second Edition)	0.30	10.78
730.1-INLET 8.0	6,389.42	6,382.84	6,385.07	6,385.07	HEC-22 Energy (Second Edition)	0.00	2.20
730.3-INLET 7.0	6,389.40	6,382.89	6,385.09	6,385.09	HEC-22 Energy (Second Edition)	0.00	2.43
750.2-INLET 7.2	6,418.42	6,414.41	6,415.60	6,415.60	HEC-22 Energy (Second Edition)	0.00	6.31
760-MH	6,410.22	6,405.68	6,407.84	6,407.74	HEC-22 Energy (Second Edition)	0.10	5.92
760.1-INLET C5.13	6,410.38	6,405.98	6,408.16	6,408.16	HEC-22 Energy (Second Edition)	0.00	7.54
760.2-INLET C5.14	6,409.85	6,406.25	6,408.02	6,408.02	HEC-22 Energy (Second Edition)	0.00	3.17
800-MH	6,386.01	6,375.00	6,378.03	6,377.61	HEC-22 Energy (Second Edition)	0.42	8.82
800.1-INLET C5.04	6,385.95	6,380.98	6,382.13	6,382.13	HEC-22 Energy (Second Edition)	0.00	6.08
800.2-INLET C5.03	6,385.94	6,380.98	6,382.19	6,382.19	HEC-22 Energy (Second Edition)	0.00	6.45
801-MH	6,391.12	6,384.73	6,386.97	6,386.57	HEC-22 Energy (Second Edition)	0.40	9.39
802-MH	6,396.53	6,390.15	6,392.40	6,391.99	HEC-22 Energy (Second Edition)	0.41	9.48
810-MH	6,399.58	6,393.87	6,396.65	6,395.72	HEC-22 Energy (Second Edition)	0.93	9.56
810.2-INLET C5.01	6,399.20	6,395.01	6,396.97	6,396.97	HEC-22 Energy (Second Edition)	0.00	5.16
810.2-INLET C5.02	6,399.24	6,394.64	6,397.12	6,397.12	HEC-22 Energy (Second Edition)	0.00	7.64
INLET 8.2 (TOWN)	6,418.80	6,413.46	6,414.72	6,414.72	HEC-22 Energy (Second Edition)	0.00	4.55
STRC-84	6,404.15	6,395.74	6,397.80	6,397.70	HEC-22 Energy (Second Edition)	0.10	8.02
STRC-85 (TOWN)	6,396.17	6,388.49	6,390.61	6,390.43	HEC-22 Energy (Second Edition)	0.18	7.93
STRC-87 (TOWN)	6,418.76	6,412.87	6,414.70	6,414.35	HEC-22 Energy (Second Edition)	0.36	6.28
STRC-106 (TOWN)	6,407.69	6,399.49	6,401.55	6,401.46	HEC-22 Energy (Second Edition)	0.09	8.07
STRC-115 (TOWN)	6,412.62	6,403.48	6,405.85	6,405.74	HEC-22 Energy (Second Edition)	0.11	8.12

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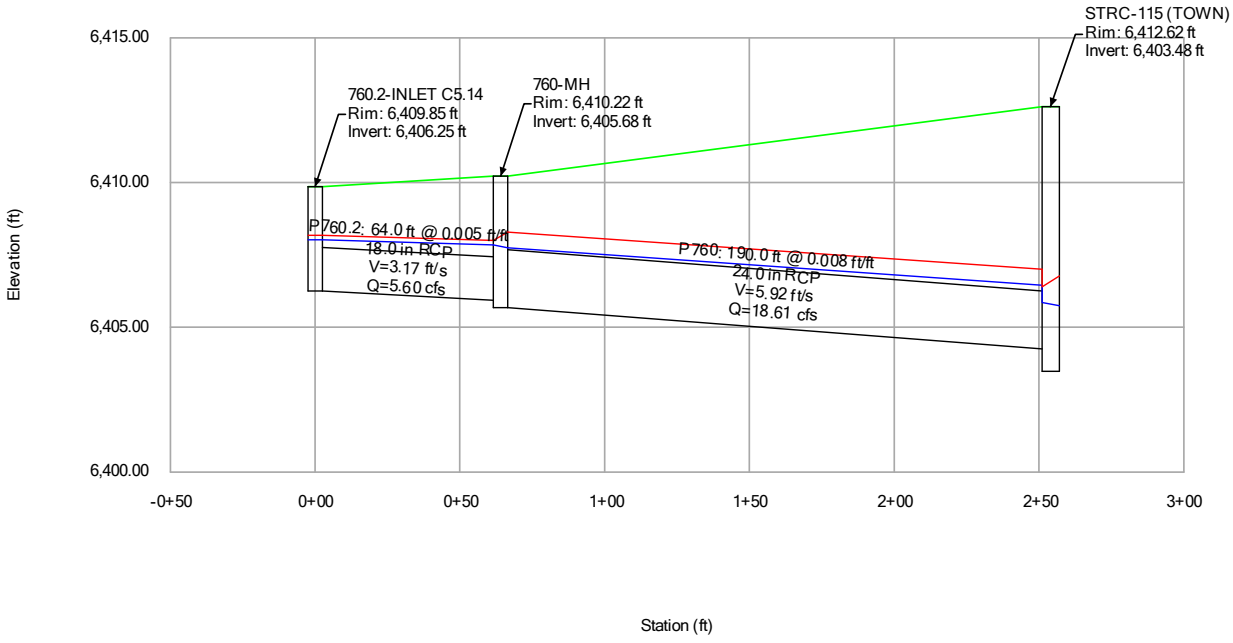
Active Scenario: Major-100-yr



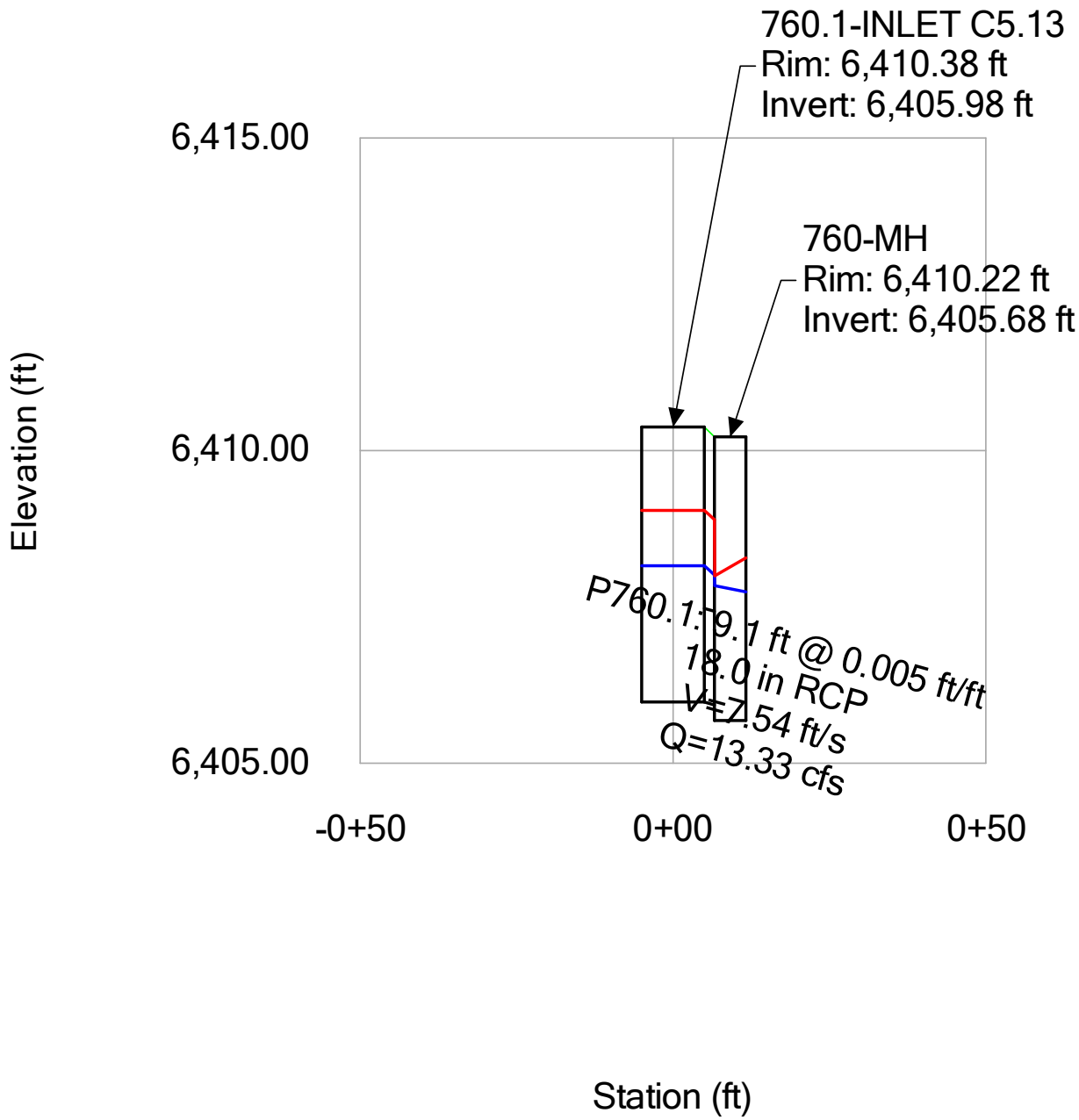
Active Scenario: Major-100-yr



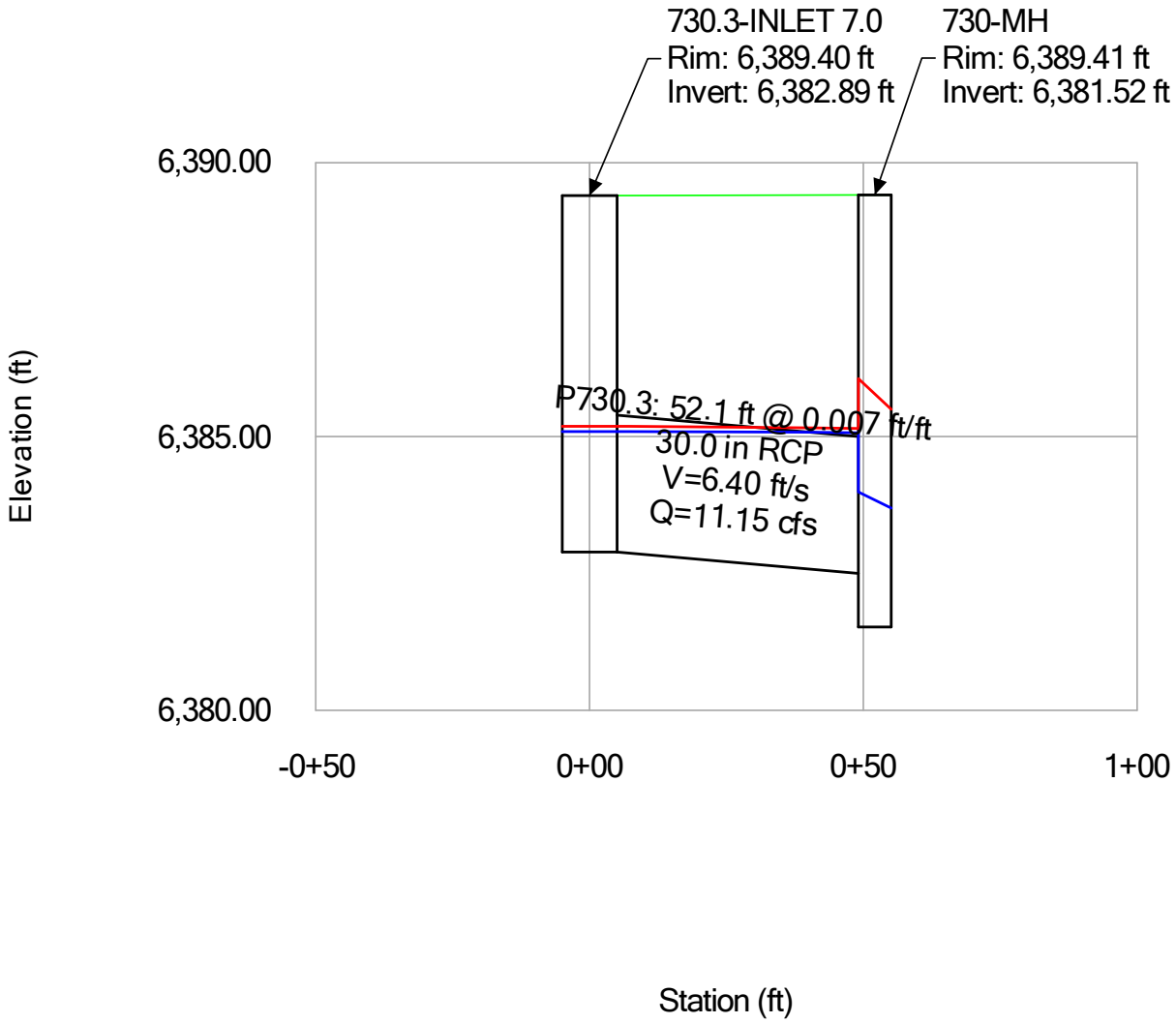
Active Scenario: Major-100-yr



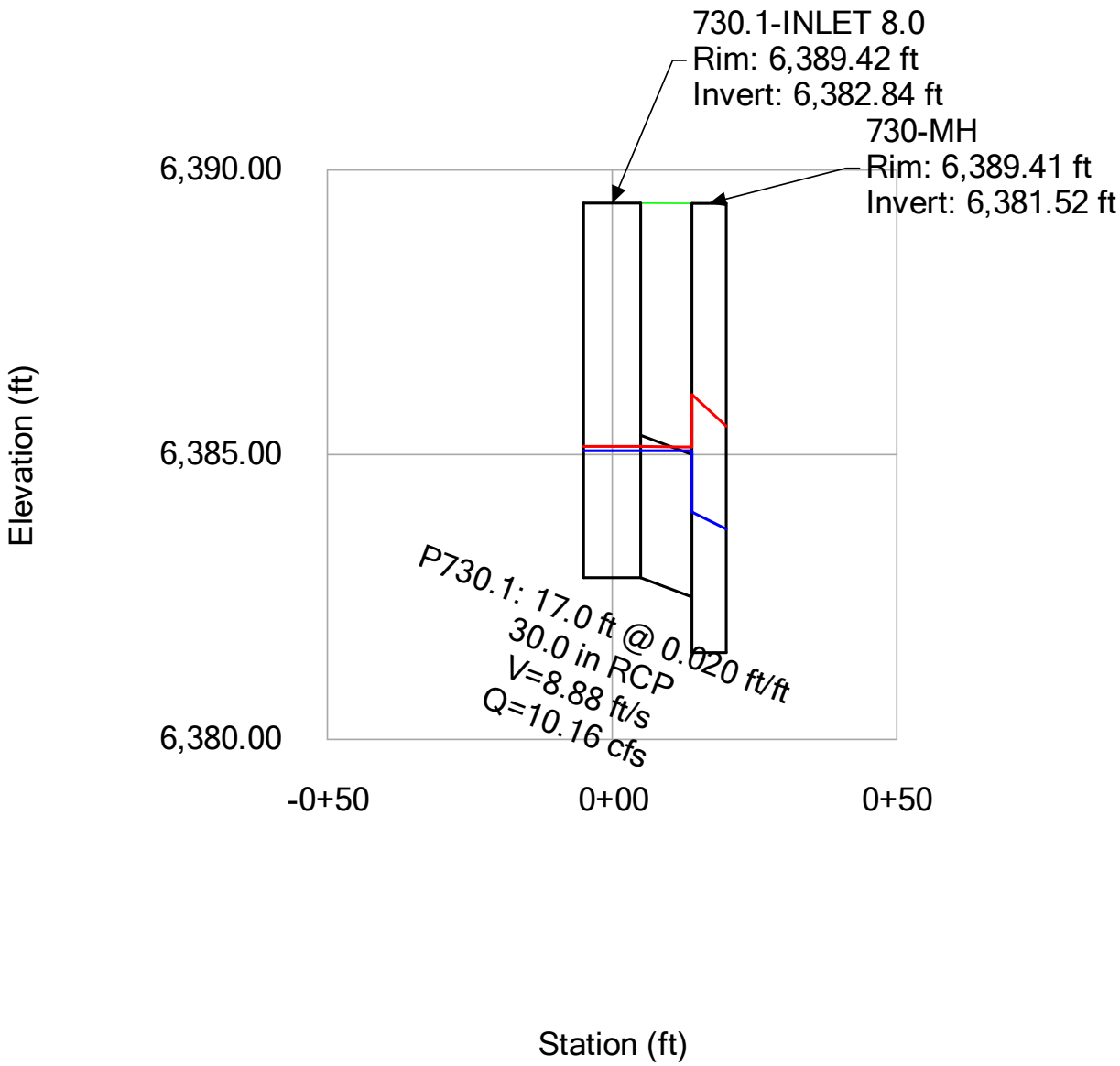
Active Scenario: Major-100-yr



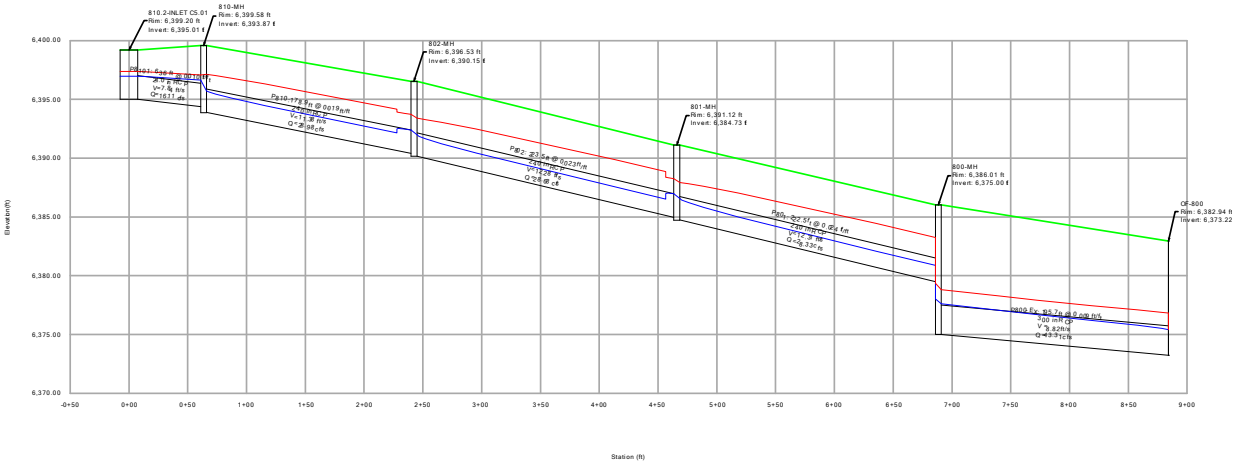
Active Scenario: Major-100-yr



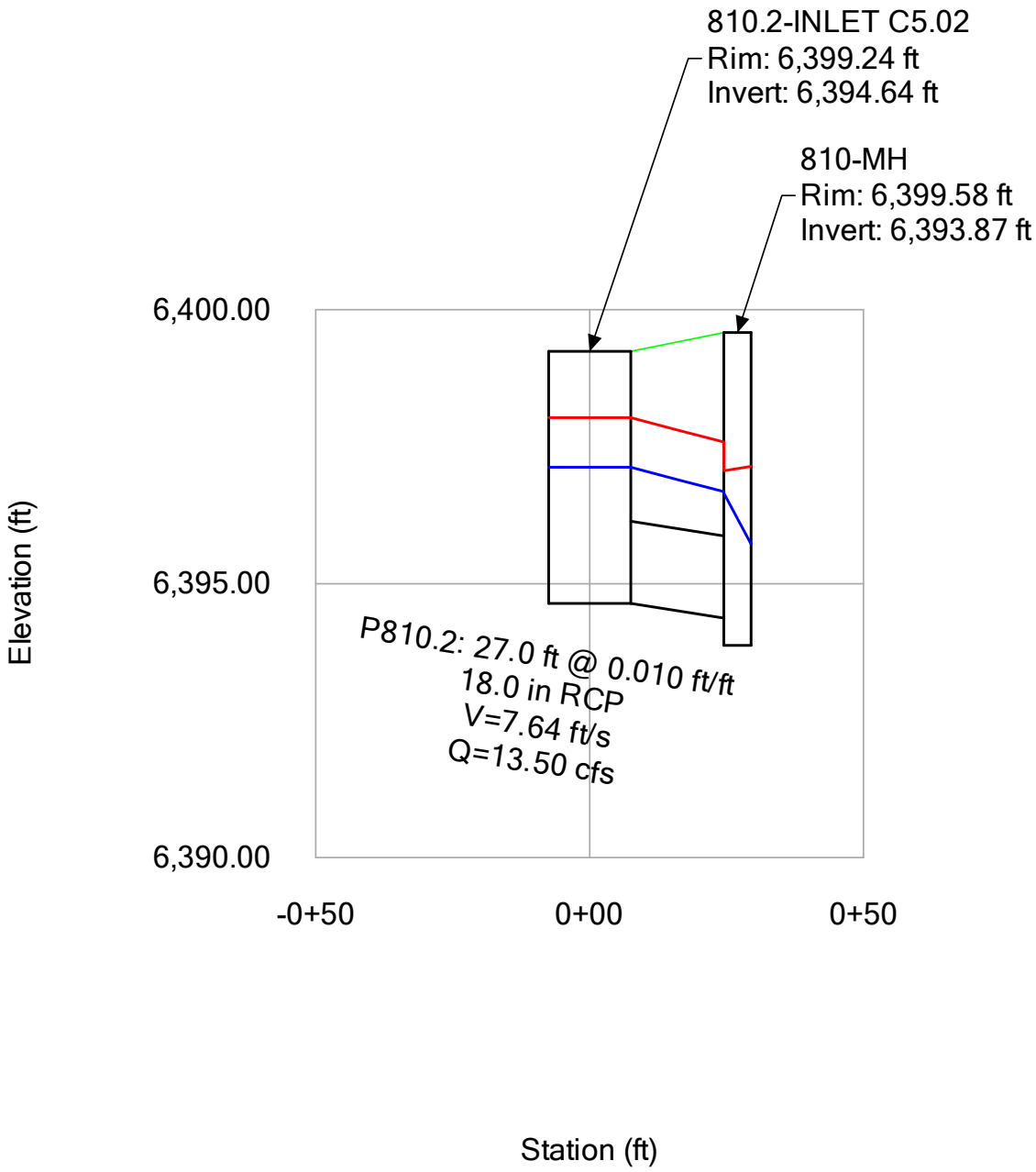
Active Scenario: Major-100-yr



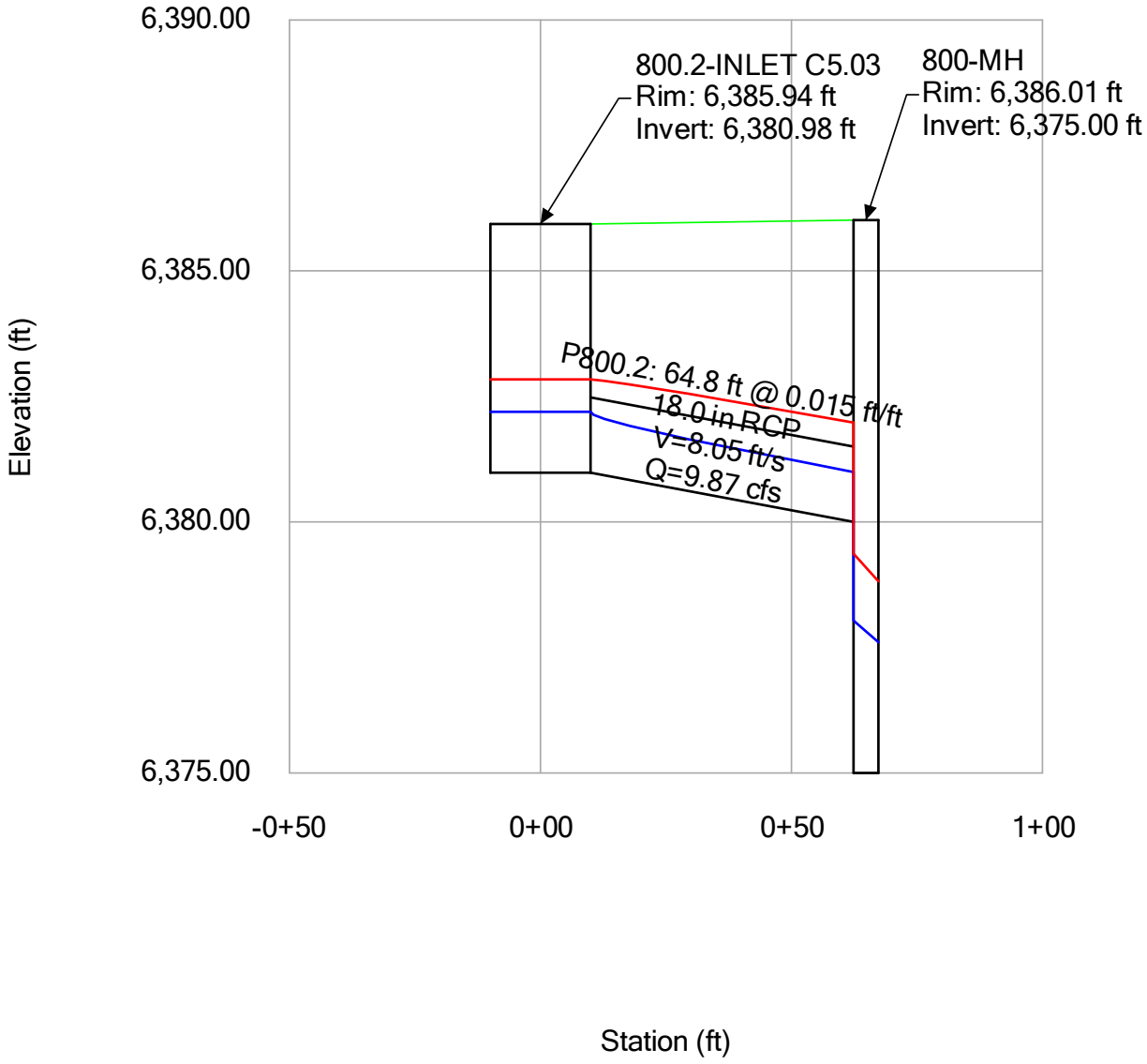
Active Scenario: Major-100-yr



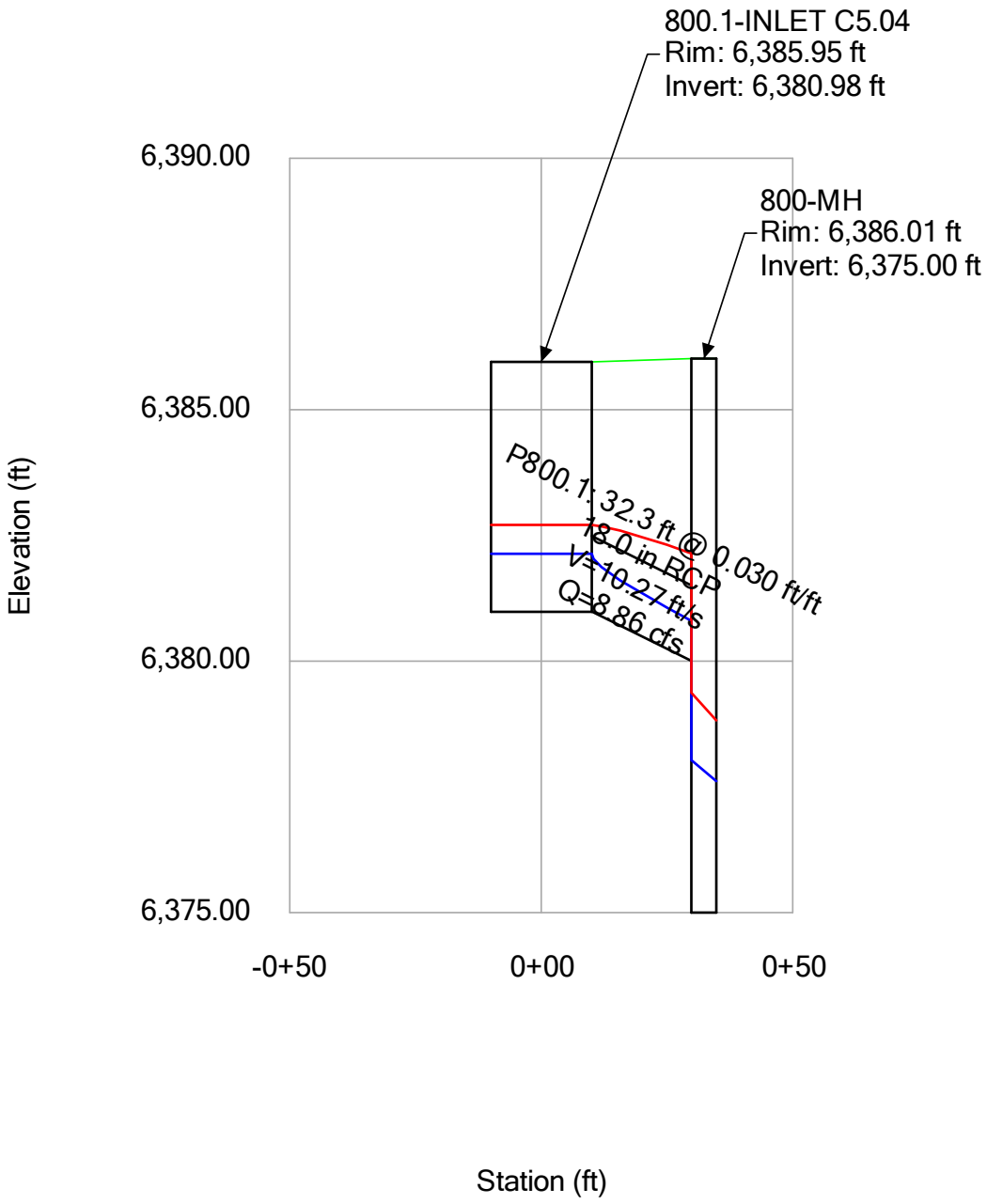
Active Scenario: Major-100-yr



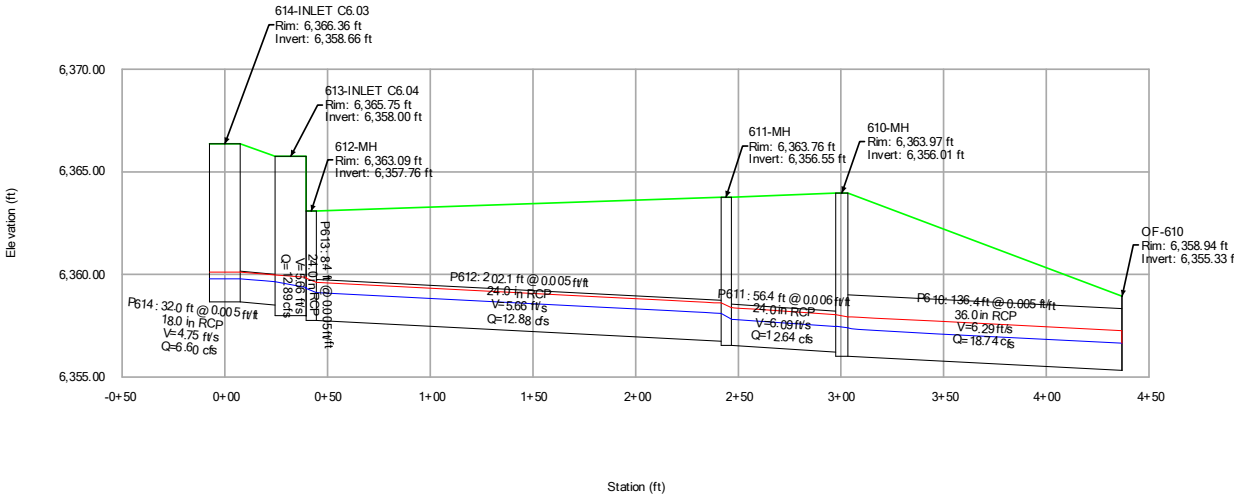
Active Scenario: Major-100-yr



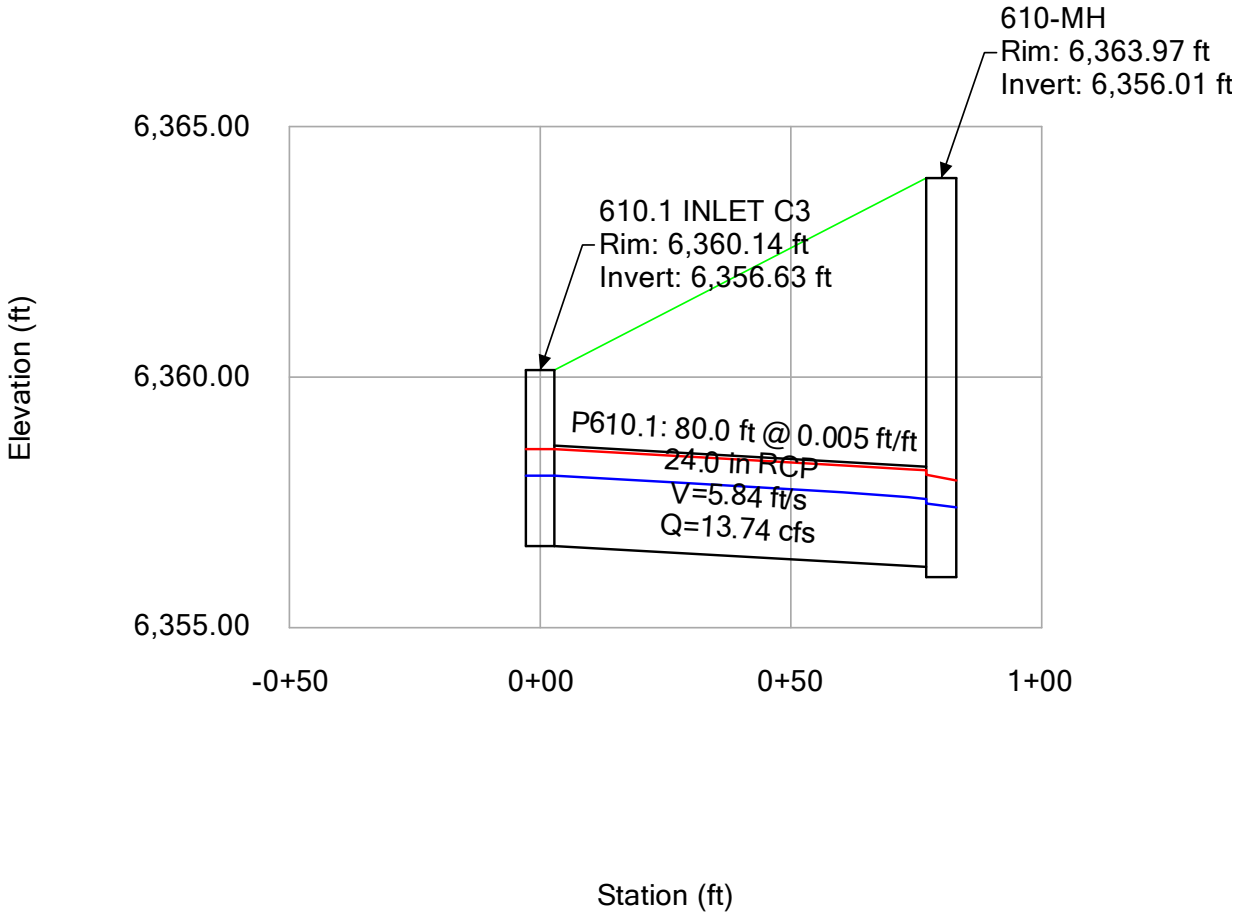
Active Scenario: Major-100-yr



Active Scenario: Major-100-yr



Active Scenario: Major-100-yr



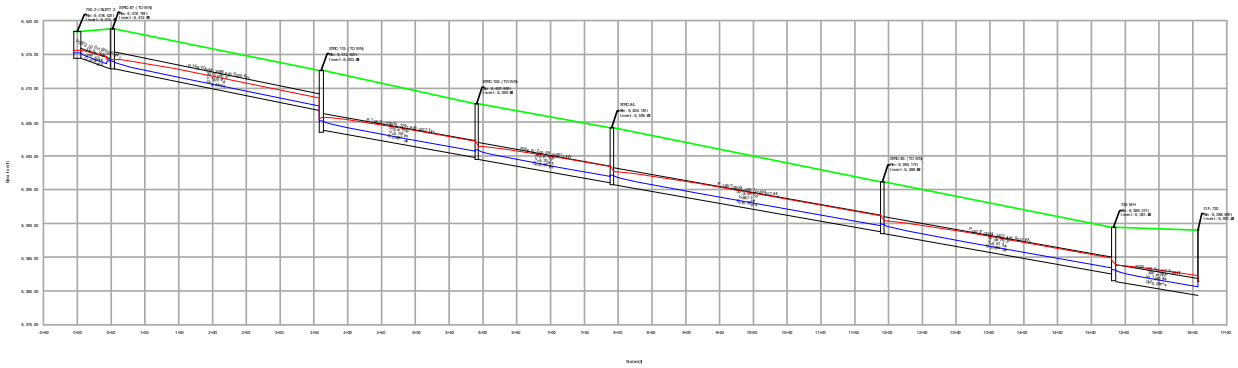
Scenario: Minor-5-yr
Current Time Step: 0.0 h
FlexTable: Conduit Table

Label	Start Node	Stop Node	Invert (Start) (ft)	Invert (Stop) (ft)	Slope (Calculated) (ft/ft)	Length (Scaled) (ft)	Manning's n	Flow (cfs)	Diameter (in)	Velocity (ft/s)
P-147 (TOWN)	INLET 8.2 (TOWN)	STRC-87 (TOWN)	6,413.46	6,413.37	0.005	17.0	0.013	4.74	24.0	4.44
P-148 (1)	STRC-106 (TOWN)	STRC-84	6,399.49	6,395.99	0.017	200.0	0.013	16.56	30.0	9.70
P-148 (2) (TOWN)	STRC-115 (TOWN)	STRC-106 (TOWN)	6,403.76	6,399.74	0.017	229.6	0.013	16.81	30.0	9.75
P-148 (TOWN)	STRC-87 (TOWN)	STRC-115 (TOWN)	6,412.87	6,406.70	0.020	308.8	0.013	9.45	30.0	8.70
P-149 (TOWN)	STRC-84	STRC-85 (TOWN)	6,395.74	6,388.74	0.017	400.0	0.013	16.35	30.0	9.67
P-150 (TOWN)	STRC-85 (TOWN)	730-MH	6,388.49	6,382.51	0.017	342.0	0.013	15.94	30.0	9.61
P040	040-OUTLET STR	OUT-210	6,496.01	6,492.01	0.047	84.6	0.013	0.90	18.0	6.27
P050	050-OUTLET STR	OF-050	6,548.01	6,546.01	0.010	201.1	0.013	1.30	18.0	4.03
P401	401-INLET D4.02	OF-400	6,498.87	6,498.26	0.012	51.2	0.013	5.31	18.0	6.37
P402	402-INLET D4.01	401-INLET D4.02	6,499.41	6,499.07	0.010	34.0	0.013	2.83	18.0	5.05
P500	500-MH	OF-500	6,550.17	6,550.01	0.005	30.7	0.013	5.43	18.0	4.59
P501	501-INLET D5.02	500-MH	6,550.92	6,550.46	0.033	14.0	0.013	5.44	18.0	9.29
P502	502-INLET D5.01	501-INLET D5.02	6,551.76	6,551.42	0.010	34.0	0.013	2.73	18.0	4.99
P610	610-MH	OF-610	6,356.01	6,355.33	0.005	136.4	0.013	10.04	36.0	5.30
P610.1	610.1 INLET C3	610-MH	6,356.63	6,356.21	0.005	80.0	0.013	7.56	24.0	5.11
P611	611-MH	610-MH	6,356.55	6,356.21	0.006	56.4	0.013	6.26	24.0	5.12
P612	612-MH	611-MH	6,357.76	6,356.75	0.005	202.1	0.013	6.40	24.0	4.81
P613	613-INLET C6.04	612-MH	6,358.00	6,357.96	0.005	13.7	0.013	6.41	24.0	4.81
P614	614-INLET C6.03	613-INLET C6.04	6,358.66	6,358.50	0.005	32.0	0.013	3.28	18.0	4.07
P620	620-HW	OF-620	6,368.99	6,368.75	0.002	134.0	0.013	55.00	-	4.91
P621	621-INLET C6.02	OF-621	6,369.24	6,368.63	0.011	57.6	0.013	10.39	18.0	6.97
P622	622-INLET C6.01A	621-INLET C6.02	6,373.37	6,372.74	0.012	49.7	0.013	6.54	18.0	6.79
P730	730-MH	OF-730	6,381.38	6,379.37	0.016	105.8	0.013	25.09	30.0	10.50
P730.1	730.1-INLET 8.0	730-MH	6,382.84	6,382.50	0.020	17.0	0.013	5.07	30.0	7.26
P730.3	730.3-INLET 7.0	730-MH	6,382.89	6,382.50	0.007	52.1	0.013	5.57	30.0	5.27
P750.2	750.2-INLET 7.2	STRC-87 (TOWN)	6,414.41	6,412.87	0.030	52.0	0.013	4.74	18.0	8.62
P760	760-MH	STRC-115 (TOWN)	6,405.68	6,404.25	0.008	214.0	0.013	9.30	24.0	6.16
P760.1	760.1-INLET C5.13	760-MH	6,405.98	6,405.93	0.005	9.1	0.013	6.64	18.0	4.75
P760.2	760.2-INLET C5.14	760-MH	6,406.25	6,405.93	0.005	64.0	0.013	2.79	18.0	3.90
P800-EX	800-MH	OF-800	6,375.00	6,373.22	0.009	195.7	0.013	21.49	30.0	8.16
P800.1	800.1-INLET C5.04	800-MH	6,380.98	6,380.00	0.030	34.7	0.013	4.43	18.0	8.53
P800.2	800.2-INLET C5.03	800-MH	6,380.98	6,380.00	0.015	66.0	0.013	4.95	18.0	6.83
P801	801-MH	800-MH	6,384.73	6,379.50	0.024	222.4	0.013	14.07	24.0	10.46
P802	802-MH	801-MH	6,390.15	6,384.96	0.023	223.4	0.013	14.27	24.0	10.46
P810	810-MH	802-MH	6,393.87	6,390.40	0.019	178.8	0.013	14.44	24.0	9.81
P810.1	810.2-INLET C5.01	810-MH	6,395.01	6,394.37	0.010	65.4	0.013	8.03	24.0	6.60
P810.2	810.2-INLET C5.02	810-MH	6,394.64	6,394.37	0.010	29.4	0.013	6.75	18.0	6.27

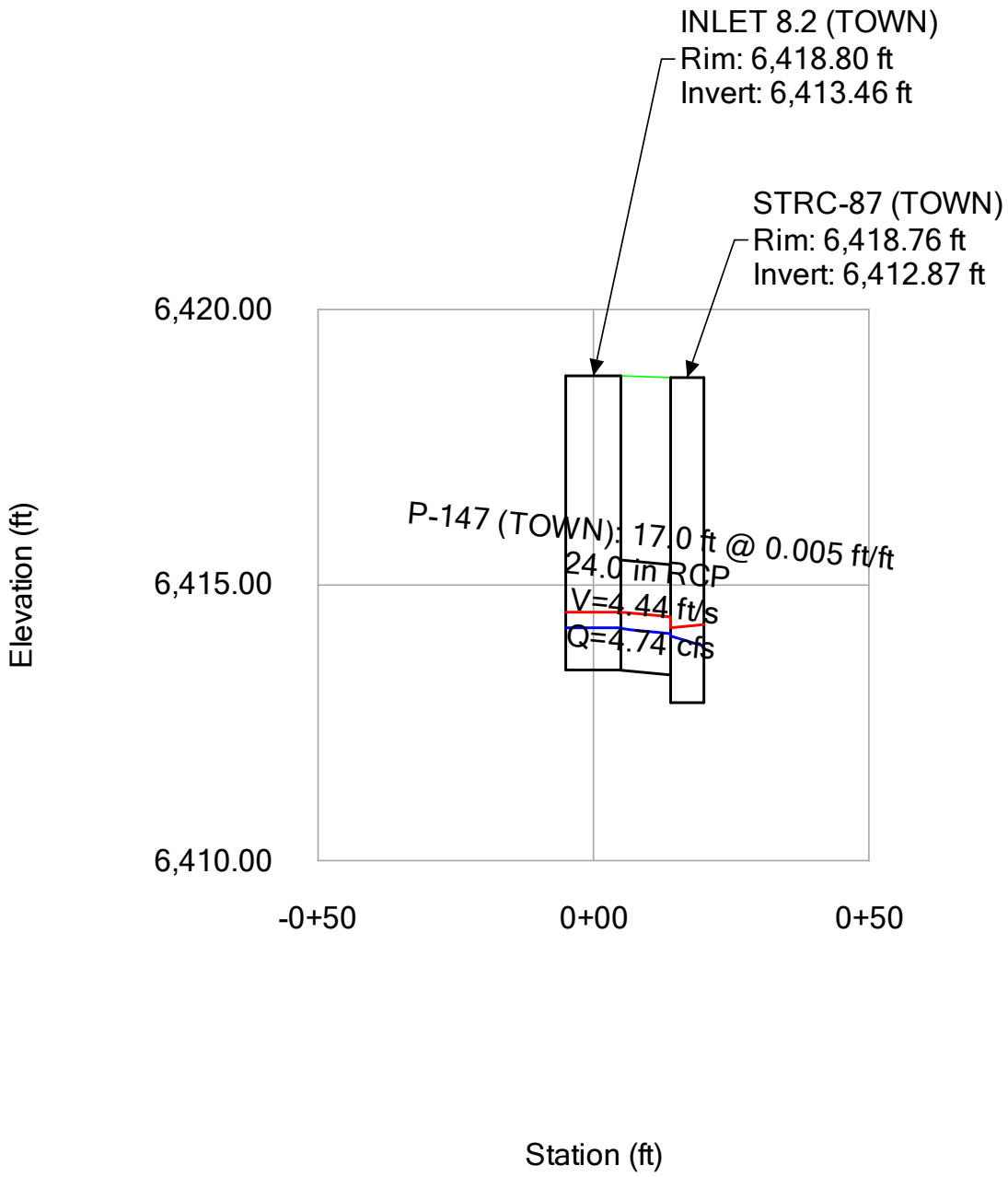
Scenario: Minor-5-yr
Current Time Step: 0.0 h
FlexTable: Manhole Table

Label	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Headloss Method	Headloss (ft)	Velocity (Out) (ft/s)
040-OUTLET STR	6,499.51	6,496.01	6,496.37	6,496.37	HEC-22 Energy (Second Edition)	0.00	2.83
050-OUTLET STR	6,551.64	6,548.01	6,548.44	6,548.44	HEC-22 Energy (Second Edition)	0.00	3.14
401-INLET D4.02	6,504.67	6,498.87	6,499.96	6,499.76	HEC-22 Energy (Second Edition)	0.20	4.88
402-INLET D4.01	6,504.76	6,499.41	6,500.05	6,500.05	HEC-22 Energy (Second Edition)	0.00	3.95
500-MH	6,556.42	6,550.17	6,551.16	6,551.12	HEC-22 Energy (Second Edition)	0.04	4.59
501-INLET D5.02	6,556.15	6,550.92	6,551.89	6,551.82	HEC-22 Energy (Second Edition)	0.07	4.92
502-INLET D5.01	6,556.15	6,551.76	6,552.39	6,552.39	HEC-22 Energy (Second Edition)	0.00	3.90
610-MH	6,363.97	6,356.01	6,357.06	6,357.02	HEC-22 Energy (Second Edition)	0.04	4.85
610.1 INLET C3	6,360.14	6,356.63	6,357.61	6,357.61	HEC-22 Energy (Second Edition)	0.00	4.95
611-MH	6,363.76	6,356.55	6,357.57	6,357.44	HEC-22 Energy (Second Edition)	0.13	4.66
612-MH	6,363.09	6,357.76	6,358.77	6,358.66	HEC-22 Energy (Second Edition)	0.11	4.70
613-INLET C6.04	6,365.75	6,358.00	6,359.06	6,358.90	HEC-22 Energy (Second Edition)	0.16	4.70
614-INLET C6.03	6,366.36	6,358.66	6,359.36	6,359.36	HEC-22 Energy (Second Edition)	0.00	4.07
620-HW	6,376.20	6,368.99	6,370.35	6,370.35	HEC-22 Energy (Second Edition)	0.00	5.03
621-INLET C6.02	6,377.67	6,369.24	6,370.77	6,370.48	HEC-22 Energy (Second Edition)	0.29	6.65
622-INLET C6.01A	6,377.89	6,373.37	6,374.35	6,374.35	HEC-22 Energy (Second Edition)	0.00	5.29
730-MH	6,389.41	6,381.52	6,383.19	6,383.09	HEC-22 Energy (Second Edition)	0.11	7.02
730.1-INLET 8.0	6,389.42	6,382.84	6,383.58	6,383.58	HEC-22 Energy (Second Edition)	0.00	4.15
730.3-INLET 7.0	6,389.40	6,382.89	6,383.67	6,383.67	HEC-22 Energy (Second Edition)	0.00	4.26
750.2-INLET 7.2	6,418.42	6,414.41	6,415.25	6,415.25	HEC-22 Energy (Second Edition)	0.00	4.68
760-MH	6,410.22	6,405.68	6,406.83	6,406.77	HEC-22 Energy (Second Edition)	0.06	5.32
760.1-INLET C5.13	6,410.38	6,405.98	6,407.04	6,407.04	HEC-22 Energy (Second Edition)	0.00	4.96
760.2-INLET C5.14	6,409.85	6,406.25	6,406.89	6,406.89	HEC-22 Energy (Second Edition)	0.00	3.90
800-MH	6,386.01	6,375.00	6,376.75	6,376.58	HEC-22 Energy (Second Edition)	0.18	6.59
800.1-INLET C5.04	6,385.95	6,380.98	6,381.79	6,381.79	HEC-22 Energy (Second Edition)	0.00	4.57
800.2-INLET C5.03	6,385.94	6,380.98	6,381.84	6,381.84	HEC-22 Energy (Second Edition)	0.00	4.75
801-MH	6,391.12	6,384.73	6,386.23	6,386.08	HEC-22 Energy (Second Edition)	0.15	6.23
802-MH	6,396.53	6,390.15	6,391.66	6,391.51	HEC-22 Energy (Second Edition)	0.15	6.27
810-MH	6,399.58	6,393.87	6,395.58	6,395.24	HEC-22 Energy (Second Edition)	0.34	6.30
810.2-INLET C5.01	6,399.20	6,395.01	6,396.02	6,396.02	HEC-22 Energy (Second Edition)	0.00	5.05
810.2-INLET C5.02	6,399.24	6,394.64	6,395.64	6,395.64	HEC-22 Energy (Second Edition)	0.00	5.36
INLET 8.2 (TOWN)	6,418.80	6,413.46	6,414.22	6,414.22	HEC-22 Energy (Second Edition)	0.00	4.28
STRC-84	6,404.15	6,395.74	6,397.15	6,397.11	HEC-22 Energy (Second Edition)	0.04	5.96
STRC-85 (TOWN)	6,396.17	6,388.49	6,389.92	6,389.84	HEC-22 Energy (Second Edition)	0.08	5.90
STRC-87 (TOWN)	6,418.76	6,412.87	6,414.08	6,413.90	HEC-22 Energy (Second Edition)	0.18	4.98
STRC-106 (TOWN)	6,407.69	6,399.49	6,400.91	6,400.87	HEC-22 Energy (Second Edition)	0.04	5.98
STRC-115 (TOWN)	6,412.62	6,403.48	6,405.20	6,405.15	HEC-22 Energy (Second Edition)	0.05	6.01

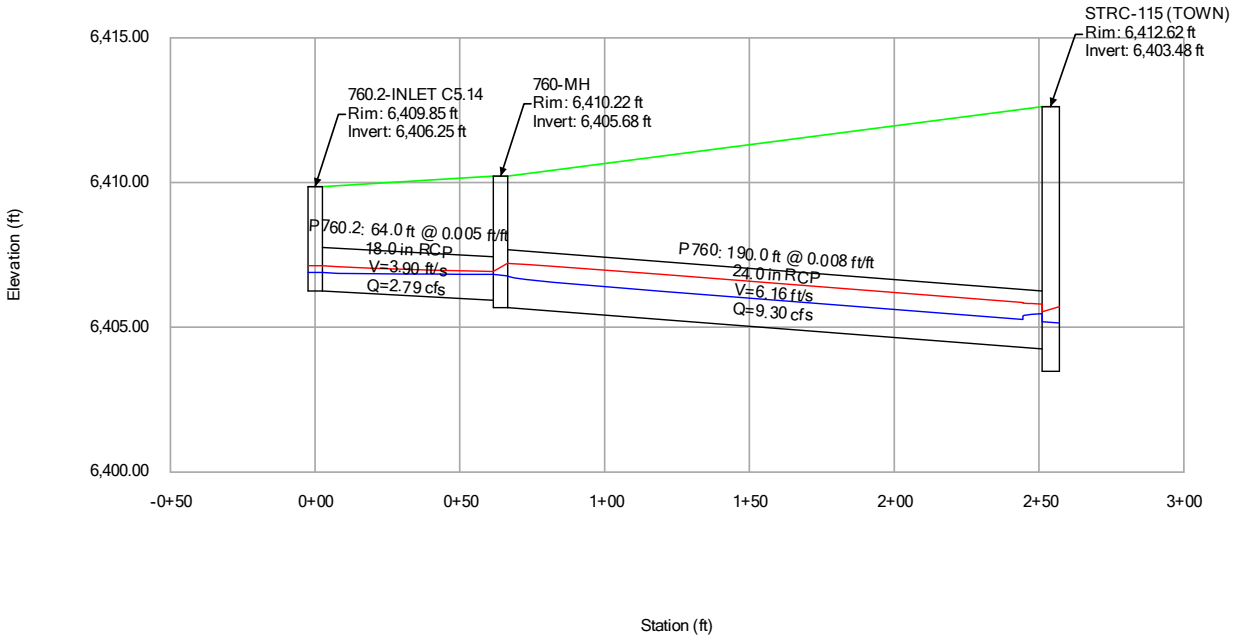
Active Scenario: Minor-5-yr



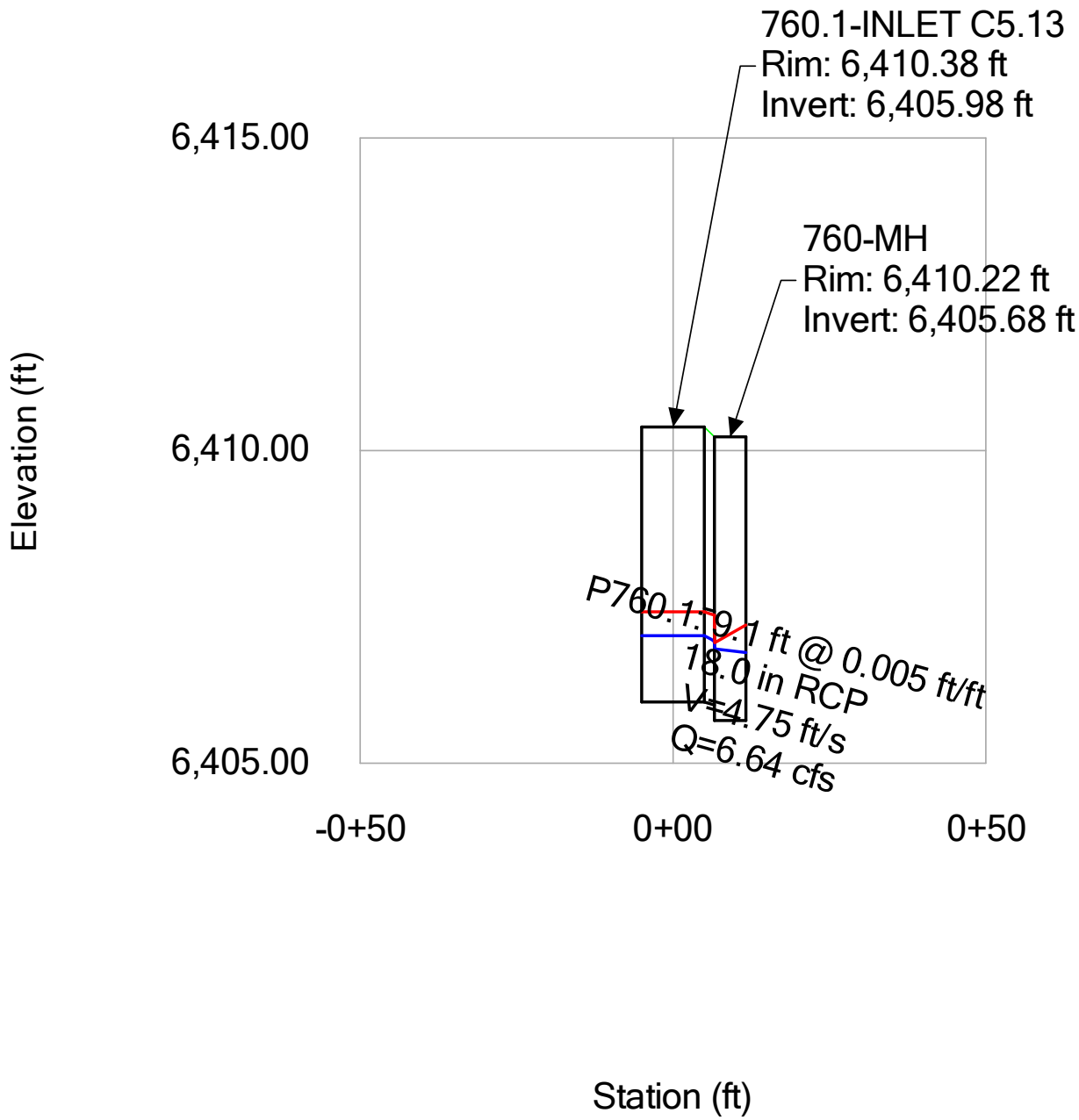
Active Scenario: Minor-5-yr



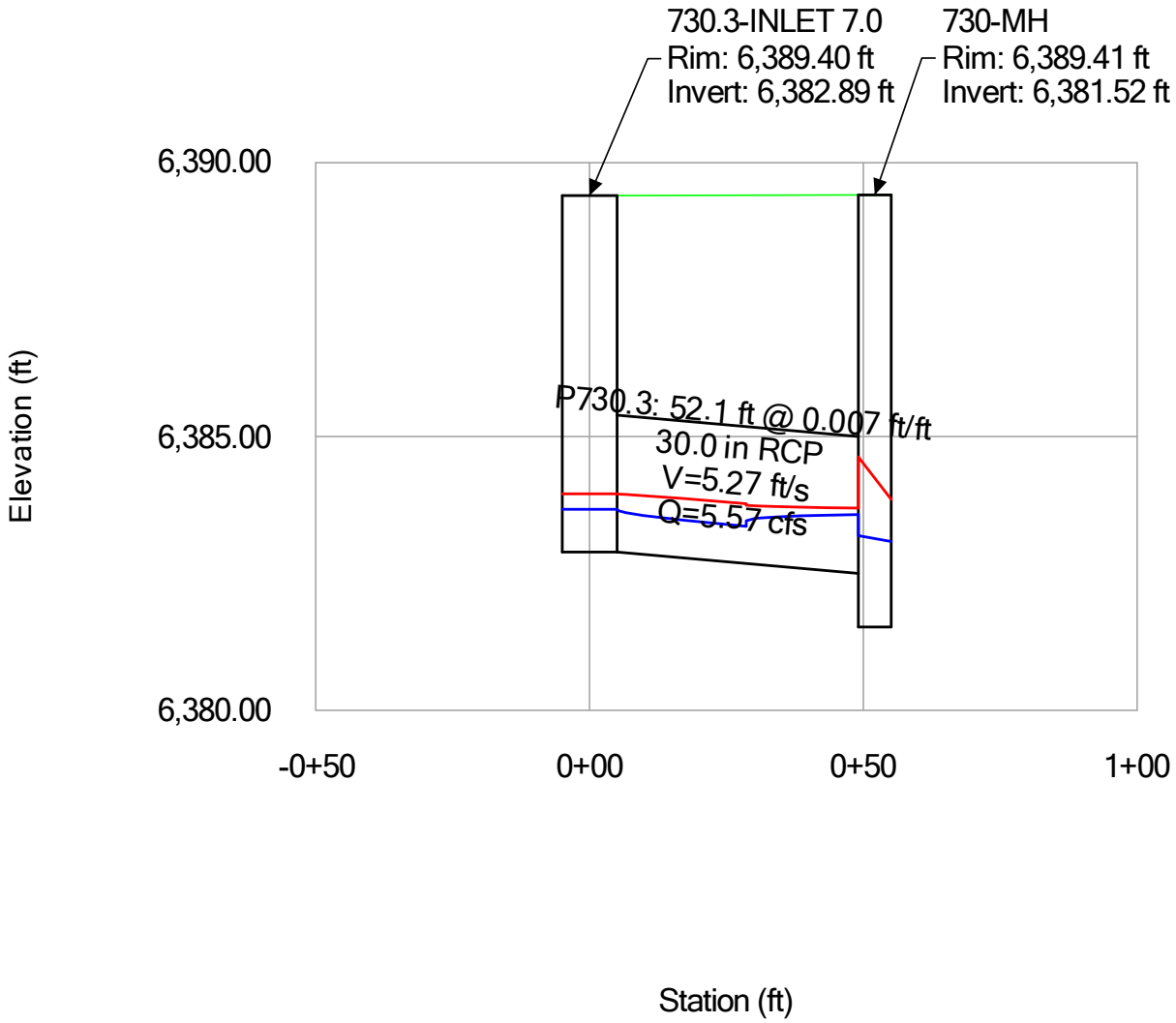
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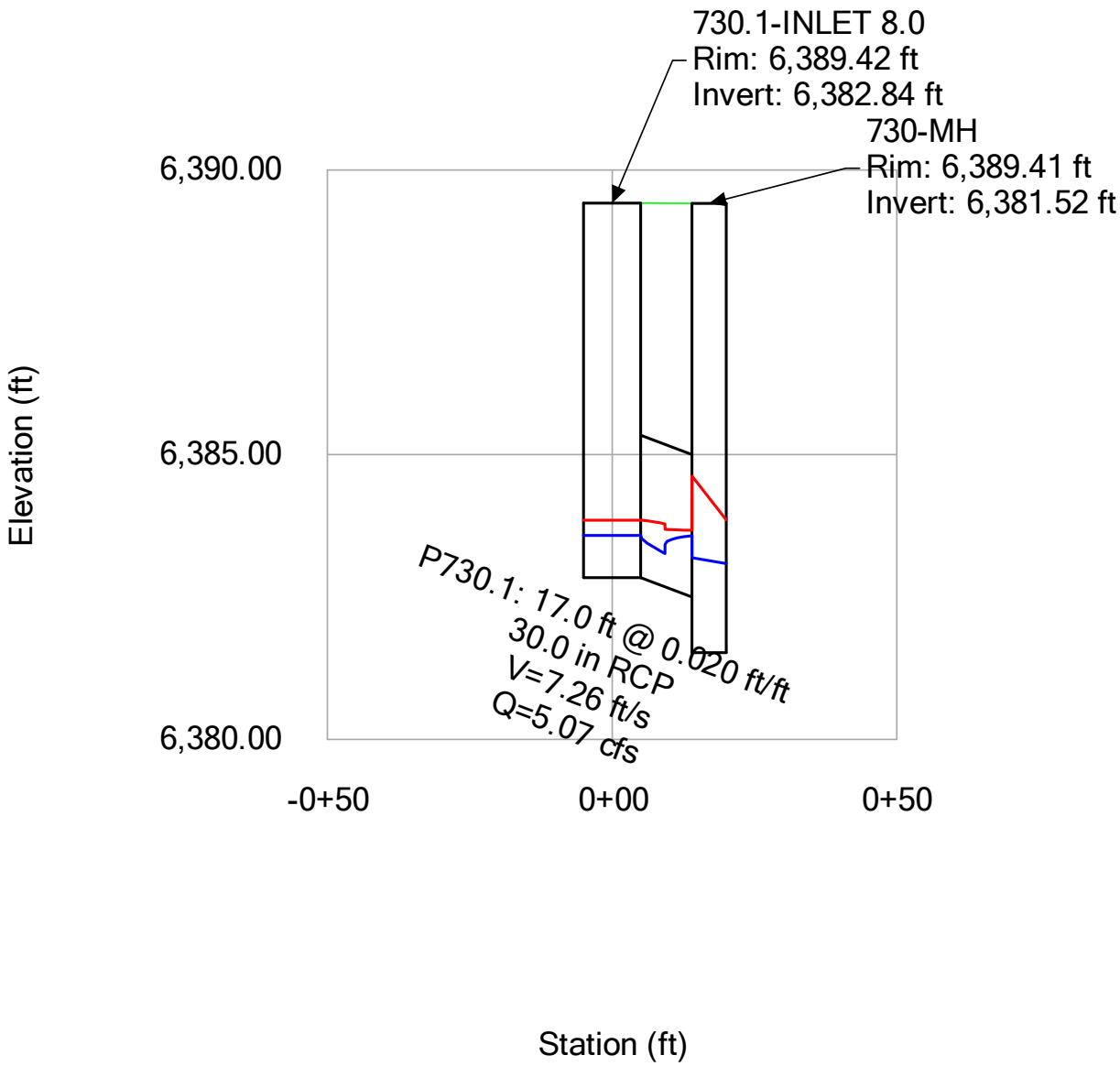
Active Scenario: Minor-5-yr



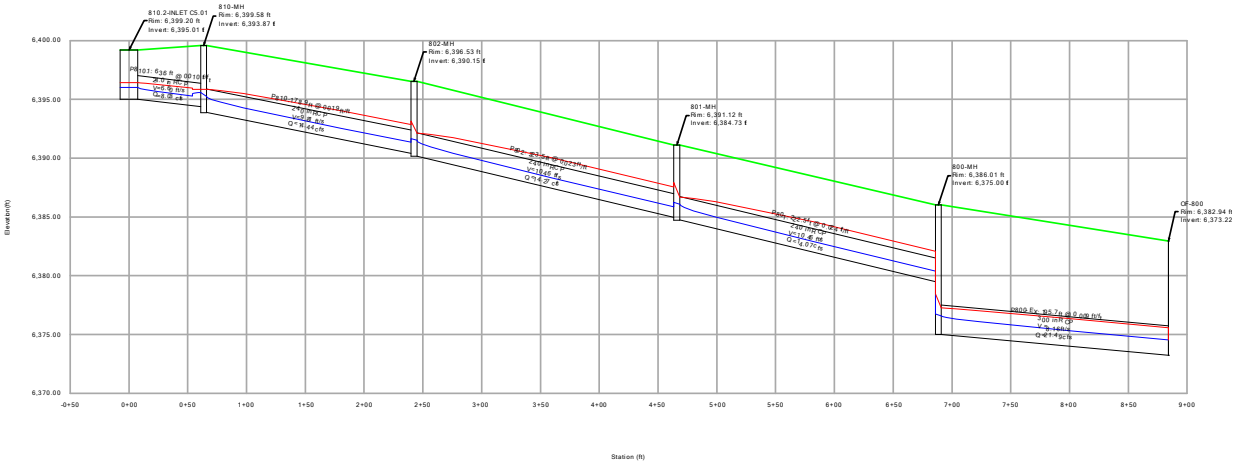
Active Scenario: Minor-5-yr



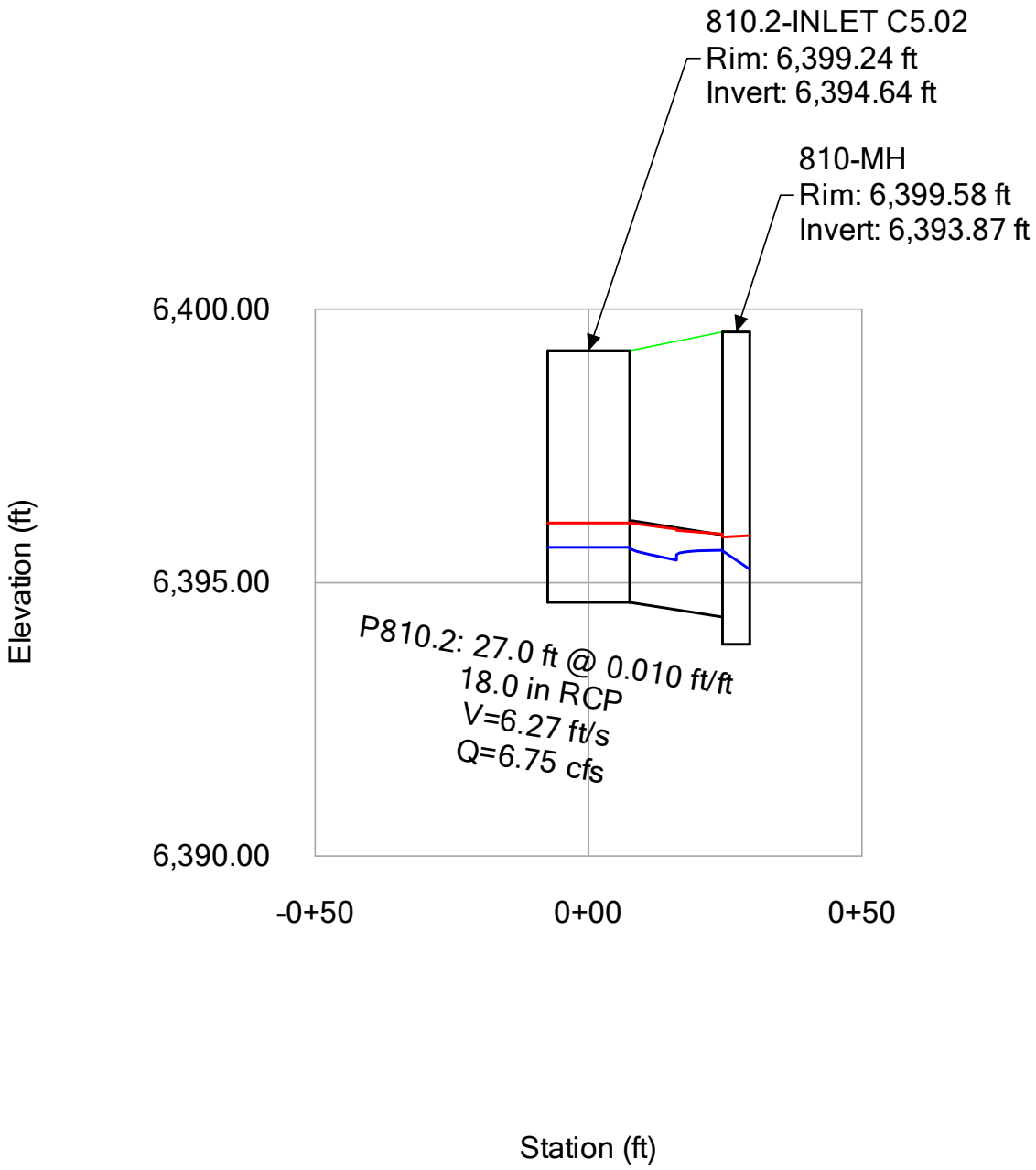
Active Scenario: Minor-5-yr



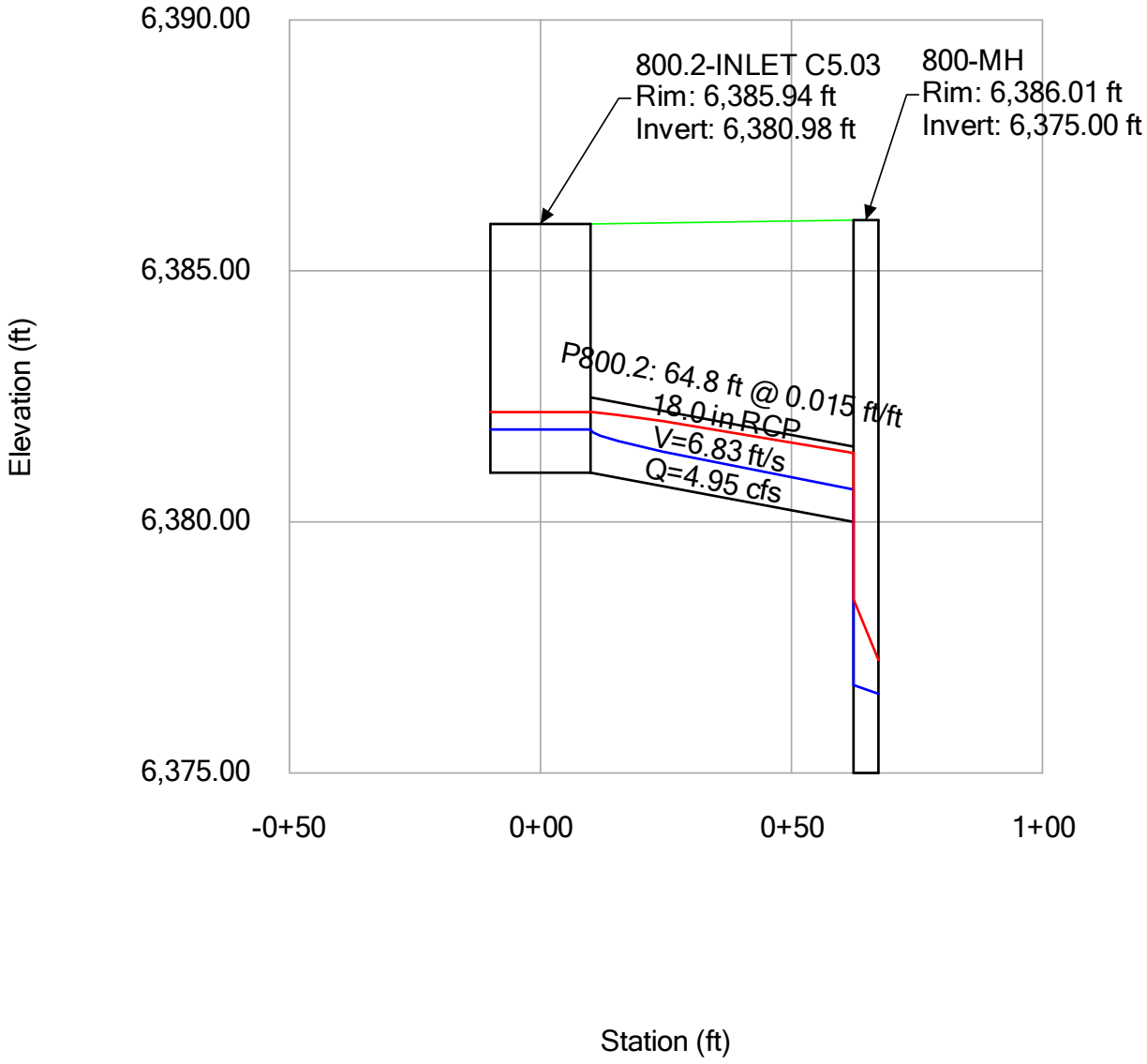
Active Scenario: Minor-5-yr



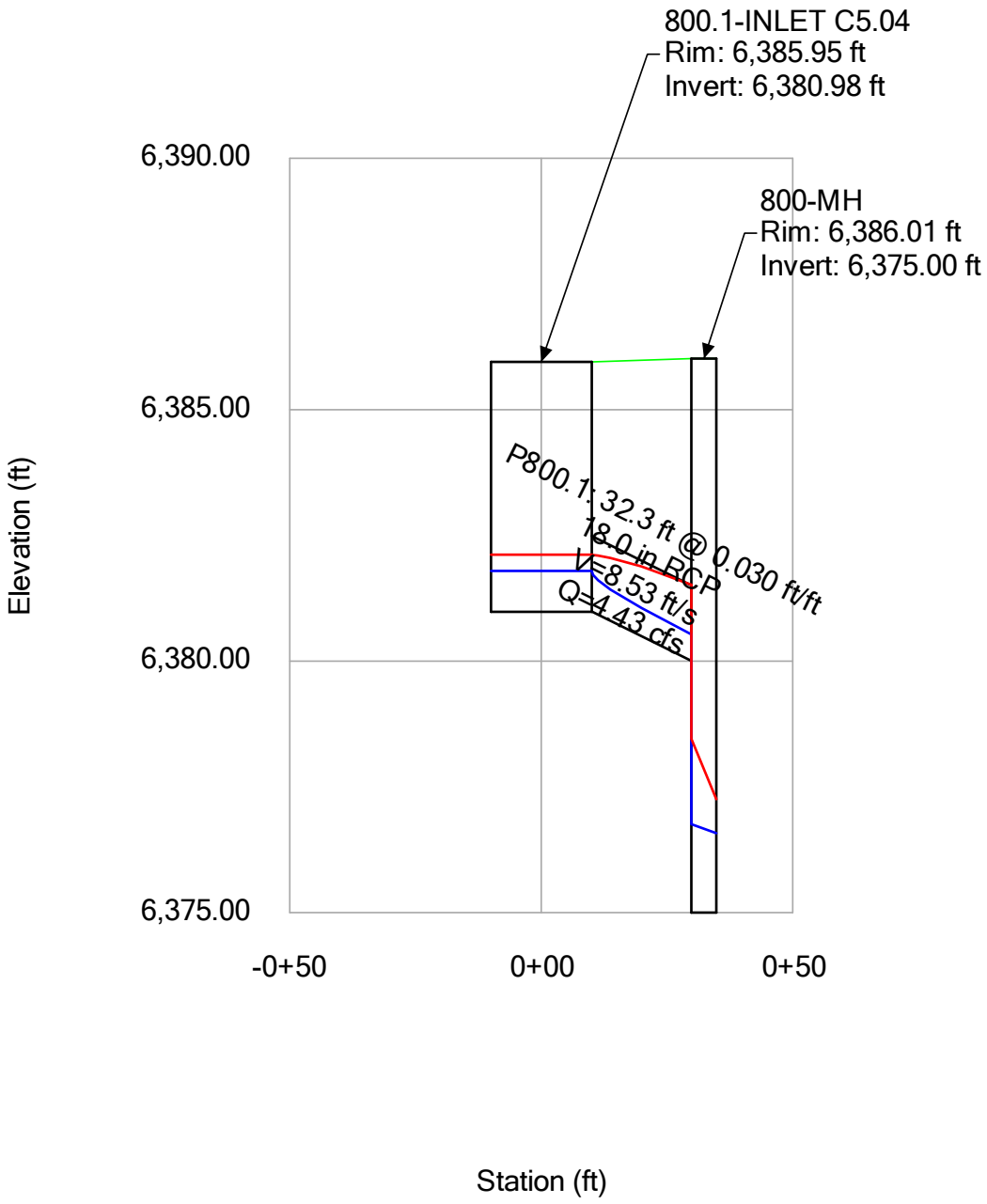
Active Scenario: Minor-5-yr



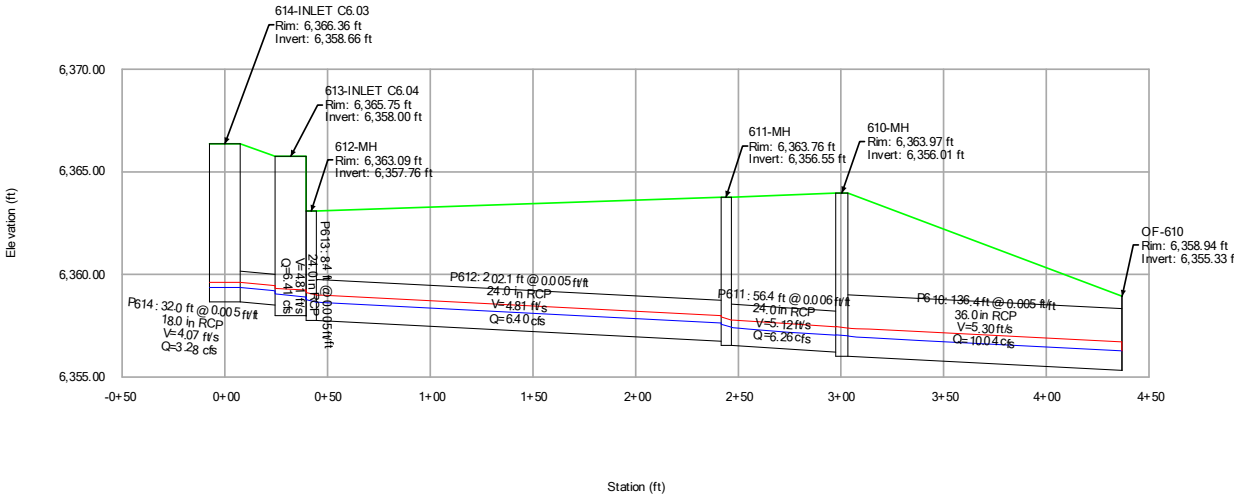
Active Scenario: Minor-5-yr



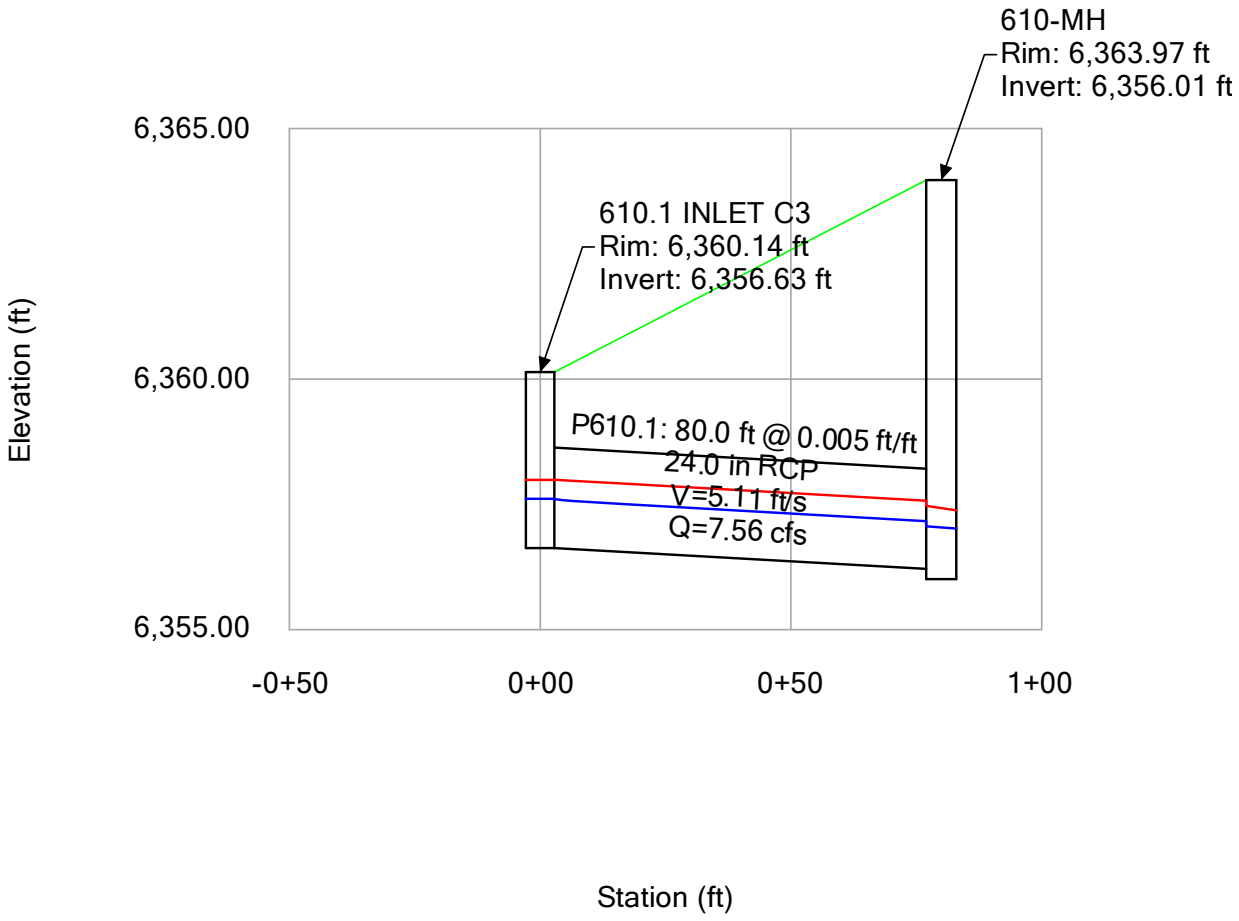
Active Scenario: Minor-5-yr



Active Scenario: Minor-5-yr



Active Scenario: Minor-5-yr



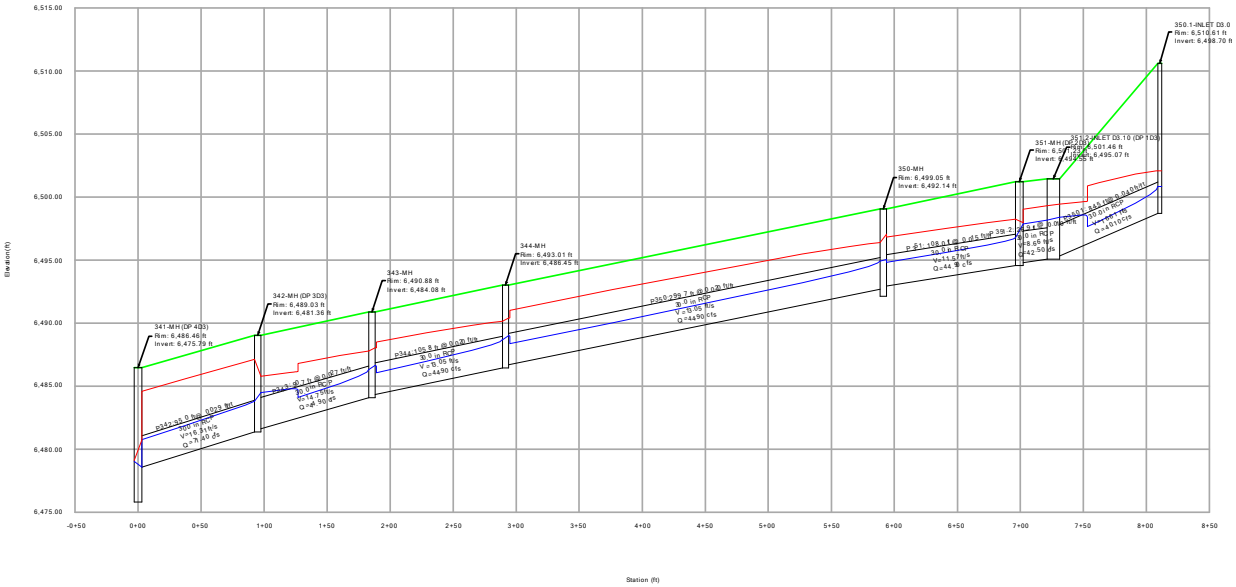
Scenario: 100-YR
Current Time Step: 0.000 h
FlexTable: Conduit Table

Label	Start Node	Stop Node	Invert (Start) (ft)	Invert (Stop) (ft)	Slope (Calculated) (ft/ft)	Length (Scaled) (ft)	Flow (cfs)	Diameter (in)	Velocity (ft/s)
P-491	3.3a	310-MH (DP 13D3)	6,443.38	6,442.21	0.025	46.5	117.80	36.0	16.67
P-492	D3.2f	321-MH (DP 8D3)	6,449.00	6,445.17	0.050	76.5	6.60	18.0	11.41
P-519	3.3b	300-MH (DP 15D3)	6,427.17	6,424.70	0.011	231.4	39.10	24.0	12.45
P300	300-MH (DP 15D3)	O-300	6,421.70	6,420.92	0.010	78.0	259.80	60.0	15.12
P301	301-MH	STRC-313 (DP 14D3)	6,430.70	6,428.90	0.007	257.6	229.70	60.0	12.55
P301(1)	STRC-313 (DP 14D3)	300-MH (DP 15D3)	6,426.40	6,424.88	0.010	152.5	234.90	60.0	15.01
P310	310-MH (DP 13D3)	301-MH	6,432.88	6,430.96	0.007	275.0	229.70	60.0	12.55
P311	311-MH (DP 12D3)	310-MH (DP 13D3)	6,433.83	6,433.38	0.005	89.8	140.90	54.0	9.96
P311.1	311.1-INLET D3.21	311-MH (DP 12D3)	6,443.35	6,443.29	0.004	14.0	2.80	18.0	3.69
P311.2	311.2-INLET D3.22	311-MH (DP 12D3)	6,443.18	6,443.08	0.005	20.0	2.00	18.0	3.57
P312	312-MH (DP 11D3)	311-MH (DP 12D3)	6,435.71	6,434.08	0.005	326.0	139.90	54.0	9.96
P312.1	312.1-INLET D3.19A	312-MH (DP 11D3)	6,442.11	6,440.25	0.077	24.0	4.10	18.0	11.65
P312.2	312.2-INLET D3.22	312-MH (DP 11D3)	6,440.44	6,440.25	0.006	31.0	2.00	18.0	3.80
P313	313-MH (DP 10D3)	312-MH (DP 11D3)	6,436.70	6,436.21	0.010	48.9	138.50	48.0	13.02
P313.1	313.1-INLET D3.20A	313-MH (DP 10D3)	6,441.53	6,439.80	0.025	74.4	2.90	18.0	7.05
P313.2	313.2-INLET D3.20	313.1-INLET D3.20A	6,442.30	6,441.73	0.025	22.9	2.90	18.0	7.06
P320	320-MH (DP 9D3)	313-MH (DP 10D3)	6,438.21	6,437.21	0.023	43.8	134.60	42.0	13.99
P320.1	320.1-INLET D3.19	320-MH (DP 9D3)	6,439.80	6,439.71	0.010	8.5	4.10	24.0	1.31
P320.2	320.2-INLET D3.18	320-MH (DP 9D3)	6,441.96	6,440.21	0.049	35.6	2.10	18.0	1.19
P321	330-MH (DP 7D3)	321-MH (DP 8D3)	6,449.77	6,445.92	0.028	137.7	119.30	36.0	17.70
P321(1)	321-MH (DP 8D3)	320-MH (DP 9D3)	6,442.39	6,439.96	0.023	105.4	131.10	42.0	17.83
P330.1	D3.2c	330-MH (DP 7D3)	6,455.84	6,454.77	0.017	61.5	36.30	30.0	11.81
P331	331-MH (DP 6D3)	330-MH (DP 7D3)	6,455.32	6,453.06	0.028	80.8	93.60	36.0	17.68
P331.1	331.1-INLET D3.16	331-MH (DP 6D3)	6,460.18	6,460.07	0.013	8.5	2.10	18.0	5.09
P331.2	331.2-INLET D3.15	331-MH (DP 6D3)	6,460.72	6,460.07	0.018	35.5	3.60	18.0	6.71
P340	340-MH (DP 5D3)	332- MH	6,470.07	6,465.82	0.029	146.5	90.70	36.0	17.84
P340(2)	332- MH	331-MH (DP 6D3)	6,462.85	6,458.57	0.029	146.5	90.70	36.0	17.89
P340.1	D3.2b	340-MH (DP 5D3)	6,475.36	6,473.87	0.029	50.9	15.90	30.0	11.55
P341	341-MH (DP 4D3)	340-MH (DP 5D3)	6,475.79	6,473.37	0.030	80.4	80.50	36.0	17.66
P341.1	341.1-INLET D3.13	341-MH (DP 4D3)	6,479.15	6,479.07	0.010	7.9	3.60	24.0	5.27
P341.2	341.2-INLET D3.12	341-MH (DP 4D3)	6,479.86	6,479.57	0.011	26.1	9.50	18.0	7.04
P342	342-MH (DP 3D3)	341-MH (DP 4D3)	6,481.36	6,478.57	0.029	95.0	71.40	30.0	16.31
P342.1	342.1-INLET D3.12A	342-MH (DP 3D3)	6,483.45	6,482.11	0.015	89.1	34.00	30.0	6.93
P343	343-MH	342-MH (DP 3D3)	6,484.08	6,481.61	0.027	90.6	44.90	30.0	14.75
P344	344-MH	343-MH	6,486.45	6,484.34	0.020	105.8	44.90	30.0	13.05
P350	350-MH	344-MH	6,492.69	6,486.70	0.020	299.6	44.90	30.0	13.05
P350.1	350.1-INLET D3.0	351.2-INLET D3.10 (DP 1D3)	6,498.70	6,495.32	0.040	84.4	40.10	30.0	16.61
P351	351-MH (DP 2D3)	350-MH	6,494.55	6,492.93	0.015	108.0	44.90	30.0	11.57
P351.1	351.1-INLET D3.11	351-MH (DP 2D3)	6,495.87	6,495.80	0.010	7.1	4.20	18.0	2.38
P351.2	351.2-INLET D3.10 (DP 1D3)	351-MH (DP 2D3)	6,495.07	6,494.80	0.010	26.9	42.50	30.0	8.66

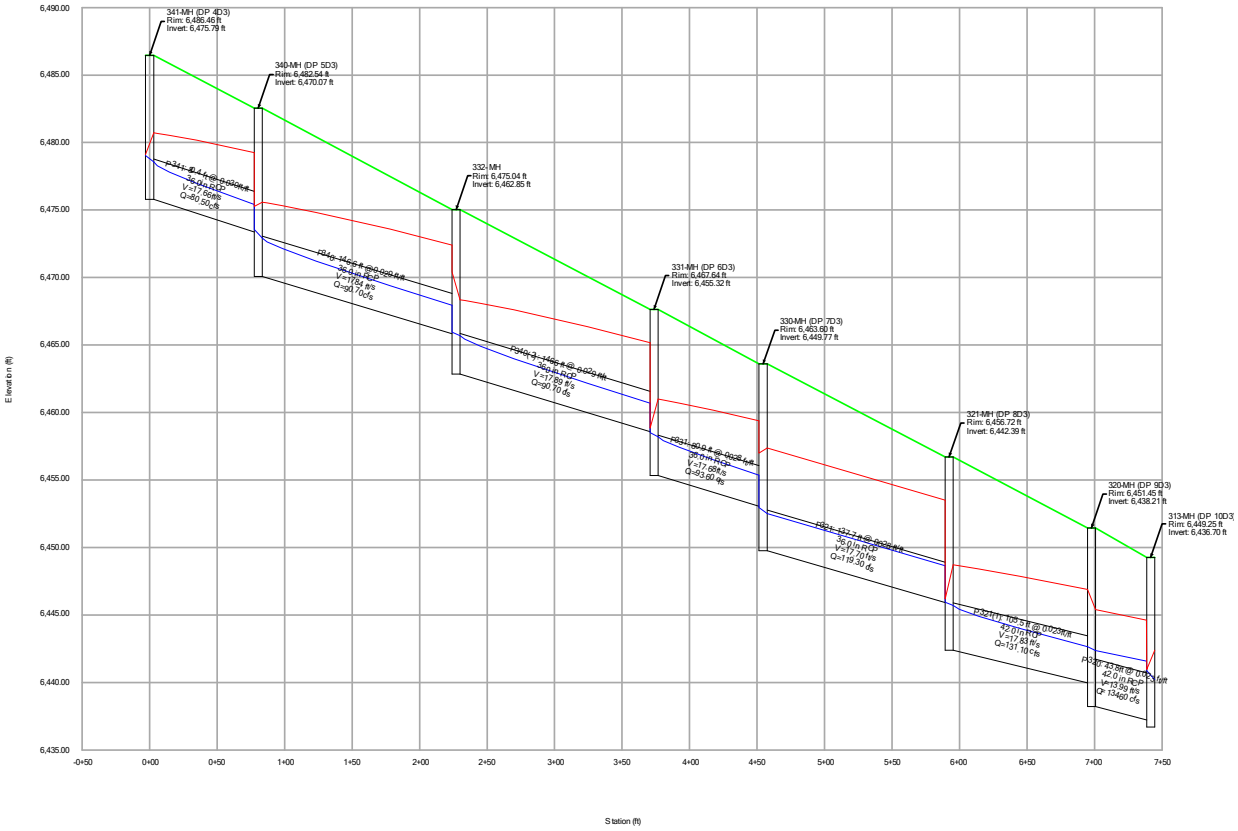
Scenario: 100-YR
Current Time Step: 0.000 h
FlexTable: Manhole Table

Label	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Headloss Method	Headloss (ft)	Velocity (Out) (ft/s)
3.3a	6,446.71	6,443.38	6,446.64	6,446.64	HEC-22 Energy (Second Edition)	0.00	16.67
3.3b	6,429.60	6,427.17	6,429.60	6,429.60	HEC-22 Energy (Second Edition)	0.00	12.45
300-MH (DP 15D3)	6,441.70	6,421.70	6,427.17	6,426.19	HEC-22 Energy (Second Edition)	0.99	14.00
301-MH	6,446.26	6,430.70	6,435.24	6,435.10	HEC-22 Energy (Second Edition)	0.14	12.55
310-MH (DP 13D3)	6,452.05	6,432.88	6,437.40	6,437.28	HEC-22 Energy (Second Edition)	0.11	12.55
311-MH (DP 12D3)	6,451.34	6,433.83	6,437.88	6,437.77	HEC-22 Energy (Second Edition)	0.11	9.55
311.1-INLET D3.21	6,450.93	6,443.35	6,444.01	6,444.01	HEC-22 Energy (Second Edition)	0.00	3.70
311.2-INLET D3.22	6,450.93	6,443.18	6,443.72	6,443.72	HEC-22 Energy (Second Edition)	0.00	3.55
312-MH (DP 11D3)	6,449.09	6,435.71	6,439.91	6,439.43	HEC-22 Energy (Second Edition)	0.48	9.95
312.1-INLET D3.19A	6,449.79	6,442.11	6,442.88	6,442.88	HEC-22 Energy (Second Edition)	0.00	4.45
312.2-INLET D3.22	6,447.38	6,440.44	6,440.97	6,440.97	HEC-22 Energy (Second Edition)	0.00	3.55
313-MH (DP 10D3)	6,449.25	6,436.70	6,440.88	6,440.20	HEC-22 Energy (Second Edition)	0.68	11.89
313.1-INLET D3.20A	6,449.80	6,441.53	6,442.31	6,442.18	HEC-22 Energy (Second Edition)	0.13	3.98
313.2-INLET D3.20	6,450.00	6,442.30	6,442.95	6,442.95	HEC-22 Energy (Second Edition)	0.00	3.98
320-MH (DP 9D3)	6,451.45	6,438.21	6,442.66	6,442.36	HEC-22 Energy (Second Edition)	0.30	13.99
320.1-INLET D3.19	6,451.67	6,439.26	6,444.91	6,444.91	HEC-22 Energy (Second Edition)	0.00	1.31
320.2-INLET D3.18	6,451.84	6,441.96	6,444.93	6,444.93	HEC-22 Energy (Second Edition)	0.00	1.19
321-MH (DP 8D3)	6,456.72	6,442.39	6,445.95	6,445.70	HEC-22 Energy (Second Edition)	0.25	13.91
330-MH (DP 7D3)	6,463.60	6,449.77	6,452.96	6,452.50	HEC-22 Energy (Second Edition)	0.46	17.70
331-MH (DP 6D3)	6,467.64	6,455.32	6,458.51	6,458.19	HEC-22 Energy (Second Edition)	0.32	13.45
331.1-INLET D3.16	6,467.88	6,460.18	6,460.73	6,460.73	HEC-22 Energy (Second Edition)	0.00	3.60
331.2-INLET D3.15	6,468.08	6,460.72	6,461.45	6,461.45	HEC-22 Energy (Second Edition)	0.00	4.26
332- MH	6,475.04	6,462.85	6,465.96	6,465.70	HEC-22 Energy (Second Edition)	0.26	13.07
340-MH (DP 5D3)	6,482.54	6,470.07	6,473.56	6,472.92	HEC-22 Energy (Second Edition)	0.63	13.07
341-MH (DP 4D3)	6,486.46	6,475.79	6,479.03	6,478.56	HEC-22 Energy (Second Edition)	0.47	11.79
341.1-INLET D3.13	6,486.69	6,479.15	6,480.15	6,480.15	HEC-22 Energy (Second Edition)	0.00	2.29
341.2-INLET D3.12	6,486.44	6,479.86	6,481.05	6,481.05	HEC-22 Energy (Second Edition)	0.00	6.31
342-MH (DP 3D3)	6,489.03	6,481.36	6,484.49	6,483.81	HEC-22 Energy (Second Edition)	0.68	14.63
342.1-INLET D3.12A	6,489.36	6,483.45	6,486.96	6,486.96	HEC-22 Energy (Second Edition)	0.00	6.93
343-MH	6,490.88	6,484.08	6,486.64	6,486.31	HEC-22 Energy (Second Edition)	0.33	9.73
344-MH	6,493.01	6,486.45	6,489.01	6,488.68	HEC-22 Energy (Second Edition)	0.33	9.73
350-MH	6,499.05	6,492.14	6,495.06	6,494.92	HEC-22 Energy (Second Edition)	0.14	9.73
350.1-INLET D3.0	6,510.61	6,498.70	6,500.83	6,500.83	HEC-22 Energy (Second Edition)	0.00	8.99
351-MH (DP 2D3)	6,501.23	6,494.55	6,497.87	6,496.78	HEC-22 Energy (Second Edition)	1.10	9.73
351.1-INLET D3.11	6,501.46	6,494.87	6,497.88	6,497.88	HEC-22 Energy (Second Edition)	0.00	2.38
351.2-INLET D3.10 (DP 1D3)	6,501.46	6,495.07	6,498.41	6,498.16	HEC-22 Energy (Second Edition)	0.24	8.66
D3.2b	6,483.30	6,475.36	6,476.71	6,476.71	HEC-22 Energy (Second Edition)	0.00	5.90
D3.2c	6,459.54	6,455.84	6,457.89	6,457.89	HEC-22 Energy (Second Edition)	0.00	8.45
D3.2f	6,457.76	6,449.00	6,449.99	6,449.99	HEC-22 Energy (Second Edition)	0.00	5.31
STRC-313 (DP 14D3)	6,443.66	6,426.40	6,432.15	6,430.73	HEC-22 Energy (Second Edition)	1.43	13.02

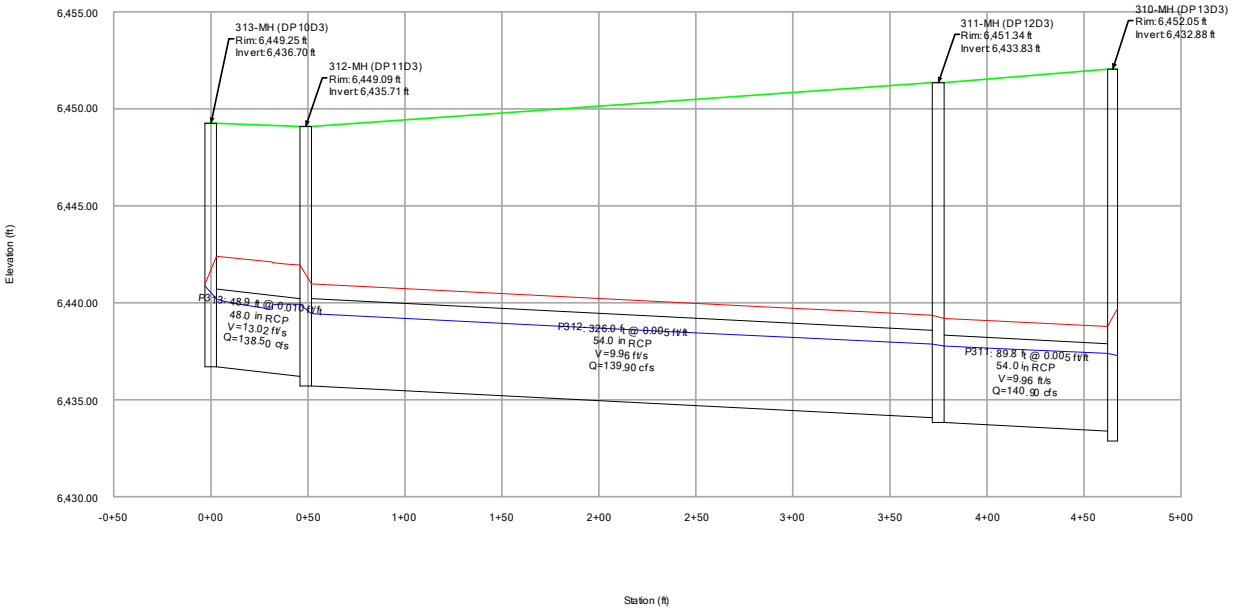
Active Scenario: 100-YR



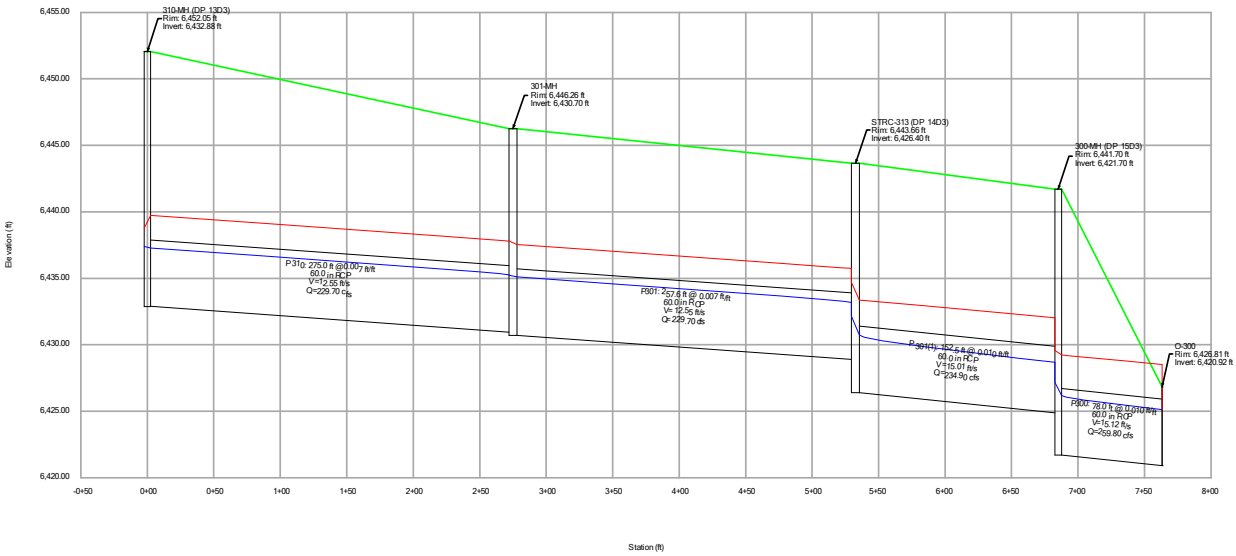
Active Scenario: 100-YR

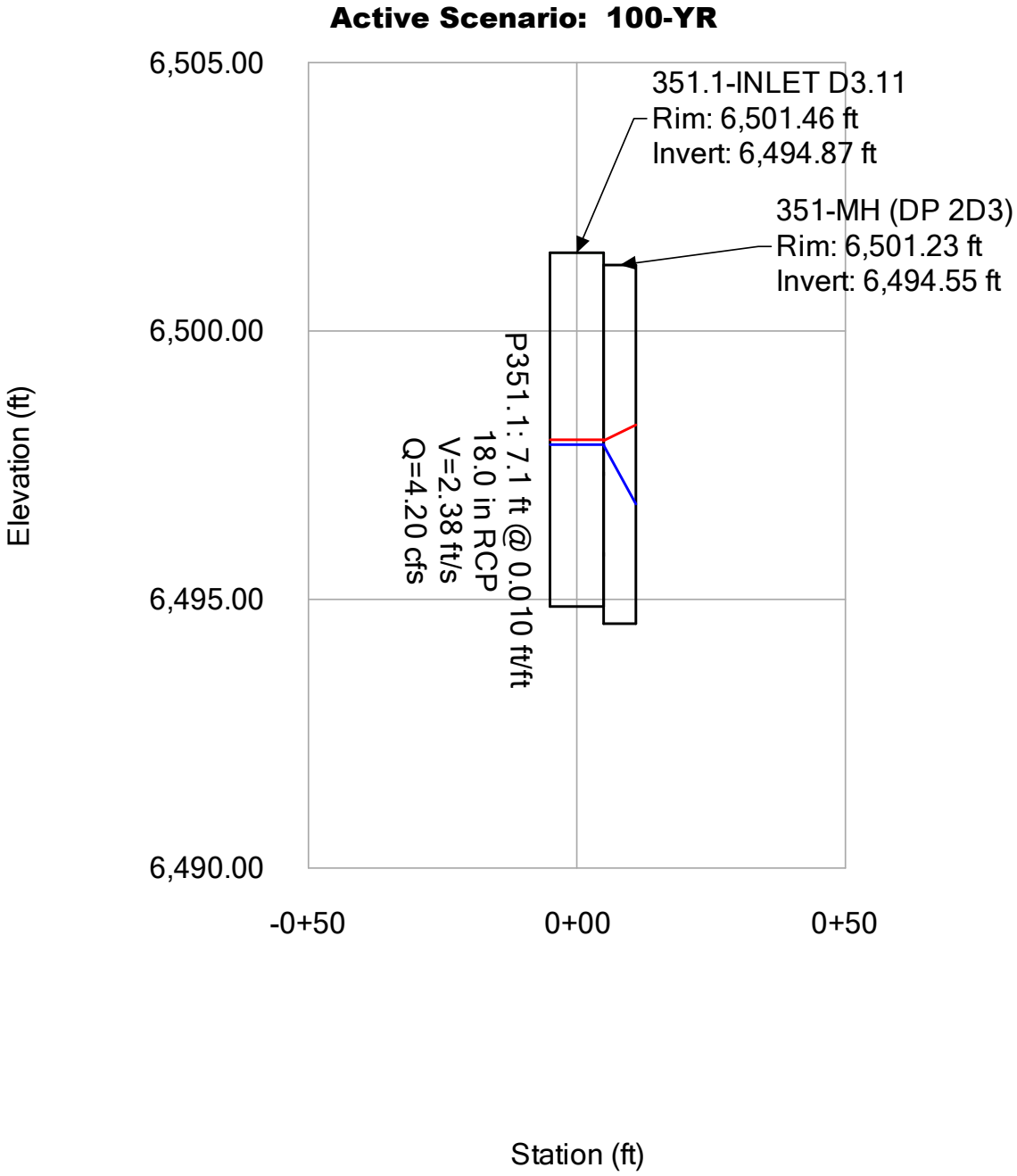


Active Scenario: 100-YR

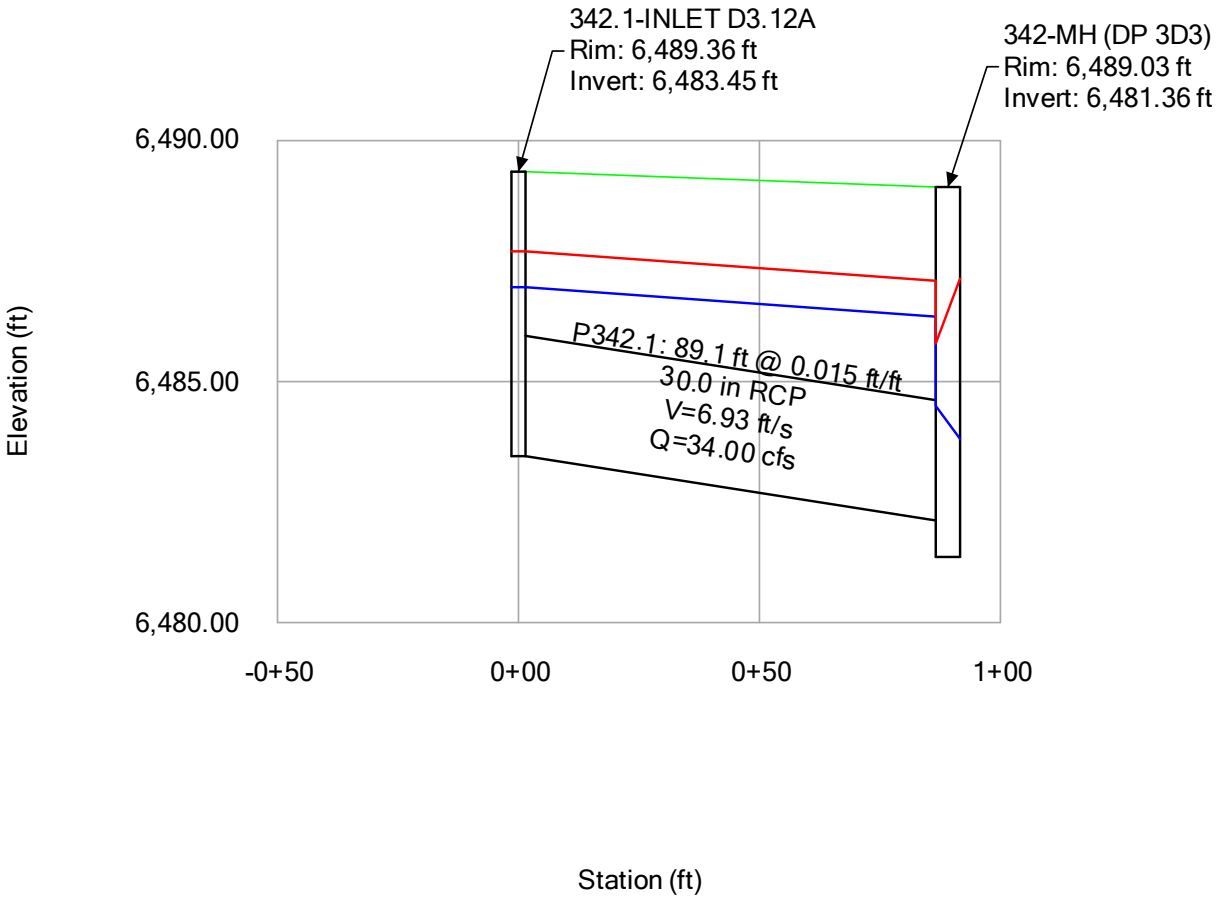


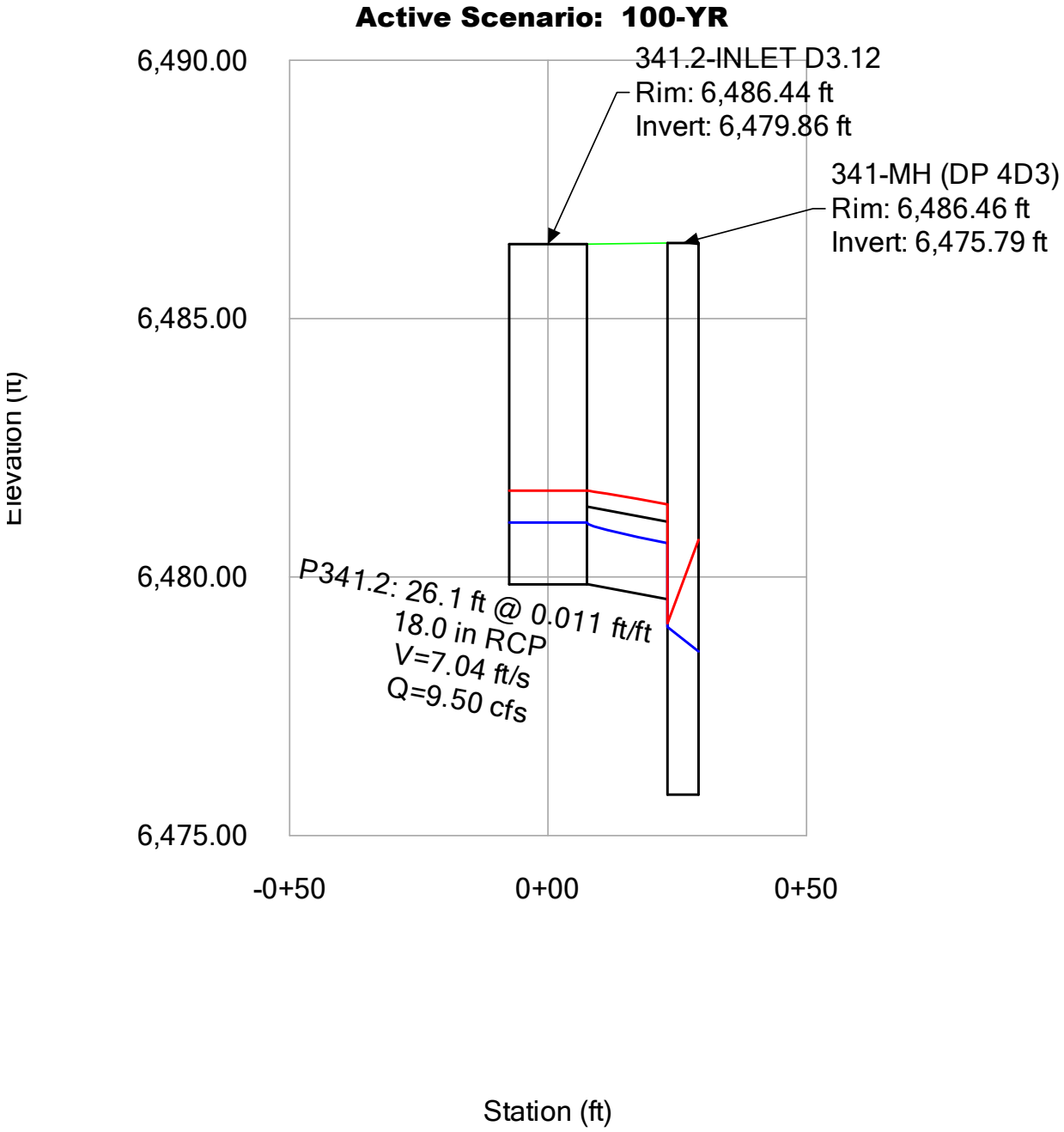
Active Scenario: 100-YR

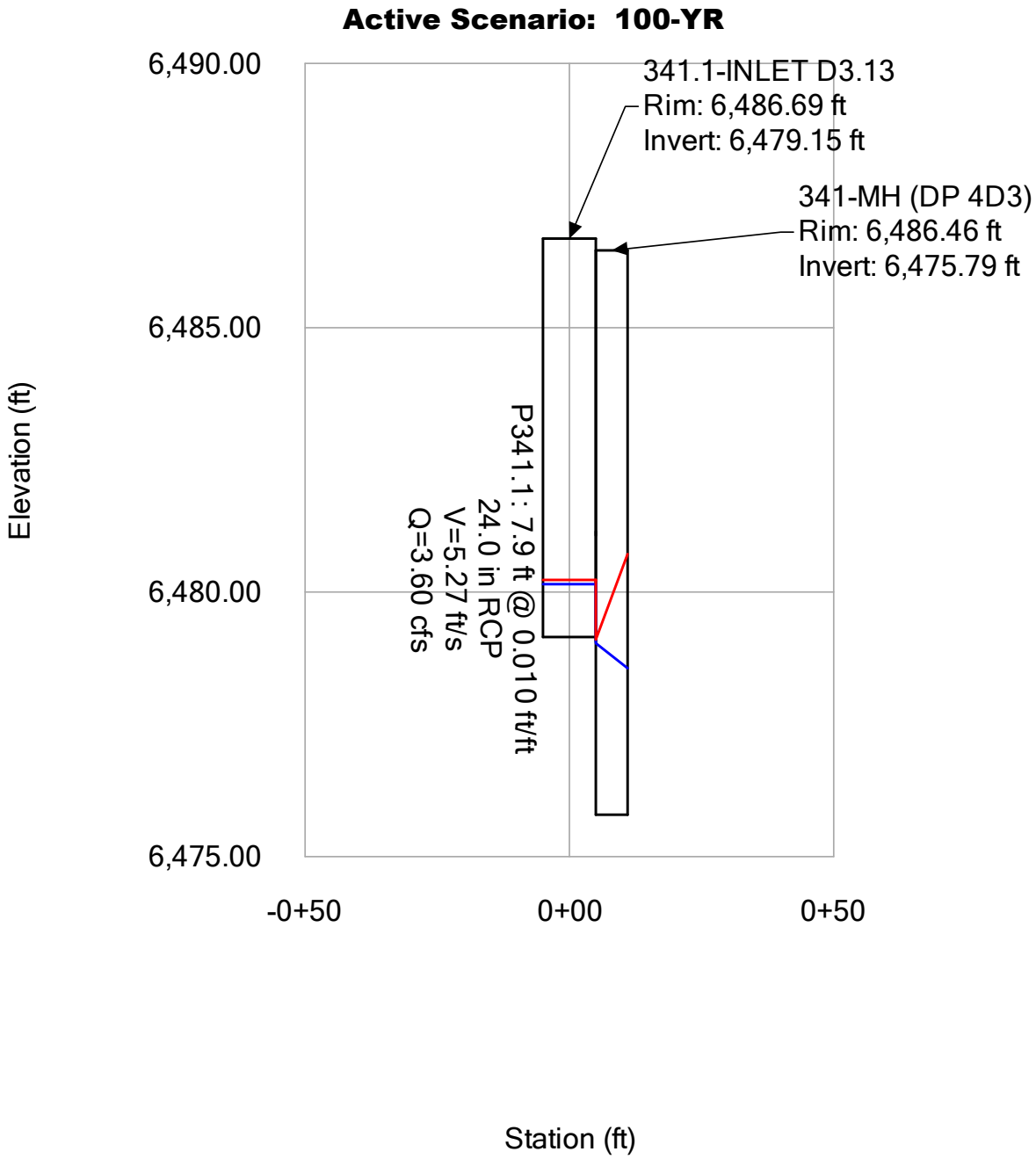


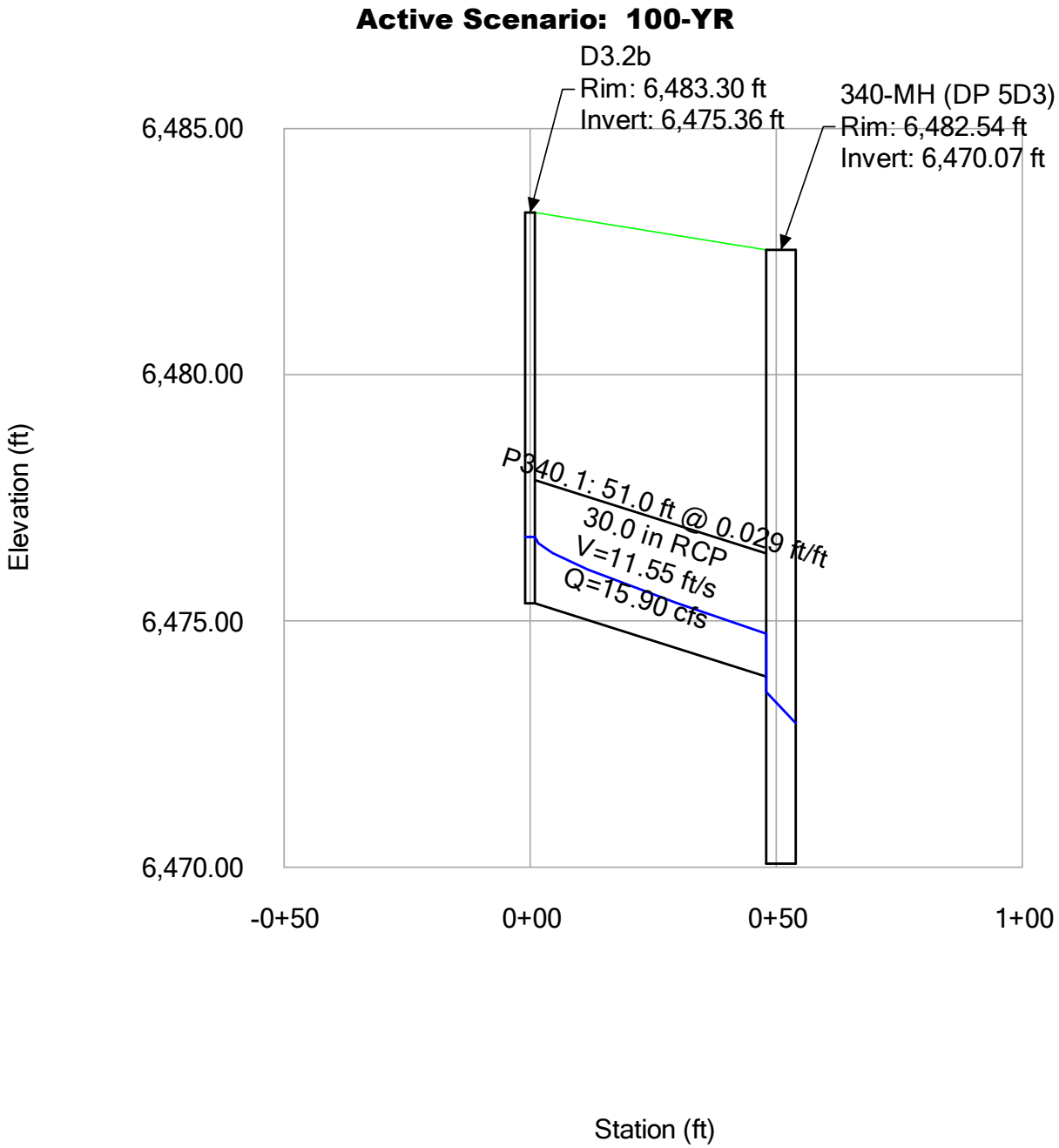

Active Scenario: 100-YR
6,505.00
6,500.00
6,495.00
6,490.00
Elevation (ft)
351.1-INLET D3.11
Rim: 6,501.46 ft
Invert: 6,494.87 ft
351-MH (DP 2D3)
Rim: 6,501.23 ft
Invert: 6,494.55 ft
P351.1: 7.1 ft @ 0.010 ft/ft
18.0 in RCP
V=2.38 ft/s
Q=4.20 cfs
-0+50
0+00
0+50
Station (ft)

Active Scenario: 100-YR

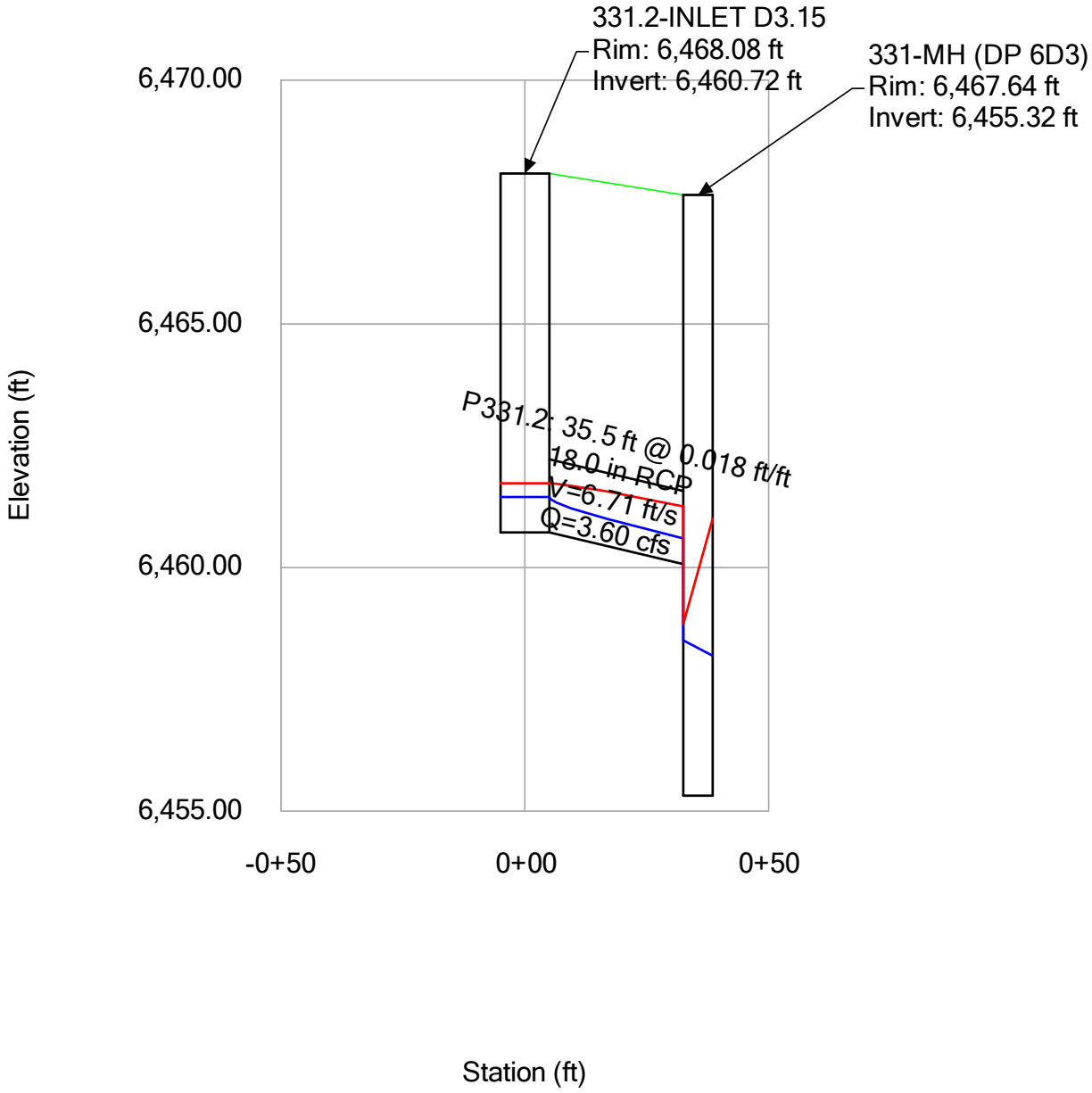



Active Scenario: 100-YR
6,490.00
6,485.00
6,480.00
6,475.00
Elevation (ft)
341.2-INLET D3.12
Rim: 6,486.44 ft
Invert: 6,479.86 ft
341-MH (DP 4D3)
Rim: 6,486.46 ft
Invert: 6,475.79 ft
P341.2: 26.1 ft @ 0.011 ft/ft
18.0 in RCP
V=7.04 ft/s
Q=9.50 cfs
-0+50
0+00
0+50
Station (ft)

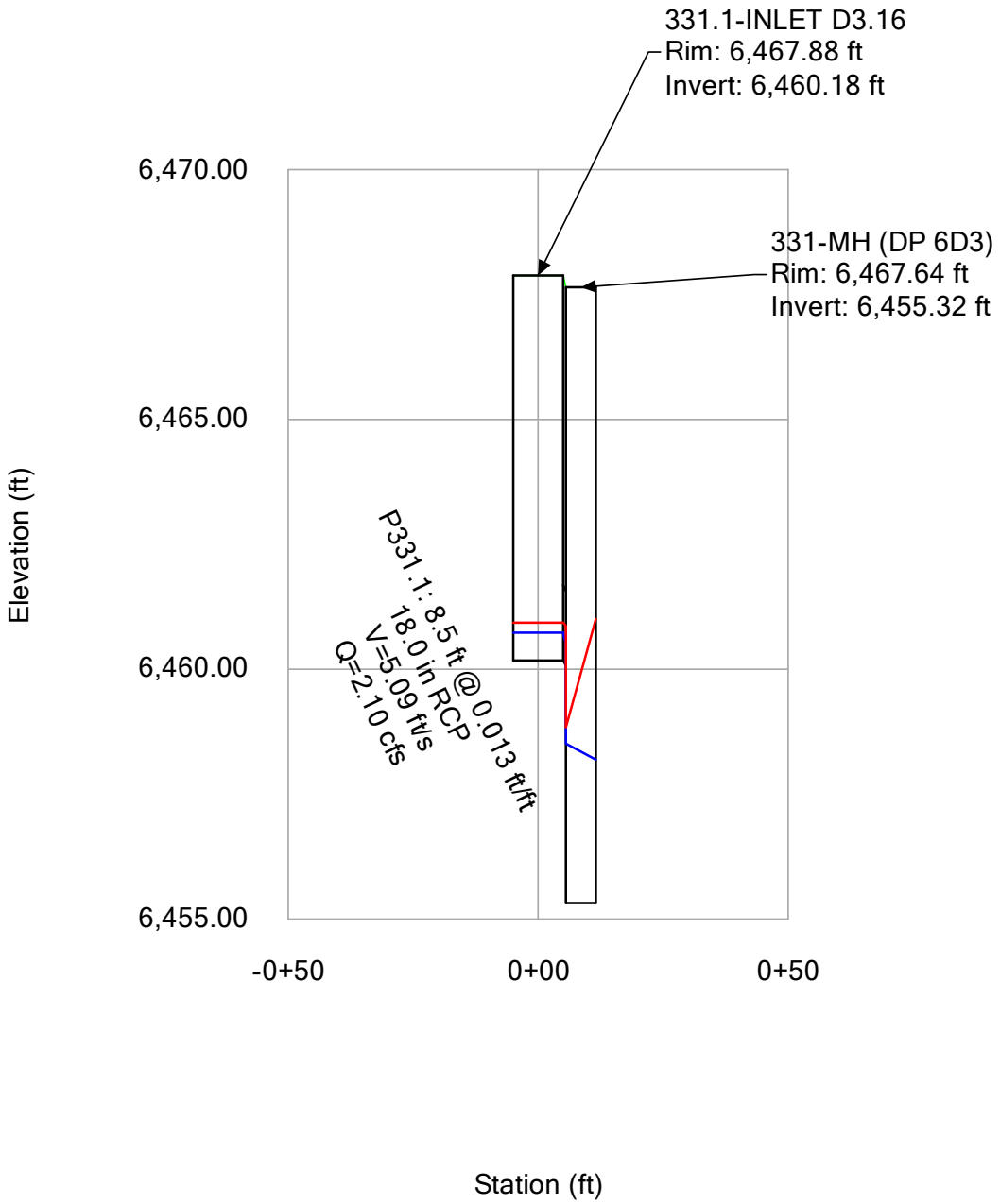

Active Scenario: 100-YR
6,490.00
6,485.00
6,480.00
6,475.00
Elevation (ft)
341.1-INLET D3.13
Rim: 6,486.69 ft
Invert: 6,479.15 ft
341-MH (DP 4D3)
Rim: 6,486.46 ft
Invert: 6,475.79 ft
P341.1: 7.9 ft @ 0.010 ft/ft
24.0 in RCP
V=5.27 ft/s
Q=3.60 cfs
-0+50
0+00
0+50
Station (ft)


Active Scenario: 100-YR
D3.2b
Rim: 6,483.30 ft
Invert: 6,475.36 ft
340-MH (DP 5D3)
Rim: 6,482.54 ft
Invert: 6,470.07 ft
6,485.00
6,480.00
6,475.00
6,470.00
Elevation (ft)
P340.1: 51.0 ft @ 0.029 ft/ft
30.0 in RCP
V=11.55 ft/s
Q=15.90 cfs
-0+50
0+00
0+50
1+00
Station (ft)

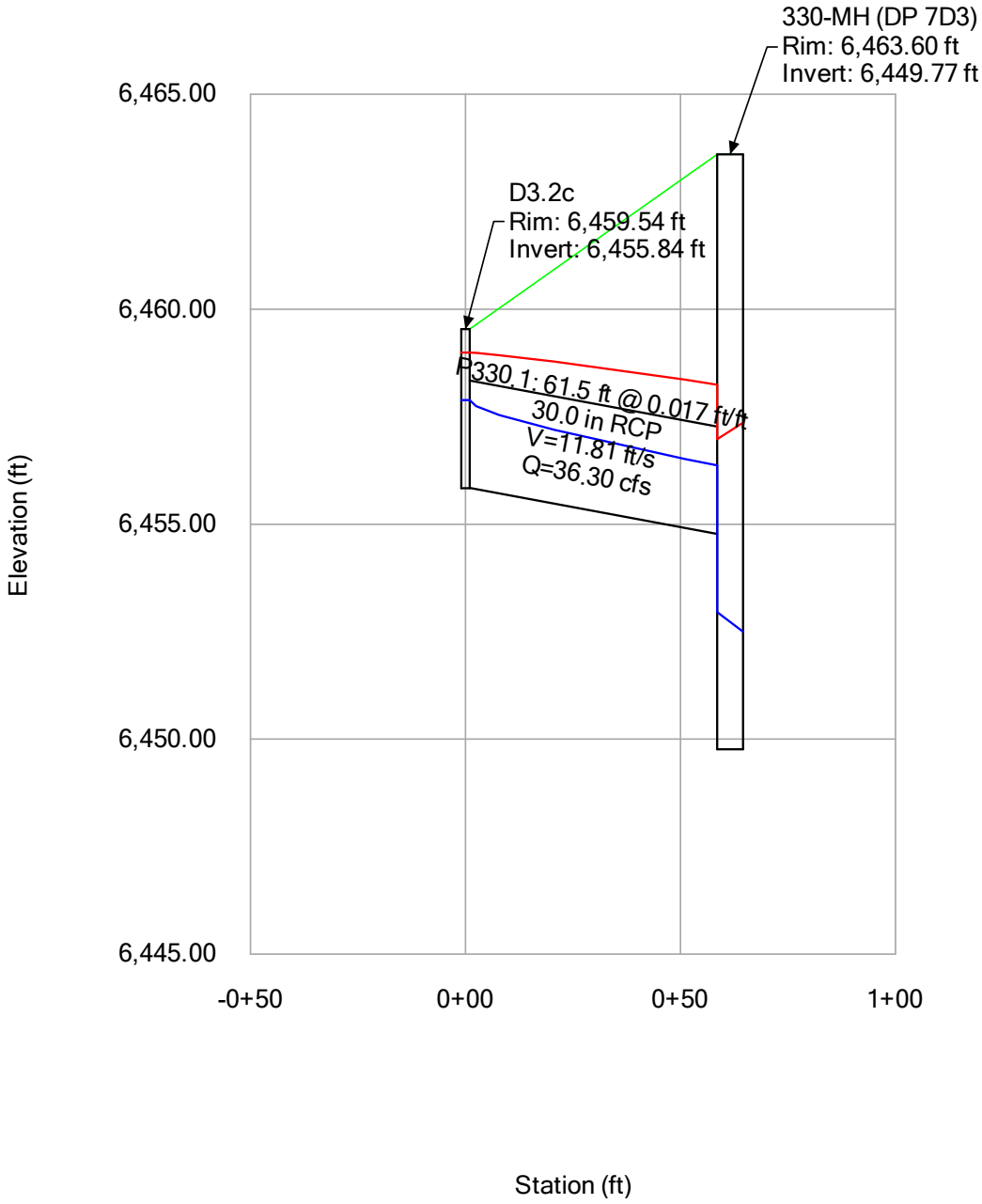
Active Scenario: 100-YR

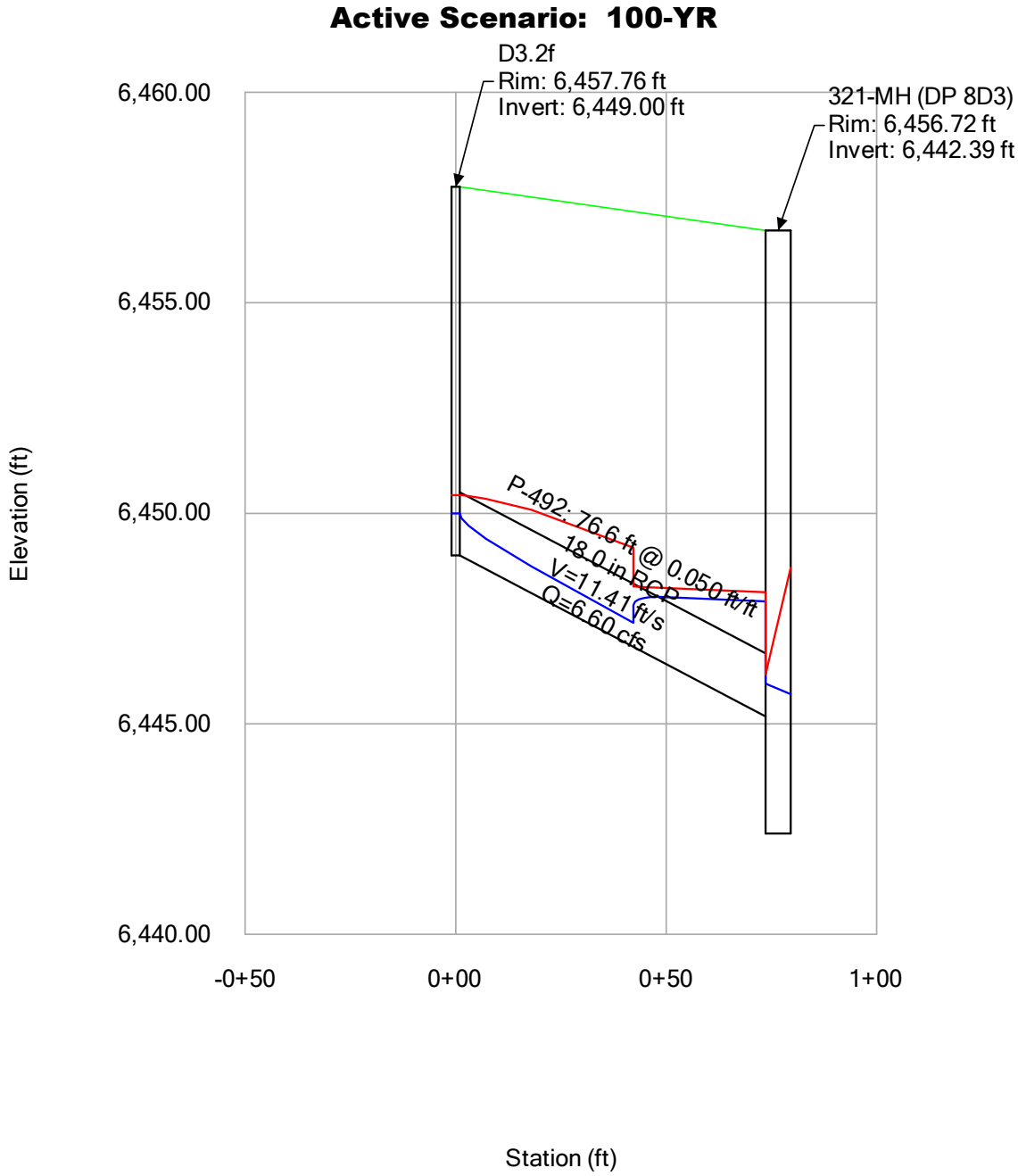


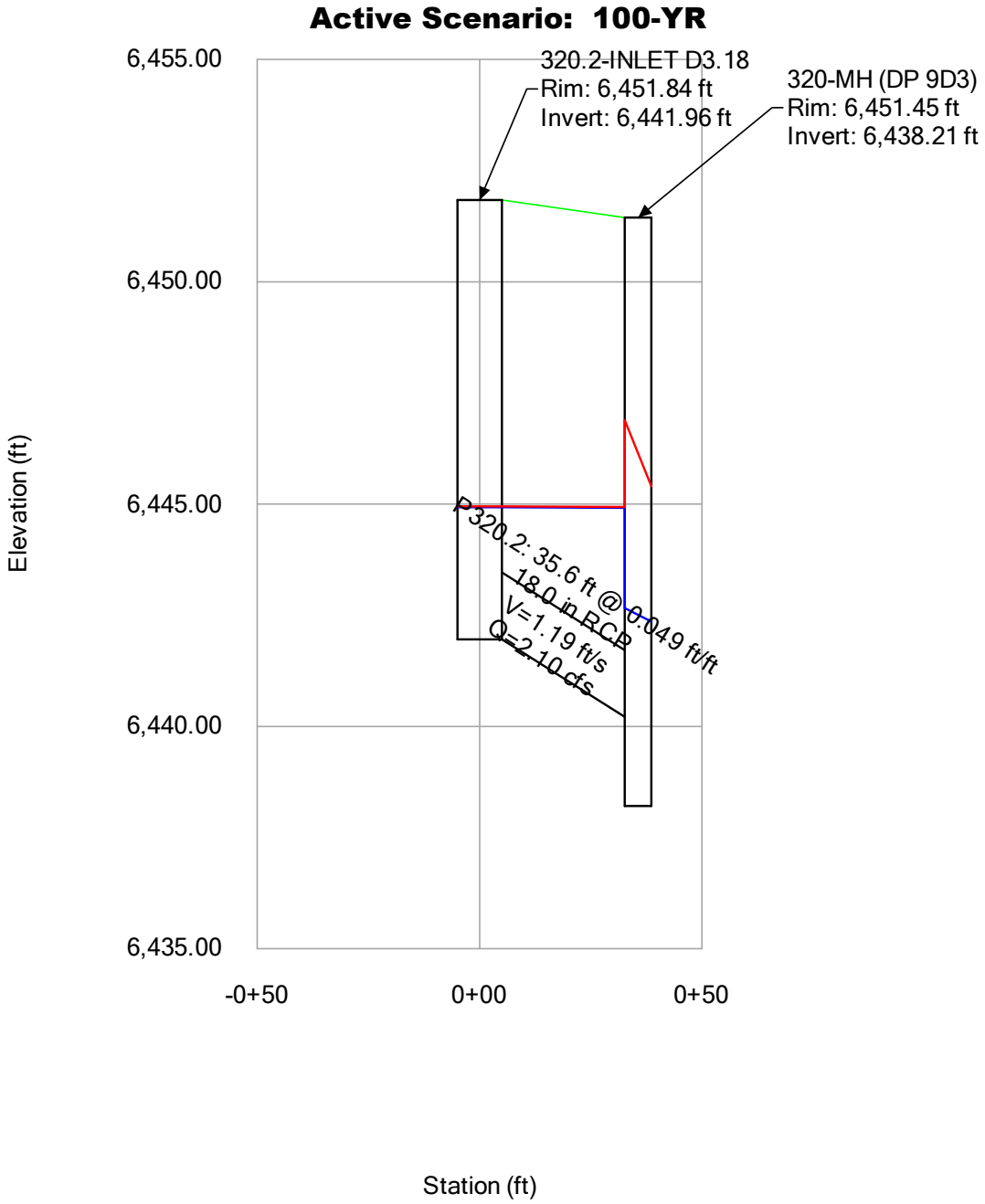
Active Scenario: 100-YR



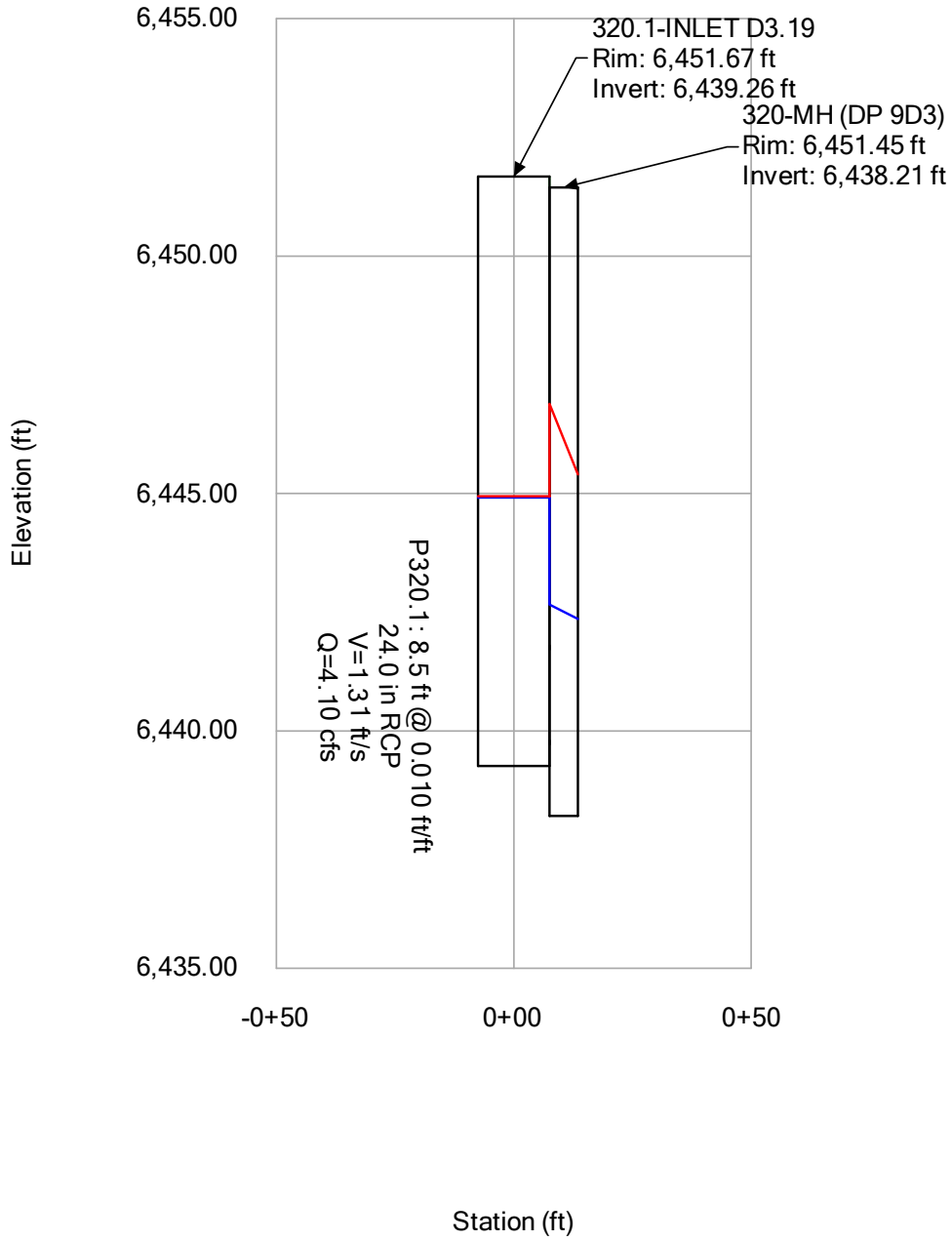
Active Scenario: 100-YR



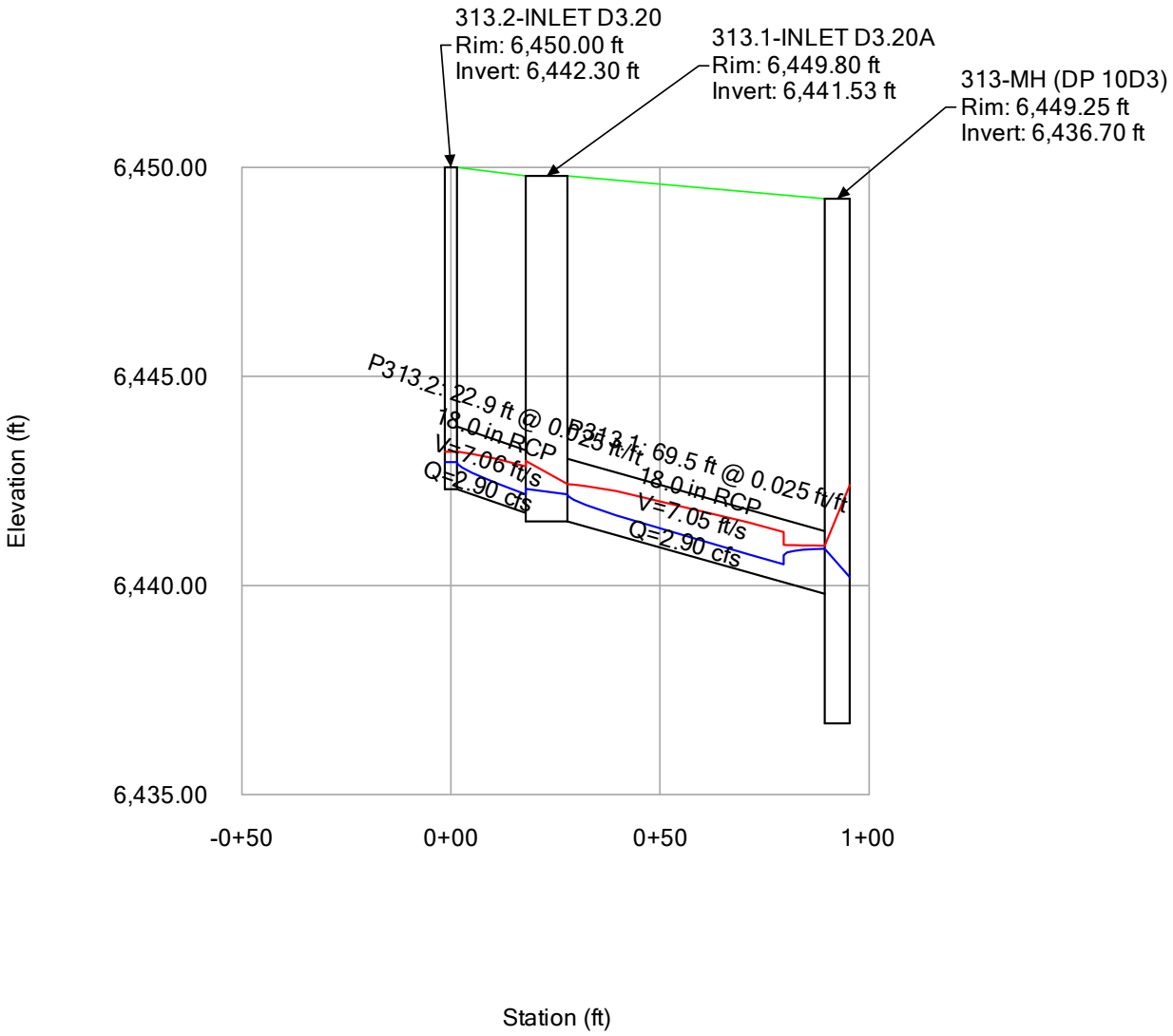

Active Scenario: 100-YR
D3.2f
Rim: 6,457.76 ft
Invert: 6,449.00 ft
321-MH (DP 8D3)
Rim: 6,456.72 ft
Invert: 6,442.39 ft
6,460.00
6,455.00
6,450.00
6,445.00
6,440.00
Elevation (ft)
P-492: 76.6 ft @ 0.050 ft/ft
18.0 in RCP
V=11.41 ft/s
Q=6.60 cfs
-0+50
0+00
0+50
1+00
Station (ft)


Active Scenario: 100-YR
320.2-INLET D3.18
Rim: 6,451.84 ft
Invert: 6,441.96 ft
320-MH (DP 9D3)
Rim: 6,451.45 ft
Invert: 6,438.21 ft
P-320.2: 35.6 ft @ 0.049 ft/ft
18.0 in RCP
V=1.19 ft/s
Q=2.10 cfs
6,455.00
6,450.00
6,445.00
6,440.00
6,435.00
Elevation (ft)
-0+50
0+00
0+50
Station (ft)

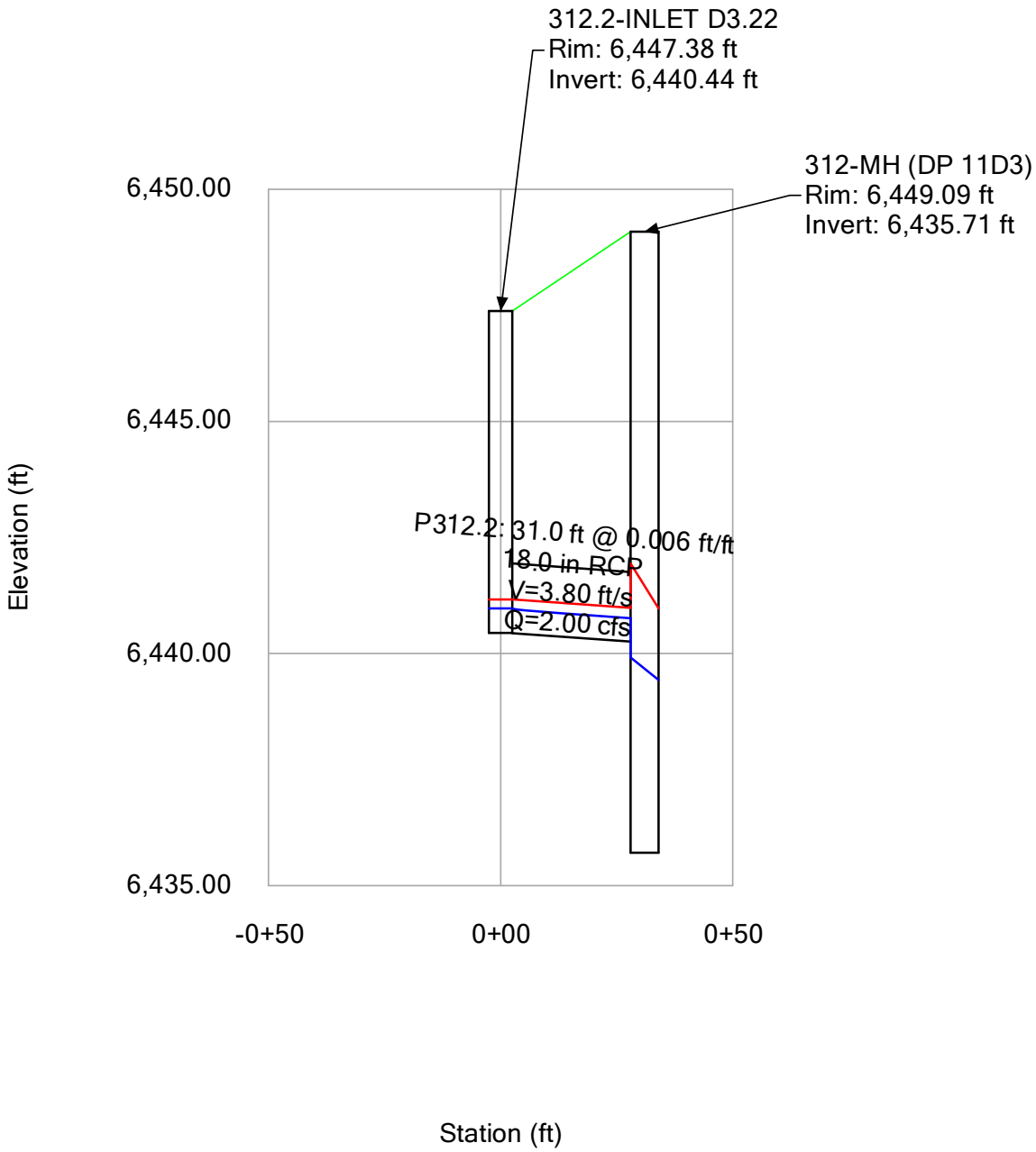
Active Scenario: 100-YR

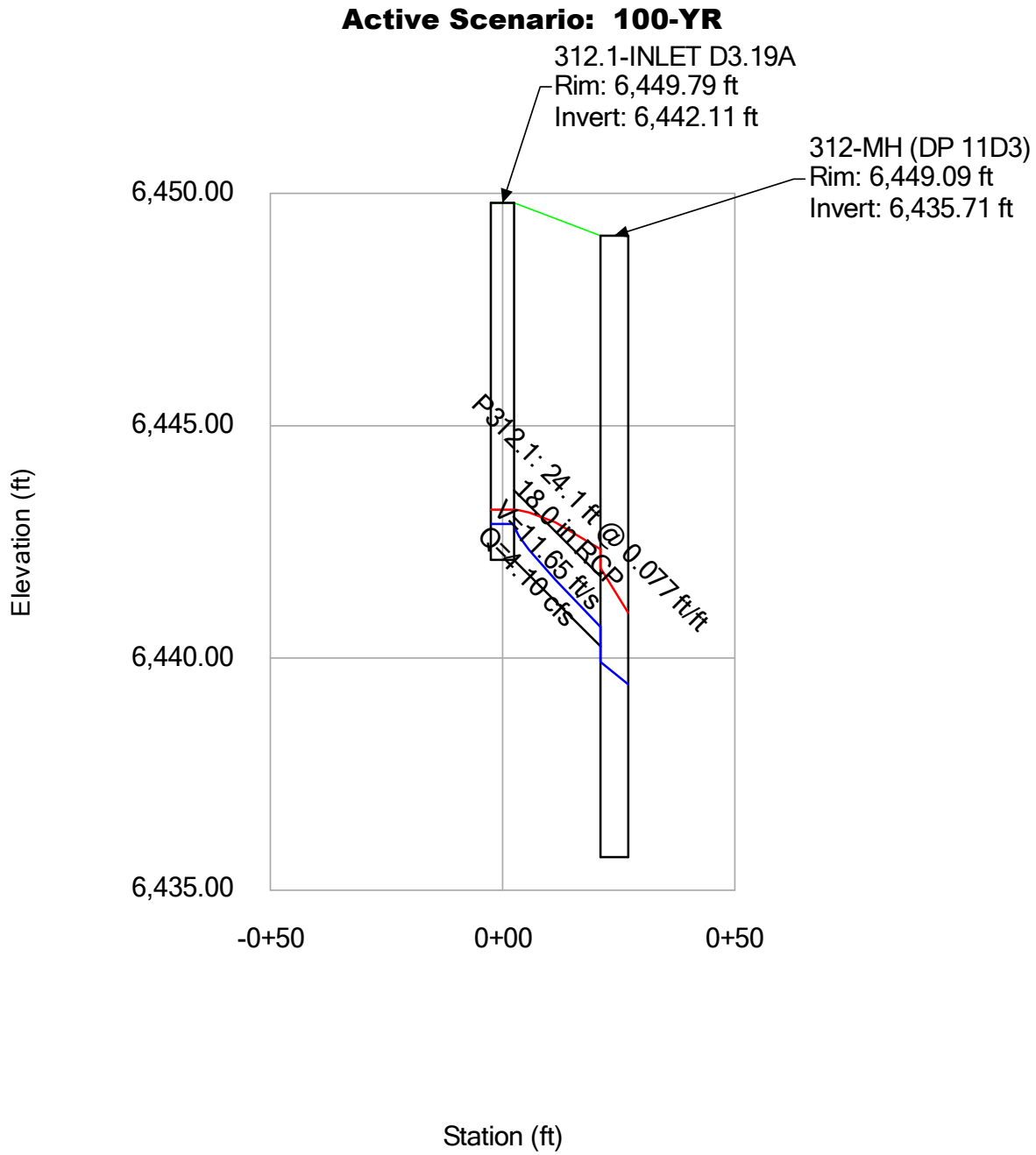


Active Scenario: 100-YR

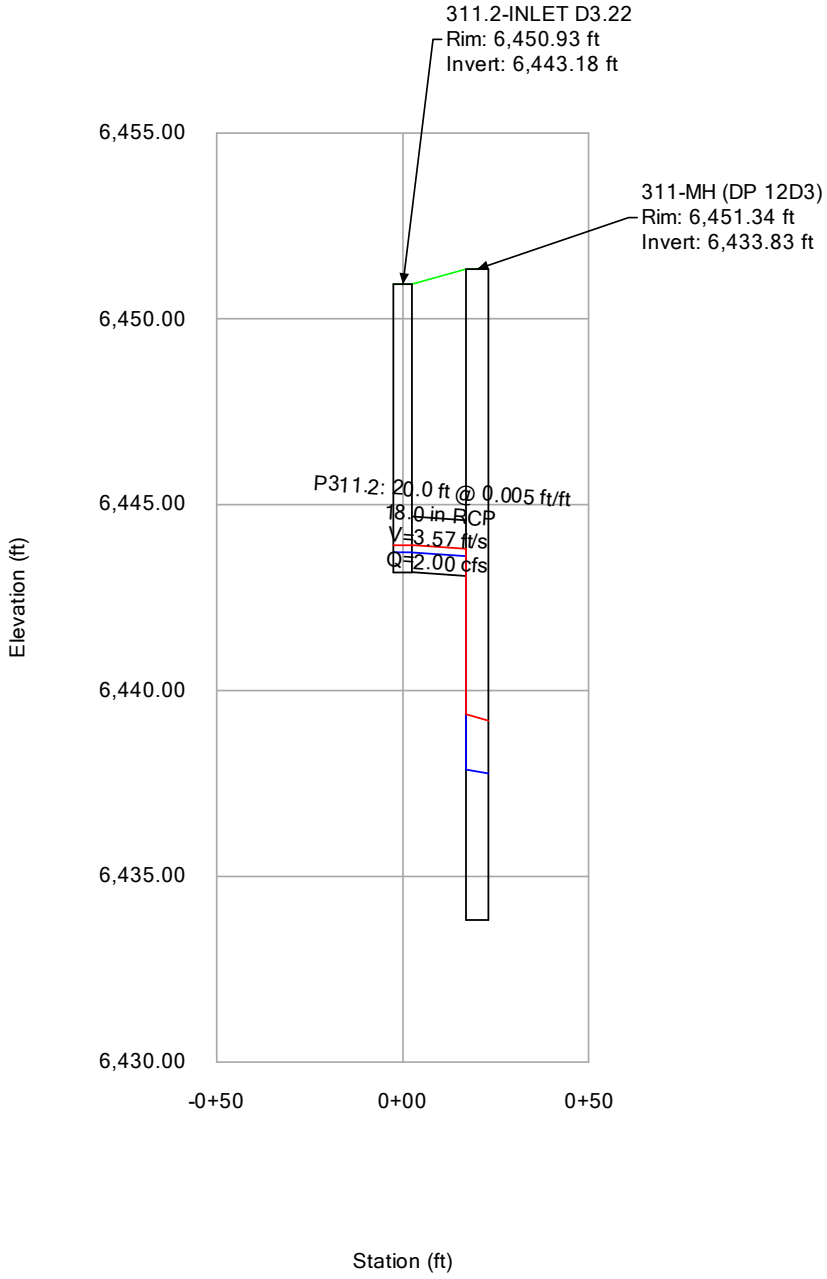


Active Scenario: 100-YR

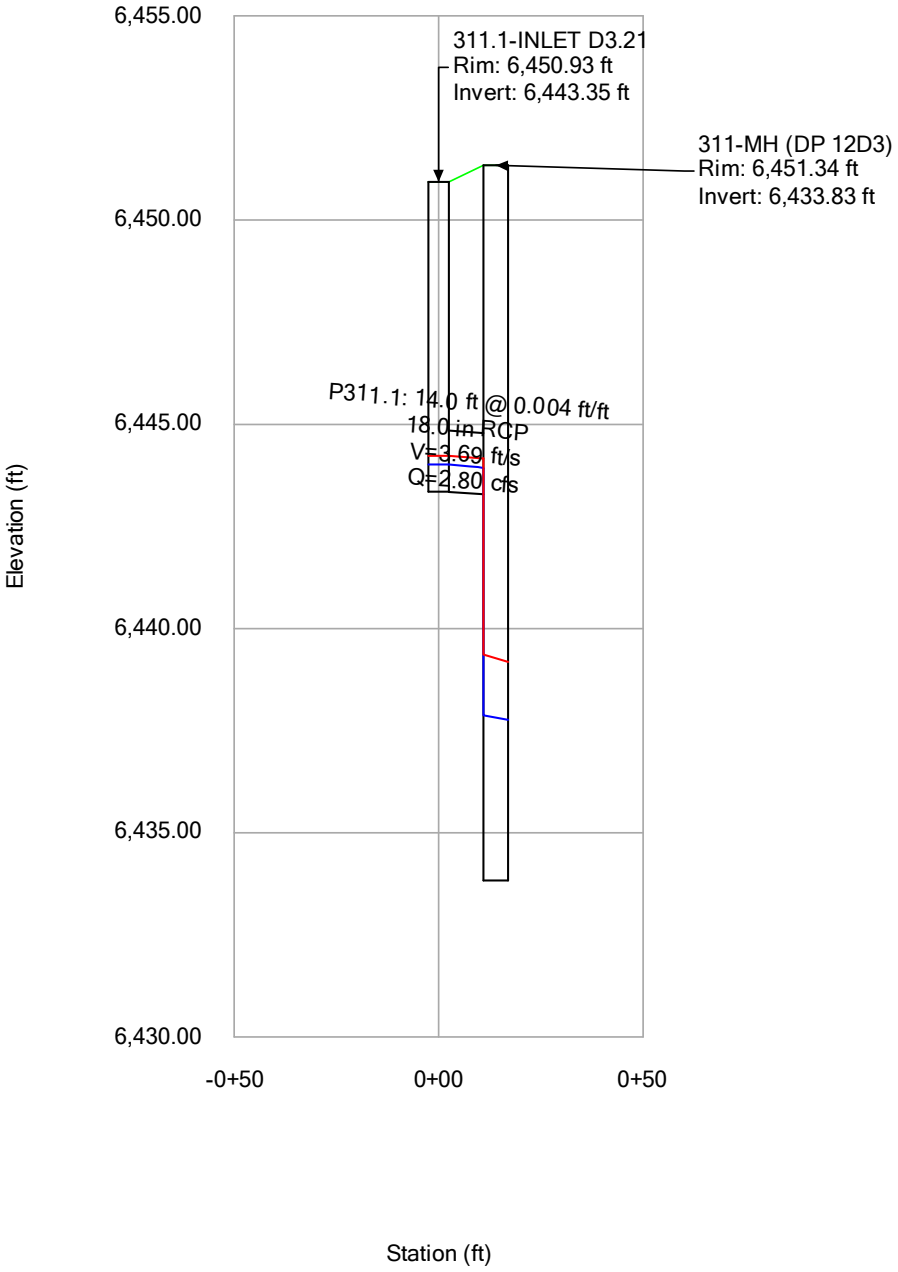



Active Scenario: 100-YR
312.1-INLET D3.19A
Rim: 6,449.79 ft
Invert: 6,442.11 ft
312-MH (DP 11D3)
Rim: 6,449.09 ft
Invert: 6,435.71 ft
6,450.00
6,445.00
6,440.00
6,435.00
Elevation (ft)
P312.1: 24.1 ft @ 0.077 ft/ft
18.0-in RCP
V=11.65 ft/s
Q=4.10 cfs
-0+50
0+00
0+50
Station (ft)

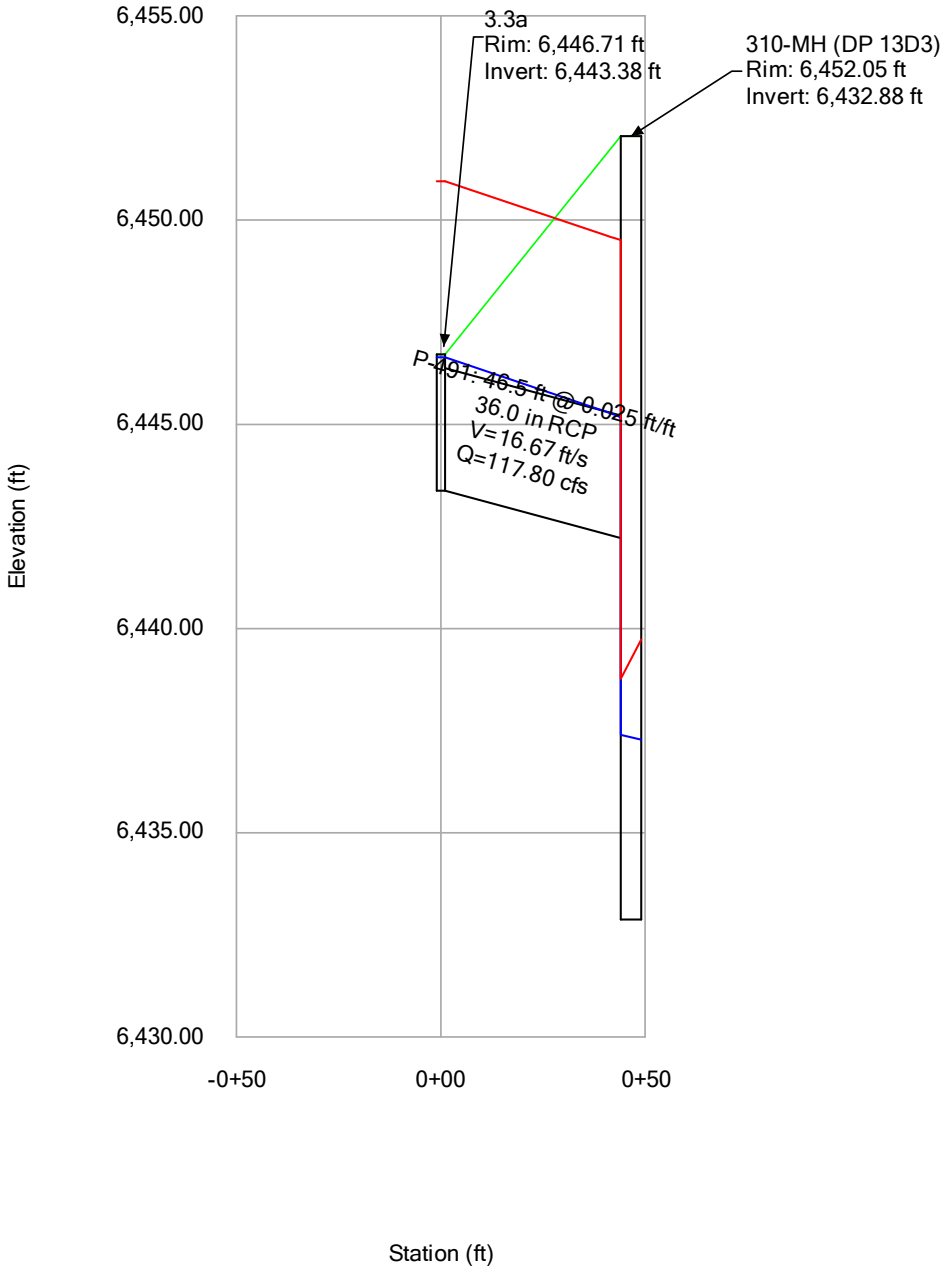
Active Scenario: 100-YR



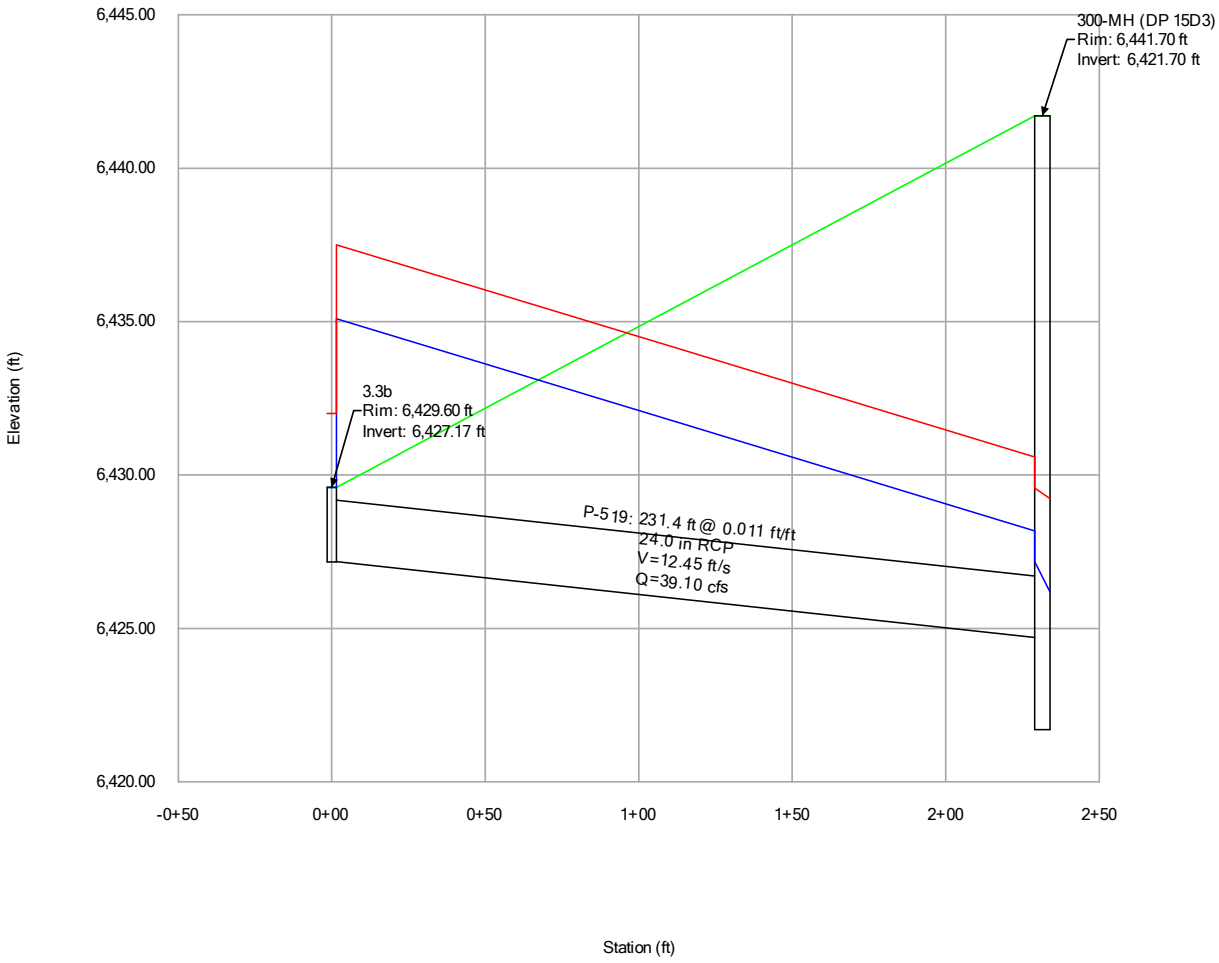
Active Scenario: 100-YR



Active Scenario: 100-YR



Active Scenario: 100-YR



Scenario: 5-YR
Current Time Step: 0.000 h
FlexTable: Conduit Table

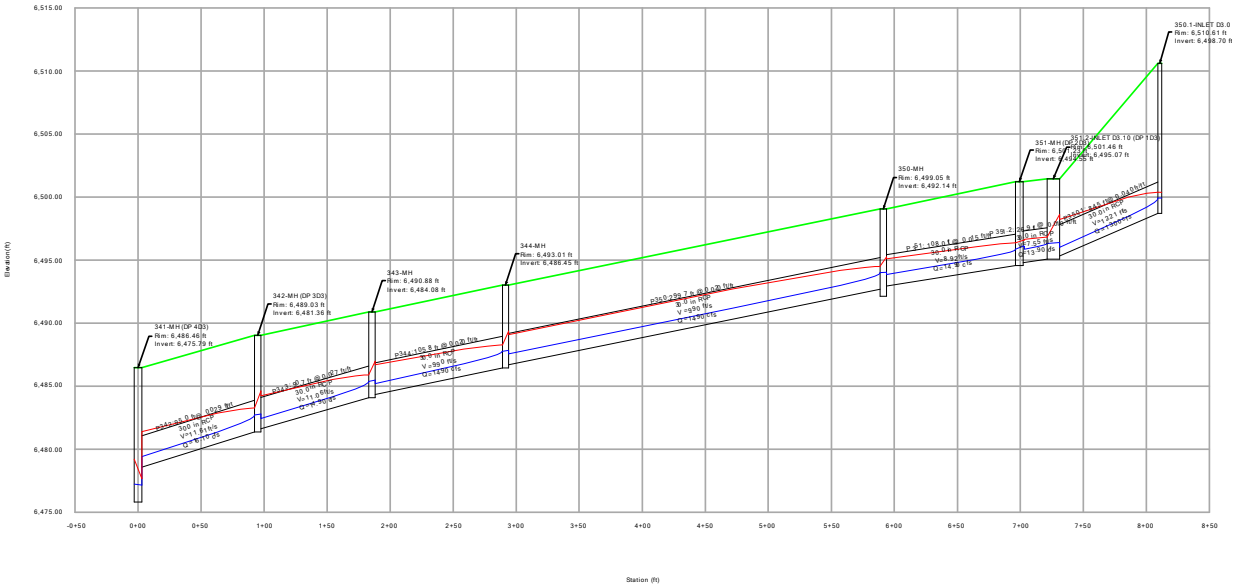
Label	Start Node	Stop Node	Invert (Start) (ft)	Invert (Stop) (ft)	Slope (Calculated) (ft/ft)	Length (Scaled) (ft)	Flow (cfs)	Diameter (in)	Velocity (ft/s)
P-491	3.3a	310-MH (DP 13D3)	6,443.38	6,442.21	0.025	46.5	48.80	36.0	14.63
P-492	D3.2f	321-MH (DP 8D3)	6,449.00	6,445.17	0.050	76.5	3.10	18.0	9.21
P-519	3.3b	300-MH (DP 15D3)	6,427.17	6,424.70	0.011	231.4	16.20	24.0	8.03
P300	300-MH (DP 15D3)	O-300	6,421.70	6,420.92	0.010	78.0	89.70	60.0	12.04
P301	301-MH	STRC-313 (DP 14D3)	6,430.70	6,428.90	0.007	257.6	76.70	60.0	10.13
P301(1)	STRC-313 (DP 14D3)	300-MH (DP 15D3)	6,426.40	6,424.88	0.010	152.5	79.30	60.0	11.64
P310	310-MH (DP 13D3)	301-MH	6,432.88	6,430.96	0.007	275.0	76.70	60.0	10.13
P311	311-MH (DP 12D3)	310-MH (DP 13D3)	6,433.83	6,433.38	0.005	89.8	39.90	54.0	7.55
P311.1	311.1-INLET D3.21	311-MH (DP 12D3)	6,443.35	6,443.29	0.004	14.0	0.90	18.0	2.69
P311.2	311.2-INLET D3.22	311-MH (DP 12D3)	6,443.18	6,443.08	0.005	20.0	1.00	18.0	2.93
P312	312-MH (DP 11D3)	311-MH (DP 12D3)	6,435.71	6,434.08	0.005	326.0	39.90	54.0	7.55
P312.1	312.1-INLET D3.19A	312-MH (DP 11D3)	6,442.11	6,440.25	0.077	24.0	0.80	18.0	7.18
P312.2	312.2-INLET D3.22	312-MH (DP 11D3)	6,440.44	6,440.25	0.006	31.0	1.00	18.0	3.11
P313	313-MH (DP 10D3)	312-MH (DP 11D3)	6,436.70	6,436.21	0.010	48.9	38.70	48.0	9.70
P313.1	313.1-INLET D3.20A	313-MH (DP 10D3)	6,441.53	6,439.80	0.025	74.4	1.20	18.0	5.45
P313.2	313.2-INLET D3.20	313.1-INLET D3.20A	6,442.30	6,441.73	0.025	22.9	1.20	18.0	5.46
P320	320-MH (DP 9D3)	313-MH (DP 10D3)	6,438.21	6,437.21	0.023	43.8	36.80	42.0	13.05
P320.1	320.1-INLET D3.19	320-MH (DP 9D3)	6,439.80	6,439.71	0.010	8.5	0.80	24.0	3.39
P320.2	320.2-INLET D3.18	320-MH (DP 9D3)	6,441.96	6,440.21	0.049	35.6	0.90	18.0	6.36
P321	330-MH (DP 7D3)	321-MH (DP 8D3)	6,449.77	6,445.92	0.028	137.7	33.40	36.0	13.79
P321(1)	321-MH (DP 8D3)	320-MH (DP 9D3)	6,442.39	6,439.96	0.023	105.4	35.30	42.0	12.90
P330.1	D3.2c	330-MH (DP 7D3)	6,455.84	6,454.77	0.017	61.5	14.70	30.0	9.37
P331	331-MH (DP 6D3)	330-MH (DP 7D3)	6,455.32	6,453.06	0.028	80.8	22.90	36.0	12.42
P331.1	331.1-INLET D3.16	331-MH (DP 6D3)	6,460.18	6,460.07	0.013	8.5	0.60	18.0	3.52
P331.2	331.2-INLET D3.15	331-MH (DP 6D3)	6,460.72	6,460.07	0.018	35.5	1.10	18.0	4.77
P340	340-MH (DP 5D3)	332- MH	6,470.07	6,465.82	0.029	146.5	22.00	36.0	12.43
P340(2)	332- MH	331-MH (DP 6D3)	6,462.85	6,458.57	0.029	146.5	22.00	36.0	12.46
P340.1	D3.2b	340-MH (DP 5D3)	6,475.36	6,473.87	0.029	50.9	6.40	30.0	8.89
P341	341-MH (DP 4D3)	340-MH (DP 5D3)	6,475.79	6,473.37	0.030	80.4	17.80	36.0	11.84
P341.1	341.1-INLET D3.13	341-MH (DP 4D3)	6,479.15	6,479.07	0.010	7.9	1.40	24.0	4.00
P341.2	341.2-INLET D3.12	341-MH (DP 4D3)	6,479.86	6,479.57	0.011	26.1	1.20	18.0	4.10
P342	342-MH (DP 3D3)	341-MH (DP 4D3)	6,481.36	6,478.57	0.029	95.0	16.10	30.0	11.61
P342.1	342.1-INLET D3.12A	342-MH (DP 3D3)	6,483.45	6,482.11	0.015	89.1	1.90	30.0	4.91
P343	343-MH	342-MH (DP 3D3)	6,484.08	6,481.61	0.027	90.6	14.90	30.0	11.06
P344	344-MH	343-MH	6,486.45	6,484.34	0.020	105.8	14.90	30.0	9.90
P350	350-MH	344-MH	6,492.69	6,486.70	0.020	299.6	14.90	30.0	9.90
P350.1	350.1-INLET D3.0	351.2-INLET D3.10 (DP 1D3)	6,498.70	6,495.32	0.040	84.4	13.00	30.0	12.21
P351	351-MH (DP 2D3)	350-MH	6,494.55	6,492.93	0.015	108.0	14.90	30.0	8.92
P351.1	351.1-INLET D3.11	351-MH (DP 2D3)	6,495.87	6,495.80	0.010	7.1	1.70	18.0	4.37
P351.2	351.2-INLET D3.10 (DP 1D3)	351-MH (DP 2D3)	6,495.07	6,494.80	0.010	26.9	13.90	30.0	7.55

Scenario: 5-YR
Current Time Step: 0.000 h
FlexTable: Manhole Table

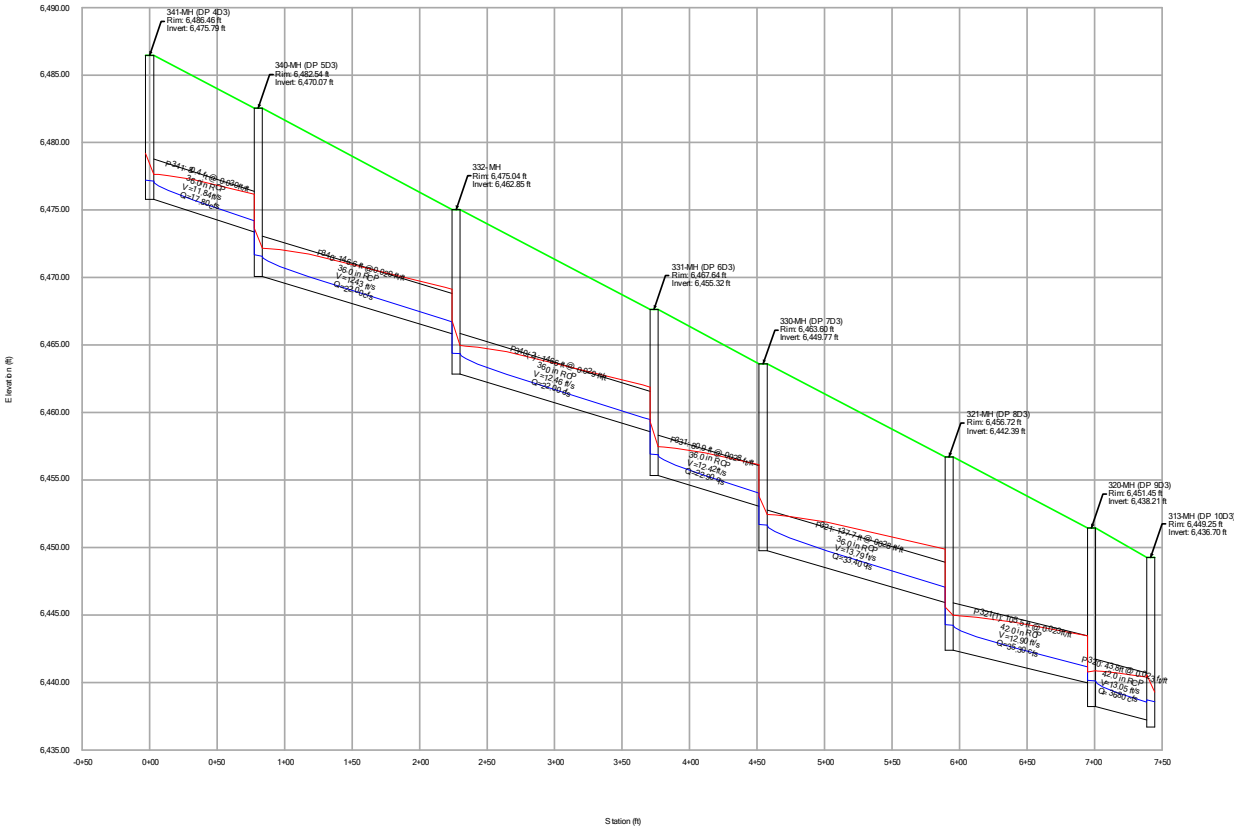
Label	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Headloss Method	Headloss (ft)	Velocity (Out) (ft/s)
3.3a	6,446.71	6,443.38	6,445.65	6,445.65	HEC-22 Energy (Second Edition)	0.00	8.49
3.3b	6,429.60	6,427.17	6,428.63	6,428.63	HEC-22 Energy (Second Edition)	0.00	6.63
300-MH (DP 15D3)	6,441.70	6,421.70	6,424.65	6,424.39	HEC-22 Energy (Second Edition)	0.26	8.33
301-MH	6,446.26	6,430.70	6,433.22	6,433.18	HEC-22 Energy (Second Edition)	0.04	7.90
310-MH (DP 13D3)	6,452.05	6,432.88	6,435.39	6,435.36	HEC-22 Energy (Second Edition)	0.03	7.90
311-MH (DP 12D3)	6,451.34	6,433.83	6,435.69	6,435.65	HEC-22 Energy (Second Edition)	0.04	6.62
311.1-INLET D3.21	6,450.93	6,443.35	6,443.72	6,443.72	HEC-22 Energy (Second Edition)	0.00	2.69
311.2-INLET D3.22	6,450.93	6,443.18	6,443.55	6,443.55	HEC-22 Energy (Second Edition)	0.00	2.92
312-MH (DP 11D3)	6,449.09	6,435.71	6,437.67	6,437.53	HEC-22 Energy (Second Edition)	0.14	6.62
312.1-INLET D3.19A	6,449.79	6,442.11	6,442.44	6,442.44	HEC-22 Energy (Second Edition)	0.00	2.74
312.2-INLET D3.22	6,447.38	6,440.44	6,440.81	6,440.81	HEC-22 Energy (Second Edition)	0.00	2.92
313-MH (DP 10D3)	6,449.25	6,436.70	6,438.71	6,438.56	HEC-22 Energy (Second Edition)	0.15	6.78
313.1-INLET D3.20A	6,449.80	6,441.53	6,442.00	6,441.94	HEC-22 Energy (Second Edition)	0.06	3.07
313.2-INLET D3.20	6,450.00	6,442.30	6,442.71	6,442.71	HEC-22 Energy (Second Edition)	0.00	3.07
320-MH (DP 9D3)	6,451.45	6,438.21	6,440.14	6,440.10	HEC-22 Energy (Second Edition)	0.05	6.97
320.1-INLET D3.19	6,451.67	6,439.26	6,440.49	6,440.49	HEC-22 Energy (Second Edition)	0.00	0.83
320.2-INLET D3.18	6,451.84	6,441.96	6,442.31	6,442.31	HEC-22 Energy (Second Edition)	0.00	2.83
321-MH (DP 8D3)	6,456.72	6,442.39	6,444.27	6,444.23	HEC-22 Energy (Second Edition)	0.04	6.87
330-MH (DP 7D3)	6,463.60	6,449.77	6,451.71	6,451.65	HEC-22 Energy (Second Edition)	0.06	7.18
331-MH (DP 6D3)	6,467.64	6,455.32	6,456.91	6,456.86	HEC-22 Energy (Second Edition)	0.05	6.26
331.1-INLET D3.16	6,467.88	6,460.18	6,460.47	6,460.47	HEC-22 Energy (Second Edition)	0.00	2.54
331.2-INLET D3.15	6,468.08	6,460.72	6,461.11	6,461.11	HEC-22 Energy (Second Edition)	0.00	2.99
332- MH	6,475.04	6,462.85	6,464.40	6,464.36	HEC-22 Energy (Second Edition)	0.04	6.18
340-MH (DP 5D3)	6,482.54	6,470.07	6,471.68	6,471.58	HEC-22 Energy (Second Edition)	0.10	6.18
341-MH (DP 4D3)	6,486.46	6,475.79	6,477.21	6,477.14	HEC-22 Energy (Second Edition)	0.07	5.77
341.1-INLET D3.13	6,486.69	6,479.15	6,479.56	6,479.56	HEC-22 Energy (Second Edition)	0.00	3.04
341.2-INLET D3.12	6,486.44	6,479.86	6,480.27	6,480.27	HEC-22 Energy (Second Edition)	0.00	3.07
342-MH (DP 3D3)	6,489.03	6,481.36	6,482.80	6,482.72	HEC-22 Energy (Second Edition)	0.08	5.92
342.1-INLET D3.12A	6,489.36	6,483.45	6,483.90	6,483.90	HEC-22 Energy (Second Edition)	0.00	3.17
343-MH	6,490.88	6,484.08	6,485.47	6,485.38	HEC-22 Energy (Second Edition)	0.09	5.77
344-MH	6,493.01	6,486.45	6,487.84	6,487.75	HEC-22 Energy (Second Edition)	0.08	5.77
350-MH	6,499.05	6,492.14	6,494.03	6,493.99	HEC-22 Energy (Second Edition)	0.04	5.77
350.1-INLET D3.0	6,510.61	6,498.70	6,499.91	6,499.91	HEC-22 Energy (Second Edition)	0.00	5.51
351-MH (DP 2D3)	6,501.23	6,494.55	6,496.13	6,495.85	HEC-22 Energy (Second Edition)	0.28	5.77
351.1-INLET D3.11	6,501.46	6,494.87	6,496.36	6,496.36	HEC-22 Energy (Second Edition)	0.00	3.39
351.2-INLET D3.10 (DP 1D3)	6,501.46	6,495.07	6,496.40	6,496.33	HEC-22 Energy (Second Edition)	0.07	5.63
D3.2b	6,483.30	6,475.36	6,476.20	6,476.20	HEC-22 Energy (Second Edition)	0.00	4.43
D3.2c	6,459.54	6,455.84	6,457.14	6,457.14	HEC-22 Energy (Second Edition)	0.00	5.74
D3.2f	6,457.76	6,449.00	6,449.67	6,449.67	HEC-22 Energy (Second Edition)	0.00	4.06
STRC-313 (DP 14D3)	6,443.66	6,426.40	6,429.31	6,428.92	HEC-22 Energy (Second Edition)	0.39	7.99

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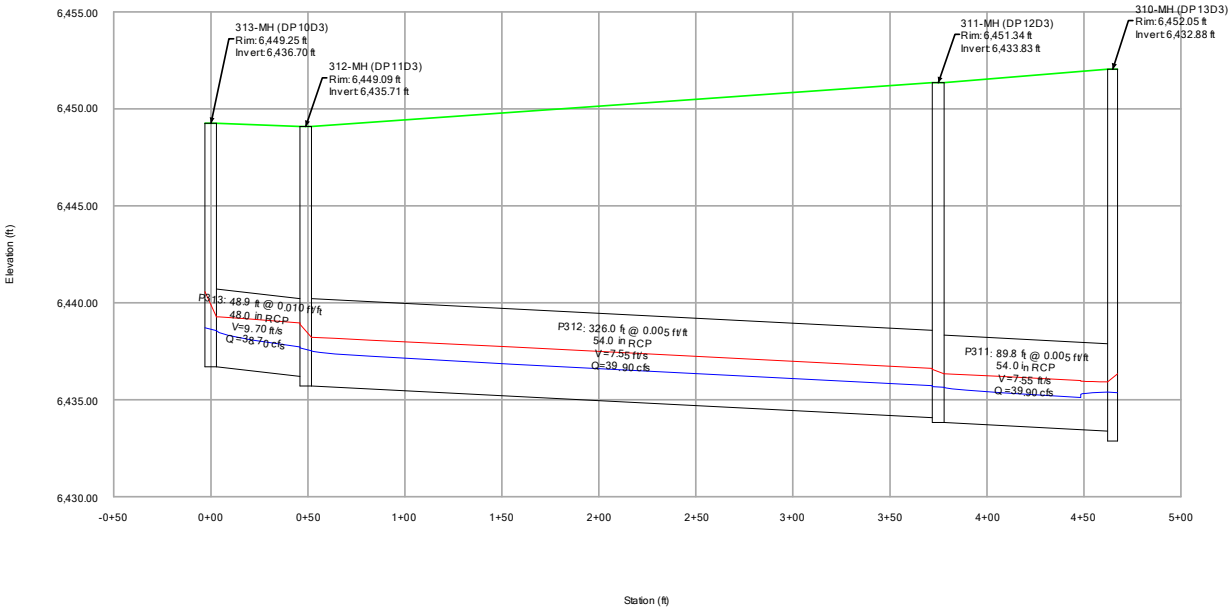
Active Scenario: 5-YR



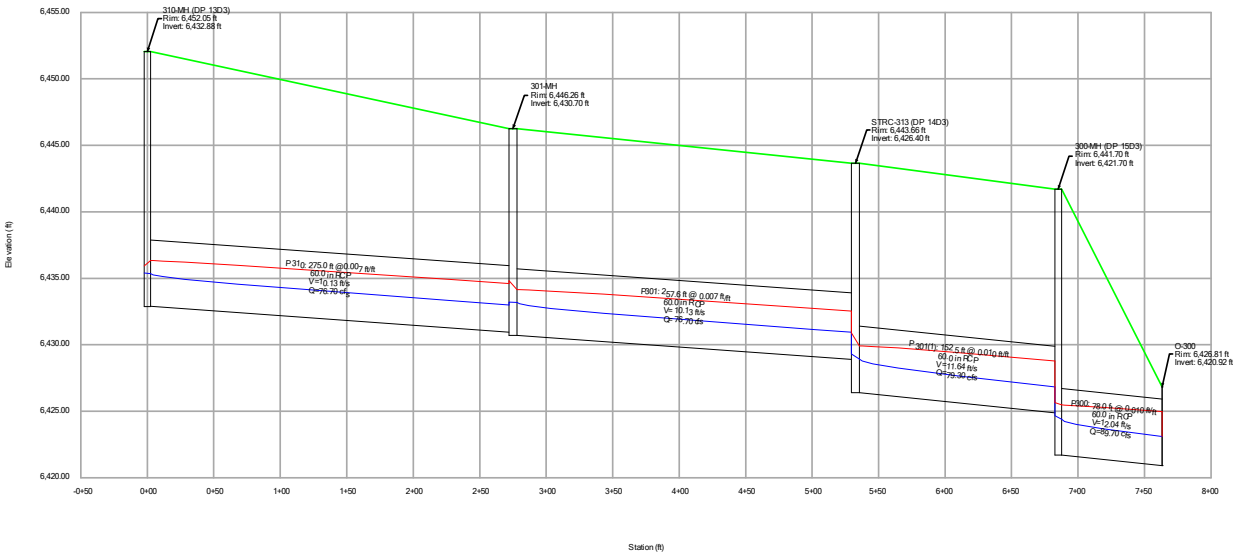
Active Scenario: 5-YR



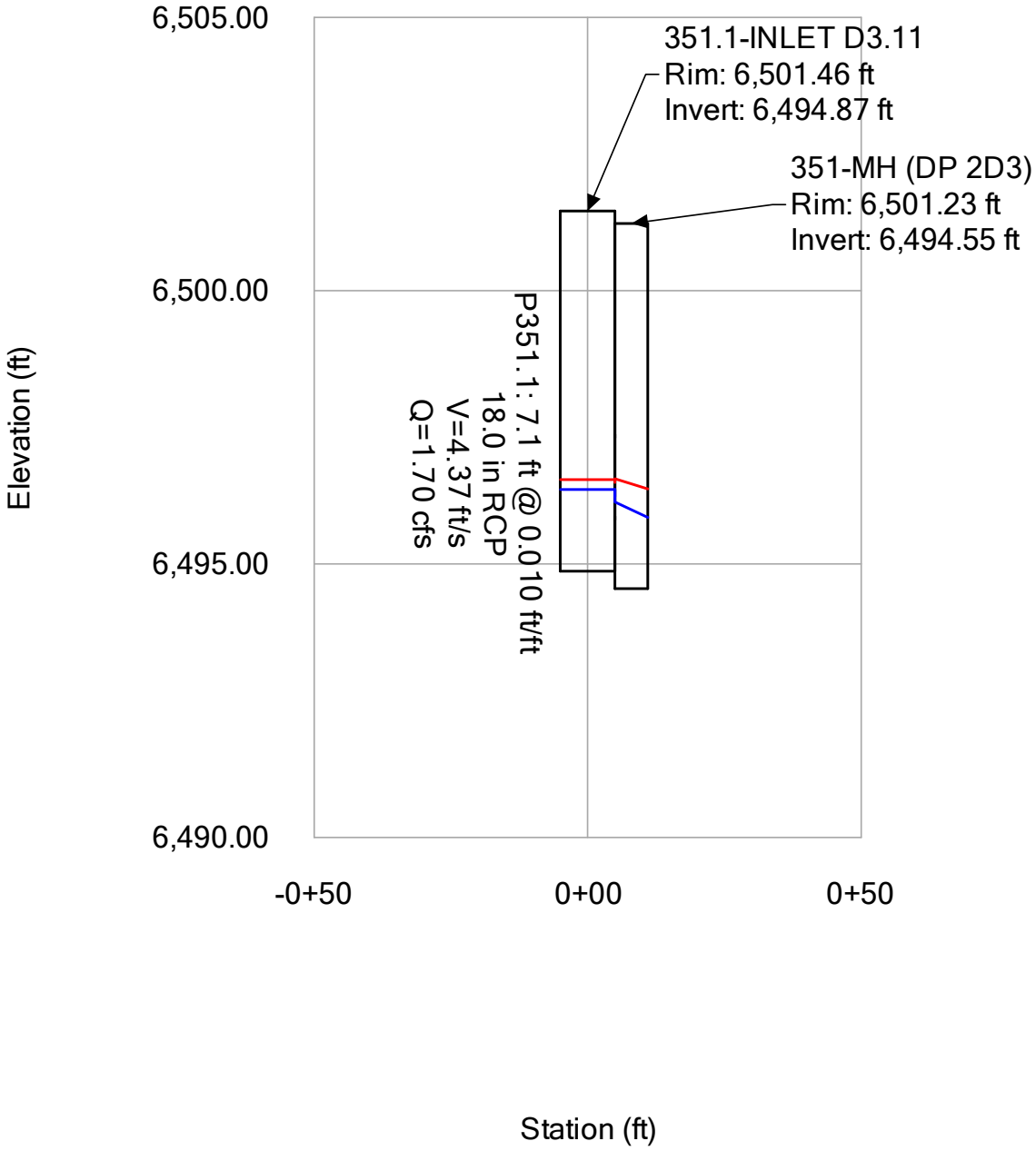
Active Scenario: 5-YR



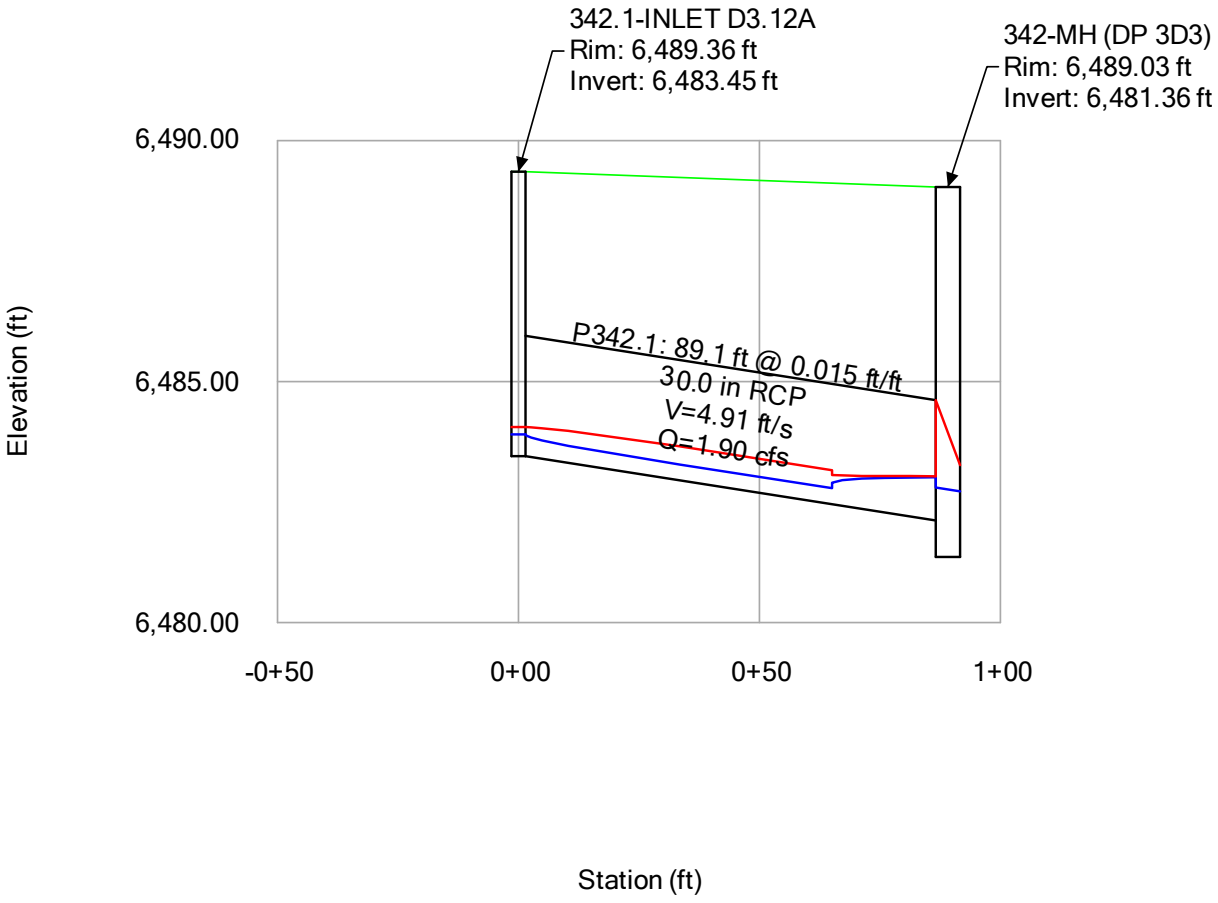
Active Scenario: 5-YR

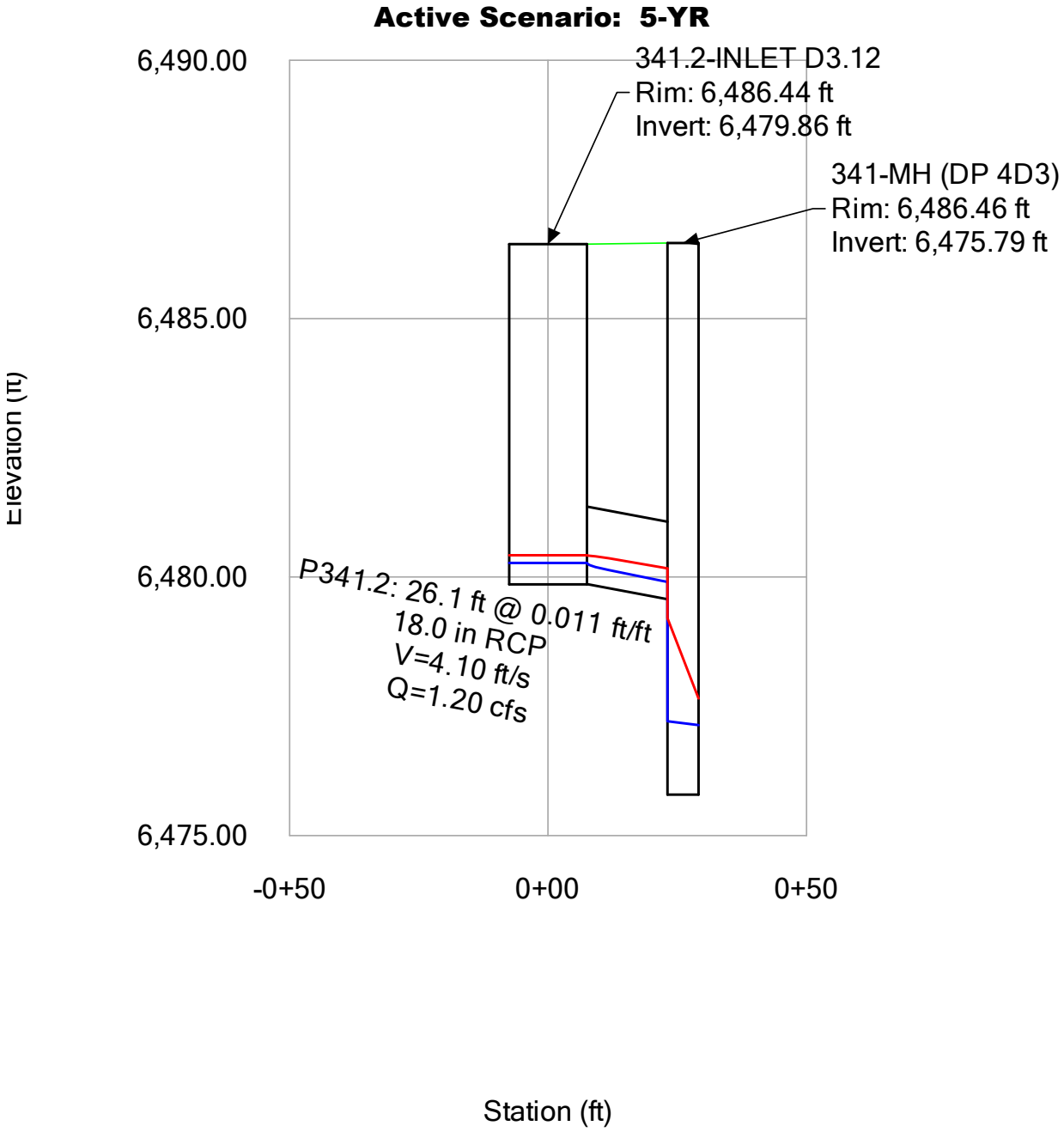


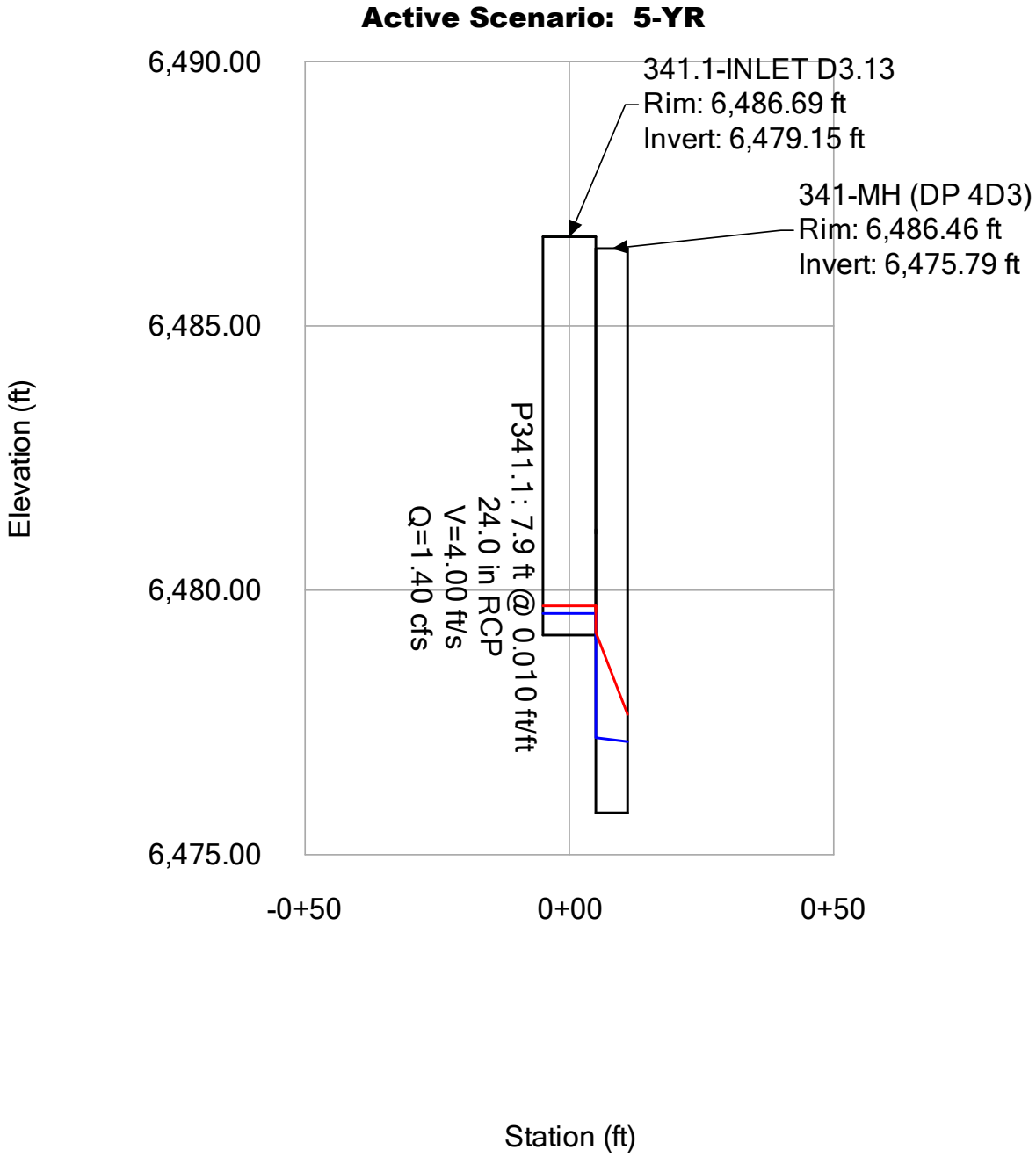
Active Scenario: 5-YR

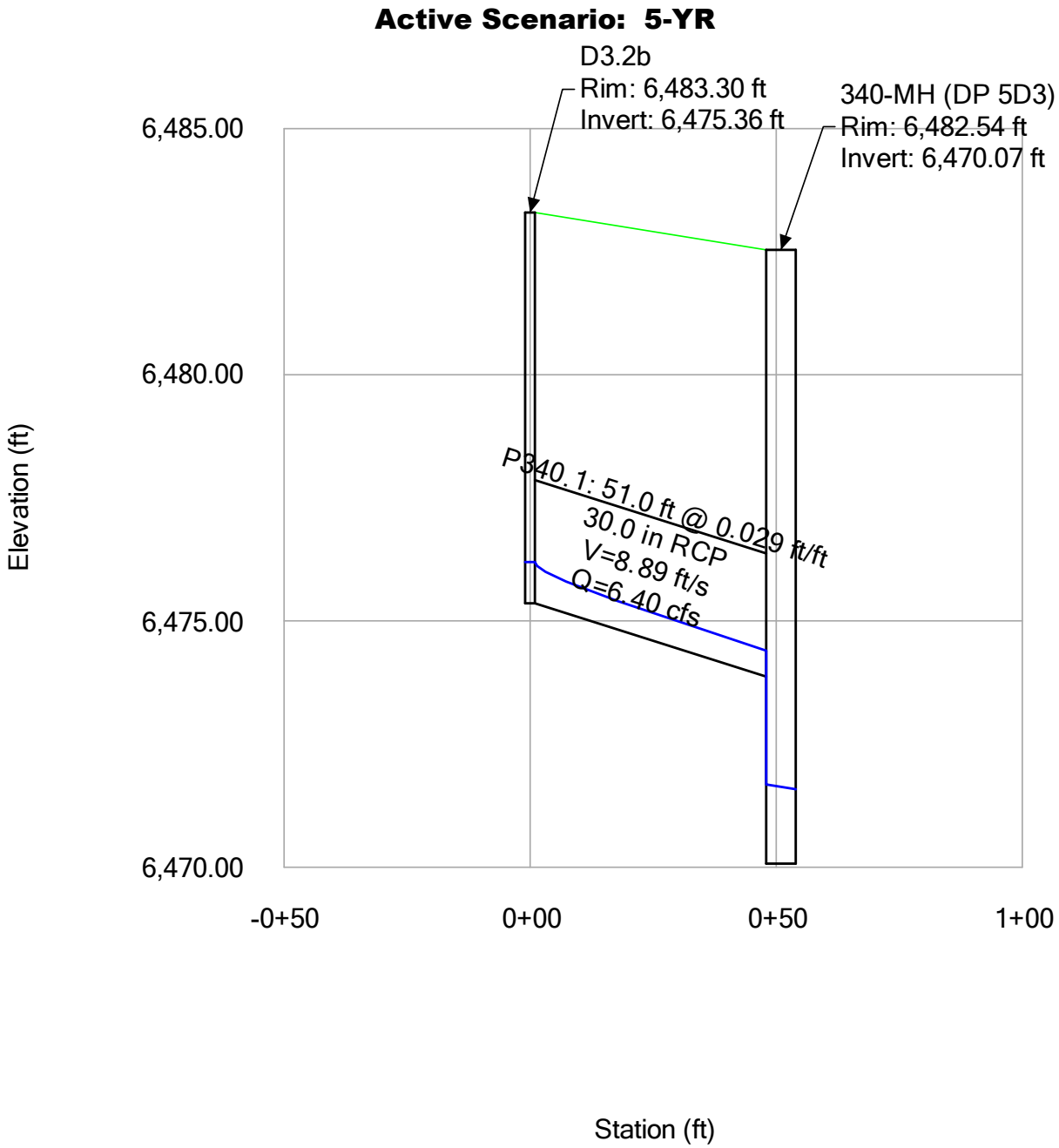


Active Scenario: 5-YR

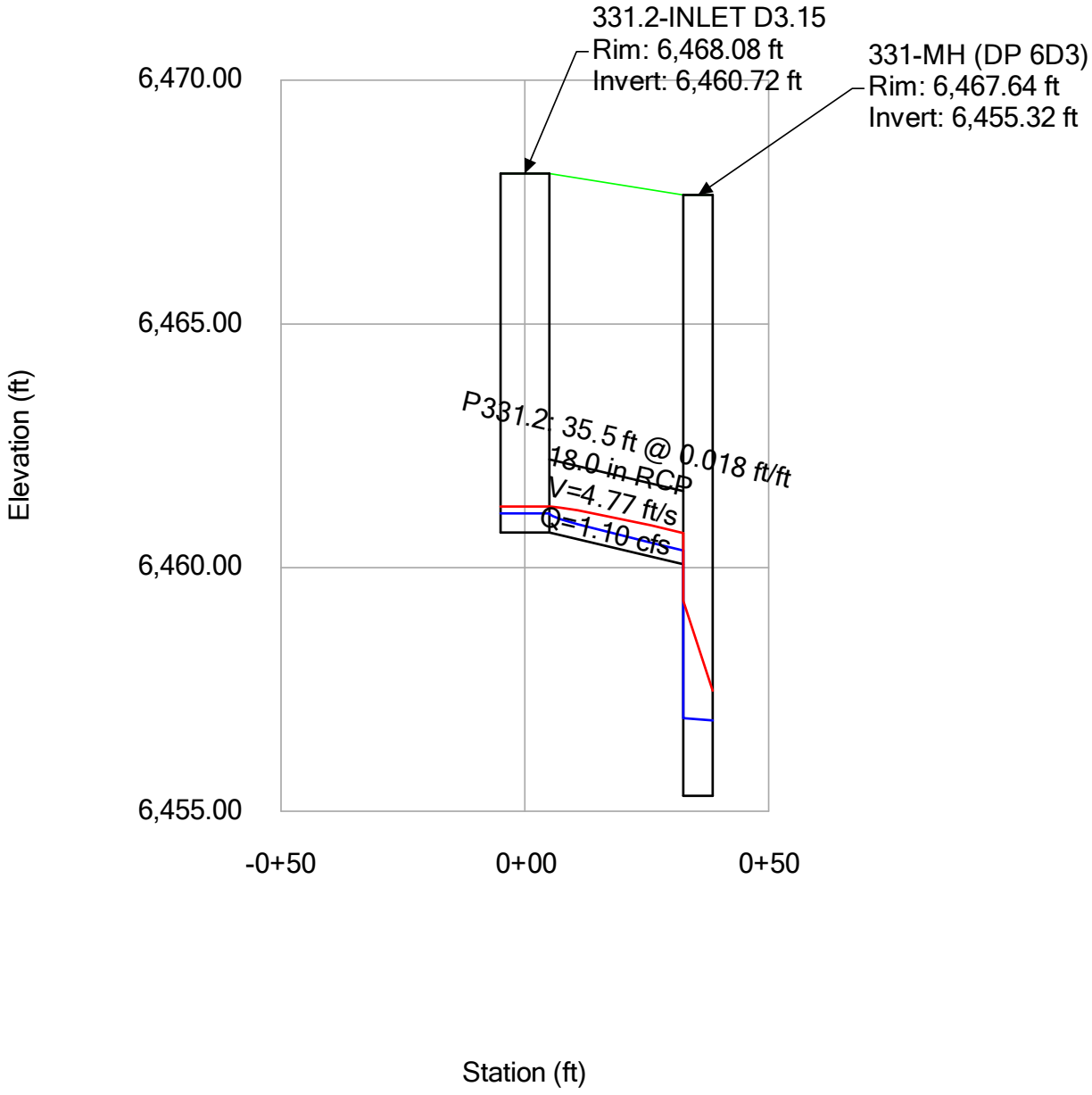



Active Scenario: 5-YR
6,490.00
6,485.00
6,480.00
6,475.00
Elevation (ft)
341.2-INLET D3.12
Rim: 6,486.44 ft
Invert: 6,479.86 ft
341-MH (DP 4D3)
Rim: 6,486.46 ft
Invert: 6,475.79 ft
P341.2: 26.1 ft @ 0.011 ft/ft
18.0 in RCP
V=4.10 ft/s
Q=1.20 cfs
-0+50
0+00
0+50
Station (ft)

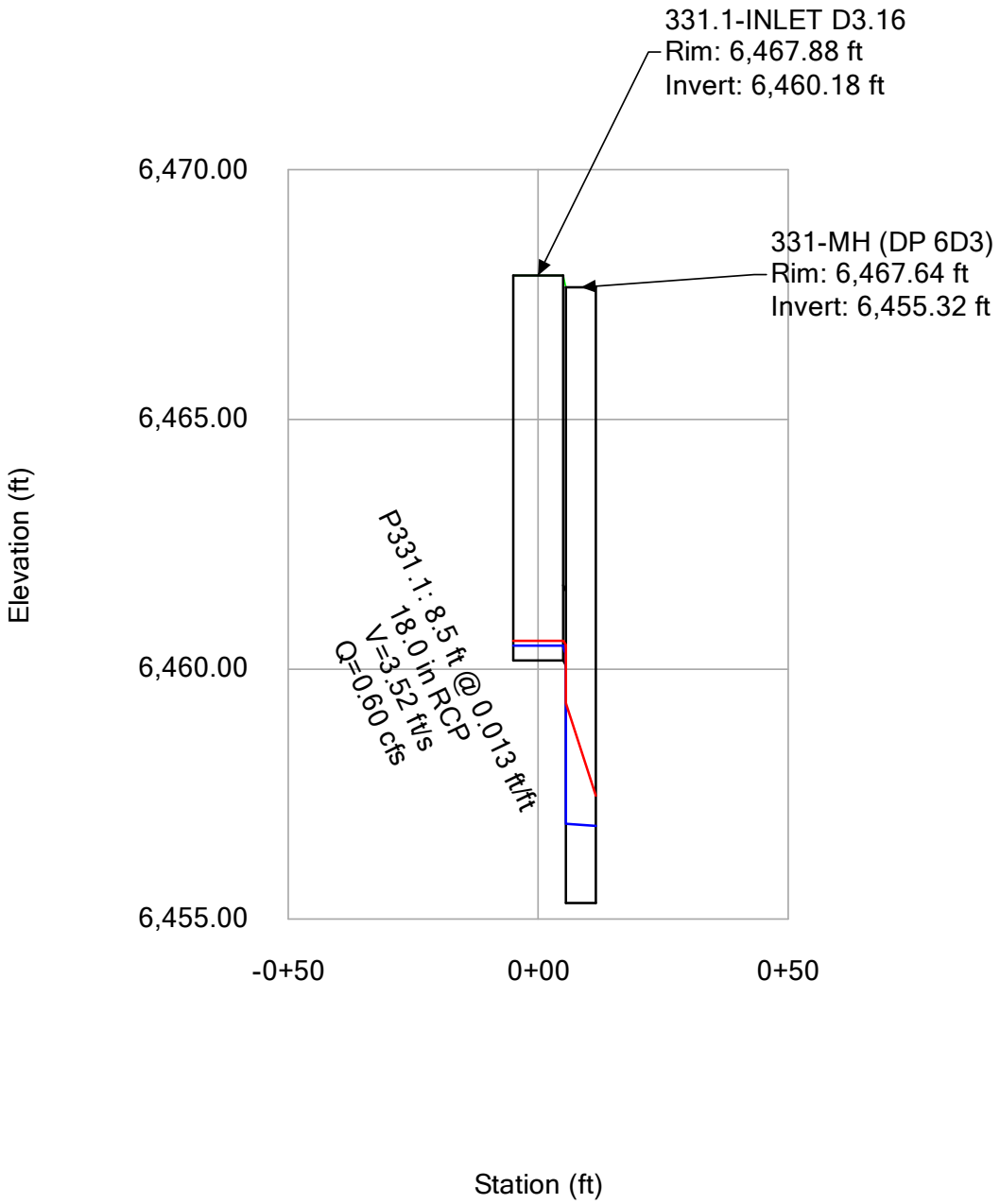

Active Scenario: 5-YR
6,490.00
6,485.00
6,480.00
6,475.00
Elevation (ft)
341.1-INLET D3.13
Rim: 6,486.69 ft
Invert: 6,479.15 ft
341-MH (DP 4D3)
Rim: 6,486.46 ft
Invert: 6,475.79 ft
P341.1: 7.9 ft @ 0.010 ft/ft
24.0 in RCP
V=4.00 ft/s
Q=1.40 cfs
-0+50
0+00
0+50
Station (ft)


Active Scenario: 5-YR
D3.2b
Rim: 6,483.30 ft
Invert: 6,475.36 ft
340-MH (DP 5D3)
Rim: 6,482.54 ft
Invert: 6,470.07 ft
6,485.00
6,480.00
6,475.00
6,470.00
Elevation (ft)
P340.1: 51.0 ft @ 0.029 ft/ft
30.0 in RCP
V=8.89 ft/s
Q=6.40 cfs
-0+50
0+00
0+50
1+00
Station (ft)

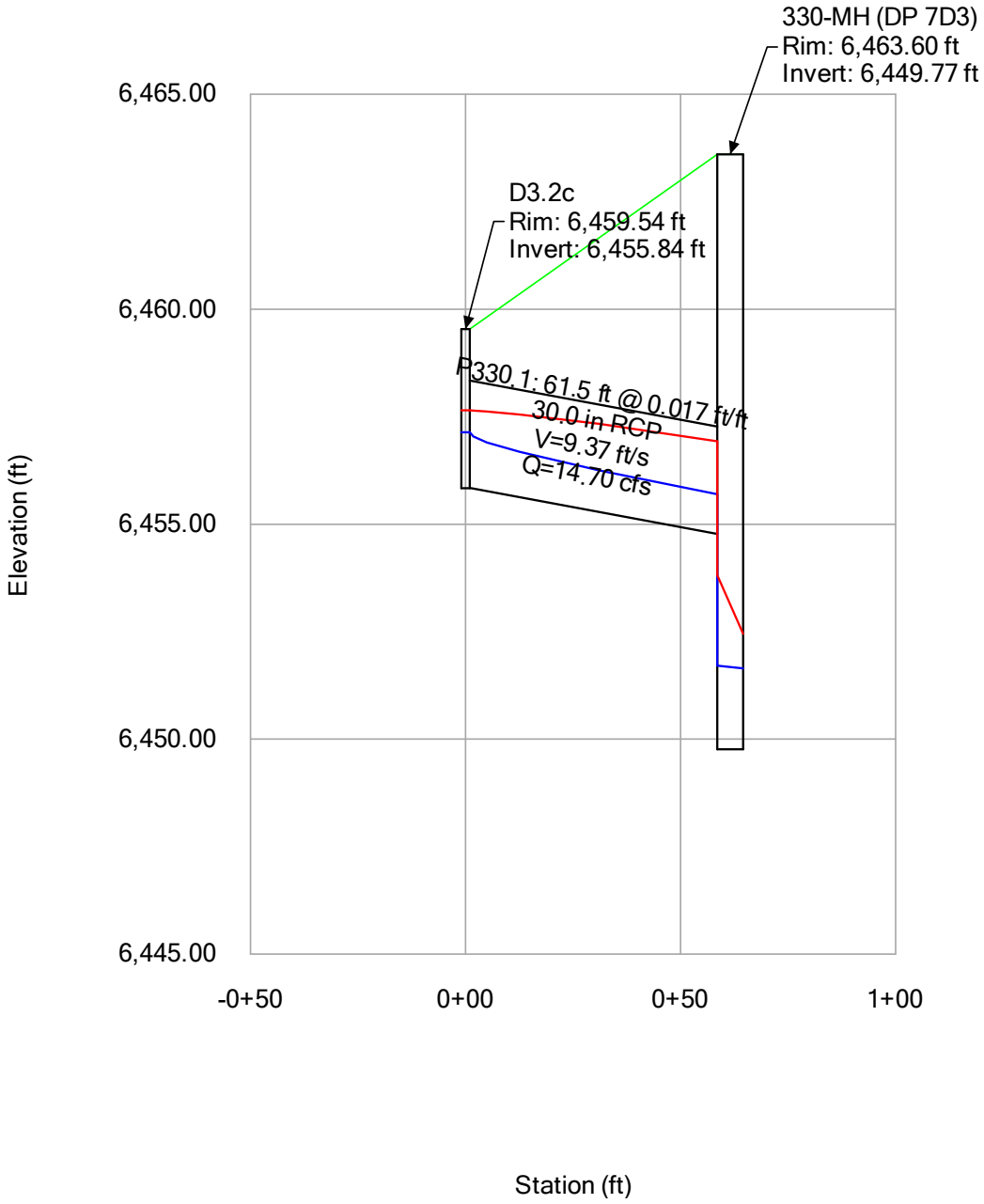
Active Scenario: 5-YR



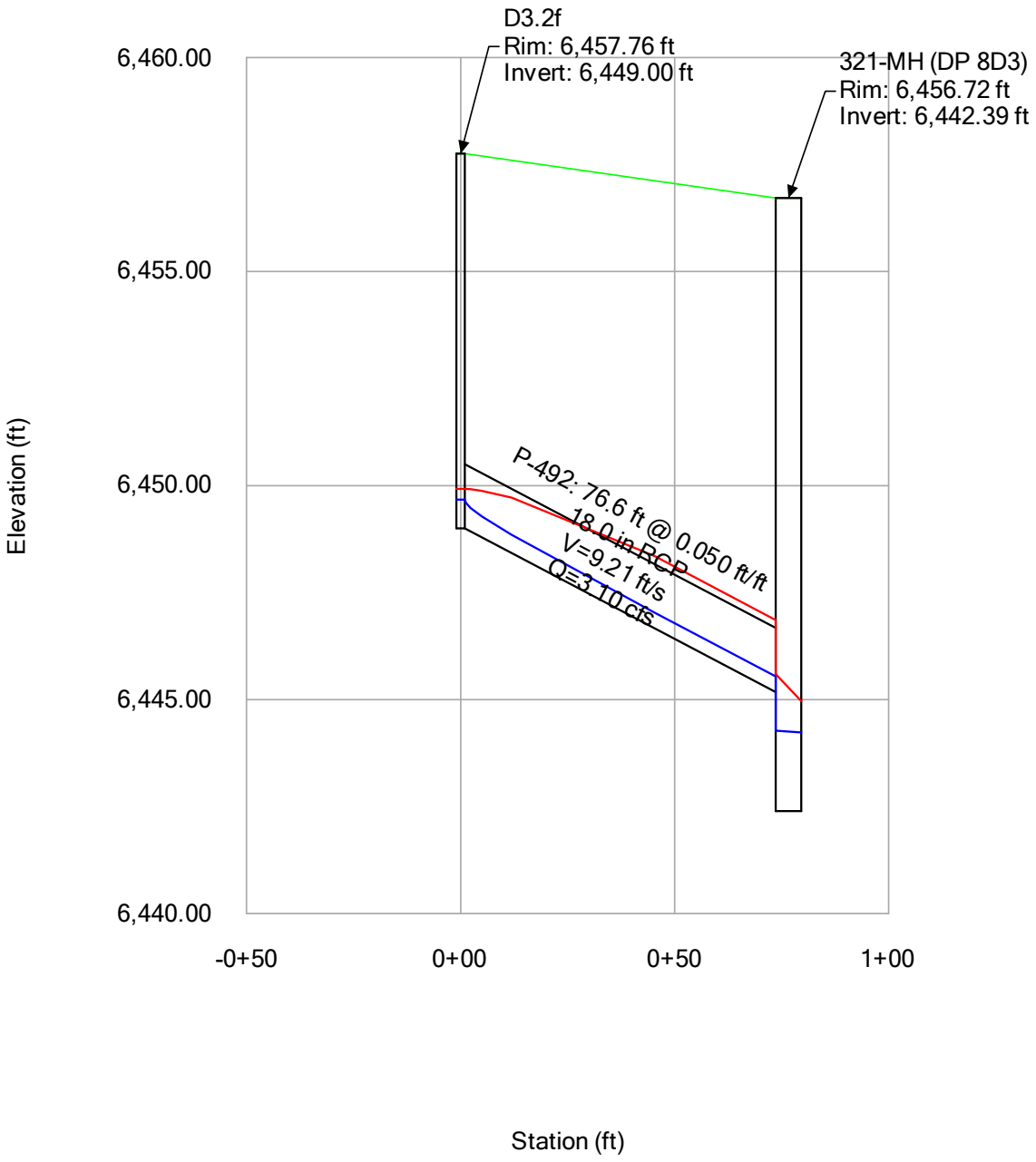
Active Scenario: 5-YR

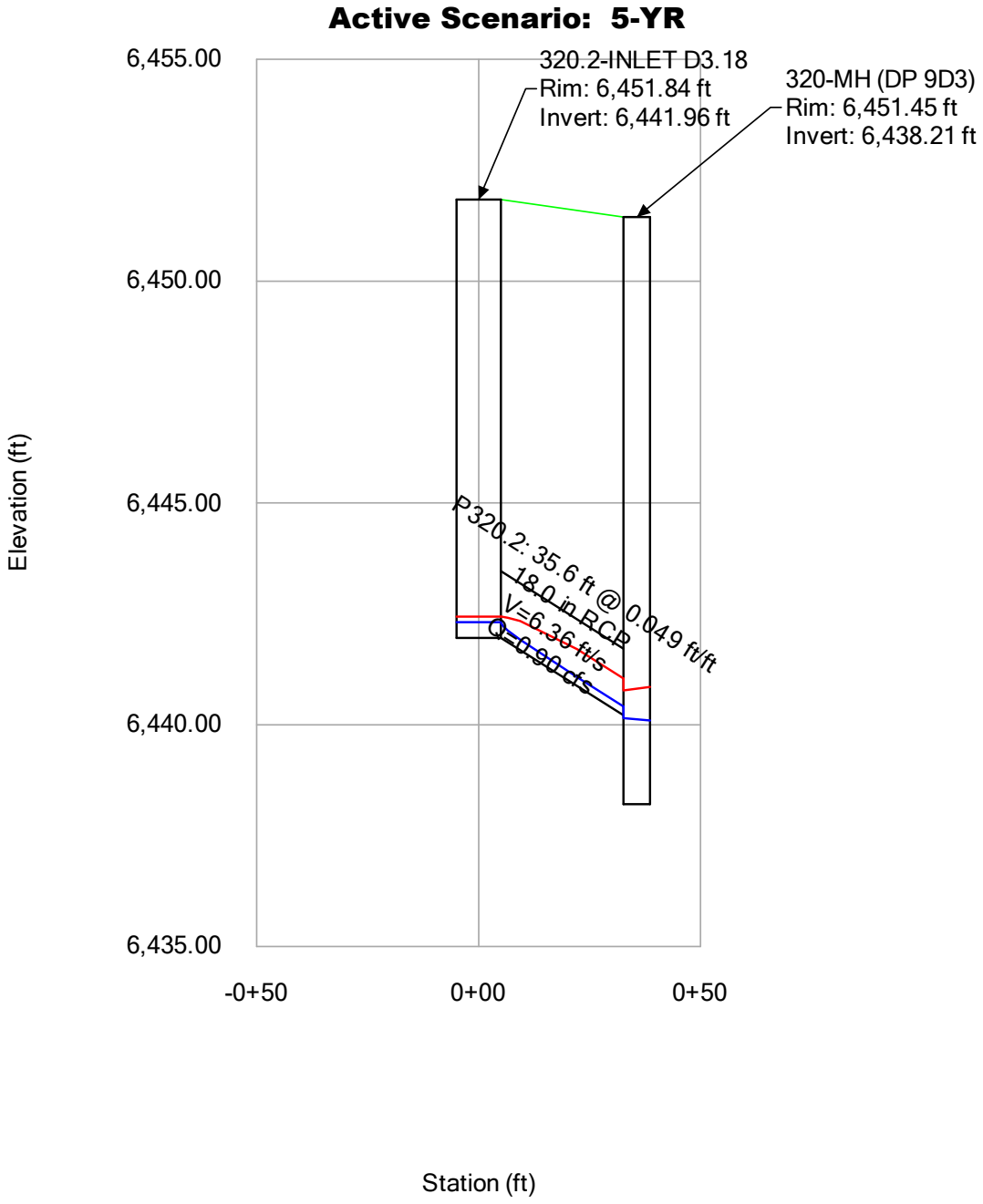


Active Scenario: 5-YR

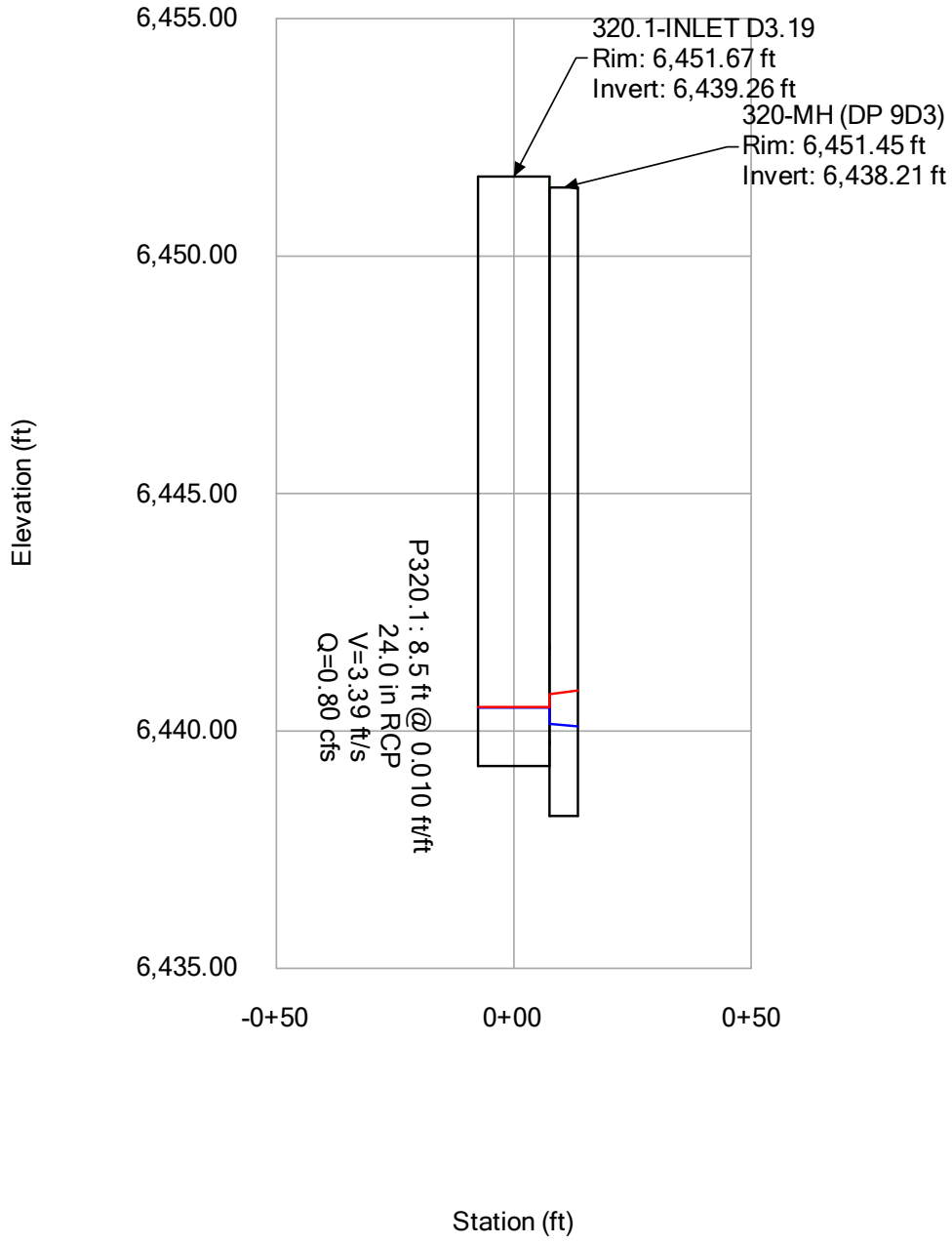


Active Scenario: 5-YR

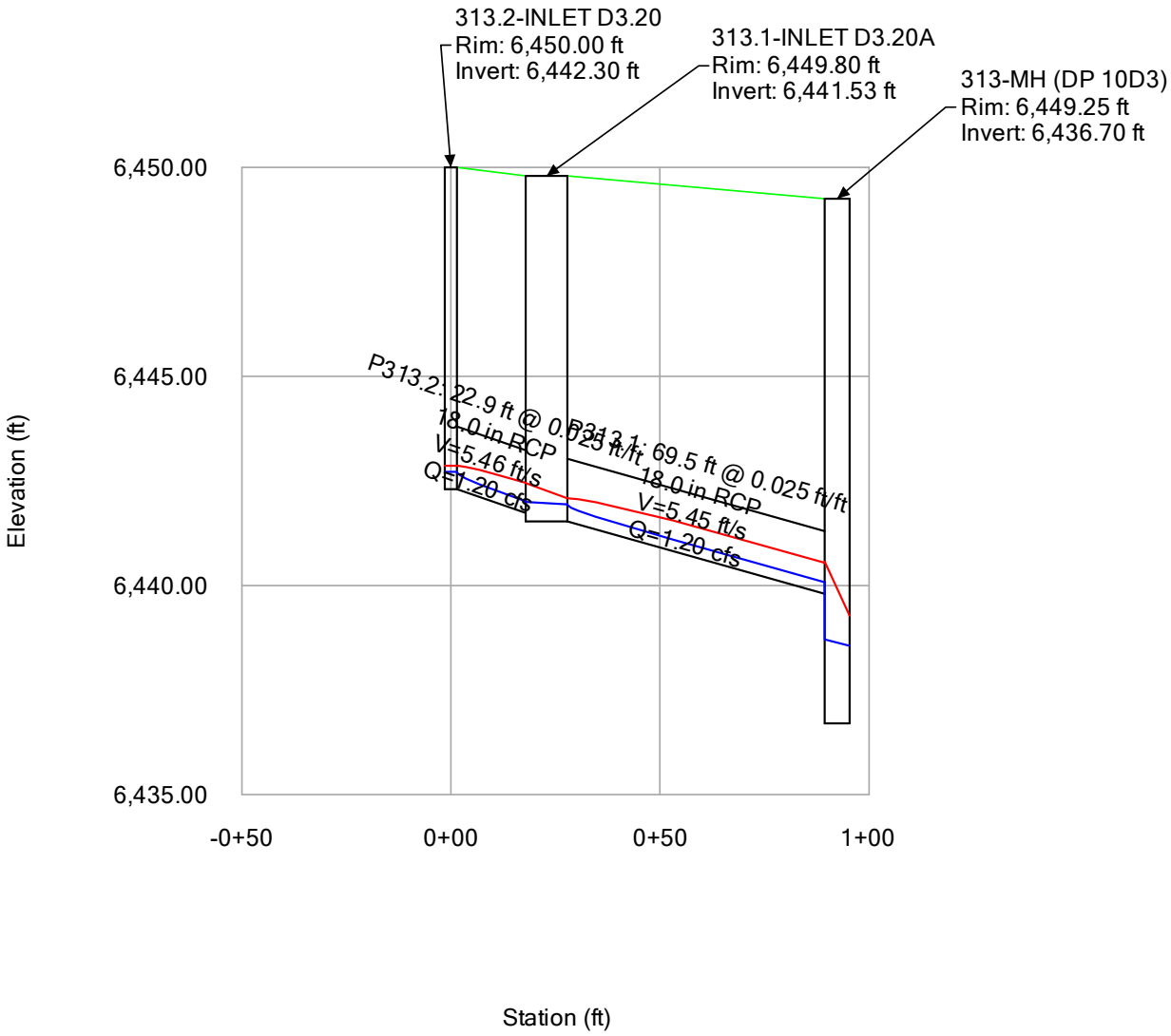



Active Scenario: 5-YR
320.2-INLET D3.18
Rim: 6,451.84 ft
Invert: 6,441.96 ft
320-MH (DP 9D3)
Rim: 6,451.45 ft
Invert: 6,438.21 ft
P320.2: 35.6 ft @ 0.049 ft/ft
18.0 in RCP
V=6.36 ft/s
Q=0.90 cfs
6,455.00
6,450.00
6,445.00
6,440.00
6,435.00
Elevation (ft)
-0+50
0+00
0+50
Station (ft)

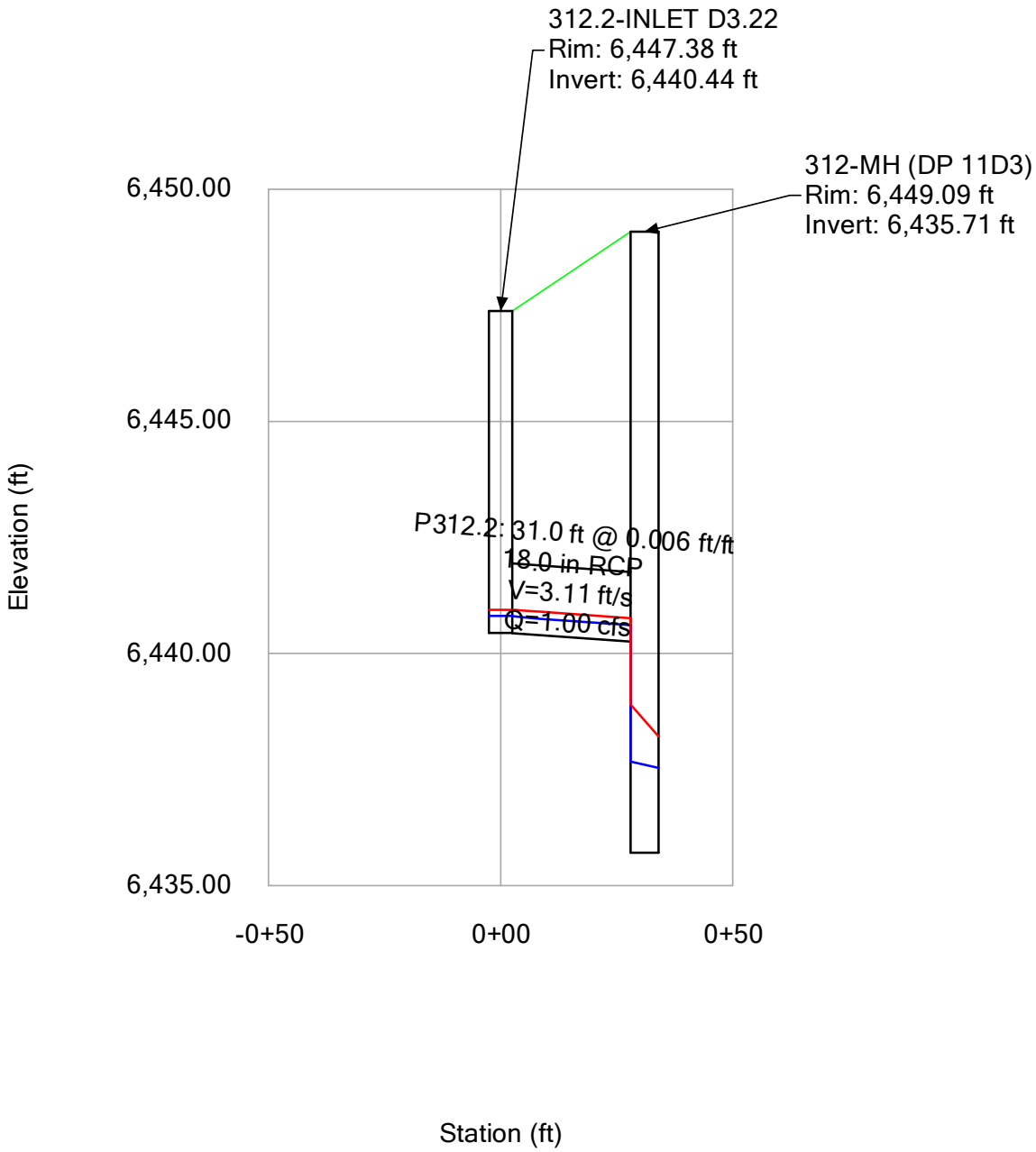
Active Scenario: 5-YR



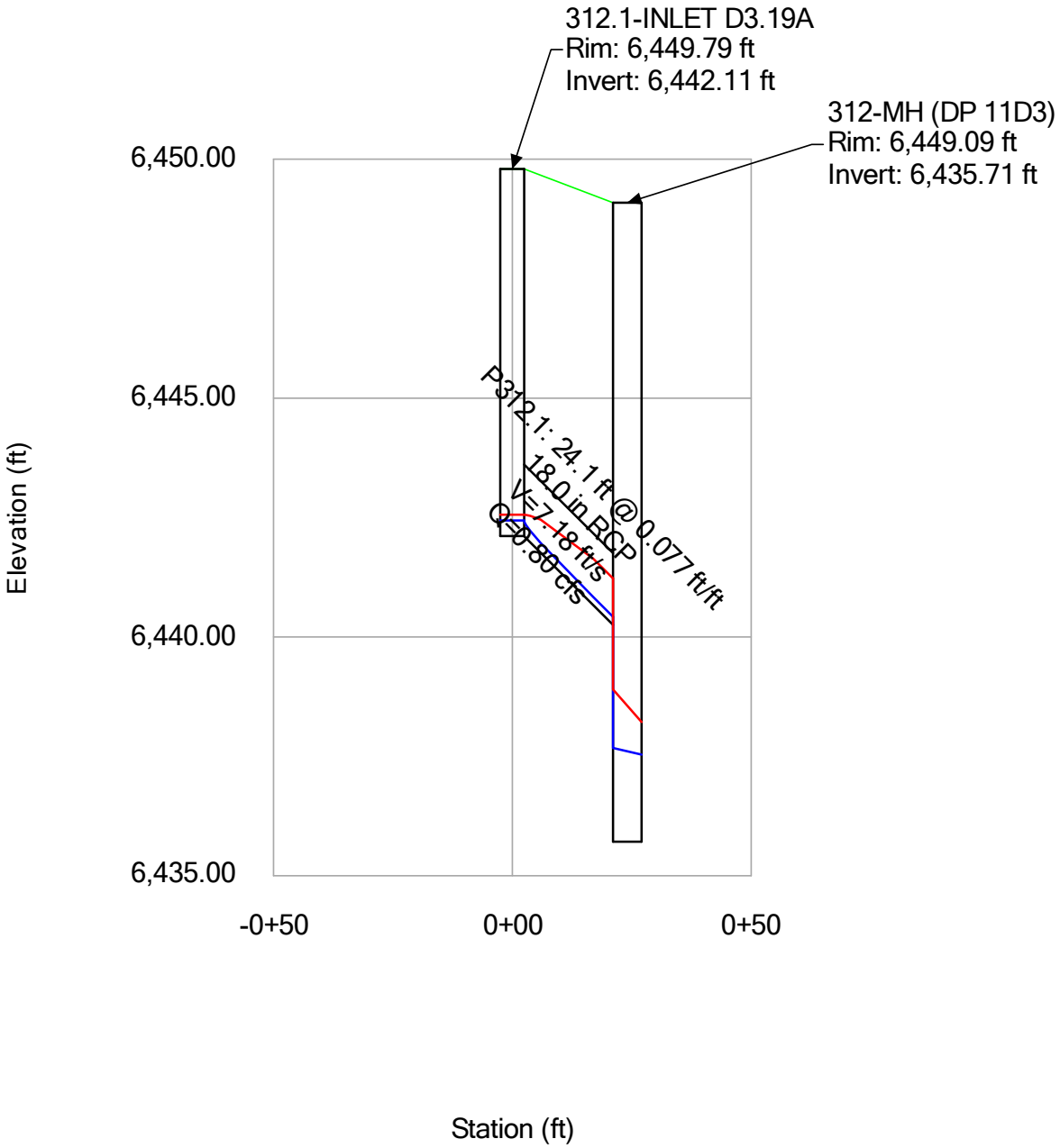
Active Scenario: 5-YR



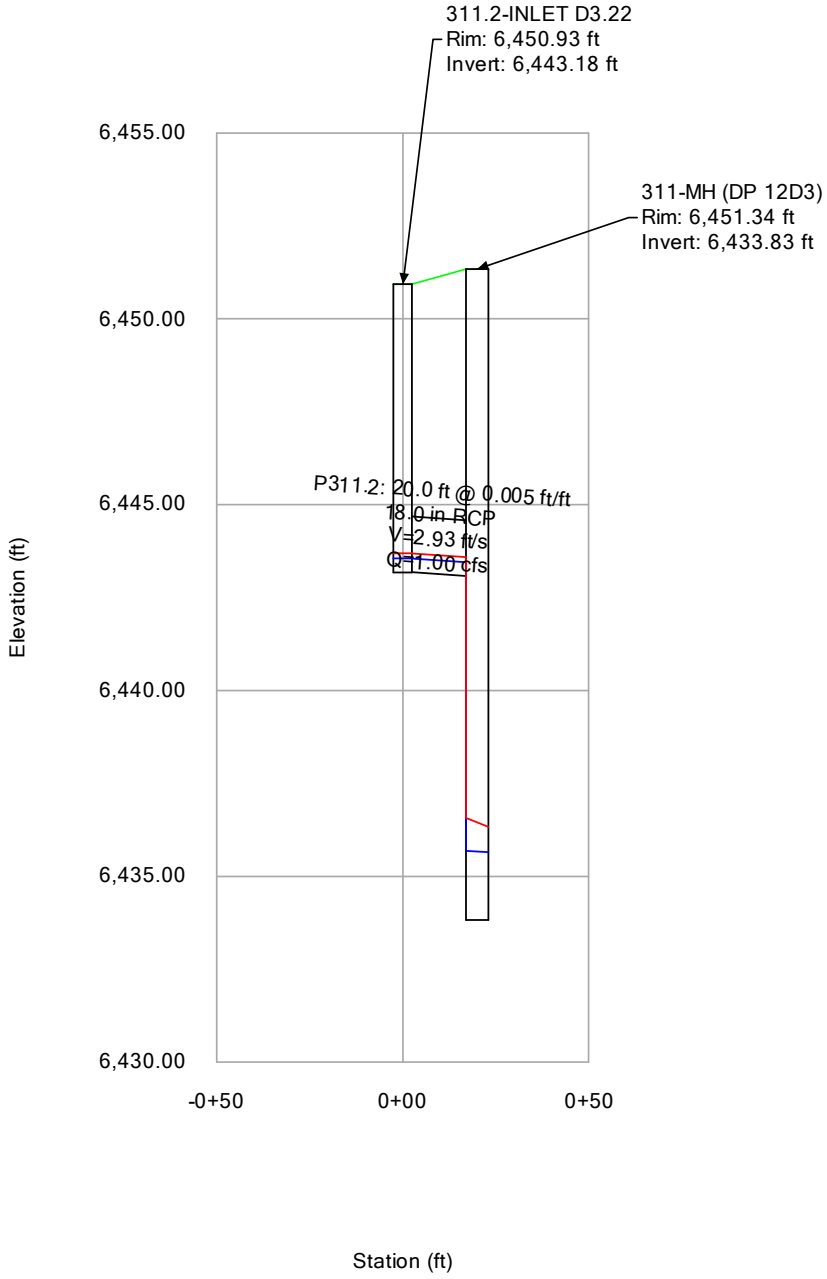
Active Scenario: 5-YR



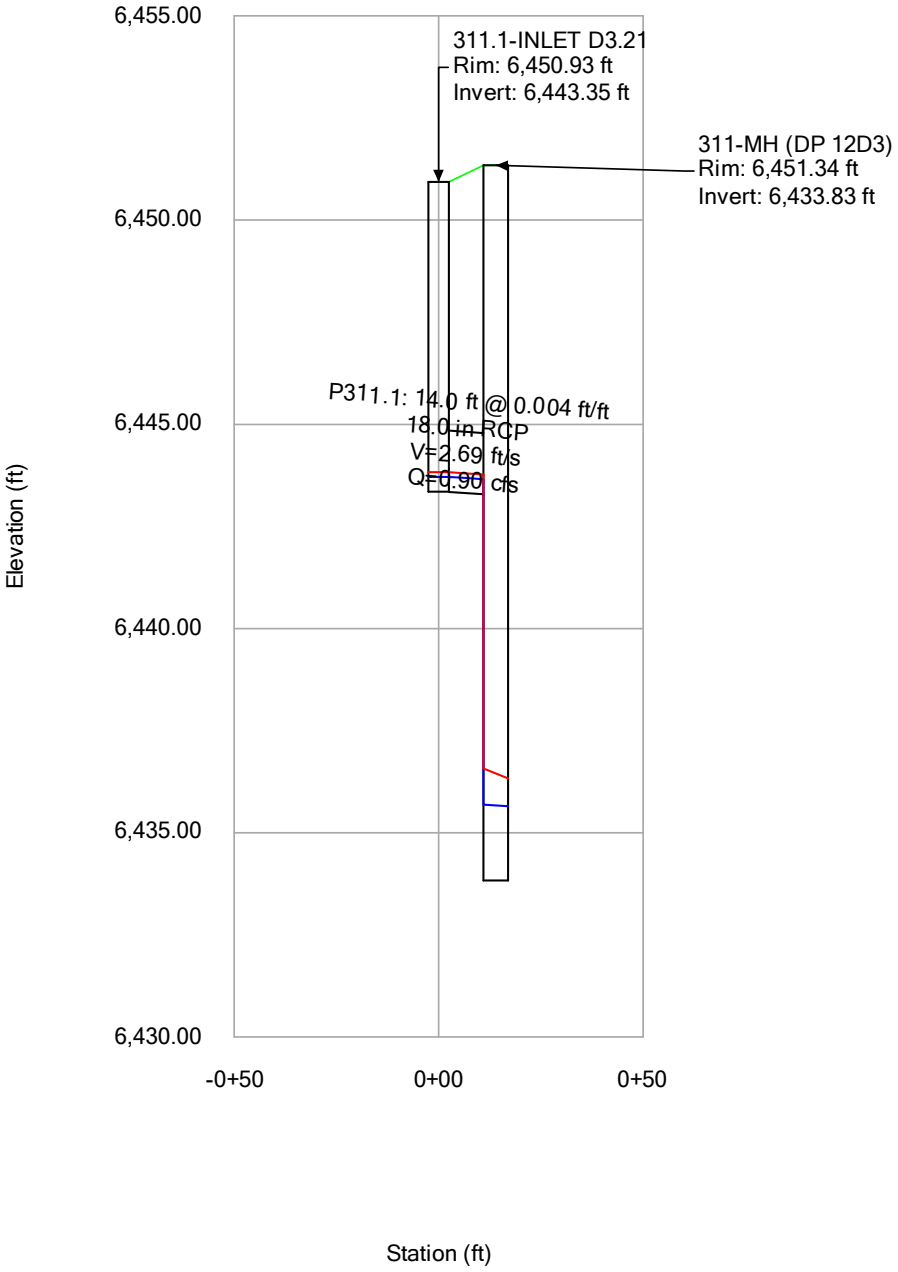
Active Scenario: 5-YR



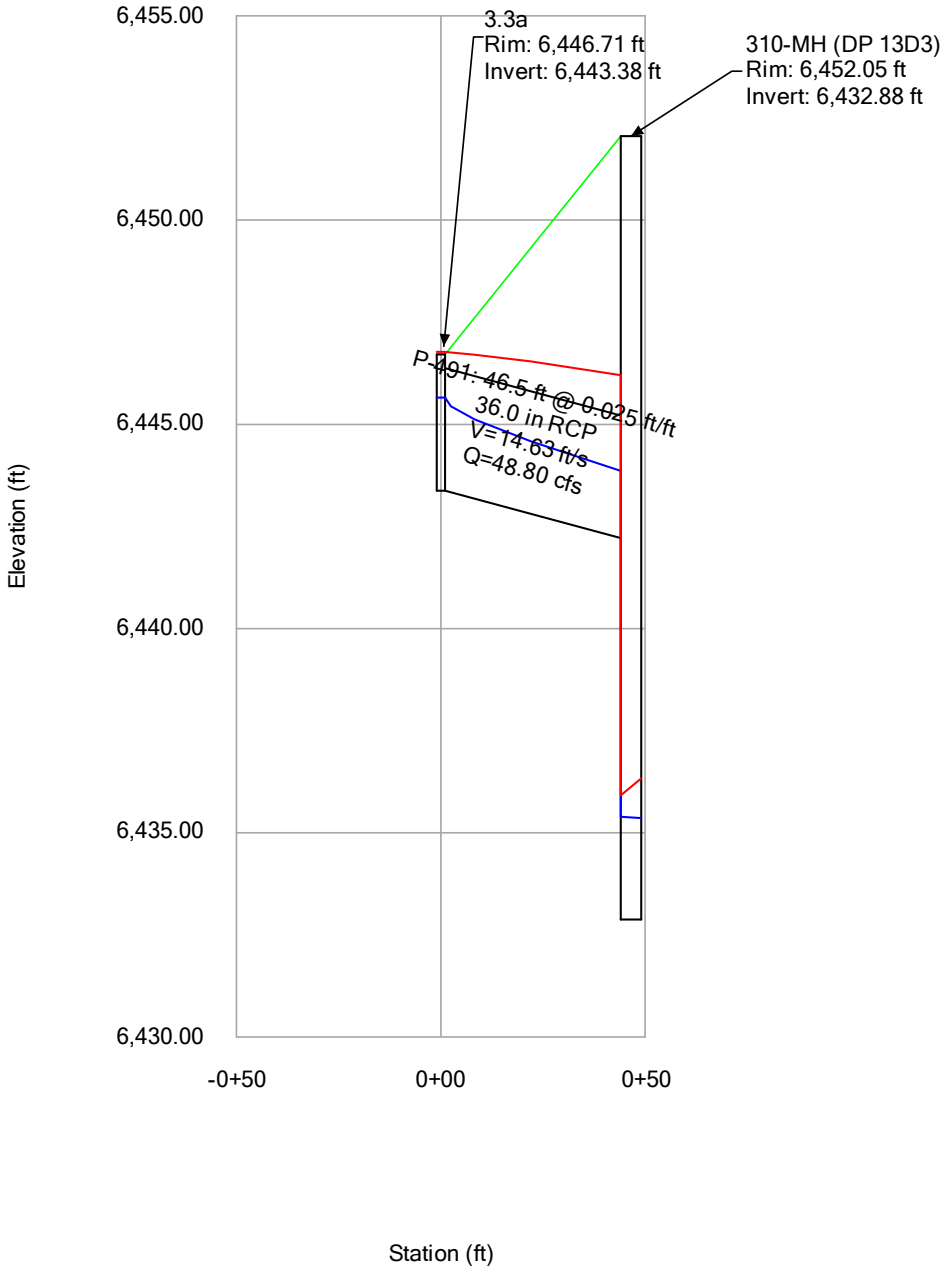
Active Scenario: 5-YR



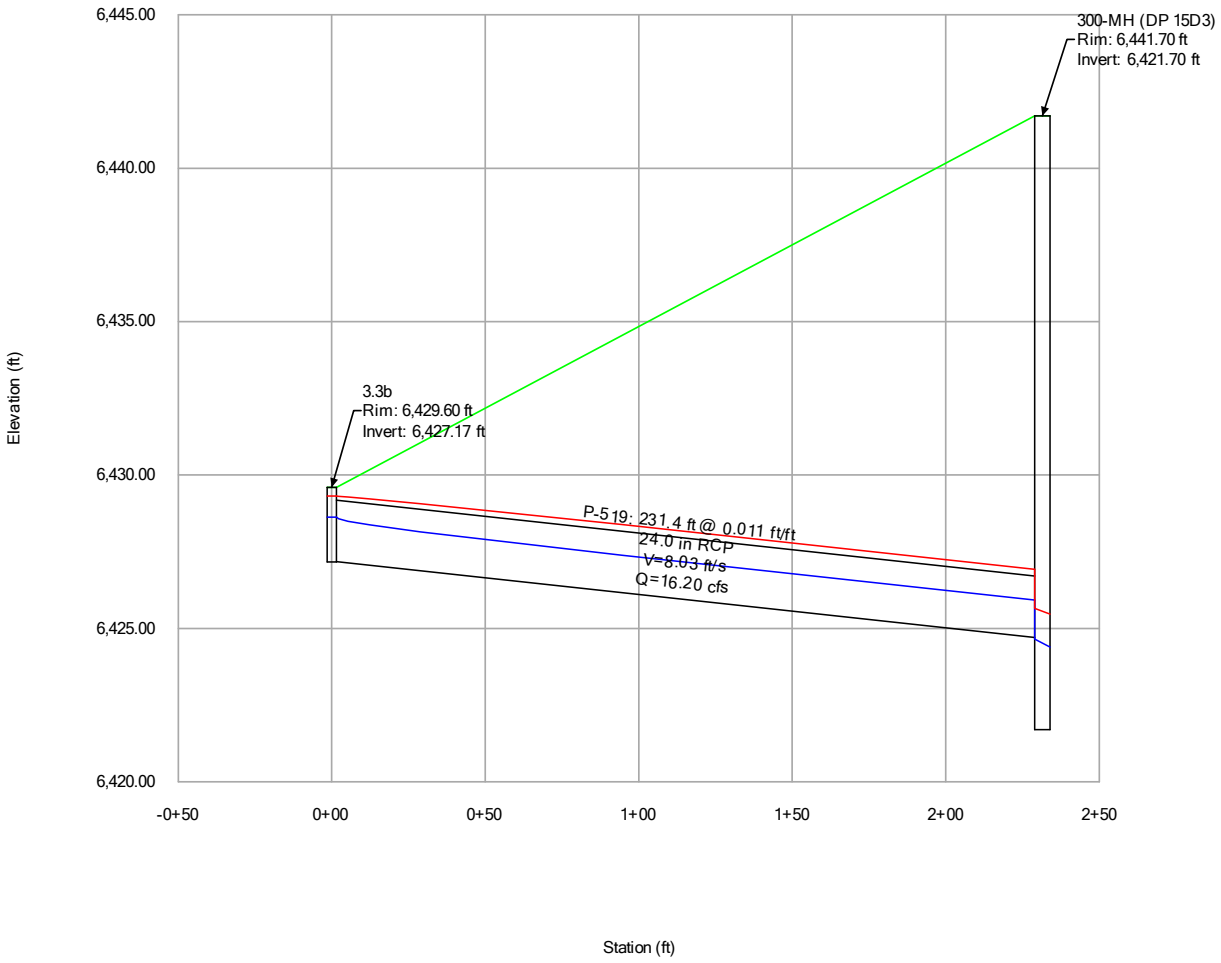
Active Scenario: 5-YR



Active Scenario: 5-YR



Active Scenario: 5-YR



Scenario: 100-YR
Current Time Step: 0.000 h
FlexTable: Conduit Table

Label	Start Node	Stop Node	Invert (Start) (ft)	Invert (Stop) (ft)	Slope (Calculated) (ft/ft)	Length (Scaled) (ft)	Manning's n	Flow (cfs)	Diameter (in)	Velocity (ft/s)
P-16	STRC-22 (EXISTING)	O-1	6,416.97	6,416.17	0.005	145.8	0.013	122.30	48.0	9.73
P-19	STMH 9D1.1 (EXISTING)	STRC-22 (EXISTING)	6,419.32	6,418.57	0.010	75.1	0.013	122.30	42.0	12.71
P-21	INLET 9D1 (EXISTING INLET 6)	STMH 9D1.1 (EXISTING)	6,422.45	6,421.57	0.015	58.5	0.013	11.50	18.0	6.51
P-520	PLUG 6D1	STMH 6D1.1	6,423.27	6,422.63	0.010	63.7	0.013	25.20	30.0	5.13
P-521	PLUG 7D1	INLET 8D1	6,421.46	6,420.98	0.010	47.2	0.013	32.30	30.0	6.58
P220.1	INLET 8D1	STMH 9D1.1 (EXISTING)	6,420.73	6,420.62	0.010	10.5	0.013	43.40	30.0	8.84
P221	STMH 6D1.1	STMH 9D1.1 (EXISTING)	6,421.43	6,419.62	0.006	325.5	0.013	71.10	42.0	7.39
P222	STMH 5D1.3	STMH 6D1.1	6,423.81	6,421.63	0.006	372.4	0.013	46.40	42.0	8.38
P230	STMH 3D1.1	STMH 5D1.3	6,425.45	6,424.07	0.007	201.5	0.013	39.30	42.0	8.54
P230.1	INLET 3D1	STMH 3D1.1	6,427.52	6,427.45	0.005	12.6	0.013	5.30	18.0	4.56
P231	INLET 2D1	STMH 3D1.1	6,426.30	6,425.95	0.005	70.9	0.013	35.20	36.0	7.32
P232	INLET 1D1	INLET 2D1	6,427.22	6,426.80	0.007	60.2	0.013	27.40	30.0	7.76
P240	STMH 5D1.2	STMH 5D1.3	6,425.58	6,424.06	0.006	244.9	0.013	10.00	24.0	5.84
P242	STMH 5D1.1	STMH 5D1.2	6,426.68	6,425.83	0.006	141.1	0.013	10.00	18.0	5.66
P242.1	INLET 4D1	STMH 5D1.1	6,427.23	6,426.93	0.006	50.0	0.013	7.40	18.0	4.19
P242.2	INLET 5D1	STMH 5D1.1	6,427.01	6,426.93	0.010	8.0	0.013	2.90	18.0	1.64

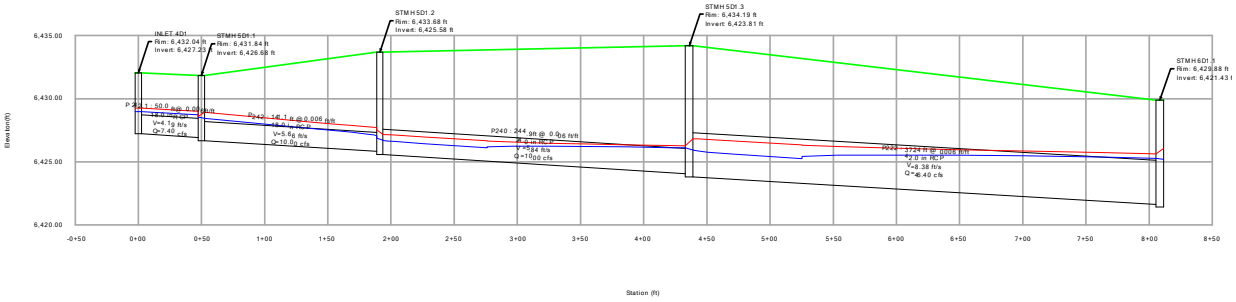
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Scenario: 100-YR
Current Time Step: 0.000 h
FlexTable: Manhole Table

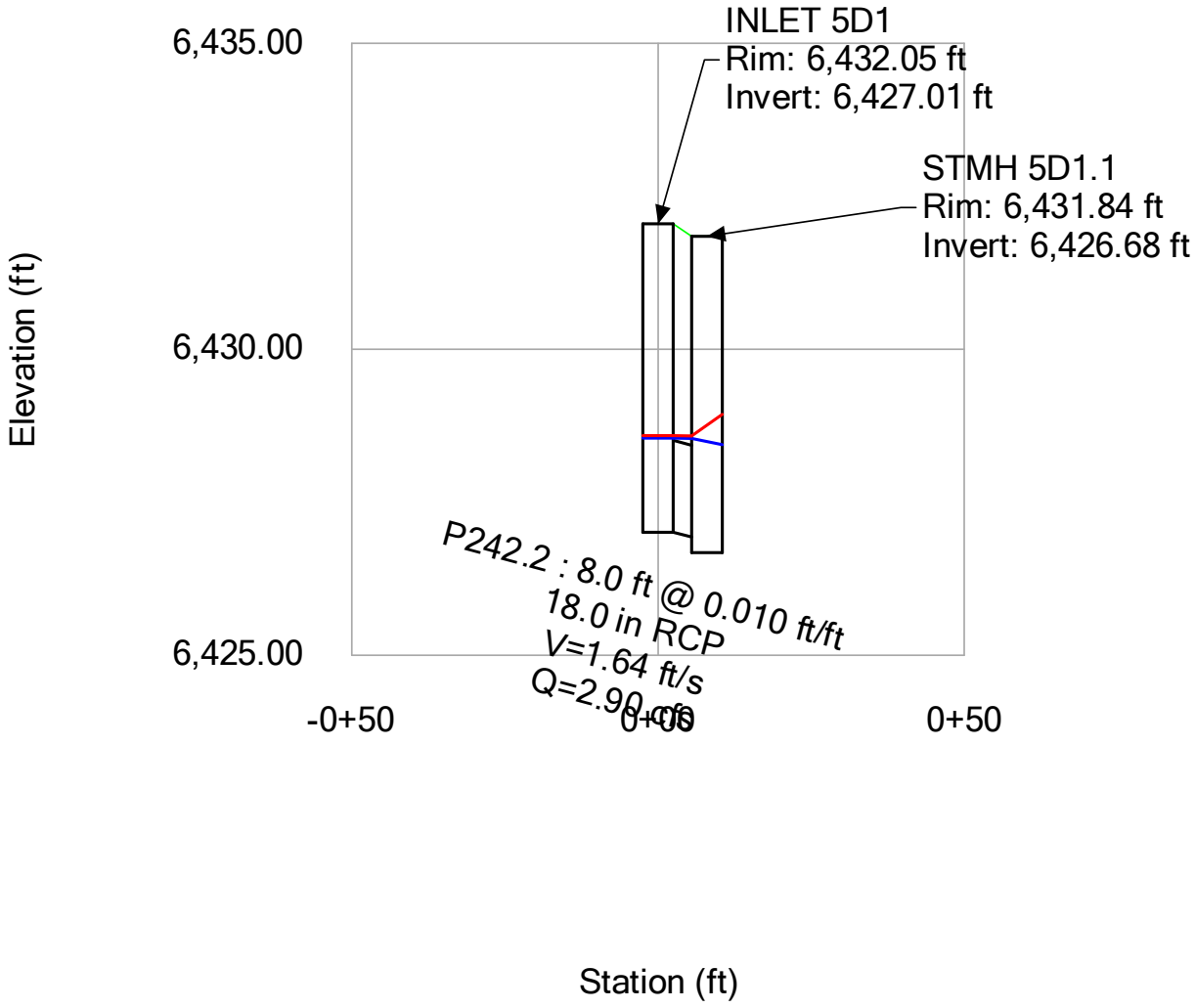
Label	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Headloss Method	Headloss (ft)	Velocity (Out) (ft/s)
INLET 1D1	6,434.58	6,427.22	6,429.01	6,429.01	HEC-22 Energy (Second Edition)	0.00	7.31
INLET 2D1	6,433.15	6,426.30	6,428.67	6,428.23	HEC-22 Energy (Second Edition)	0.44	7.32
INLET 3D1	6,432.90	6,427.52	6,428.44	6,428.44	HEC-22 Energy (Second Edition)	0.00	4.61
INLET 4D1	6,432.04	6,427.23	6,428.98	6,428.98	HEC-22 Energy (Second Edition)	0.00	4.19
INLET 5D1	6,432.05	6,427.01	6,428.55	6,428.55	HEC-22 Energy (Second Edition)	0.00	1.64
INLET 8D1	6,427.35	6,420.73	6,425.78	6,425.53	HEC-22 Energy (Second Edition)	0.24	8.84
INLET 9D1 (EXISTING INLET 6)	6,427.14	6,422.45	6,426.12	6,426.12	HEC-22 Energy (Second Edition)	0.00	6.51
PLUG 6D1	6,431.39	6,423.27	6,426.12	6,426.12	HEC-22 Energy (Second Edition)	0.00	5.13
PLUG 7D1	6,424.83	6,421.46	6,424.83	6,424.83	HEC-22 Energy (Second Edition)	0.00	6.58
STMH 3D1.1	6,432.77	6,425.45	6,427.75	6,427.40	HEC-22 Energy (Second Edition)	0.35	7.14
STMH 5D1.1	6,431.84	6,426.68	6,428.54	6,428.44	HEC-22 Energy (Second Edition)	0.10	5.66
STMH 5D1.2	6,433.68	6,425.58	6,426.86	6,426.71	HEC-22 Energy (Second Edition)	0.15	5.45
STMH 5D1.3	6,434.19	6,423.81	6,426.11	6,425.94	HEC-22 Energy (Second Edition)	0.17	7.59
STMH 6D1.1	6,429.88	6,421.43	6,425.29	6,425.21	HEC-22 Energy (Second Edition)	0.08	7.39
STMH 9D1.1 (EXISTING)	6,427.04	6,419.16	6,423.58	6,423.27	HEC-22 Energy (Second Edition)	0.31	12.71
STRC-22 (EXISTING)	6,427.42	6,416.97	6,422.17	6,421.02	HEC-22 Energy (Second Edition)	1.15	9.73

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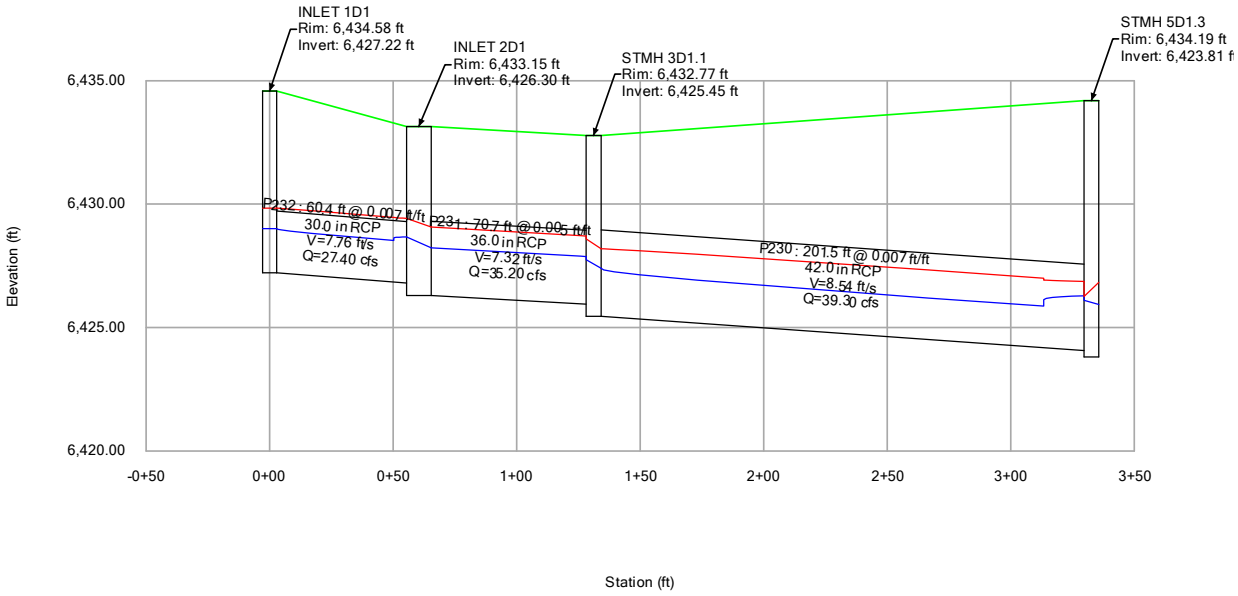
Active Scenario: 100-YR

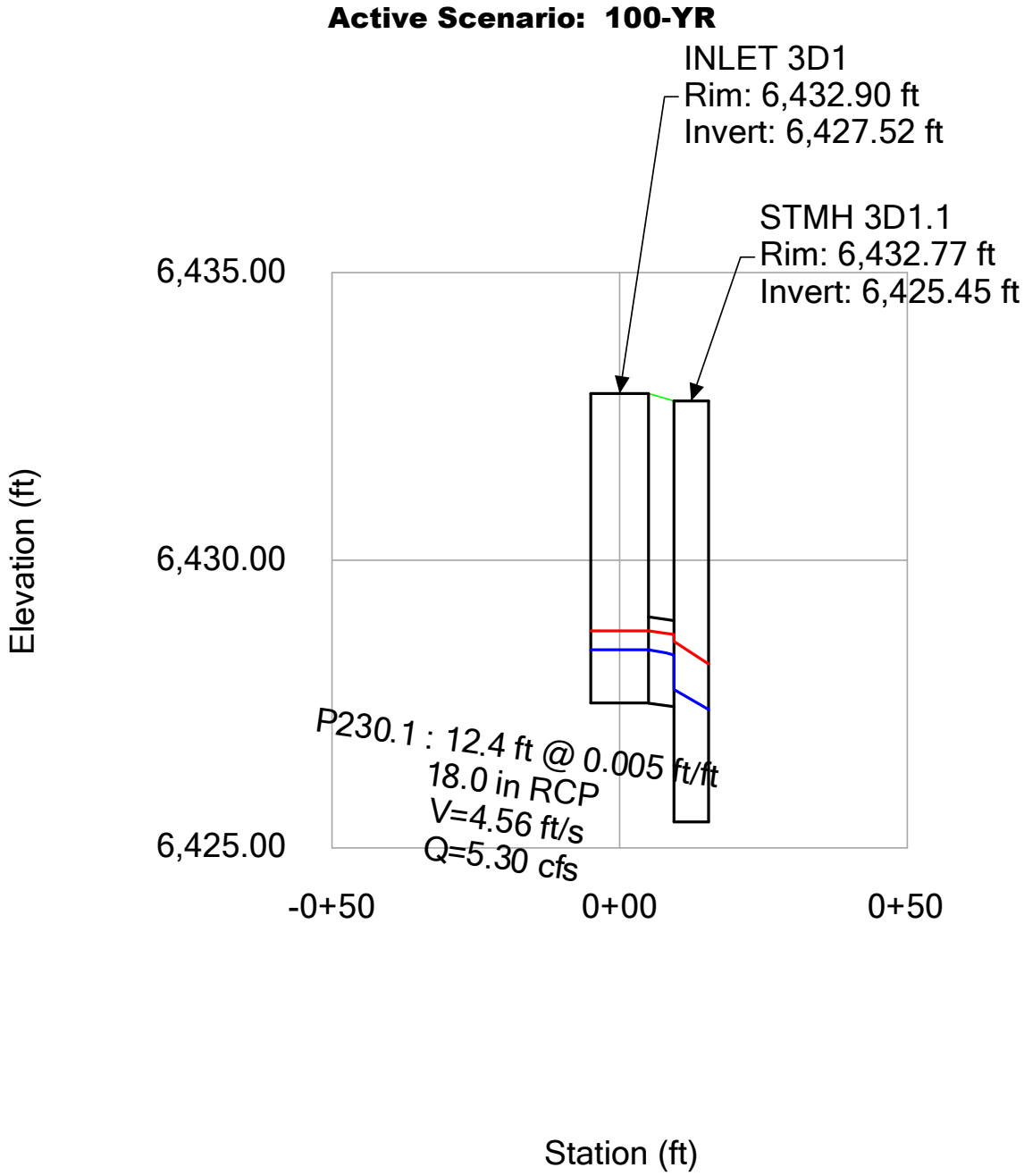


Active Scenario: 100-YR

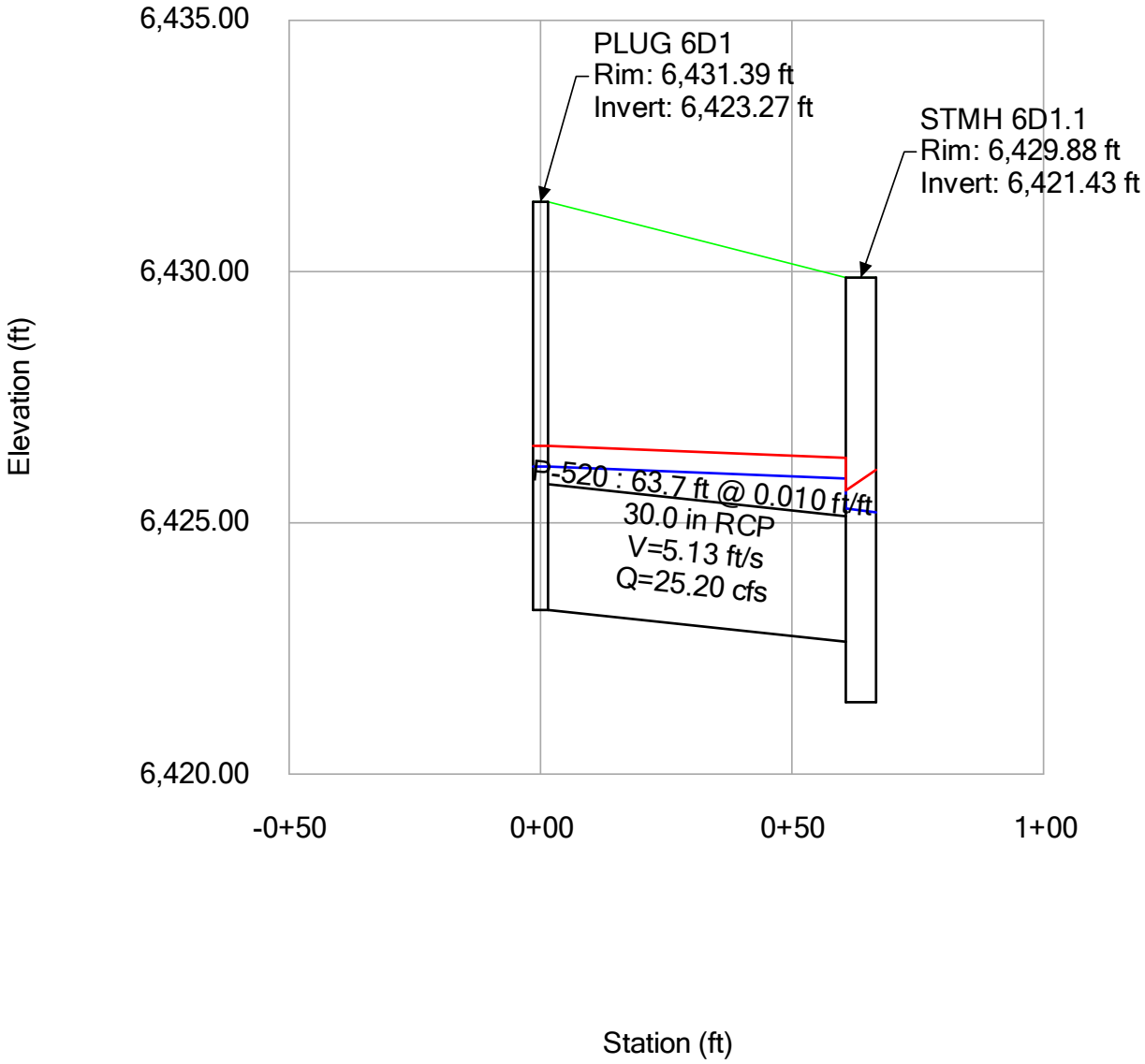


Active Scenario: 100-YR

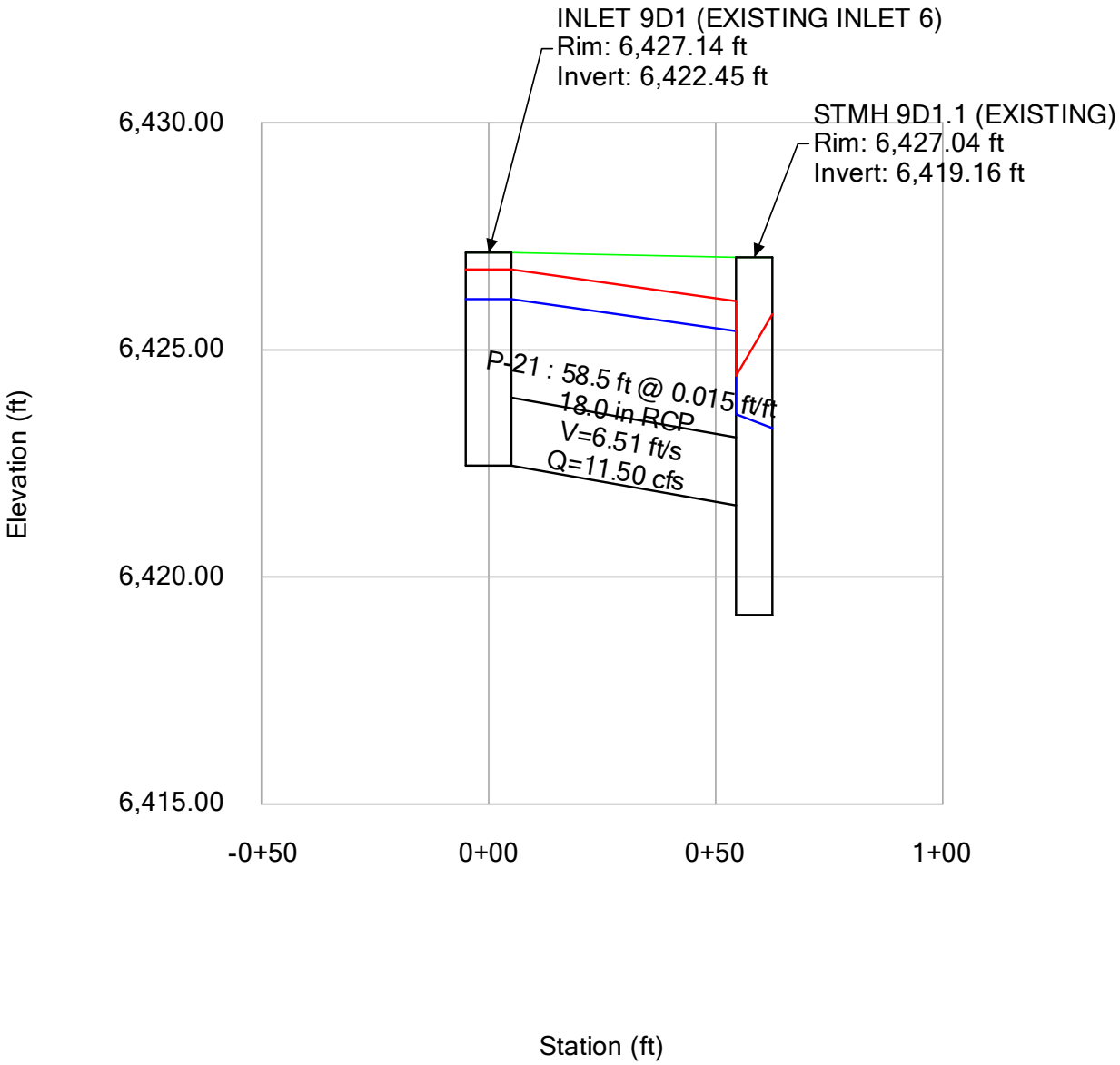



Active Scenario: 100-YR
INLET 3D1
Rim: 6,432.90 ft
Invert: 6,427.52 ft
STMH 3D1.1
Rim: 6,432.77 ft
Invert: 6,425.45 ft
6,435.00
6,430.00
6,425.00
Elevation (ft)
P230.1 : 12.4 ft @ 0.005 ft/ft
18.0 in RCP
V=4.56 ft/s
Q=5.30 cfs
-0+50
0+00
0+50
Station (ft)

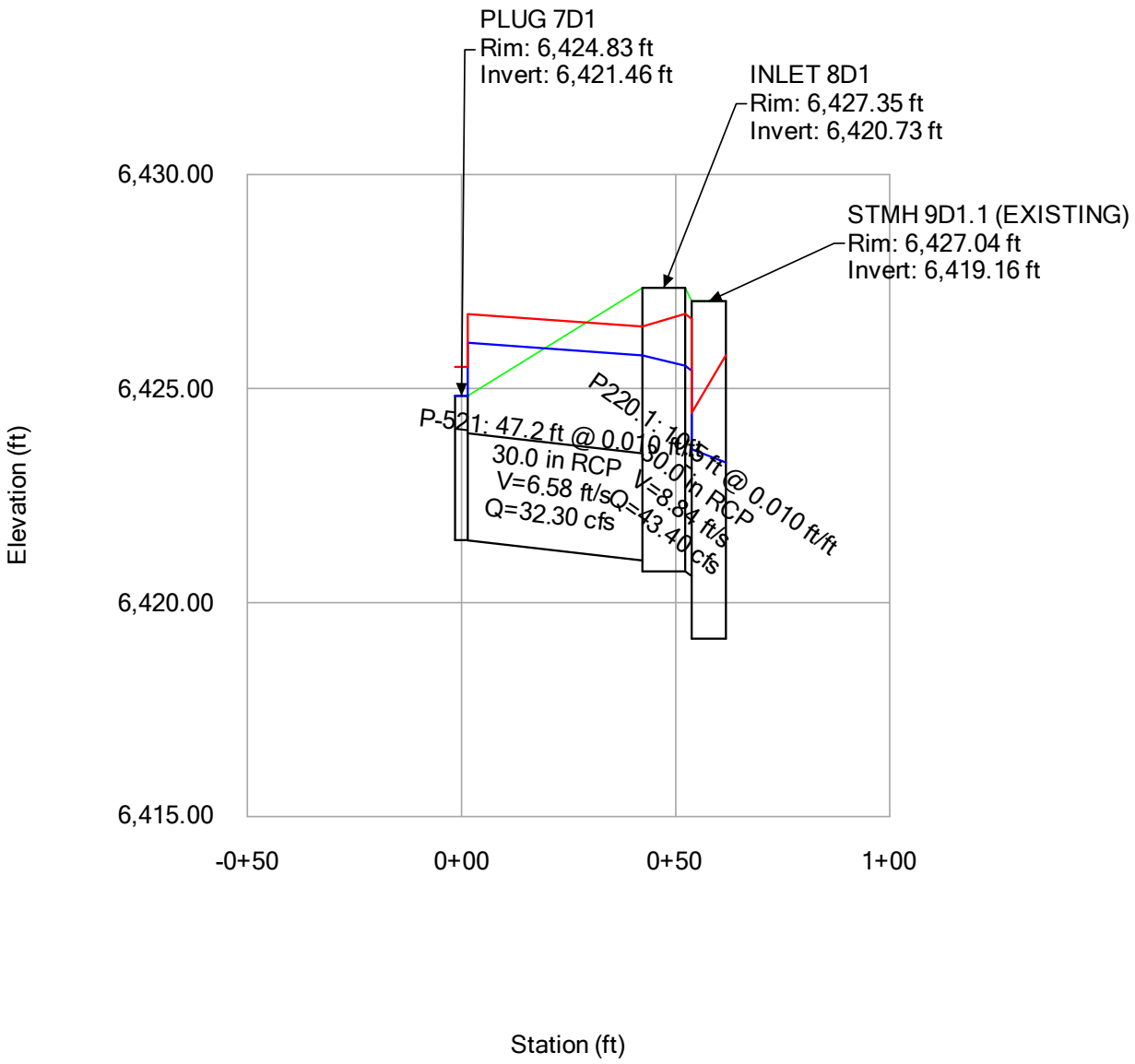
Active Scenario: 100-YR



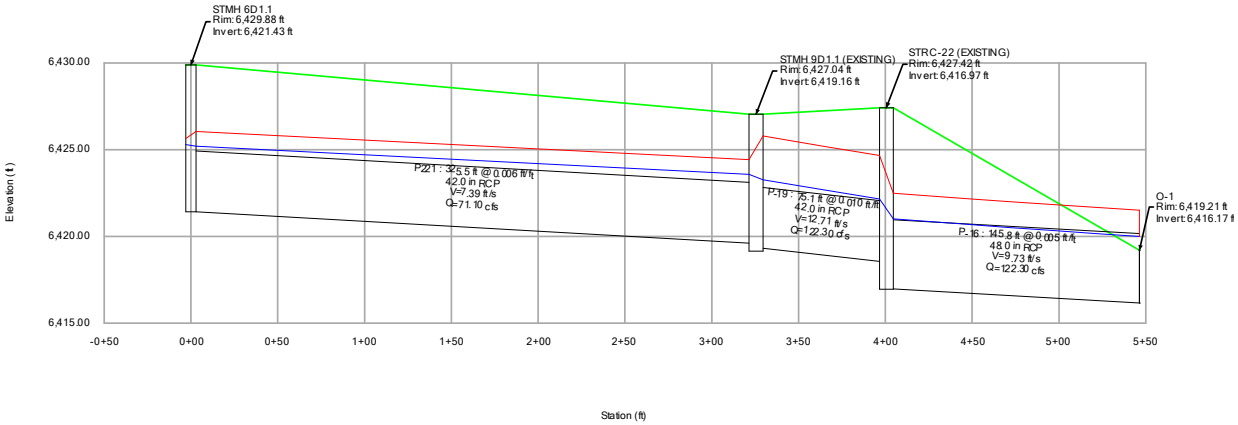
Active Scenario: 100-YR



Active Scenario: 100-YR



Active Scenario: 100-YR



Scenario: 5-YR
Current Time Step: 0.000 h
FlexTable: Conduit Table

Label	Start Node	Stop Node	Invert (Start) (ft)	Invert (Stop) (ft)	Slope (Calculated) (ft/ft)	Length (Scaled) (ft)	Manning's n	Flow (cfs)	Diameter (in)	Velocity (ft/s)
P-16	STRC-22 (EXISTING)	O-1	6,416.97	6,416.17	0.005	145.8	0.013	52.50	48.0	8.45
P-19	STMH 9D1.1 (EXISTING)	STRC-22 (EXISTING)	6,419.32	6,418.57	0.010	75.1	0.013	52.50	42.0	10.57
P-21	INLET 9D1 (EXISTING INLET 6)	STMH 9D1.1 (EXISTING)	6,422.45	6,421.57	0.015	58.5	0.013	5.10	18.0	6.86
P-520	PLUG 6D1	STMH 6D1.1	6,423.27	6,422.63	0.010	63.7	0.013	10.90	30.0	7.06
P-521	PLUG 7D1	INLET 8D1	6,421.46	6,420.98	0.010	47.2	0.013	13.90	30.0	7.55
P220.1	INLET 8D1	STMH 9D1.1 (EXISTING)	6,420.73	6,420.62	0.010	10.5	0.013	18.90	30.0	8.19
P221	STMH 6D1.1	STMH 9D1.1 (EXISTING)	6,421.43	6,419.62	0.006	325.5	0.013	31.30	42.0	7.45
P222	STMH 5D1.3	STMH 6D1.1	6,423.81	6,421.63	0.006	372.4	0.013	21.10	42.0	6.83
P230	STMH 3D1.1	STMH 5D1.3	6,425.45	6,424.07	0.007	201.5	0.013	18.40	42.0	6.96
P230.1	INLET 3D1	STMH 3D1.1	6,427.52	6,427.45	0.005	12.6	0.013	2.50	18.0	3.79
P231	INLET 2D1	STMH 3D1.1	6,426.30	6,425.95	0.005	70.9	0.013	15.50	36.0	5.98
P232	INLET 1D1	INLET 2D1	6,427.22	6,426.80	0.007	60.2	0.013	11.80	30.0	6.34
P240	STMH 5D1.2	STMH 5D1.3	6,425.58	6,424.06	0.006	244.9	0.013	4.60	24.0	4.76
P242	STMH 5D1.1	STMH 5D1.2	6,426.68	6,425.83	0.006	141.1	0.013	4.60	18.0	4.75
P242.1	INLET 4D1	STMH 5D1.1	6,427.23	6,426.93	0.006	50.0	0.013	3.40	18.0	4.40
P242.2	INLET 5D1	STMH 5D1.1	6,427.01	6,426.93	0.010	8.0	0.013	1.30	18.0	4.04

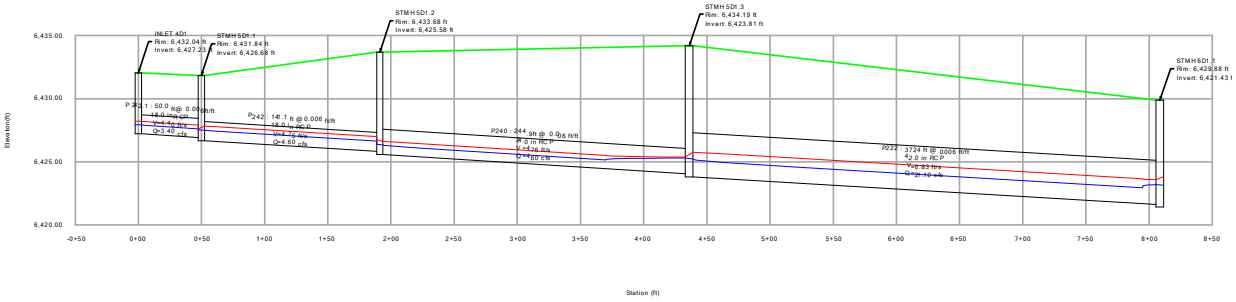
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Scenario: 5-YR
Current Time Step: 0.000 h
FlexTable: Manhole Table

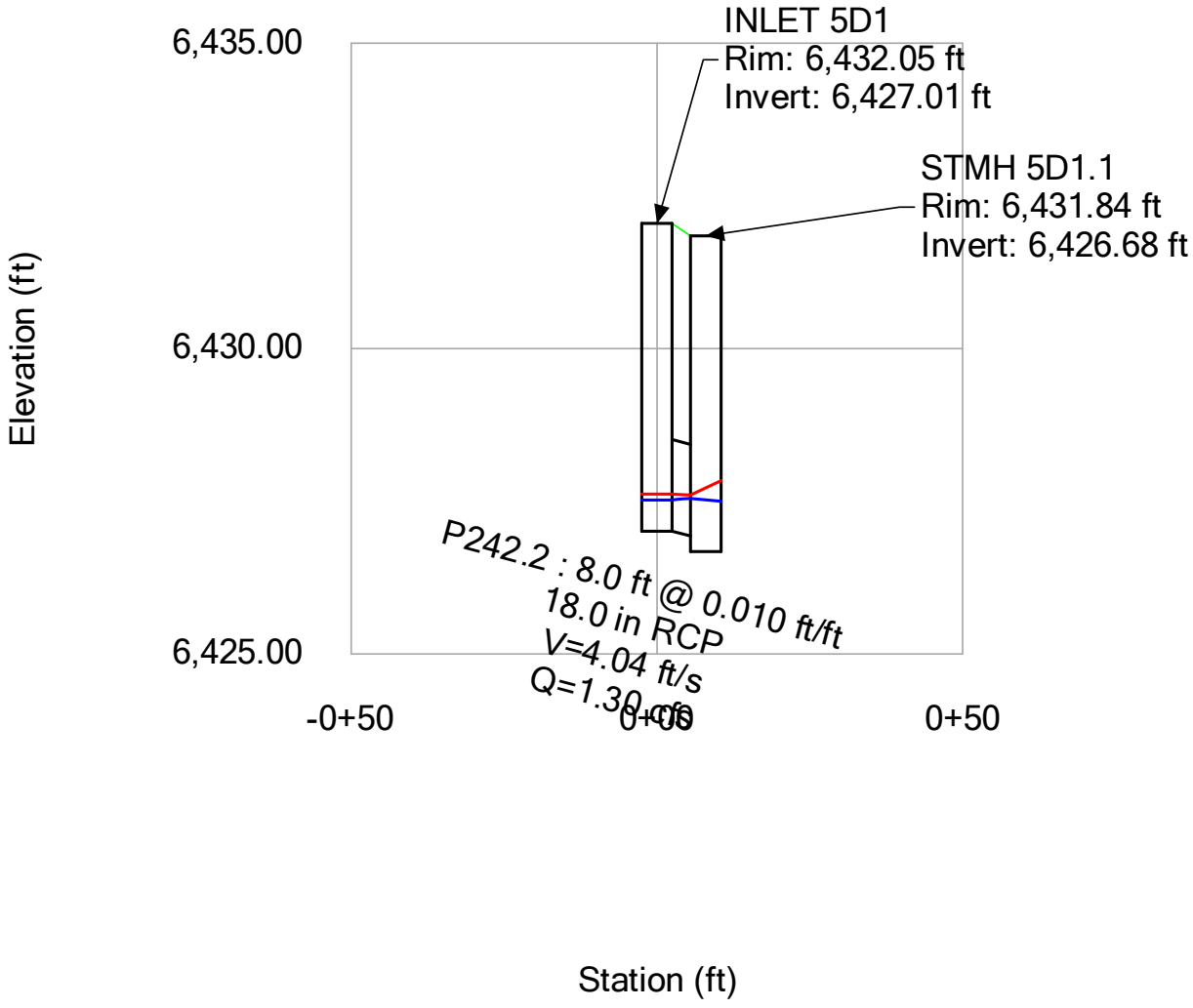
Label	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Headloss Method	Headloss (ft)	Velocity (Out) (ft/s)
INLET 1D1	6,434.58	6,427.22	6,428.38	6,428.38	HEC-22 Energy (Second Edition)	0.00	5.34
INLET 2D1	6,433.15	6,426.30	6,427.76	6,427.56	HEC-22 Energy (Second Edition)	0.20	5.52
INLET 3D1	6,432.90	6,427.52	6,428.11	6,428.11	HEC-22 Energy (Second Edition)	0.00	3.79
INLET 4D1	6,432.04	6,427.23	6,427.94	6,427.94	HEC-22 Energy (Second Edition)	0.00	4.18
INLET 5D1	6,432.05	6,427.01	6,427.52	6,427.52	HEC-22 Energy (Second Edition)	0.00	2.45
INLET 8D1	6,427.35	6,420.73	6,422.29	6,422.20	HEC-22 Energy (Second Edition)	0.09	6.28
INLET 9D1 (EXISTING INLET 6)	6,427.14	6,422.45	6,423.32	6,423.32	HEC-22 Energy (Second Edition)	0.00	4.80
PLUG 6D1	6,431.39	6,423.27	6,424.38	6,424.38	HEC-22 Energy (Second Edition)	0.00	5.21
PLUG 7D1	6,424.83	6,421.46	6,422.71	6,422.71	HEC-22 Energy (Second Edition)	0.00	5.63
STMH 3D1.1	6,432.77	6,425.45	6,426.97	6,426.76	HEC-22 Energy (Second Edition)	0.20	5.59
STMH 5D1.1	6,431.84	6,426.68	6,427.55	6,427.50	HEC-22 Energy (Second Edition)	0.04	4.63
STMH 5D1.2	6,433.68	6,425.58	6,426.41	6,426.34	HEC-22 Energy (Second Edition)	0.07	4.24
STMH 5D1.3	6,434.19	6,423.81	6,425.30	6,425.22	HEC-22 Energy (Second Edition)	0.08	5.83
STMH 6D1.1	6,429.88	6,421.43	6,423.20	6,423.16	HEC-22 Energy (Second Edition)	0.04	6.60
STMH 9D1.1 (EXISTING)	6,427.04	6,419.16	6,421.68	6,421.59	HEC-22 Energy (Second Edition)	0.09	7.96
STRC-22 (EXISTING)	6,427.42	6,416.97	6,419.62	6,419.15	HEC-22 Energy (Second Edition)	0.47	7.51

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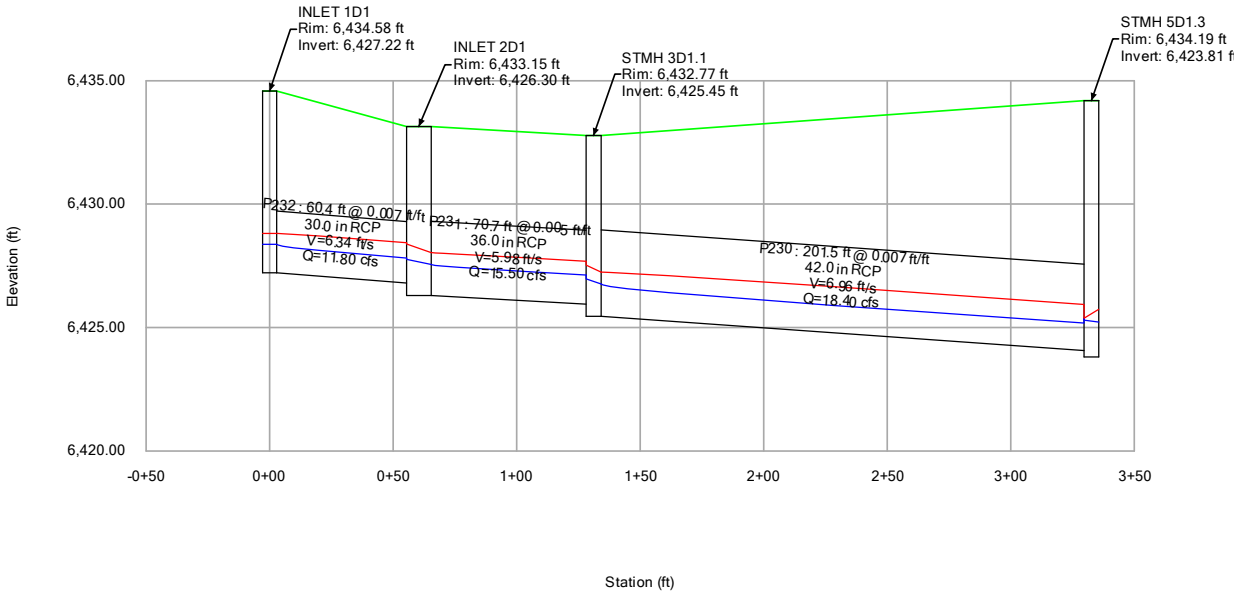
Active Scenario: 5-YR



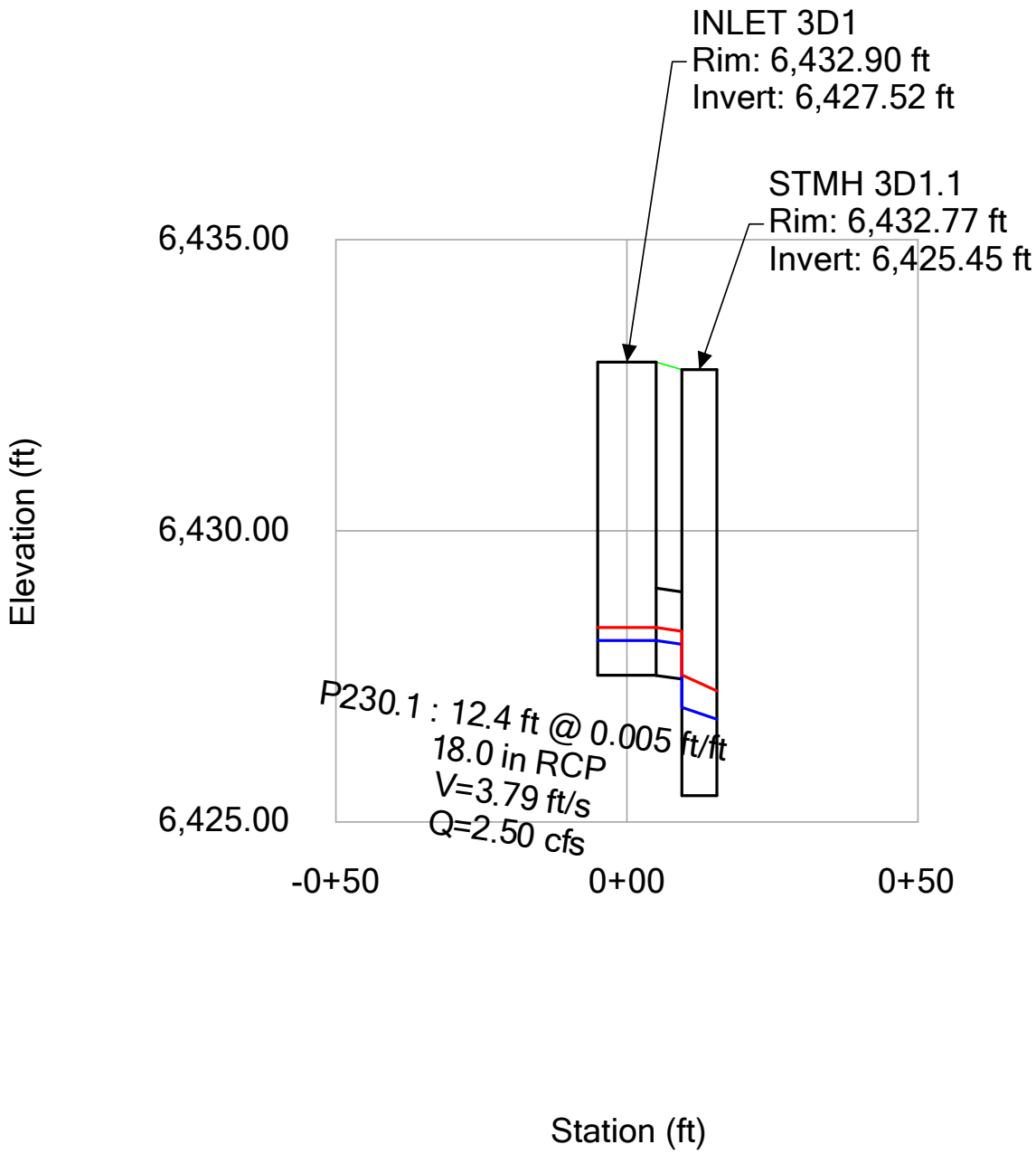
Active Scenario: 5-YR



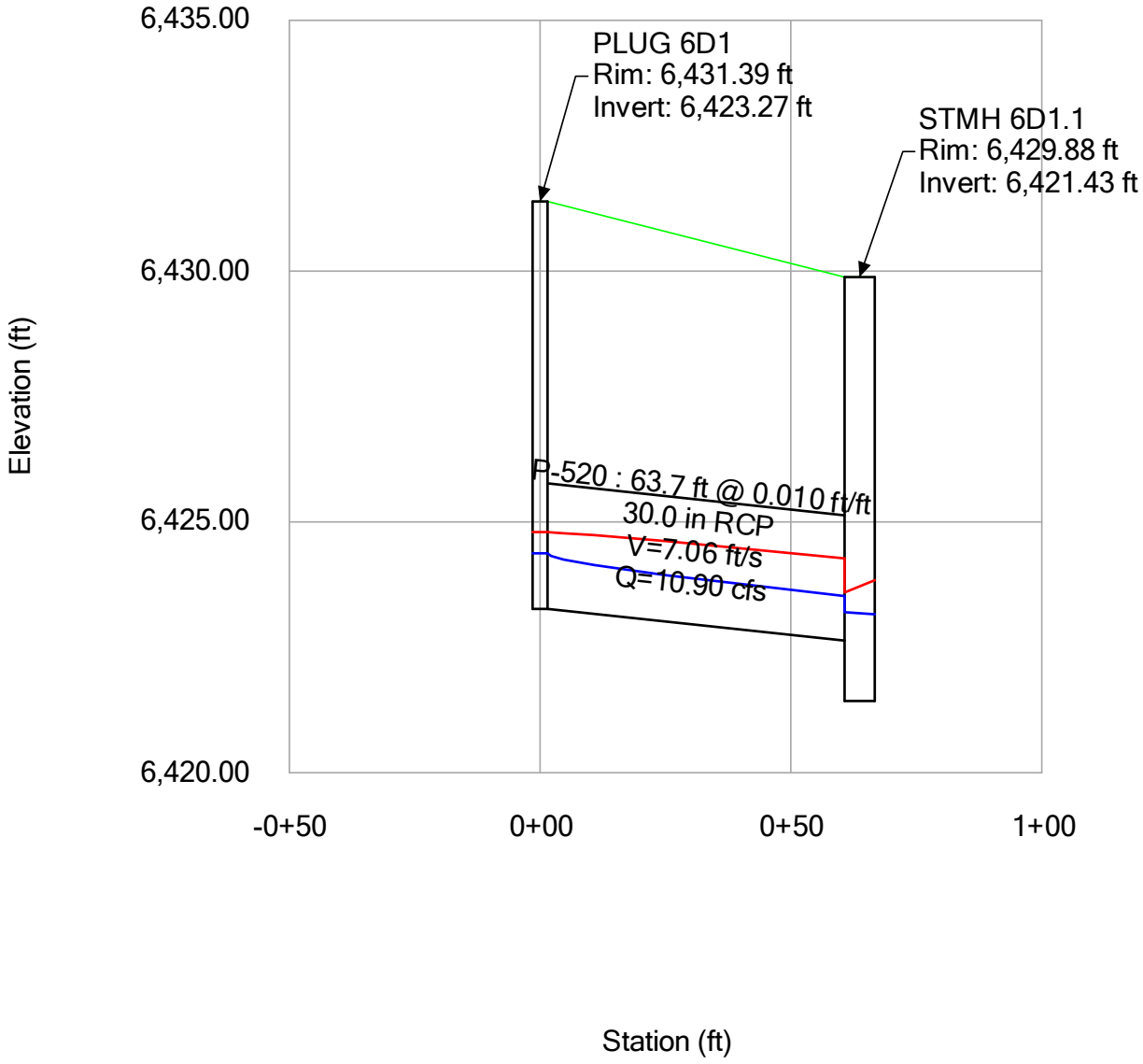
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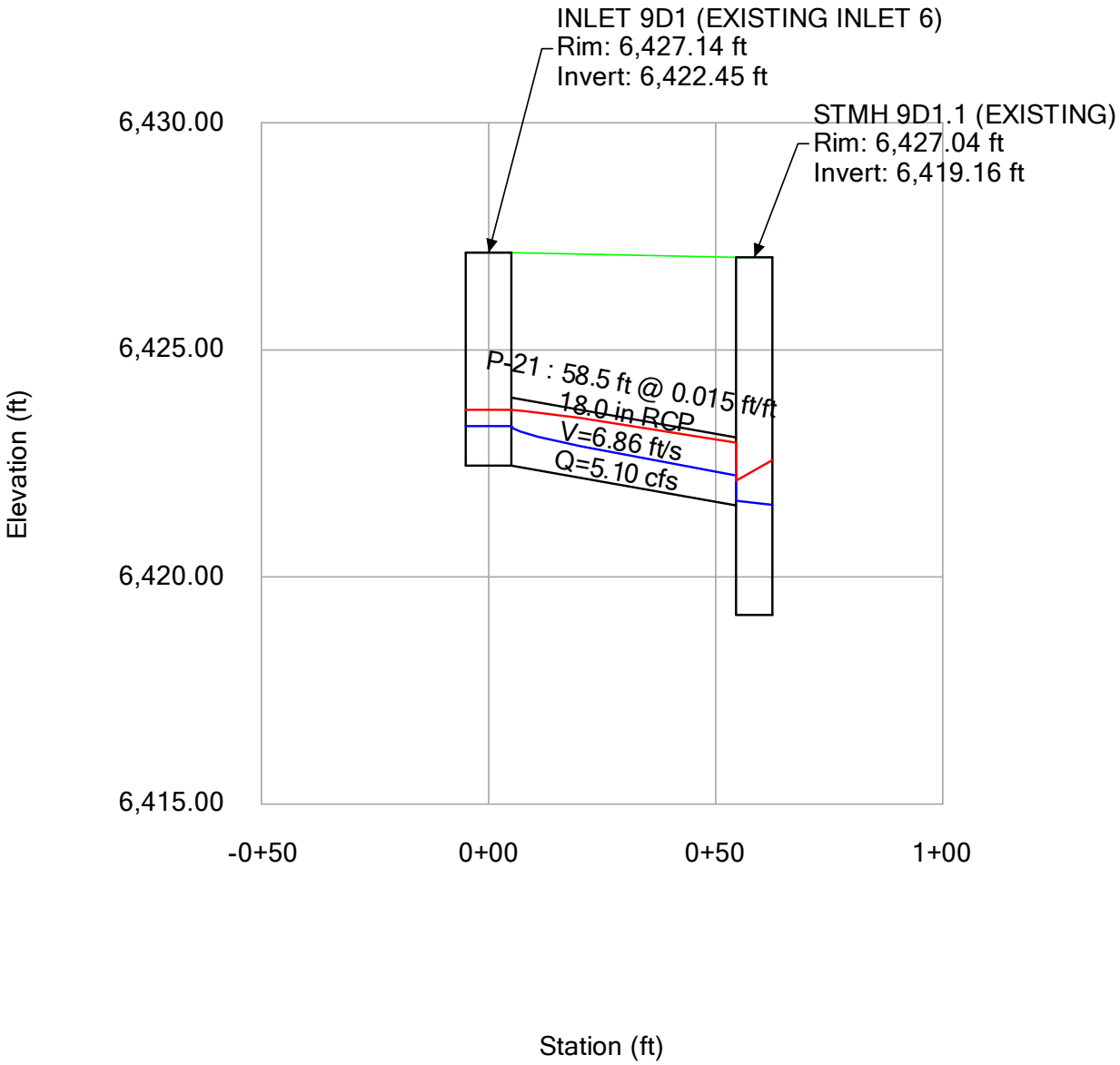
Active Scenario: 5-YR



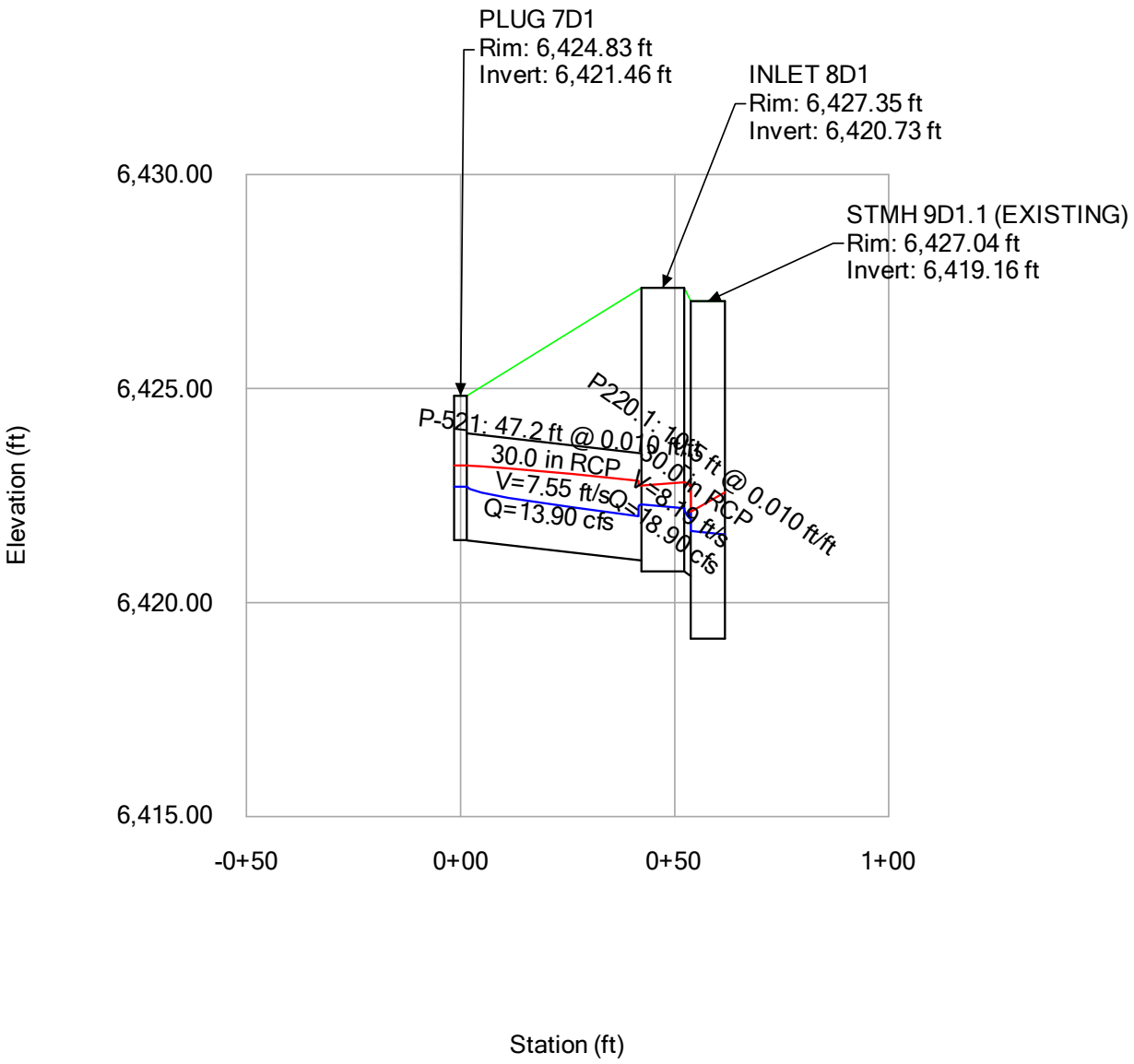
Active Scenario: 5-YR



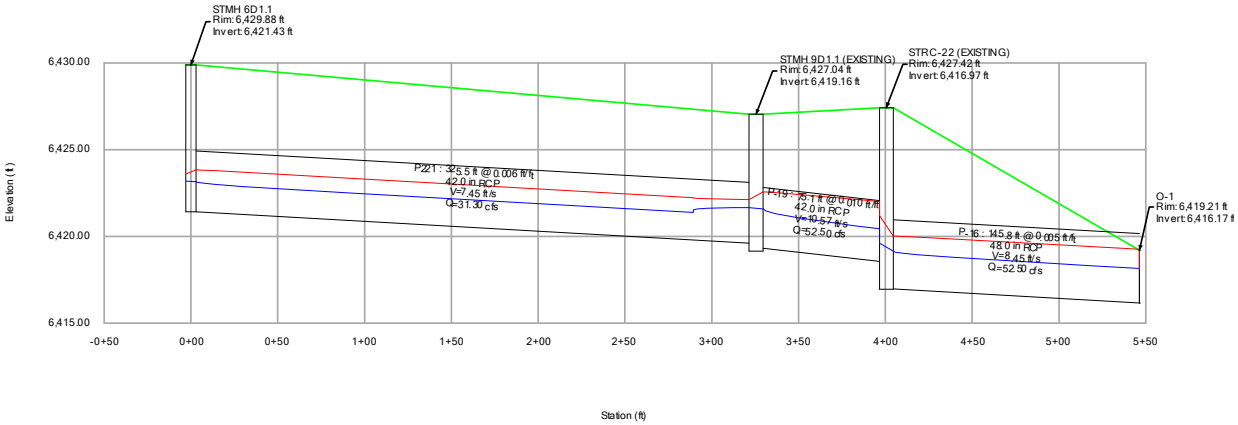
Active Scenario: 5-YR



Active Scenario: 5-YR



Active Scenario: 5-YR



APPENDIX C

WATER QUALITY ENHANCEMENT CONTROL MEASURES

Water Quality Pond Design Workbooks
Permanent Water Quality Worksheet
MS-4 Permit Abidance
Variance Request for GSB Drop Structures

Dawson Trails Infrastructure 1 - Pond D1 Interim Watershed Imperviousness

CORE Project #: 20-224

Prepared By: LCC

IMPERVIOUS CALCULATIONS

-REFERENCE UDFCD Vol.1 RUNOFF Table 6-3

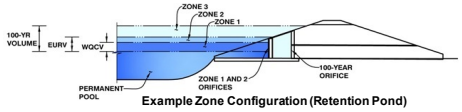
		Residential & Commercial							Landscape Area					Soil Type		
		Single Family			0.00											
		0.25 acres or less	Attached	Commercial	Parks	Roof/ Concrete	Asphalt/ Ponded Water	Schools	2-7% Slope	>7% Slope	Historic			Soil Type A Area	Soil Type B Area	Soil Type C/D Area
% Imperv.		45.00%	75.00%	95.00%	10.00%	90.00%	100.00%	55.00%	2.00%	2.00%	2.00%					
BASIN	Design Point	Area (ac)	Area (ac)	Area (ac)	Area (ac)	Area (ac)	Area (ac)	Area (ac)	Area (ac)	Area (ac)	Area (ac)	Total Area (ac)	Percent Impervious	Area (ac)	Area (ac)	Area (ac)
D1.0	D1.0	-	-	-	-	-	-	-	-	-	8.28	8.28	2.0%	-	-	8.28
D1.10	D1.10	-	-	-	-	0.20	0.94	-	0.22	-	-	1.36	82.4%	-	-	1.36
D1.11	D1.11	-	-	-	-	0.10	0.50	-	0.13	-	-	0.73	81.6%	-	-	0.73
		-	-	-	-	-	-	-	-	-	-	-		-	-	-
D1.30	D1.30	-	-	-	-	0.20	0.91	-	0.32	-	-	1.42	76.6%	-	-	1.42
D1.31	D1.31	-	-	-	-	0.10	0.29	-	0.15	-	-	0.54	70.6%	-	-	0.54
D1.32	D1.32	-	-	-	-	0.20	0.90	-	0.33	-	-	1.43	76.2%	-	-	1.43
D1.33	D1.33	-	-	-	-	0.10	0.29	-	0.17	-	-	0.55	68.8%	-	-	0.55
		-	-	-	-	-	-	-	-	-	-	-		-	-	-
		-	-	-	-	-	-	-	-	-	-	-		-	-	-
		-	-	-	-	-	-	-	-	-	-	-		-	-	-
		-	-	-	-	-	-	-	-	-	-	-		-	-	-
POND D1		-	-	-	-	0.89	3.82	-	1.31	-	8.28	14.30	33.7%	-	-	14.30

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: DAWSON TRAILS BLVD

Basin ID: Pond B



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	14.30	acres
Watershed Length =	1,411	ft
Watershed Length to Centroid =	455	ft
Watershed Slope =	0.010	ft/ft
Watershed Imperviousness =	33.70%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	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) =	0.194	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	0.442	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 1.06 in.) =	0.448	acre-feet	1.06 inches
5-yr Runoff Volume (P1 = 1.43 in.) =	0.823	acre-feet	1.43 inches
10-yr Runoff Volume (P1 = 1.66 in.) =	1.085	acre-feet	1.66 inches
25-yr Runoff Volume (P1 = 1.69 in.) =	1.178	acre-feet	inches
50-yr Runoff Volume (P1 = 2.26 in.) =	1.864	acre-feet	2.26 inches
100-yr Runoff Volume (P1 = 2.6 in.) =	2.339	acre-feet	2.60 inches
500-yr Runoff Volume (P1 = 3.14 in.) =	3.008	acre-feet	inches
Approximate 2-yr Detention Volume =	0.340	acre-feet	
Approximate 5-yr Detention Volume =	0.591	acre-feet	
Approximate 10-yr Detention Volume =	0.678	acre-feet	
Approximate 25-yr Detention Volume =	0.673	acre-feet	
Approximate 50-yr Detention Volume =	0.835	acre-feet	
Approximate 100-yr Detention Volume =	1.033	acre-feet	

Define Zones and Basin Geometry

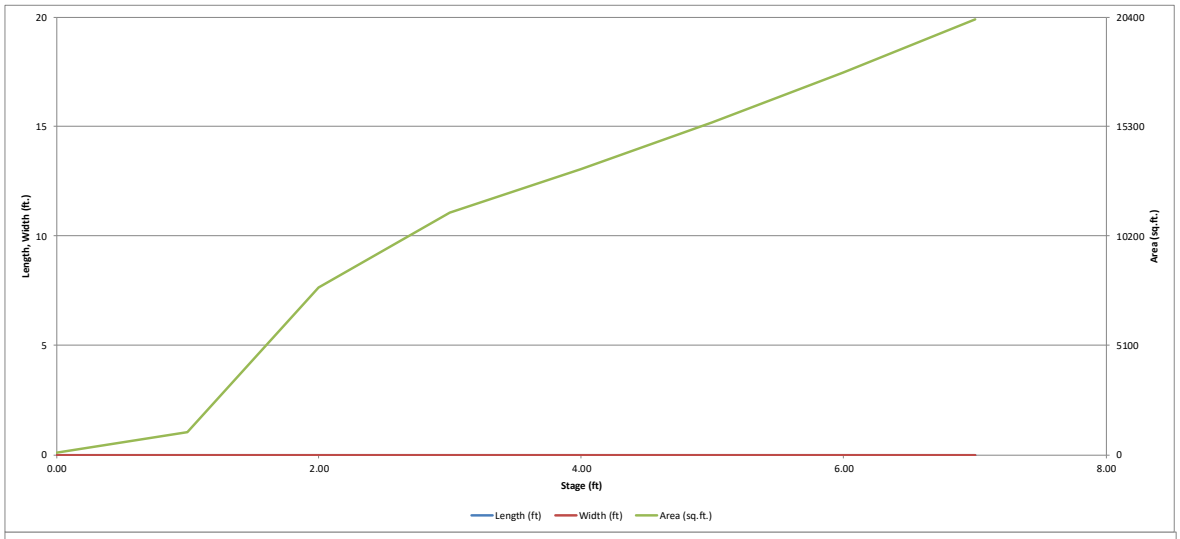
Zone 1 Volume (WQCV) =	0.194	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.248	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.592	acre-feet
Total Detention Basin Volume =	1.033	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (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

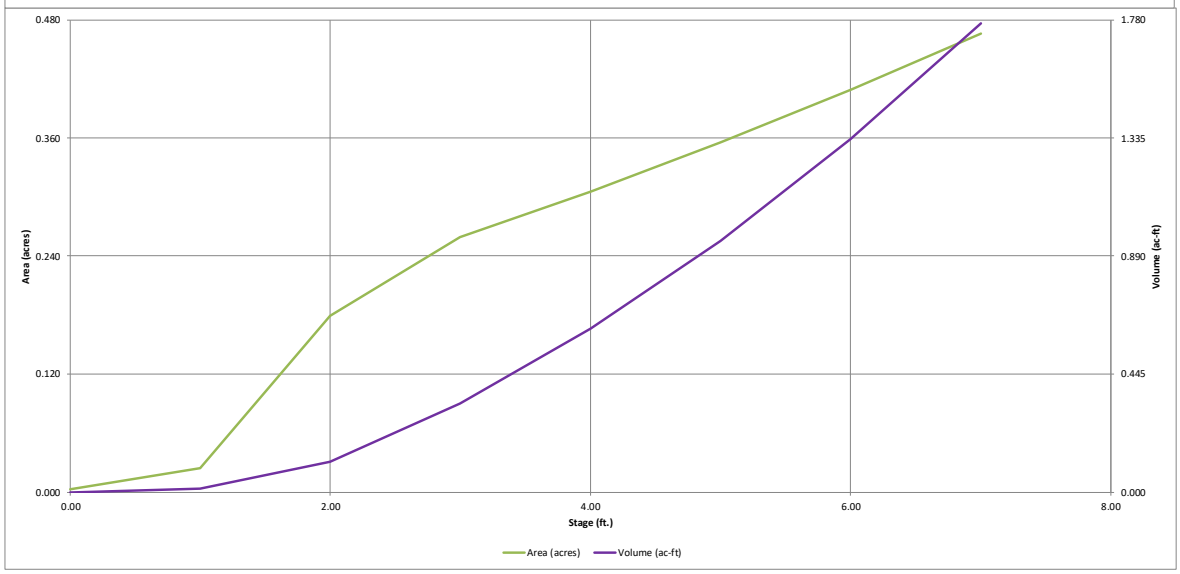
Depth Increment = 0.50 ft

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	--	--	--	125	0.003		
6416	--	1.00	--	--	--	1,061	0.024	593	0.014
6417	--	2.00	--	--	--	7,791	0.179	5,019	0.115
6418	--	3.00	--	--	--	11,294	0.259	14,561	0.334
6419	--	4.00	--	--	--	13,308	0.306	26,863	0.617
6420	--	5.00	--	--	--	15,475	0.355	41,254	0.947
6421 (SPILLWAY)	--	6.00	--	--	--	17,809	0.409	57,897	1.329
6422 (BERM)	--	7.00	--	--	--	20,302	0.466	76,952	1.767

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)



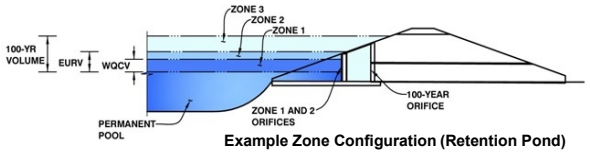


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: DAWSON TRAILS BLVD

Basin ID: Pond B



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.41	0.194	Orifice Plate
Zone 2 (EURV)	3.41	0.248	Circular Orifice
Zone 3 (100-year)	5.24	0.592	Weir&Pipe (Restrict)
Total (all zones)		1.033	

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

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	5.139E-03	ft^2
Depth at top of Zone using Orifice Plate =	2.44	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	9.80	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.74	sq. inches (diameter = 15/16 inch)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.81	1.63					
Orifice Area (sq. inches)	0.74	0.74	0.74					

	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)

	Zone 2 Circular	Not Selected			Zone 2 Circular	Not Selected	
Invert of Vertical Orifice =	2.44	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	0.00	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	3.55	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	0.03	N/A	feet
Vertical Orifice Diameter =	0.62	N/A	inches				

Calculated Parameters for Vertical Orifice

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

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.55	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	4.30	N/A	feet
Overflow Weir Front Edge Length =	6.00	N/A	feet	Overflow Weir Slope Length =	3.09	N/A	feet
Overflow Weir Grate Slope =	4.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	7.31	N/A	
Horiz. Length of Weir Sides =	3.00	N/A	feet	Overflow Grate Open Area w/o Debris =	12.91	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	6.46	N/A	ft^2
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			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	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

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.25	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.50	feet
Spillway Crest Length =	24.00	feet	Stage at Top of Freeboard =	6.75	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.45	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	1.65	acre-ft

Calculated Parameters for Spillway

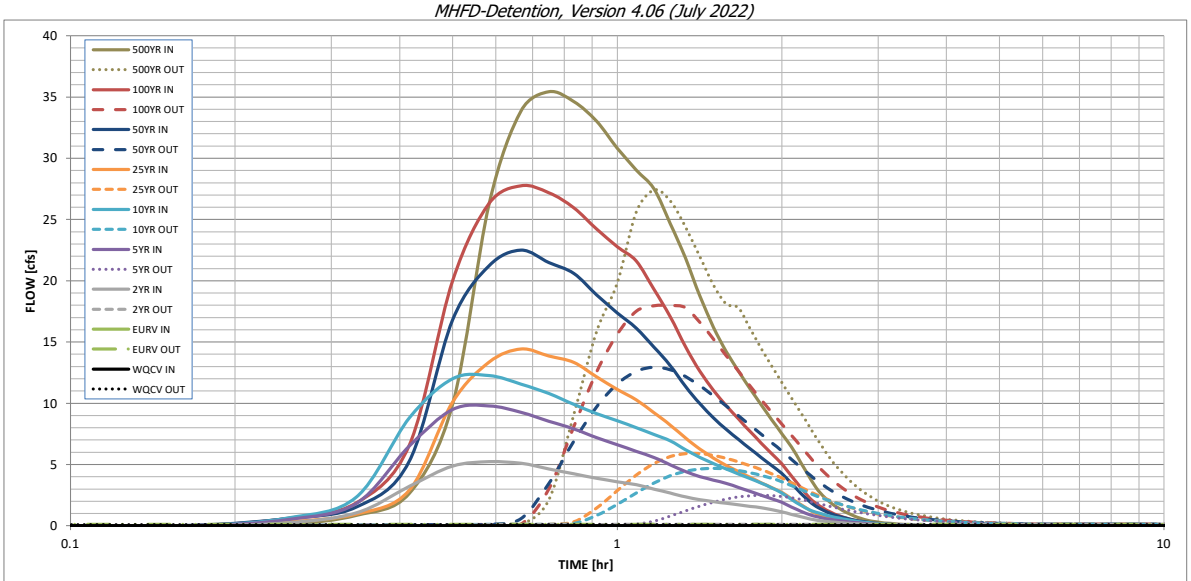
Routed Hydrograph Results

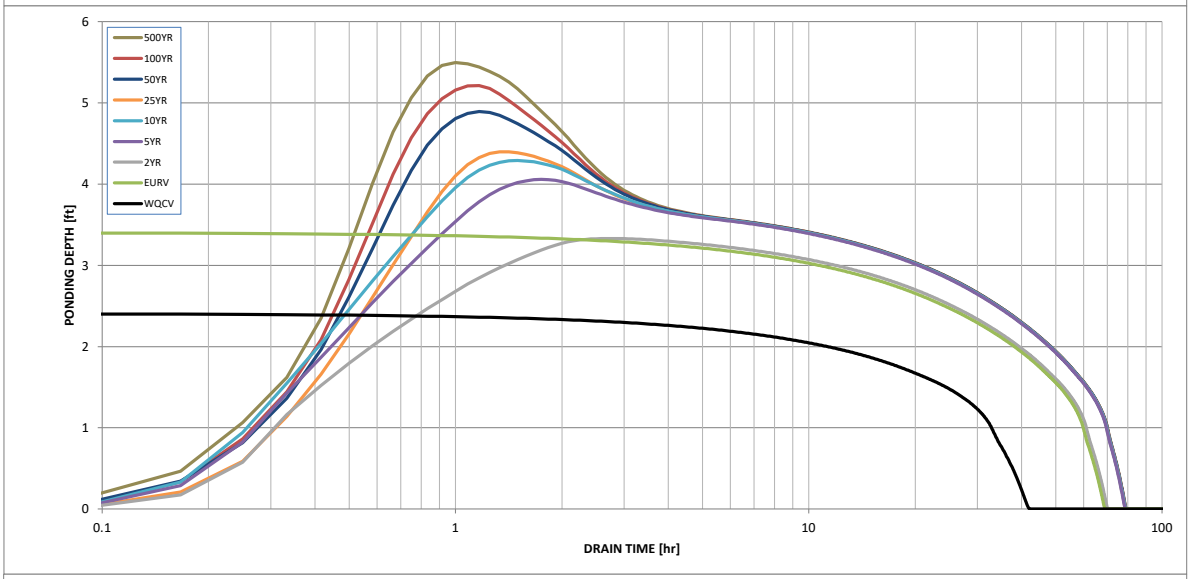
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

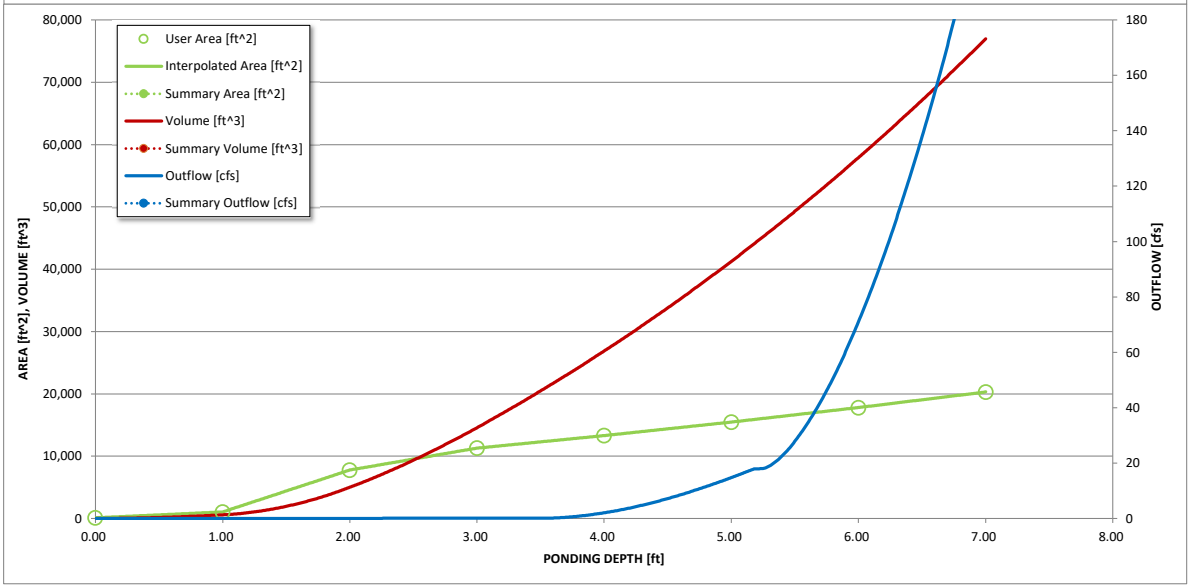
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.06	1.43	1.66	1.69	2.26	2.60	3.14
CUHP Runoff Volume (acre-ft) =	0.194	0.442	0.448	0.823	1.085	1.178	1.864	2.339	3.008
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.448	0.823	1.085	1.178	1.864	2.339	3.008
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.3	4.6	6.5	8.3	14.3	18.7	24.6
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.09	0.32	0.45	0.58	1.00	1.31	1.72
Peak Inflow Q (cfs) =	N/A	N/A	5.2	9.8	12.3	14.4	22.5	27.8	35.4
Peak Outflow Q (cfs) =	0.1	0.1	0.1	2.5	4.7	5.9	12.9	18.0	27.4
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.5	0.7	0.7	0.9	1.0	1.1
Structure Controlling Flow =	Plate	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	0.2	0.4	0.4	1.0	1.4	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) =	37	60	61	66	64	64	59	56	53
Time to Drain 99% of Inflow Volume (hours) =	**40**	65	66	72	71	70	68	67	65
Maximum Ponding Depth (ft) =	2.41	3.41	3.33	4.06	4.29	4.40	4.89	5.21	5.49
Area at Maximum Ponding Depth (acres) =	0.21	0.28	0.27	0.31	0.32	0.32	0.35	0.37	0.38
Maximum Volume Stored (acre-ft) =	0.195	0.444	0.420	0.632	0.704	0.740	0.905	1.023	1.128

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.02	0.13
	0:15:00	0.00	0.00	0.25	0.51	0.63	0.32	0.59	0.61	0.84
	0:20:00	0.00	0.00	1.04	1.82	2.34	0.96	1.53	1.86	2.64
	0:25:00	0.00	0.00	3.21	6.51	8.81	2.91	5.28	6.59	9.91
	0:30:00	0.00	0.00	4.88	9.48	11.99	10.11	16.80	20.01	26.27
	0:35:00	0.00	0.00	5.23	9.79	12.25	13.36	21.23	26.33	33.86
	0:40:00	0.00	0.00	5.10	9.27	11.57	14.43	22.49	27.76	35.42
	0:45:00	0.00	0.00	4.64	8.53	10.79	13.86	21.49	27.18	34.62
	0:50:00	0.00	0.00	4.23	7.90	9.90	13.32	20.59	25.96	33.02
	0:55:00	0.00	0.00	3.87	7.20	9.16	12.15	18.85	24.22	30.84
	1:00:00	0.00	0.00	3.59	6.61	8.57	11.14	17.39	22.79	29.04
	1:05:00	0.00	0.00	3.34	6.08	8.02	10.29	16.13	21.60	27.53
	1:10:00	0.00	0.00	3.00	5.57	7.46	9.24	14.59	19.32	24.67
	1:15:00	0.00	0.00	2.66	4.99	6.92	8.23	13.08	17.06	21.85
	1:20:00	0.00	0.00	2.35	4.42	6.21	7.17	11.38	14.63	18.75
	1:25:00	0.00	0.00	2.13	4.02	5.59	6.26	9.95	12.61	16.20
	1:30:00	0.00	0.00	1.97	3.73	5.08	5.52	8.81	11.06	14.23
	1:35:00	0.00	0.00	1.83	3.47	4.64	4.93	7.86	9.80	12.61
	1:40:00	0.00	0.00	1.71	3.13	4.23	4.42	7.03	8.70	11.18
	1:45:00	0.00	0.00	1.59	2.81	3.85	3.95	6.28	7.69	9.88
	1:50:00	0.00	0.00	1.47	2.50	3.49	3.52	5.58	6.76	8.66
	1:55:00	0.00	0.00	1.31	2.21	3.11	3.11	4.91	5.88	7.52
	2:00:00	0.00	0.00	1.14	1.91	2.67	2.71	4.27	5.05	6.44
	2:05:00	0.00	0.00	0.94	1.54	2.15	2.21	3.45	4.06	5.16
	2:10:00	0.00	0.00	0.74	1.19	1.67	1.72	2.66	3.11	3.93
	2:15:00	0.00	0.00	0.56	0.90	1.30	1.28	1.96	2.27	2.87
	2:20:00	0.00	0.00	0.44	0.70	1.05	0.93	1.47	1.68	2.15
	2:25:00	0.00	0.00	0.35	0.57	0.86	0.70	1.13	1.27	1.64
	2:30:00	0.00	0.00	0.29	0.46	0.70	0.54	0.88	0.96	1.25
	2:35:00	0.00	0.00	0.24	0.38	0.57	0.42	0.68	0.72	0.94
	2:40:00	0.00	0.00	0.19	0.31	0.46	0.33	0.53	0.54	0.70
	2:45:00	0.00	0.00	0.16	0.25	0.36	0.25	0.41	0.39	0.51
	2:50:00	0.00	0.00	0.13	0.19	0.28	0.19	0.31	0.29	0.38
	2:55:00	0.00	0.00	0.10	0.15	0.22	0.15	0.24	0.22	0.29
	3:00:00	0.00	0.00	0.08	0.12	0.17	0.12	0.19	0.18	0.23
	3:05:00	0.00	0.00	0.07	0.09	0.13	0.10	0.15	0.14	0.19
	3:10:00	0.00	0.00	0.05	0.07	0.10	0.07	0.12	0.11	0.14
	3:15:00	0.00	0.00	0.04	0.05	0.08	0.06	0.09	0.08	0.11
	3:20:00	0.00	0.00	0.03	0.04	0.06	0.04	0.06	0.06	0.08
	3:25:00	0.00	0.00	0.02	0.02	0.04	0.03	0.04	0.04	0.05
	3:30:00	0.00	0.00	0.01	0.02	0.02	0.02	0.03	0.03	0.03
	3:35:00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

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

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

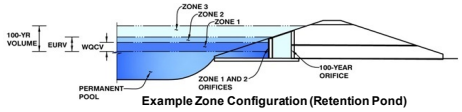
Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: Pond D3

Basin ID: Pond D3 (Stage 0.00 = 6417.50, 100-yr crest = 6424.75', 100-yr WS = 6425.98, top of berm = 6427.00')



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	90.80	acres
Watershed Length =	3,991	ft
Watershed Length to Centroid =	2,182	ft
Watershed Slope =	0.047	ft/ft
Watershed Imperviousness =	47.60%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	25.0%	percent
Percentage Hydrologic Soil Groups C/D =	75.0%	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) =	1.512	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	4.205	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 1.06 in.) =	3.861	acre-feet	1.06 inches
5-yr Runoff Volume (P1 = 1.43 in.) =	6.329	acre-feet	1.43 inches
10-yr Runoff Volume (P1 = 1.66 in.) =	8.009	acre-feet	1.66 inches
25-yr Runoff Volume (P1 = 2 in.) =	10.945	acre-feet	2.00 inches
50-yr Runoff Volume (P1 = 2.26 in.) =	12.978	acre-feet	2.26 inches
100-yr Runoff Volume (P1 = 2.6 in.) =	15.965	acre-feet	2.60 inches
500-yr Runoff Volume (P1 = 3.2 in.) =	20.773	acre-feet	3.20 inches
Approximate 2-yr Detention Volume =	3.165	acre-feet	
Approximate 5-yr Detention Volume =	4.992	acre-feet	
Approximate 10-yr Detention Volume =	5.884	acre-feet	
Approximate 25-yr Detention Volume =	6.755	acre-feet	
Approximate 50-yr Detention Volume =	7.053	acre-feet	
Approximate 100-yr Detention Volume =	8.260	acre-feet	

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	1.512	acre-feet
Zone 2 Volume (EURV - Zone 1) =	2.693	acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	4.205	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	

Total detention volume is less than 100-year volume.

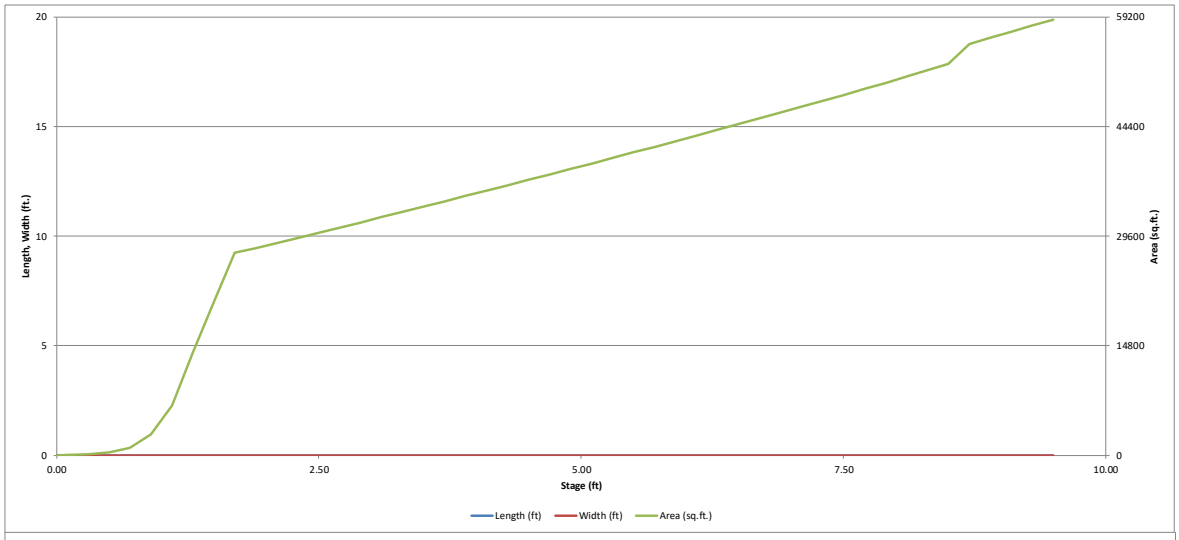
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	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

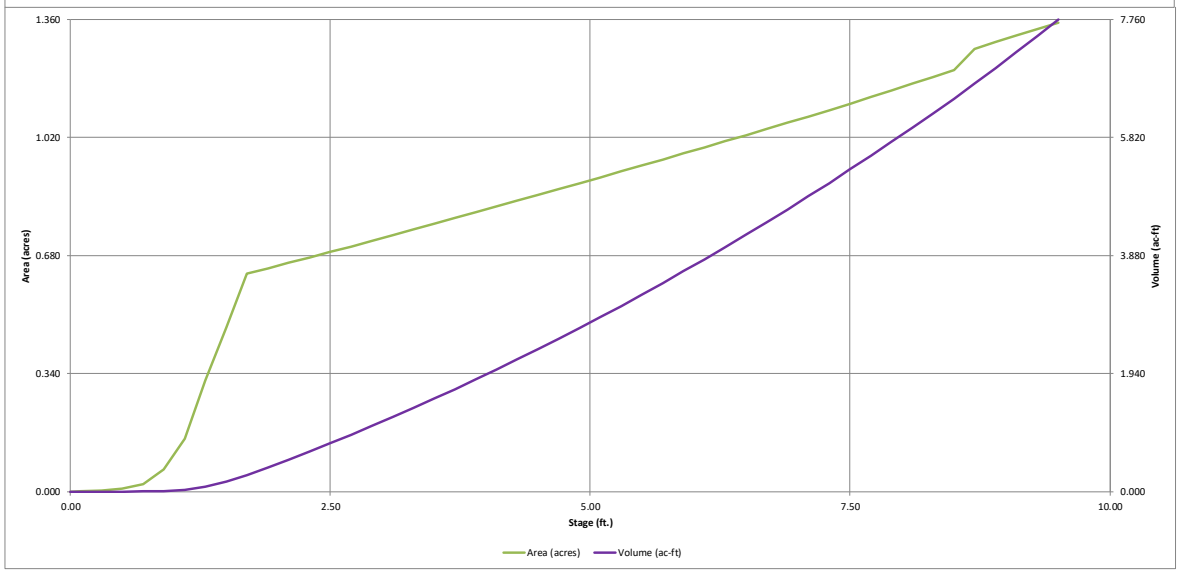
Depth Increment = ft

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	--	--	--	1	0.000		
	--	0.10	--	--	--	63	0.001	3	0.000
	--	0.30	--	--	--	132	0.003	23	0.001
	--	0.50	--	--	--	401	0.009	76	0.002
	--	0.70	--	--	--	961	0.022	212	0.005
	--	0.90	--	--	--	2,829	0.065	591	0.014
	--	1.10	--	--	--	6,672	0.153	1,541	0.035
	--	1.30	--	--	--	13,925	0.320	3,601	0.083
	--	1.50	--	--	--	20,625	0.473	7,056	0.162
	--	1.70	--	--	--	27,324	0.627	11,851	0.272
	--	1.90	--	--	--	28,004	0.643	17,384	0.399
	--	2.10	--	--	--	28,688	0.659	23,053	0.529
	--	2.30	--	--	--	29,376	0.674	28,859	0.663
	--	2.50	--	--	--	30,069	0.690	34,804	0.799
	--	2.70	--	--	--	30,765	0.706	40,887	0.939
	--	2.90	--	--	--	31,466	0.722	47,110	1.081
	--	3.10	--	--	--	32,171	0.739	53,474	1.228
	--	3.30	--	--	--	32,880	0.755	59,979	1.377
	--	3.50	--	--	--	33,594	0.771	66,626	1.530
	--	3.70	--	--	--	34,307	0.788	73,417	1.685
	--	3.90	--	--	--	35,025	0.804	80,350	1.845
	--	4.10	--	--	--	35,747	0.821	87,427	2.007
	--	4.30	--	--	--	36,472	0.837	94,649	2.173
	--	4.50	--	--	--	37,202	0.854	102,016	2.342
	--	4.70	--	--	--	37,935	0.871	109,530	2.514
	--	4.90	--	--	--	38,673	0.888	117,191	2.690
	--	5.10	--	--	--	39,414	0.905	124,999	2.870
	--	5.30	--	--	--	40,160	0.922	132,957	3.052
	--	5.50	--	--	--	40,910	0.939	141,064	3.238
	--	5.70	--	--	--	41,663	0.956	149,321	3.428
	--	5.90	--	--	--	42,421	0.974	157,730	3.621
	--	6.10	--	--	--	43,182	0.991	166,290	3.817
	--	6.30	--	--	--	43,948	1.009	175,003	4.018
	--	6.50	--	--	--	44,718	1.027	183,869	4.221
	--	6.70	--	--	--	45,491	1.044	192,890	4.428
	--	6.90	--	--	--	46,269	1.062	202,066	4.639
	--	7.10	--	--	--	47,050	1.080	211,398	4.853
	--	7.30	--	--	--	47,836	1.098	220,887	5.071
	--	7.50	--	--	--	48,626	1.116	230,533	5.292
	--	7.70	--	--	--	49,470	1.136	240,343	5.518
	--	7.90	--	--	--	50,314	1.155	250,321	5.747
	--	8.10	--	--	--	51,158	1.174	260,468	5.980
	--	8.30	--	--	--	52,001	1.194	270,784	6.216
	--	8.50	--	--	--	52,844	1.213	281,269	6.457
	--	8.70	--	--	--	55,537	1.275	292,107	6.706
	--	8.90	--	--	--	56,379	1.294	303,298	6.963
	--	9.10	--	--	--	57,217	1.314	314,658	7.224
	--	9.30	--	--	--	58,054	1.333	326,185	7.488
	--	9.50	--	--	--	58,887	1.352	337,879	7.757

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)



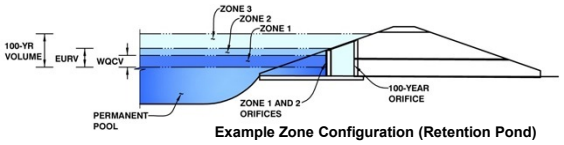


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Pond D3

Basin ID: Pond D3 (Stage 0.00 = 6417.50, 100-yr crest = 6424.75', 100-yr WS = 6425.98, top of berm = 6427.00')



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	3.48	1.512	Orifice Plate
Zone 2 (EURV)	6.49	2.693	Rectangular Orifice
Zone 3			
Total (all zones)		4.205	

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)

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	6.250E-02	ft²
Depth at top of Zone using Orifice Plate =	6.49	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	26.00	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	9.00	sq. inches (use rectangular openings)	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							
Orifice Area (sq. inches)	9.00							

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

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Rectangular	Not Selected				
Invert of Vertical Orifice =	3.48	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	0.44	N/A	ft²
Depth at top of Zone using Vertical Orifice =	6.49	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	0.33	N/A	feet
Vertical Orifice Height =	8.00	N/A	inches				
Vertical Orifice Width =	8.00		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)

	Not Selected	Not Selected				
Overflow Weir Front Edge Height, Ho =	6.49	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	N/A	N/A	feet
Overflow Weir Front Edge Length =		N/A	feet	Overflow Weir Slope Length =	N/A	N/A	feet
Overflow Weir Grate Slope =		N/A	H:V	Grate Open Area / 100-yr Orifice Area =	N/A	N/A	
Horiz. Length of Weir Sides =	N/A	N/A	feet	Overflow Grate Open Area w/o Debris =	N/A	N/A	ft²
Overflow Grate Type =	N/A	N/A		Overflow Grate Open Area w/ Debris =	N/A	N/A	ft²
Debris Clogging % =	N/A	N/A	%				

Calculated Parameters for Overflow Weir

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

	Not Selected	Not Selected				
Depth to Invert of Outlet Pipe =	N/A	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	N/A	N/A	ft²
Circular Orifice Diameter =	N/A	N/A	inches	Outlet Orifice Centroid =	N/A	N/A	feet
				Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	7.25	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	1.23	feet
Spillway Crest Length =	50.00	feet	Stage at Top of Freeboard =	9.48	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	1.35	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	7.73	acre-ft

Calculated Parameters for Spillway

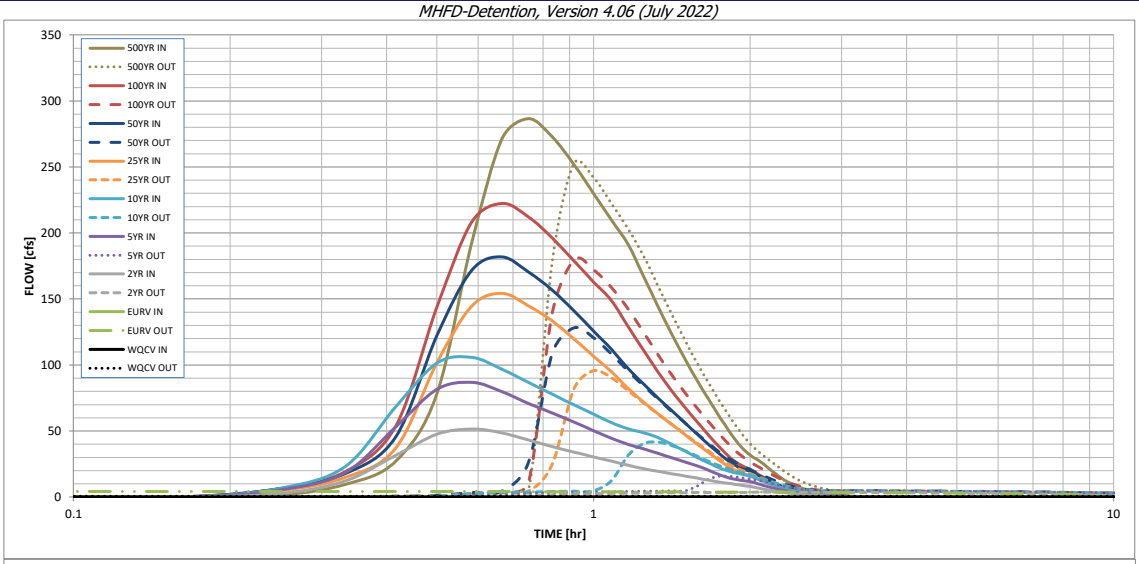
Routed Hydrograph Results

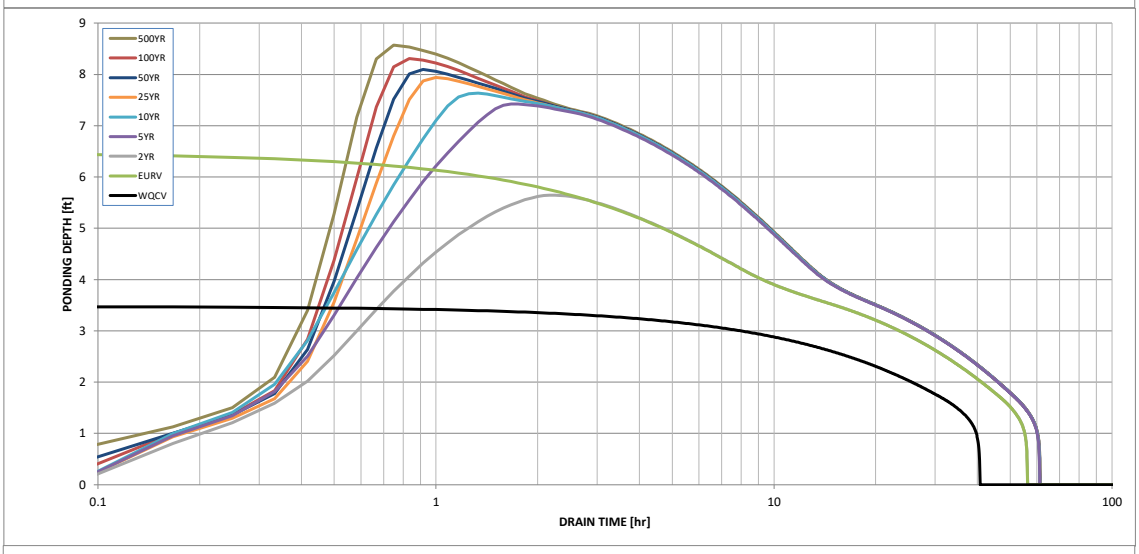
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

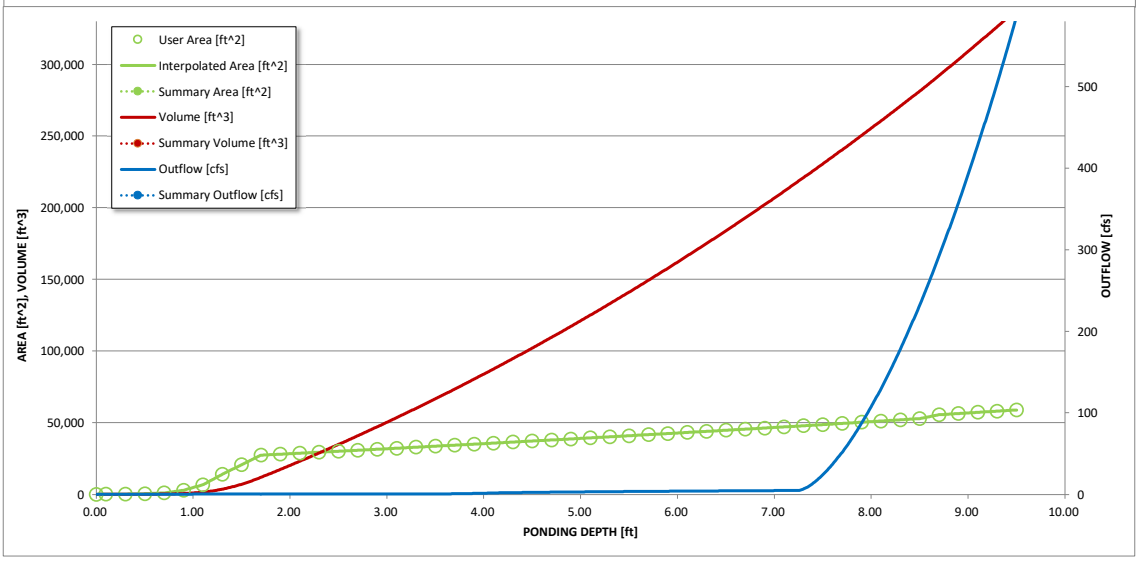
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.06	1.43	1.66	2.00	2.26	2.60	3.20
CUHP Runoff Volume (acre-ft) =	1.512	4.205	3.861	6.329	8.009	10.945	12.978	15.965	20.773
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	3.861	6.329	8.009	10.945	12.978	15.965	20.773
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	5.8	25.8	37.6	70.5	87.7	115.1	156.3
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.06	0.28	0.41	0.78	0.97	1.27	1.72
Peak Inflow Q (cfs) =	N/A	N/A	51.4	86.8	105.8	154.2	181.9	222.4	286.6
Peak Outflow Q (cfs) =	0.6	4.3	3.6	15.8	41.6	95.7	128.1	179.5	252.4
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.6	1.1	1.4	1.5	1.6	1.6
Structure Controlling Flow =	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Spillway	Spillway	Spillway	Spillway	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
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) =	39	52	52	54	53	50	48	46	42
Time to Drain 99% of Inflow Volume (hours) =	**40**	55	55	59	58	57	56	55	54
Maximum Ponding Depth (ft) =	3.48	6.49	5.65	7.42	7.63	7.94	8.10	8.31	8.57
Area at Maximum Ponding Depth (acres) =	0.77	1.03	0.95	1.11	1.13	1.16	1.17	1.19	1.23
Maximum Volume Stored (acre-ft) =	1.514	4.211	3.371	5.203	5.438	5.793	5.968	6.216	6.543

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

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

Time Interval	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.44	0.21	1.45
	0:15:00	0.00	0.00	2.65	5.38	6.67	4.92	6.39	6.44	9.57
	0:20:00	0.00	0.00	12.14	18.57	23.10	14.88	17.68	19.32	27.12
	0:25:00	0.00	0.00	31.62	53.21	68.47	37.12	45.59	53.84	78.17
	0:30:00	0.00	0.00	47.56	81.61	101.42	101.60	122.30	143.87	192.56
	0:35:00	0.00	0.00	51.44	86.80	105.80	144.60	171.78	208.25	270.96
	0:40:00	0.00	0.00	48.54	79.84	96.85	154.25	181.91	222.42	286.64
	0:45:00	0.00	0.00	43.17	70.92	86.87	144.84	170.41	212.09	272.63
	0:50:00	0.00	0.00	38.11	63.63	77.81	133.30	156.73	196.11	251.98
	0:55:00	0.00	0.00	33.97	56.85	69.90	119.80	141.03	178.86	229.98
	1:00:00	0.00	0.00	30.37	50.33	62.74	106.66	125.76	163.07	209.70
	1:05:00	0.00	0.00	27.17	44.38	56.30	94.73	111.82	148.72	191.22
	1:10:00	0.00	0.00	24.04	39.89	51.64	82.15	97.24	129.09	166.60
	1:15:00	0.00	0.00	21.46	36.36	48.64	71.69	85.29	110.72	143.78
	1:20:00	0.00	0.00	19.39	32.94	44.80	62.74	74.73	94.42	122.89
	1:25:00	0.00	0.00	17.61	29.64	39.77	54.83	65.21	80.16	104.26
	1:30:00	0.00	0.00	15.94	26.54	34.68	47.21	56.06	67.80	88.05
	1:35:00	0.00	0.00	14.30	23.61	29.99	40.07	47.52	56.80	73.66
	1:40:00	0.00	0.00	12.69	20.19	25.71	33.48	39.67	46.72	60.49
	1:45:00	0.00	0.00	11.24	16.82	21.96	27.46	32.49	37.53	48.53
	1:50:00	0.00	0.00	10.15	14.23	19.23	22.19	26.26	29.70	38.54
	1:55:00	0.00	0.00	9.03	12.70	17.43	18.47	21.96	24.24	31.71
	2:00:00	0.00	0.00	8.02	11.62	15.77	16.26	19.39	20.86	27.44
	2:05:00	0.00	0.00	6.68	9.78	13.20	13.37	15.96	16.83	22.20
	2:10:00	0.00	0.00	5.36	7.78	10.51	10.40	12.42	12.82	16.94
	2:15:00	0.00	0.00	4.24	6.10	8.25	7.99	9.54	9.60	12.69
	2:20:00	0.00	0.00	3.35	4.80	6.45	6.16	7.35	7.16	9.48
	2:25:00	0.00	0.00	2.63	3.76	4.99	4.73	5.63	5.34	7.06
	2:30:00	0.00	0.00	2.05	2.91	3.80	3.61	4.28	4.03	5.33
	2:35:00	0.00	0.00	1.60	2.21	2.87	2.73	3.23	3.06	4.03
	2:40:00	0.00	0.00	1.24	1.67	2.17	2.06	2.44	2.33	3.07
	2:45:00	0.00	0.00	0.94	1.26	1.66	1.57	1.86	1.81	2.38
	2:50:00	0.00	0.00	0.71	0.93	1.25	1.20	1.41	1.38	1.81
	2:55:00	0.00	0.00	0.50	0.66	0.90	0.88	1.04	1.01	1.32
	3:00:00	0.00	0.00	0.33	0.45	0.61	0.61	0.72	0.69	0.90
	3:05:00	0.00	0.00	0.20	0.29	0.37	0.39	0.45	0.44	0.57
	3:10:00	0.00	0.00	0.10	0.16	0.20	0.22	0.25	0.24	0.31
	3:15:00	0.00	0.00	0.04	0.07	0.08	0.09	0.11	0.10	0.13
	3:20:00	0.00	0.00	0.01	0.02	0.02	0.02	0.02	0.02	0.03
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.
The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]

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

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

Site Layout

SCM Design, Version 4.01 (December 2024)

Designer: Matthew Eberly
Company: EMK Consultants
Date: April 29, 2025
Project: Dawson Trails - Filing 2 Infrastructure
Location: Pond D3

SITE LAYOUT INFO (User Input in Blue Cells)

Water Quality Event (WQE)	0.60	inches

Outfall ID	D3												
Total Tributary Area (ft^2)	3,947,407												
Total Tributary Area (ac)	90.62												
Imperviousness (%)	47.6%												
MS4 Design Standard	WQCV												
SCM Type	EDB												

Notes:

OUTFALL RESULTS

SCM Worksheet Name	EDB_D3												
Untreated Area (ft^3)	0												
Default WQCV (ft^3)	65,713												
Optional Override WQCV (ft^3)													
WQCV Reduction (ft^3)	0												
Remaining WQCV (ft^3)	65,713												
WQCV Reduction (%)	0%												
Design WQCV of SCM (ft^3)	0												
Pollutant Removal (ft^3)	0												
Untreated WQCV (ft^3)	65,713												

TOTAL SITE RESULTS (Sums results from all Outfalls)

Total Site Area	3,947,407	ft^2	90.62	acres
Treated Area	3,947,407	ft^2	90.62	acres
Untreated Area	0	ft^2	0.00	acres
Total Site Imperviousness	47.6%	%		
Default (or Override) WQCV	65,713	ft^3	1.509	acre-feet
Remaining WQCV	65,713	ft^3	1.509	acre-feet
WQCV Reduction	0%	%		
Design WQCV	0	ft^3	0.000	acre-feet
Untreated WQCV	65,713	ft^3	1.509	acre-feet

Extended Detention Basin (EDB)

SCM Design, Version 4.01 (December 2024)

Designer:	**Matthew Eberly**
Company:	**EMK Consultants**
Date:	**April 29, 2025**
Project:	**Dawson Trails - Filing 2 Infrastructure**
Location:	**Pond D3**
Outfall ID:	**D3**

1. Inlet and Forebay

A) Is RPA (GB/GS) used for Runoff Reduction upstream of SCM? NO

Define inflow points for all areas tributary to the SCM below.

B) Inflow Points contributing to SCM (max 8)

Inflow Design Point ID	West							
Tributary Area to Inflow Point (ft^2)	3,947,407							
Imperviousness above Inflow Point (%)	47.6%							
Default WQCV for Inflow Point (ft^3)	65,713							
Optional Override WQCV for Inflow Point (ft^3)								
WQCV Reduction above Inflow Point (ft^3)	0							
Remaining WQCV at Inflow Point (ft^3)	65,713							
Will pretreatment be provided with a Sedimentation MTD (HDS)	NO							
Paired Pretreatment HDS Worksheet Name	--							
Sheet or Concentrated Flow	Conc							

C) Sheet Flow

Select sheet flow inflow feature	--							
Is Concrete Edger used?	--							
Spacing between slots, recommend ≤ 2 ft on center (ft)	--							
Slot Opening Length, recommend 1.5 (in)	--							
Select type of blind swale used to distribute flow	--							
Select energy dissipation method for level spreader	--							
Height of drop, recommend 2 to 3 (in)	--							
Is concrete mowing strip provided to facilitate maintenance?	--							

D) Concentrated Flow

Select concentrated flow inflow feature	Pipe							
Is downspout extension needed to bridge backfill zone?	--							
Depth of gutter flow line depression for curb opening, recommend 3 (in)	--							
Curb opening inlet width (ft)	--							
Height of drop to sediment pad/forebay, recommend ≥ 1 (in)	--							
Select energy dissipation method for downspouts and/or curb openings.	--							
Select energy dissipation method for swales, channels, and piped outfalls	Impact							

v) Forebay

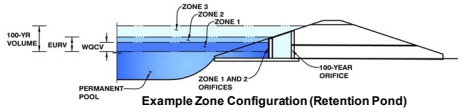
Impervious area tributary to concentrated inflow location (ft^2)	1,878,481							
Forebay Type (Concrete Sediment Pad sufficient for Imp Area ≤ 2 acre)	Forebay							
Minimum Forebay Volume (ft^3)	657							
Design Forebay Volume (ft^3)	1,238							
Maximum Forebay Depth (in)	30.00							
Design Forebay Depth (in)	27.00							
Rectangular Weir Notch Width to Empty Forebay in 5-minutes (in)	5.99							
Design Notch Width (in)	6.00							
Forebay Drain Time (minutes)	5.0							

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Dawson Trails INFRA-1**

Basin ID: **Water Quality Pond D4**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	2.77	acres
Watershed Length =	920	ft
Watershed Length to Centroid =	650	ft
Watershed Slope =	0.040	ft/ft
Watershed Imperviousness =	63.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	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) =	0.057	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	0.168	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 1.06 in.) =	0.154	acre-feet	1.06 inches
5-yr Runoff Volume (P1 = 1.43 in.) =	0.235	acre-feet	1.43 inches
10-yr Runoff Volume (P1 = 1.66 in.) =	0.288	acre-feet	1.66 inches
25-yr Runoff Volume (P1 = 1.69 in.) =	0.301	acre-feet	inches
50-yr Runoff Volume (P1 = 2.26 in.) =	0.436	acre-feet	2.26 inches
100-yr Runoff Volume (P1 = 2.6 in.) =	0.524	acre-feet	2.60 inches
500-yr Runoff Volume (P1 = 3.14 in.) =	0.655	acre-feet	inches
Approximate 2-yr Detention Volume =	0.134	acre-feet	
Approximate 5-yr Detention Volume =	0.204	acre-feet	
Approximate 10-yr Detention Volume =	0.232	acre-feet	
Approximate 25-yr Detention Volume =	0.221	acre-feet	
Approximate 50-yr Detention Volume =	0.270	acre-feet	
Approximate 100-yr Detention Volume =	0.305	acre-feet	

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.057	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.111	acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.168	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	

Total detention volume is less than 100-year volume.

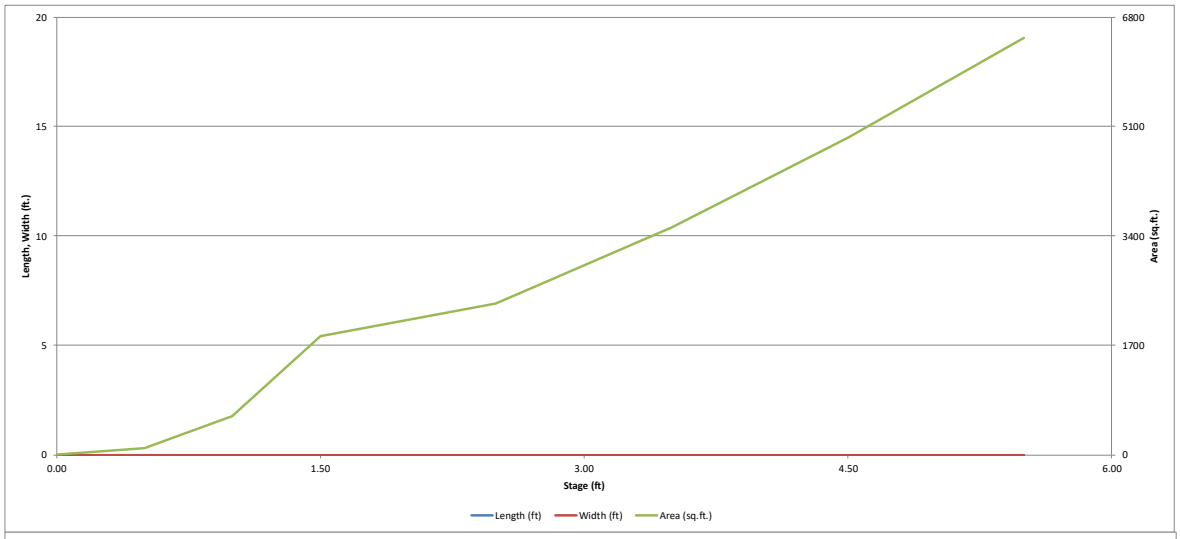
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	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

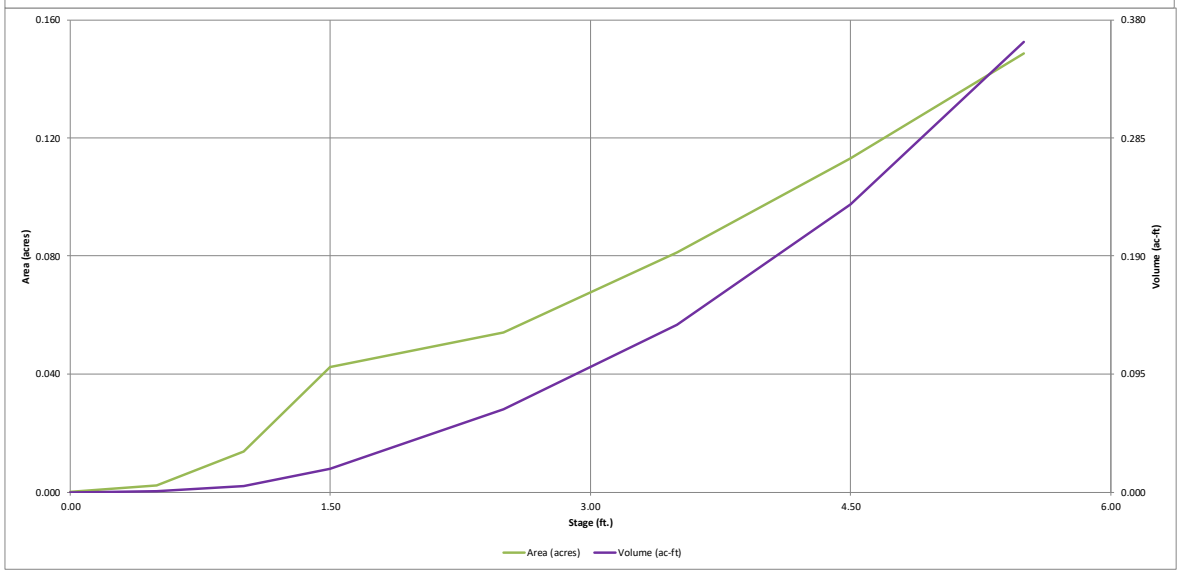
Depth Increment = 1.00 ft

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	--	--	--	4	0.000		
6497.5	--	0.50	--	--	--	100	0.002	26	0.001
6498	--	1.00	--	--	--	600	0.014	201	0.005
6498.5	--	1.50	--	--	--	1,843	0.042	812	0.019
6499	--	2.50	--	--	--	2,354	0.054	2,910	0.067
6500	--	3.50	--	--	--	3,534	0.081	5,854	0.134
6501	--	4.50	--	--	--	4,921	0.113	10,082	0.231
6502	--	5.50	--	--	--	6,481	0.149	15,783	0.362

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)



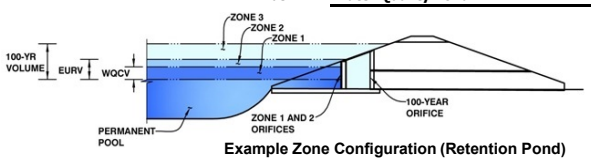


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **Dawson Trails INFRA-1**

Basin ID: **Water Quality Pond D4**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.32	0.057	Orifice Plate
Zone 2 (EURV)	3.89	0.111	Orifice Plate
Zone 3			
Total (all zones)		0.168	

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

			Calculated Parameters for Underdrain		
Underdrain Orifice Invert Depth =		ft (distance below the filtration media surface)	Underdrain Orifice Area =		ft^2
Underdrain Orifice Diameter =		inches	Underdrain Orifice Centroid =		feet

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

			Calculated Parameters for Plate		
Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	2.319E-03	ft^2
Depth at top of Zone using Orifice Plate =	3.89	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	18.00	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.33	sq. inches (diameter = 5/8 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	1.50	3.00					
Orifice Area (sq. inches)	0.33	0.33	0.33					

	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 =			ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =			ft^2
Depth at top of Zone using Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =			feet
Vertical Orifice Diameter =			inches				

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

	Not Selected	Not Selected		Calculated Parameters for Overflow Weir	Not Selected	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.90		ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	3.90		feet
Overflow Weir Front Edge Length =	5.67		feet	Overflow Weir Slope Length =	2.92		feet
Overflow Weir Grate Slope =	0.00		H:V	Grate Open Area / 100-yr Orifice Area =	6.52		
Horiz. Length of Weir Sides =	2.92		feet	Overflow Grate Open Area w/o Debris =	11.52		ft^2
Overflow Grate Type =	Type C Grate			Overflow Grate Open Area w/ Debris =	5.76		ft^2
Debris Clogging % =	50%		%				

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

	Not Selected	Not Selected		Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate	Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =	1.00		ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	1.77		ft^2
Circular Orifice Diameter =	18.00		inches	Outlet Orifice Centroid =	0.75		feet
				Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

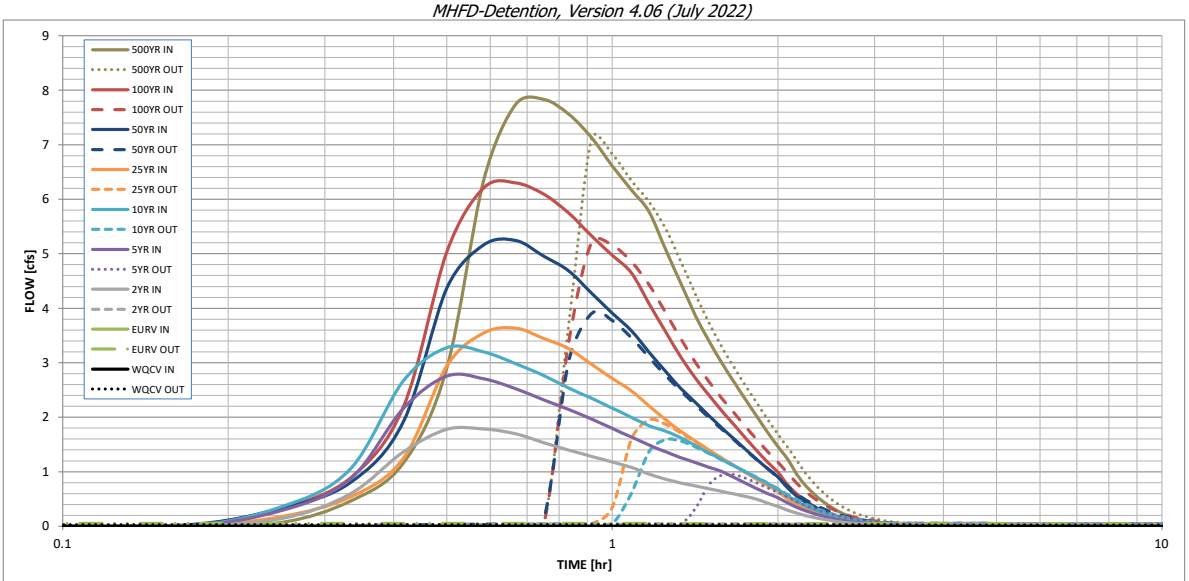
			Calculated Parameters for Spillway		
Spillway Invert Stage=	4.25	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.21	feet
Spillway Crest Length =	20.00	feet	Stage at Top of Freeboard =	5.46	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.15	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	0.36	acre-ft

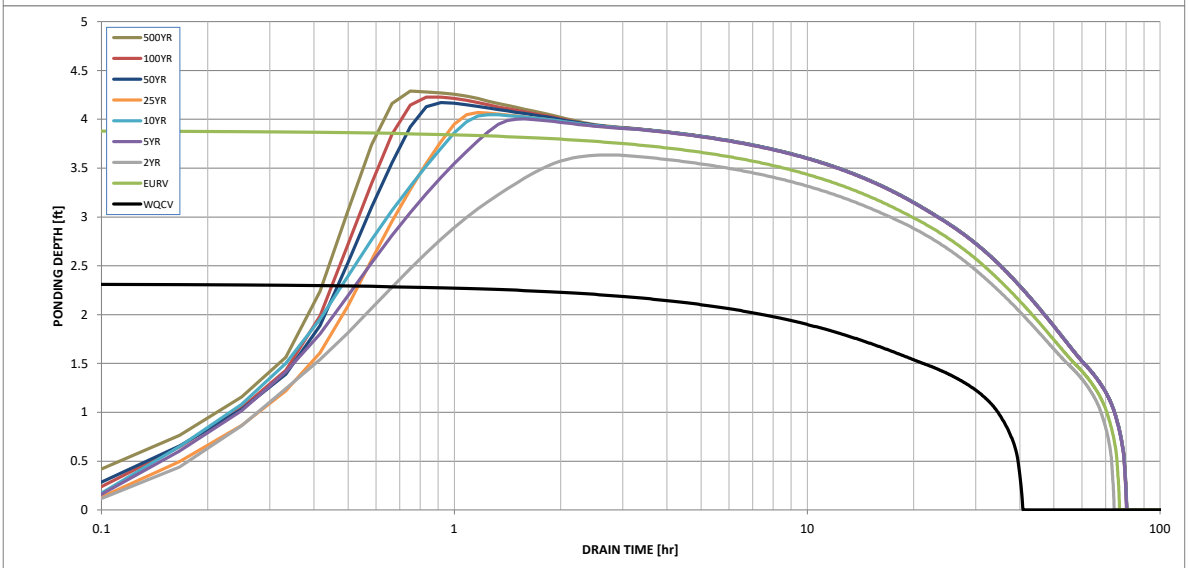
Routed Hydrograph Results — *The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).*

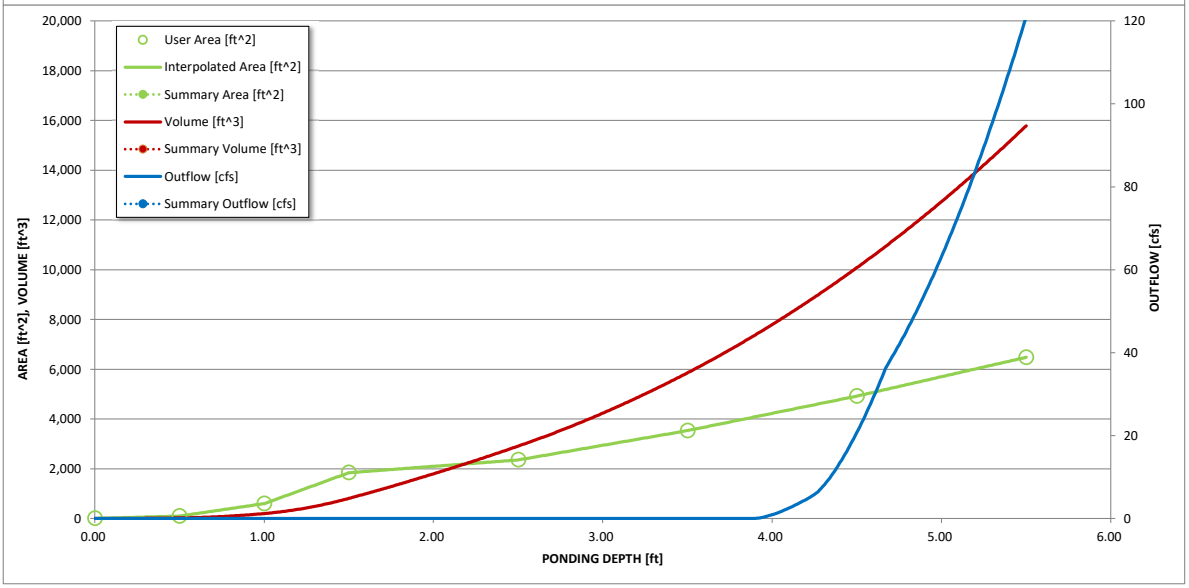
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.06	1.43	1.66	1.69	2.26	2.60	3.14
CUHP Runoff Volume (acre-ft) =	0.057	0.168	0.154	0.235	0.288	0.301	0.436	0.524	0.655
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.154	0.235	0.288	0.301	0.436	0.524	0.655
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.2	0.6	0.9	1.2	2.1	2.7	3.6
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.06	0.23	0.33	0.43	0.75	0.98	1.29
Peak Inflow Q (cfs) =	N/A	N/A	1.8	2.8	3.3	3.6	5.2	6.3	7.8
Peak Outflow Q (cfs) =	0.0	0.0	0.0	0.9	1.6	1.9	3.9	5.2	7.1
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	1.5	1.8	1.6	1.9	1.9	2.0
Structure Controlling Flow =	Plate	Plate	Plate	Overflow Weir 1	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	0.1	0.1	0.2	0.3	0.5	0.6
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	68	72	70	70	66	64	60
Time to Drain 99% of Inflow Volume (hours) =	**40**	74	72	77	76	76	75	74	72
Maximum Ponding Depth (ft) =	2.32	3.89	3.63	4.00	4.05	4.07	4.17	4.23	4.29
Area at Maximum Ponding Depth (acres) =	0.05	0.09	0.09	0.10	0.10	0.10	0.10	0.10	0.11
Maximum Volume Stored (acre-ft) =	0.057	0.168	0.145	0.179	0.183	0.185	0.195	0.201	0.207

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.07
	0:15:00	0.00	0.00	0.14	0.29	0.35	0.18	0.33	0.34	0.46
	0:20:00	0.00	0.00	0.59	0.86	1.04	0.53	0.80	0.88	1.16
	0:25:00	0.00	0.00	1.36	2.16	2.66	1.24	1.91	2.18	2.90
	0:30:00	0.00	0.00	1.78	2.75	3.27	2.94	4.37	5.03	6.34
	0:35:00	0.00	0.00	1.78	2.71	3.20	3.54	5.16	6.21	7.74
	0:40:00	0.00	0.00	1.70	2.53	2.98	3.64	5.25	6.30	7.83
	0:45:00	0.00	0.00	1.53	2.32	2.76	3.44	4.96	6.09	7.56
	0:50:00	0.00	0.00	1.39	2.14	2.53	3.26	4.69	5.75	7.13
	0:55:00	0.00	0.00	1.28	1.96	2.35	2.97	4.27	5.33	6.61
	1:00:00	0.00	0.00	1.18	1.79	2.17	2.71	3.91	4.97	6.17
	1:05:00	0.00	0.00	1.08	1.63	2.00	2.48	3.59	4.65	5.77
	1:10:00	0.00	0.00	0.96	1.49	1.85	2.21	3.19	4.08	5.08
	1:15:00	0.00	0.00	0.86	1.36	1.74	1.96	2.84	3.57	4.45
	1:20:00	0.00	0.00	0.79	1.26	1.62	1.74	2.53	3.10	3.86
	1:25:00	0.00	0.00	0.74	1.17	1.48	1.56	2.27	2.72	3.39
	1:30:00	0.00	0.00	0.69	1.08	1.34	1.40	2.02	2.40	2.99
	1:35:00	0.00	0.00	0.64	1.00	1.22	1.25	1.80	2.11	2.64
	1:40:00	0.00	0.00	0.59	0.89	1.10	1.11	1.60	1.86	2.31
	1:45:00	0.00	0.00	0.54	0.79	0.99	0.98	1.40	1.61	2.01
	1:50:00	0.00	0.00	0.49	0.69	0.89	0.86	1.22	1.38	1.72
	1:55:00	0.00	0.00	0.42	0.60	0.78	0.74	1.05	1.17	1.46
	2:00:00	0.00	0.00	0.36	0.52	0.68	0.64	0.90	0.99	1.23
	2:05:00	0.00	0.00	0.29	0.43	0.55	0.50	0.70	0.76	0.95
	2:10:00	0.00	0.00	0.24	0.35	0.45	0.39	0.55	0.59	0.74
	2:15:00	0.00	0.00	0.20	0.28	0.37	0.31	0.44	0.46	0.58
	2:20:00	0.00	0.00	0.16	0.23	0.30	0.25	0.35	0.36	0.45
	2:25:00	0.00	0.00	0.13	0.19	0.24	0.20	0.28	0.28	0.35
	2:30:00	0.00	0.00	0.10	0.15	0.19	0.16	0.22	0.22	0.27
	2:35:00	0.00	0.00	0.08	0.12	0.15	0.12	0.17	0.16	0.21
	2:40:00	0.00	0.00	0.07	0.09	0.12	0.09	0.13	0.13	0.16
	2:45:00	0.00	0.00	0.05	0.07	0.09	0.07	0.10	0.10	0.12
	2:50:00	0.00	0.00	0.04	0.06	0.07	0.06	0.08	0.08	0.10
	2:55:00	0.00	0.00	0.03	0.04	0.06	0.05	0.06	0.06	0.08
	3:00:00	0.00	0.00	0.02	0.03	0.04	0.04	0.05	0.05	0.06
	3:05:00	0.00	0.00	0.02	0.02	0.03	0.03	0.04	0.04	0.04
	3:10:00	0.00	0.00	0.01	0.02	0.02	0.02	0.03	0.02	0.03
	3:15:00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02
	3:20:00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

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

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

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]

D4 FOREBAY - FOREBAY & TRICKLE CHANNEL CALCULATIONS

Project Name: Dawson Ridge BLVD Pond A

Project No.: 20-224

Per MHFD USDCM Vol. 3, Ch. 3, S. 3.0 & Table EDB-4; Vol. 2, Ch. 12, S. 5.14.2; Vol. 1, & Ch. 8, S. 7.1. Based on an octagonal forebay typical of local installations.

Water Quality Capture Volume (WQCV)

$WQCV = (\alpha(0.91I^3 - 1.19I^2 + 0.78I)/12)A$ — *Water Quality Capture Volume (ac-ft); Equations 3-1 & 3-2 combined*

$\alpha =$ 1.0 — *BMP type coefficient; typ. 1.0 for 40 hr drain time; Table 3-2*

$I =$ 0.6300 — *Imperviousness (percent expressed as a decimal)*

$A =$ 2.77 ac — *watershed tributary area upstream*

WQCV =	0.057	ac-ft

Forebay Sizing

$V = p(WQCV)43560/100$ — *minimum forebay volume (ft^3)*

$p =$ 2 % — *percentage of WQCV; Table EDB-4*

V =	49.60	ft^3	*minimum forebay volume*

$A_R = V/D_F$ — *minimum required forebay area (ft^2)*

D_M =	1.50	ft	*maximum forebay depth (sidewall depth); Table EDB-4*
D_F =	1.25	ft	*forebay front edge depth (D_M - 3"); Figure 14-8*

$A_R =$ 39.7 ft^2

A_P =	49.5	ft^2	*forebay area provided (must be ≥ A_R);*

determined by increasing the central longitudinal dimension shown on the typical forebay detail; see detail in construction drawings for complete forebay configuration and dimensions

Forebay Notch Sizing

$Q_{100} =$ 18.15 cfs — *undetained peak discharge (from StormCAD calcs)*

$Q_{Rm} = 0.02*Q_{100}$ — *minimum forebay release (cfs); 2% of Q100; Table EDB-4*

$Q_{Rm} =$ 0.36 cfs

H =	1.25	ft	*notch depth = D_F*

$L_{Nm} = Q_{Rm}/C_{BCW}H^{1.5}$ — *minimum notch width (ft); (broad crested weir calculation); Equation 12-8; CBCW = 3.3*

$L_{Nm} =$ 0.08 ft

L_N =	0.33	ft	*notch width used for design;*
=	4.0	in	*(minimum notch width [LNm] increased by 20% of notch depth [DF] for clogged condition per MHFD BMP Worksheet and rounded up to nearest whole inch)*

Trickle Channel Sizing

$Q_R = C_{BCW}L_NH^{1.5}$ — *maximum forebay notch capacity (cfs); (broad crested weir calculation); Equation 12-8; CBCW = 3.3*

$Q_R =$ 1.52 cfs

$Q_T = (1.49/n)AR^{2/3}S^{1/2}$ — *flow in trickle channel (cfs); (Manning's Equation for uniform open channel flow); Equation 8-7*

$n =$ 0.013 — *Manning's roughness coefficient for concrete*

$S =$ 0.005 ft/ft — *friction slope (approx. slope of trickle channel for normal flow); 0.4% - 1% recommended by MHFD*

$A = WH$ — *cross-sectional area of flow in channel (ft^2); assume channel flowing full*

W =	2.0	ft	*width of trickle channel bottom*
H =	0.5	ft	*height of trickle channel sides*

$A =$ 1.00 ft^2

$R = A/P$ — *hydraulic radius (ft)*

$R =$ 0.33 ft

$P = W+2H$ — *wetted perimeter (ft)*

$P =$ 3.00 ft

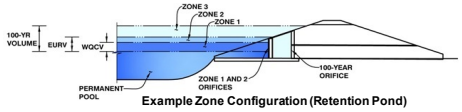
Q_T =	3.90	cfs	*maximum capacity of trickle channel (must be ≥ Q_R)*

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Dawson Trails INFRA-1**

Basin ID: **Water Quality Pond D5**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	4.24	acres
Watershed Length =	800	ft
Watershed Length to Centroid =	703	ft
Watershed Slope =	0.040	ft/ft
Watershed Imperviousness =	41.30%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	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) =	0.065	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	0.163	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 1.06 in.) =	0.160	acre-feet	1.06 inches
5-yr Runoff Volume (P1 = 1.43 in.) =	0.273	acre-feet	1.43 inches
10-yr Runoff Volume (P1 = 1.66 in.) =	0.350	acre-feet	1.66 inches
25-yr Runoff Volume (P1 = 1.69 in.) =	0.376	acre-feet	inches
50-yr Runoff Volume (P1 = 2.26 in.) =	0.578	acre-feet	2.26 inches
100-yr Runoff Volume (P1 = 2.6 in.) =	0.717	acre-feet	2.60 inches
500-yr Runoff Volume (P1 = 3.14 in.) =	0.914	acre-feet	inches
Approximate 2-yr Detention Volume =	0.127	acre-feet	
Approximate 5-yr Detention Volume =	0.211	acre-feet	
Approximate 10-yr Detention Volume =	0.240	acre-feet	
Approximate 25-yr Detention Volume =	0.234	acre-feet	
Approximate 50-yr Detention Volume =	0.290	acre-feet	
Approximate 100-yr Detention Volume =	0.348	acre-feet	

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.065	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.098	acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.163	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	

Total detention volume is less than 100-year volume.

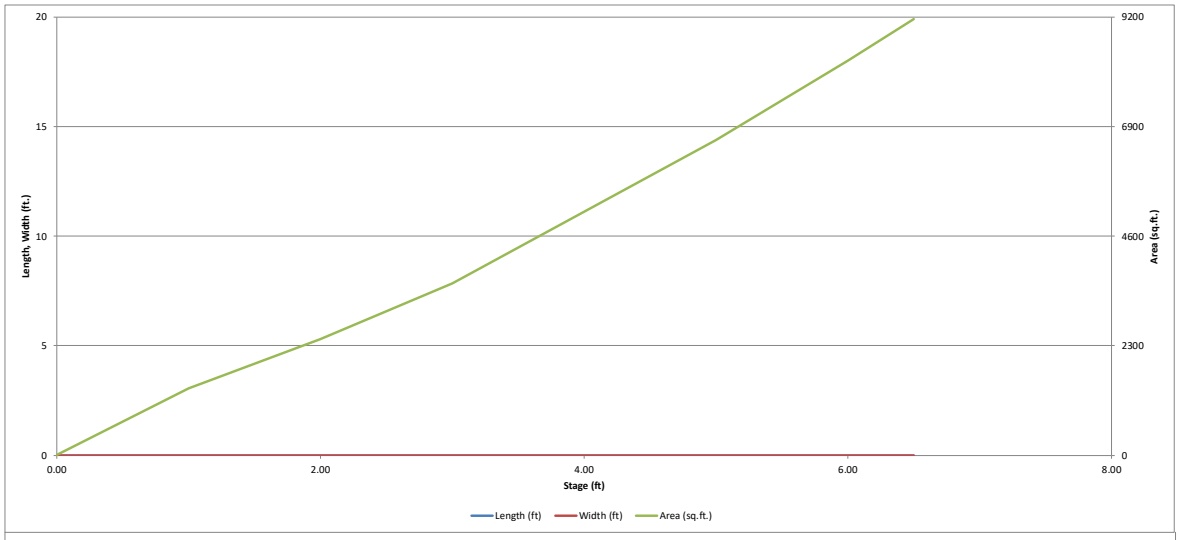
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	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

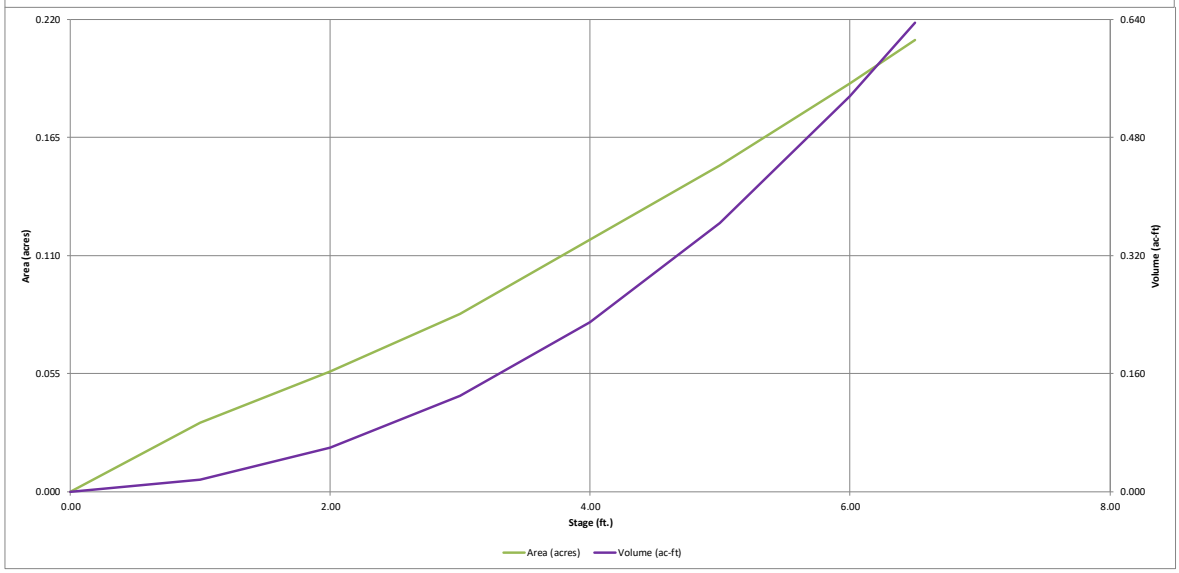
Depth Increment = 1.00 ft

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	--	--	--	4	0.000		
6550	--	1.00	--	--	--	1,400	0.032	702	0.016
6551	--	2.00	--	--	--	2,436	0.056	2,620	0.060
6552	--	3.00	--	--	--	3,609	0.083	5,642	0.130
6553	--	4.00	--	--	--	5,108	0.117	10,001	0.230
6554	--	5.00	--	--	--	6,624	0.152	15,867	0.364
6555	--	6.00	--	--	--	8,286	0.190	23,322	0.535
6555.5	--	6.50	--	--	--	9,170	0.211	27,686	0.636

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)



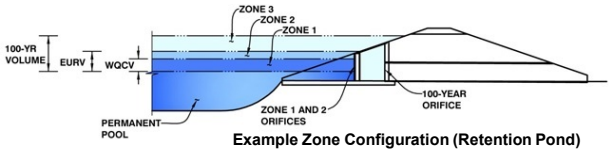


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **Dawson Trails INFRA-1**

Basin ID: **Water Quality Pond D5**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.09	0.065	Orifice Plate
Zone 2 (EURV)	3.38	0.098	Orifice Plate
Zone 3			Weir&Pipe (Circular)
Total (all zones)		0.163	

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)

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	3.264E-03	ft²
Depth at top of Zone using Orifice Plate =	3.38	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	18.00	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.47	sq. inches (diameter = 3/4 inch)	Elliptical Slot Area =	N/A	ft²

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.50	3.00					
Orifice Area (sq. inches)	0.47	0.47	0.47					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected			Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	N/A	N/A	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			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.50	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	3.50	N/A	feet
Overflow Weir Front Edge Length =	5.67	N/A	feet	Overflow Weir Slope Length =	2.92	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	6.52	N/A	
Horiz. Length of Weir Sides =	2.92	N/A	feet	Overflow Grate Open Area w/o Debris =	11.52	N/A	ft²
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	5.76	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 Circular	Not Selected			Zone 3 Circular	Not Selected	
Depth to Invert of Outlet Pipe =	1.00	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	1.77	N/A	ft²
Circular Orifice Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.75	N/A	feet
				Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.00	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.44	feet
Spillway Crest Length =	8.00	feet	Stage at Top of Freeboard =	6.44	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.21	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	0.62	acre-ft

Calculated Parameters for Spillway

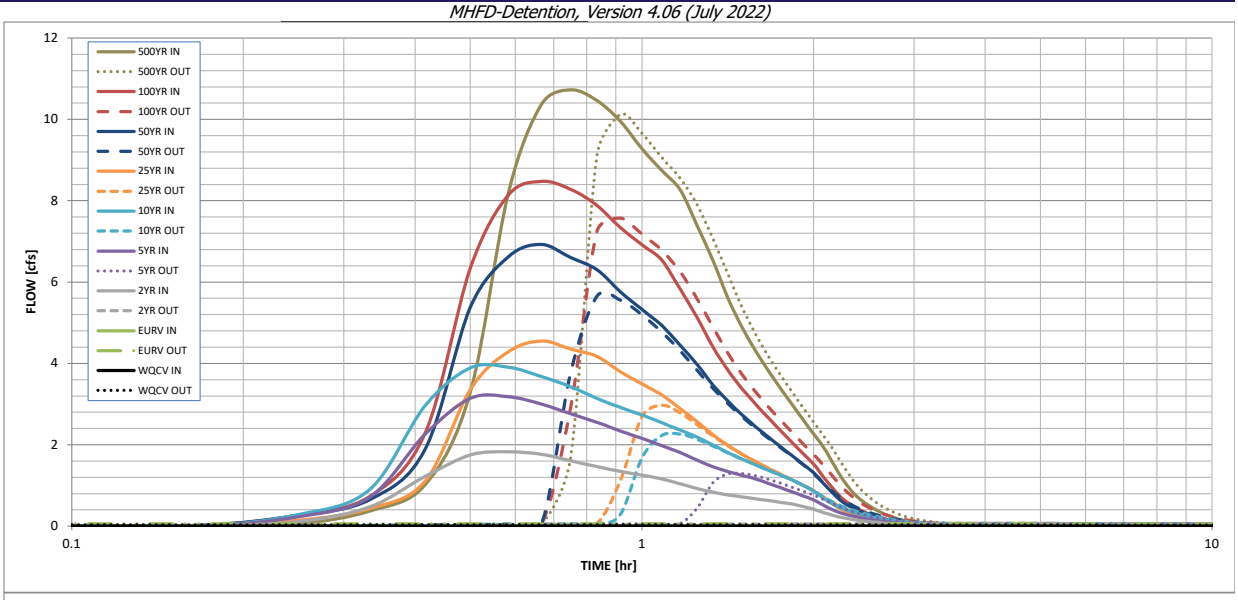
Routed Hydrograph Results

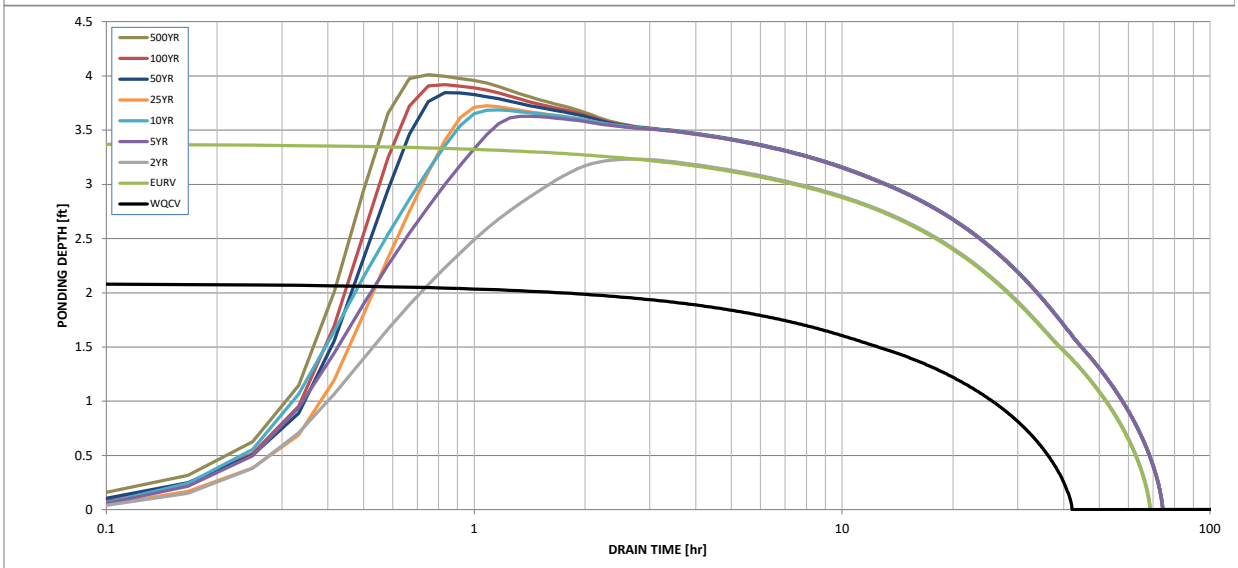
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

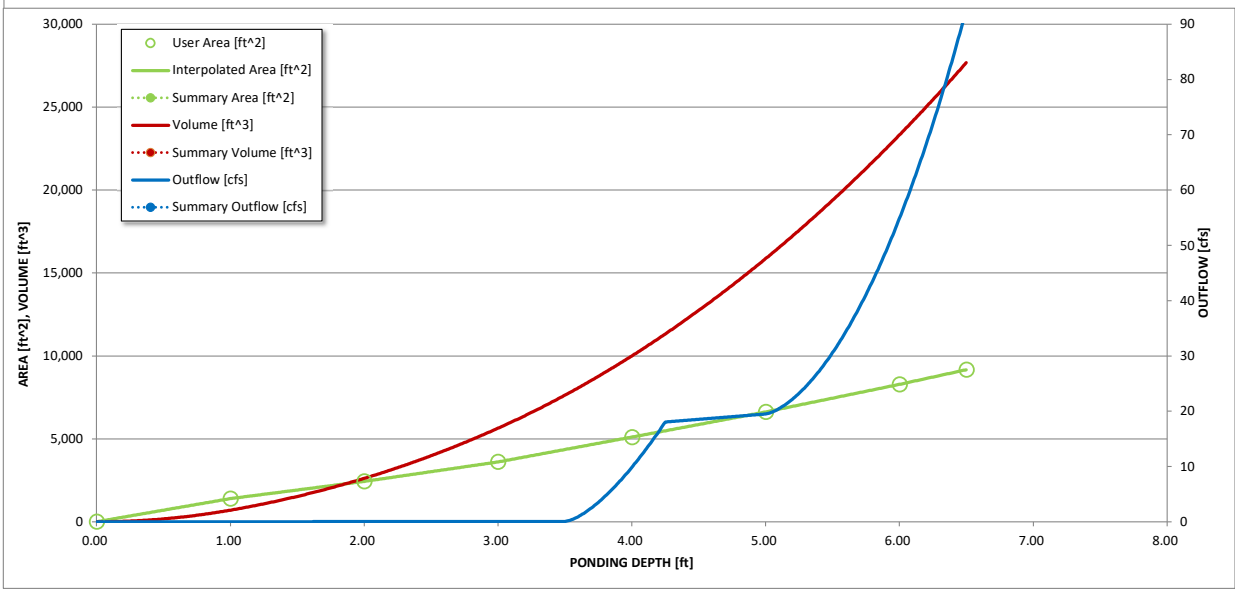
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.06	1.43	1.66	1.69	2.26	2.60	3.14
CUHP Runoff Volume (acre-ft) =	0.065	0.163	0.160	0.273	0.350	0.376	0.578	0.717	0.914
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.160	0.273	0.350	0.376	0.578	0.717	0.914
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.3	1.2	1.7	2.2	3.8	4.9	6.5
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.08	0.28	0.40	0.51	0.89	1.16	1.52
Peak Inflow Q (cfs) =	N/A	N/A	1.8	3.2	3.9	4.6	6.9	8.5	10.7
Peak Outflow Q (cfs) =	0.0	0.1	0.1	1.3	2.3	3.0	5.7	7.6	10.1
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	1.1	1.4	1.4	1.5	1.5	1.6
Structure Controlling Flow =	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	verflow Weir
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	0.1	0.2	0.2	0.5	0.7	0.9
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) =	39	62	62	64	62	62	57	54	50
Time to Drain 99% of Inflow Volume (hours) =	**41**	66	66	70	69	69	67	65	64
Maximum Ponding Depth (ft) =	2.09	3.38	3.23	3.63	3.68	3.72	3.84	3.92	4.01
Area at Maximum Ponding Depth (acres) =	0.06	0.10	0.09	0.10	0.11	0.11	0.11	0.11	0.12
Maximum Volume Stored (acre-ft) =	0.065	0.163	0.149	0.188	0.194	0.198	0.211	0.219	0.230

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







1

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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.06
	0:15:00	0.00	0.00	0.11	0.23	0.29	0.14	0.27	0.27	0.37
	0:20:00	0.00	0.00	0.47	0.72	0.90	0.43	0.65	0.73	1.01
	0:25:00	0.00	0.00	1.22	2.26	2.96	1.10	1.89	2.28	3.29
	0:30:00	0.00	0.00	1.75	3.14	3.89	3.35	5.38	6.34	8.21
	0:35:00	0.00	0.00	1.83	3.18	3.90	4.29	6.63	8.15	10.37
	0:40:00	0.00	0.00	1.77	3.00	3.68	4.55	6.92	8.47	10.73
	0:45:00	0.00	0.00	1.61	2.76	3.43	4.36	6.60	8.28	10.46
	0:50:00	0.00	0.00	1.46	2.55	3.14	4.17	6.31	7.88	9.95
	0:55:00	0.00	0.00	1.35	2.34	2.92	3.80	5.76	7.34	9.28
	1:00:00	0.00	0.00	1.25	2.15	2.73	3.49	5.32	6.91	8.74
	1:05:00	0.00	0.00	1.16	1.98	2.54	3.22	4.93	6.54	8.27
	1:10:00	0.00	0.00	1.04	1.81	2.36	2.89	4.45	5.83	7.39
	1:15:00	0.00	0.00	0.93	1.62	2.19	2.57	3.98	5.13	6.52
	1:20:00	0.00	0.00	0.83	1.46	1.99	2.24	3.46	4.40	5.60
	1:25:00	0.00	0.00	0.77	1.34	1.81	1.98	3.07	3.82	4.88
	1:30:00	0.00	0.00	0.71	1.25	1.65	1.76	2.73	3.37	4.30
	1:35:00	0.00	0.00	0.67	1.16	1.50	1.58	2.44	3.00	3.82
	1:40:00	0.00	0.00	0.63	1.05	1.37	1.42	2.19	2.66	3.39
	1:45:00	0.00	0.00	0.59	0.94	1.25	1.27	1.95	2.35	2.99
	1:50:00	0.00	0.00	0.54	0.84	1.13	1.13	1.73	2.06	2.62
	1:55:00	0.00	0.00	0.48	0.74	1.00	1.00	1.52	1.78	2.27
	2:00:00	0.00	0.00	0.42	0.64	0.86	0.87	1.32	1.53	1.94
	2:05:00	0.00	0.00	0.33	0.51	0.69	0.70	1.04	1.21	1.53
	2:10:00	0.00	0.00	0.26	0.39	0.53	0.53	0.79	0.91	1.15
	2:15:00	0.00	0.00	0.21	0.31	0.43	0.39	0.59	0.67	0.86
	2:20:00	0.00	0.00	0.17	0.25	0.35	0.30	0.46	0.51	0.66
	2:25:00	0.00	0.00	0.14	0.21	0.29	0.23	0.36	0.39	0.51
	2:30:00	0.00	0.00	0.11	0.17	0.24	0.19	0.28	0.30	0.39
	2:35:00	0.00	0.00	0.09	0.14	0.19	0.15	0.22	0.23	0.30
	2:40:00	0.00	0.00	0.08	0.11	0.15	0.11	0.17	0.17	0.22
	2:45:00	0.00	0.00	0.06	0.09	0.12	0.09	0.13	0.13	0.16
	2:50:00	0.00	0.00	0.05	0.07	0.09	0.07	0.10	0.10	0.13
	2:55:00	0.00	0.00	0.04	0.06	0.07	0.06	0.08	0.08	0.10
	3:00:00	0.00	0.00	0.03	0.04	0.06	0.04	0.06	0.06	0.08
	3:05:00	0.00	0.00	0.03	0.03	0.04	0.03	0.05	0.05	0.06
	3:10:00	0.00	0.00	0.02	0.03	0.03	0.03	0.04	0.04	0.05
	3:15:00	0.00	0.00	0.01	0.02	0.02	0.02	0.03	0.03	0.04
	3:20:00	0.00	0.00	0.01	0.01	0.02	0.01	0.02	0.02	0.02
	3:25:00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02
	3:30:00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.
The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]

D4 FOREBAY - FOREBAY & TRICKLE CHANNEL CALCULATIONS

Project Name: Dawson Ridge BLVD Pond A

Project No.: 20-224

Per MHFD USDCM Vol. 3, Ch. 3, S. 3.0 & Table EDB-4; Vol. 2, Ch. 12, S. 5.14.2; Vol. 1, & Ch. 8, S. 7.1. Based on an octagonal forebay typical of local installations.

Water Quality Capture Volume (WQCV)

$WQCV = (\alpha(0.91I^3 - 1.19I^2 + 0.78I)/12)A$ — *Water Quality Capture Volume (ac-ft); Equations 3-1 & 3-2 combined*

$\alpha =$ 1.0 — *BMP type coefficient; typ. 1.0 for 40 hr drain time; Table 3-2*

$I =$ 0.4130 — *Imperviousness (percent expressed as a decimal)*

$A =$ 4.24 ac — *watershed tributary area upstream*

WQCV =	0.065	ac-ft

Forebay Sizing

$V = p(WQCV)43560/100$ — *minimum forebay volume (ft^3)*

$p =$ 2 % — *percentage of WQCV; Table EDB-4*

V =	56.41	ft^3	*minimum forebay volume*

$A_R = V/D_F$ — *minimum required forebay area (ft^2)*

D_M =	1.50	ft	*maximum forebay depth (sidewall depth); Table EDB-4*
D_F =	1.25	ft	*forebay front edge depth (D_M - 3"); Figure 14-8*

$A_R =$ 45.1 ft^2

A_P =	49.5	ft^2	*forebay area provided (must be ≥ A_R);*

determined by increasing the central longitudinal dimension shown on the typical forebay detail; see detail in construction drawings for complete forebay configuration and dimensions

Forebay Notch Sizing

$Q_{100} =$ 24.40 cfs — *undetained peak discharge (from StormCAD calcs)*

$Q_{Rm} = 0.02*Q_{100}$ — *minimum forebay release (cfs); 2% of Q100; Table EDB-4*

$Q_{Rm} =$ 0.49 cfs

H =	1.25	ft	*notch depth = D_F*

$L_{Nm} = Q_{Rm}/C_{BCW}H^{1.5}$ — *minimum notch width (ft); (broad crested weir calculation); Equation 12-8; CBCW = 3.3*

$L_{Nm} =$ 0.11 ft

L_N =	0.36	ft	*notch width used for design;*
=	5.0	in	*(minimum notch width [LNm] increased by 20% of notch depth [DF] for clogged condition per MHFD BMP Worksheet and rounded up to nearest whole inch)*

Trickle Channel Sizing

$Q_R = C_{BCW}L_NH^{1.5}$ — *maximum forebay notch capacity (cfs); (broad crested weir calculation); Equation 12-8; CBCW = 3.3*

$Q_R =$ 1.64 cfs

$Q_T = (1.49/n)AR^{2/3}S^{1/2}$ — *flow in trickle channel (cfs); (Manning's Equation for uniform open channel flow); Equation 8-7*

$n =$ 0.013 — *Manning's roughness coefficient for concrete*

$S =$ 0.005 ft/ft — *friction slope (approx. slope of trickle channel for normal flow); 0.4% - 1% recommended by MHFD*

$A = WH$ — *cross-sectional area of flow in channel (ft^2); assume channel flowing full*

W =	2.0	ft	*width of trickle channel bottom*
H =	0.5	ft	*height of trickle channel sides*

$A =$ 1.00 ft^2

$R = A/P$ — *hydraulic radius (ft)*

$R =$ 0.33 ft

$P = W+2H$ — *wetted perimeter (ft)*

$P =$ 3.00 ft

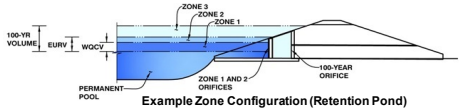
Q_T =	3.90	cfs	*maximum capacity of trickle channel (must be ≥ Q_R)*

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Dawson Trails Filing 2**

Basin ID: **Pond B1 (Stage 0.00 = Top of Micropool = 6431.00; Invert of Trickle Channel = 6431.33)**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	170.81	acres
Watershed Length =	6,799	ft
Watershed Length to Centroid =	3,400	ft
Watershed Slope =	0.050	ft/ft
Watershed Imperviousness =	40.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

			Optional User Overrides
Water Quality Capture Volume (WQCV) =	2.560	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	6.349	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 1.06 in.) =	6.354	acre-feet	1.06 inches
5-yr Runoff Volume (P1 = 1.43 in.) =	10.953	acre-feet	1.43 inches
10-yr Runoff Volume (P1 = 1.66 in.) =	14.108	acre-feet	1.66 inches
25-yr Runoff Volume (P1 = 2.01 in.) =	19.769	acre-feet	2.01 inches
50-yr Runoff Volume (P1 = 2.26 in.) =	23.455	acre-feet	2.26 inches
100-yr Runoff Volume (P1 = 2.6 in.) =	29.122	acre-feet	2.60 inches
500-yr Runoff Volume (P1 = 3.14 in.) =	37.211	acre-feet	3.14 inches
Approximate 2-yr Detention Volume =	4.932	acre-feet	
Approximate 5-yr Detention Volume =	8.248	acre-feet	
Approximate 10-yr Detention Volume =	9.392	acre-feet	
Approximate 25-yr Detention Volume =	10.935	acre-feet	
Approximate 50-yr Detention Volume =	11.377	acre-feet	
Approximate 100-yr Detention Volume =	13.744	acre-feet	

Define Zones and Basin Geometry

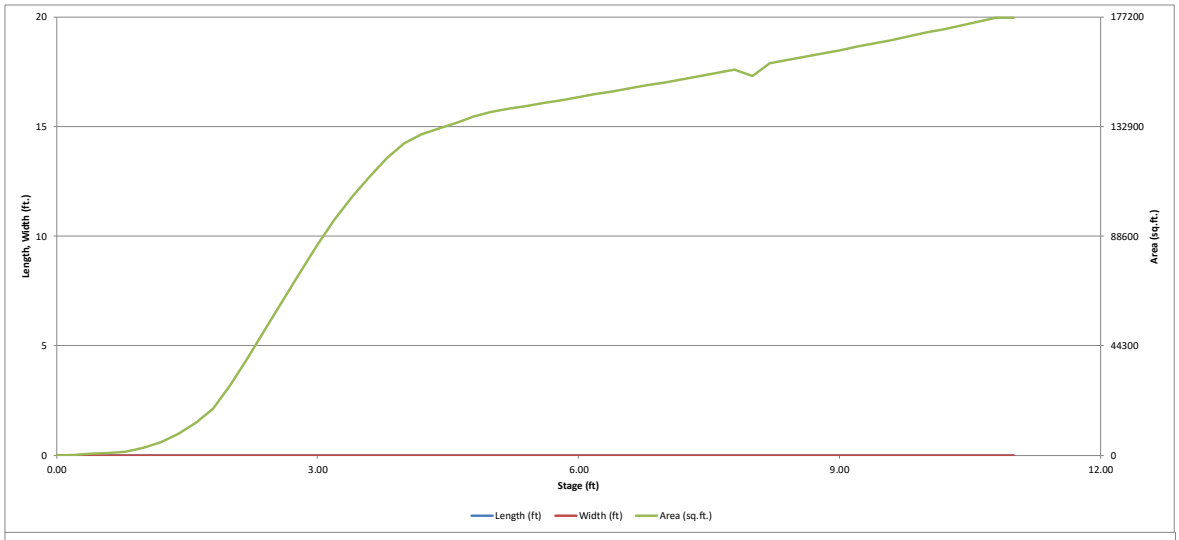
Zone 1 Volume (WQCV) =	2.560	acre-feet
Zone 2 Volume (EURV - Zone 1) =	3.790	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	7.394	acre-feet
Total Detention Basin Volume =	13.744	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention 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

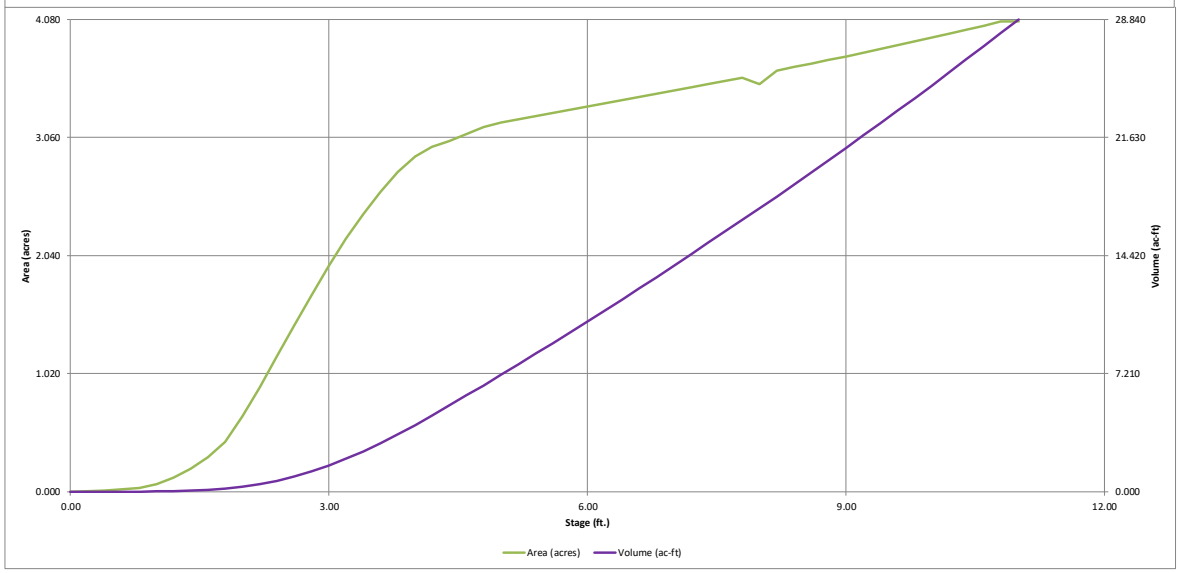
Depth Increment = ft

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	--	--	--	36	0.001		
	--	0.20	--	--	--	191	0.004	23	0.001
	--	0.40	--	--	--	497	0.011	91	0.002
	--	0.60	--	--	--	928	0.021	234	0.005
	--	0.80	--	--	--	1,486	0.034	475	0.011
	--	1.00	--	--	--	2,886	0.066	912	0.021
	--	1.20	--	--	--	5,169	0.119	1,718	0.039
	--	1.40	--	--	--	8,572	0.197	3,092	0.071
	--	1.60	--	--	--	13,046	0.300	5,254	0.121
	--	1.80	--	--	--	18,633	0.428	8,422	0.193
	--	2.00	--	--	--	28,328	0.650	13,118	0.301
	--	2.20	--	--	--	39,291	0.902	19,879	0.456
	--	2.40	--	--	--	50,984	1.170	28,907	0.664
	--	2.60	--	--	--	62,546	1.436	40,260	0.924
	--	2.80	--	--	--	73,949	1.698	53,909	1.238
	--	3.00	--	--	--	85,036	1.952	69,808	1.603
	--	3.20	--	--	--	95,314	2.188	87,843	2.017
	--	3.40	--	--	--	104,575	2.401	107,832	2.475
	--	3.60	--	--	--	112,807	2.590	129,570	2.975
	--	3.80	--	--	--	120,303	2.762	152,881	3.510
	--	4.00	--	--	--	126,037	2.893	177,515	4.075
	--	4.20	--	--	--	129,822	2.980	203,101	4.663
	--	4.40	--	--	--	131,997	3.030	229,283	5.264
	--	4.60	--	--	--	134,474	3.087	255,930	5.875
	--	4.80	--	--	--	137,154	3.149	283,093	6.499
	--	5.00	--	--	--	138,931	3.189	310,701	7.133
	--	5.20	--	--	--	140,093	3.216	338,604	7.773
	--	5.40	--	--	--	141,262	3.243	366,739	8.419
	--	5.60	--	--	--	142,437	3.270	395,109	9.070
	--	5.80	--	--	--	143,619	3.297	423,715	9.727
	--	6.00	--	--	--	144,809	3.324	452,558	10.389
	--	6.20	--	--	--	146,006	3.352	481,639	11.057
	--	6.40	--	--	--	147,211	3.380	510,961	11.730
	--	6.60	--	--	--	148,423	3.407	540,524	12.409
	--	6.80	--	--	--	149,641	3.435	570,331	13.093
	--	7.00	--	--	--	150,864	3.463	600,381	13.783
	--	7.20	--	--	--	152,092	3.492	630,677	14.478
	--	7.40	--	--	--	153,328	3.520	661,219	15.179
	--	7.60	--	--	--	154,571	3.548	692,009	15.886
	--	7.80	--	--	--	155,824	3.577	723,048	16.599
	--	8.00	--	--	--	153,437	3.522	753,974	17.309
	--	8.20	--	--	--	158,421	3.637	785,160	18.025
	--	8.40	--	--	--	159,750	3.667	816,977	18.755
	--	8.60	--	--	--	161,089	3.698	849,061	19.492
	--	8.80	--	--	--	162,440	3.729	881,414	20.234
	--	9.00	--	--	--	163,803	3.760	914,038	20.983
	--	9.20	--	--	--	165,179	3.792	946,937	21.739
	--	9.40	--	--	--	166,569	3.824	980,112	22.500
	--	9.60	--	--	--	167,974	3.856	1,013,566	23.268
	--	9.80	--	--	--	169,392	3.889	1,047,302	24.043
	--	10.00	--	--	--	170,841	3.922	1,081,326	24.824
	--	10.20	--	--	--	172,342	3.956	1,115,644	25.612
	--	10.40	--	--	--	173,844	3.991	1,150,263	26.406
	--	10.60	--	--	--	175,347	4.025	1,185,182	27.208
	--	10.80	--	--	--	176,852	4.060	1,220,402	28.017
	--	11.00	--	--	--	177,000	4.063	1,255,787	28.829

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)



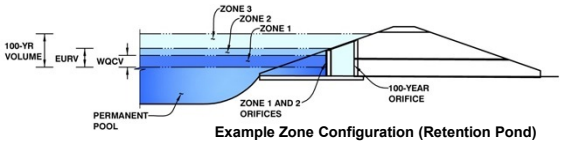


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Dawson Trails Filing 2

Basin ID: Pond B1 (Stage 0.00 = Top of Micropool = 6431.00; Invert of Trickle Channel = 6431.33)



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	3.44	2.560	Orifice Plate
Zone 2 (EURV)	4.76	3.790	Rectangular Orifice
Zone 3 (100-year)	6.99	7.394	Weir&Pipe (Restrict)
Total (all zones)		13.744	

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

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =	3.44	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	13.80	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	sq. inches	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00							
Orifice Area (sq. inches)	12.00							

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

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Rectangular	Not Selected			Zone 2 Rectangular	Not Selected	
Invert of Vertical Orifice =	3.44	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	0.94	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	4.76	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	0.38	N/A	feet
Vertical Orifice Height =	9.00	N/A	inches				
Vertical Orifice Width =	15.00		inches				

Calculated Parameters for Vertical Orifice

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

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	5.00	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	6.00	N/A	feet
Overflow Weir Front Edge Length =	30.00	N/A	feet	Overflow Weir Slope Length =	4.12	N/A	feet
Overflow Weir Grate Slope =	4.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	6.85	N/A	
Horiz. Length of Weir Sides =	4.00	N/A	feet	Overflow Grate Open Area w/o Debris =	86.09	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	43.05	N/A	ft^2
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			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.50	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	12.57	N/A	ft^2
Outlet Pipe Diameter =	48.00	N/A	inches	Outlet Orifice Centroid =	2.00	N/A	feet
Restrictor Plate Height Above Pipe Invert =	48.00		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=	8.00	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.98	feet
Spillway Crest Length =	106.00	feet	Stage at Top of Freeboard =	9.98	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	3.92	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	24.75	acre-ft

Calculated Parameters for Spillway

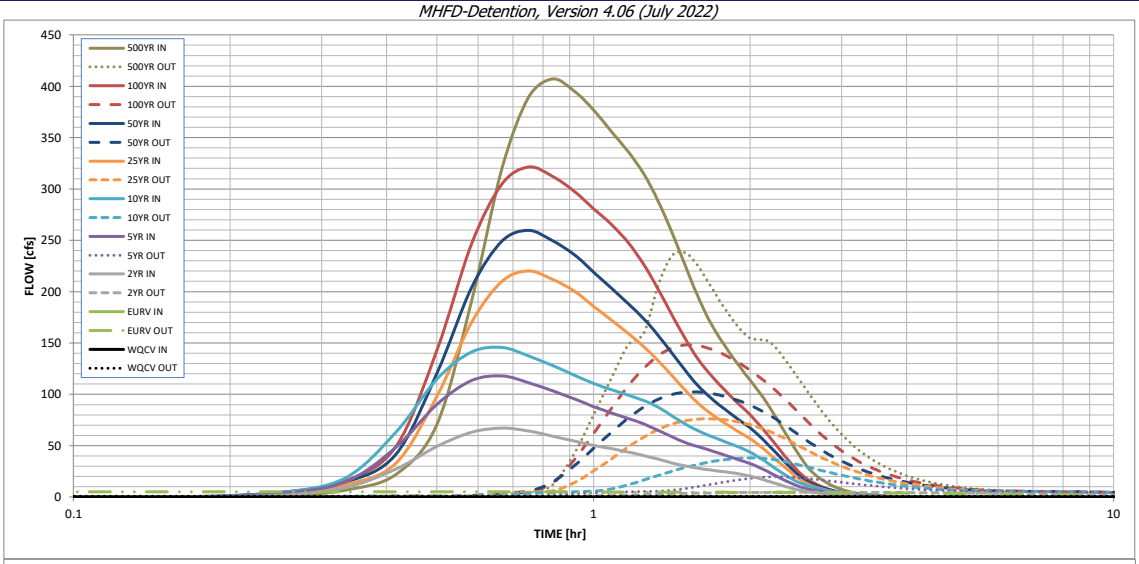
Routed Hydrograph Results

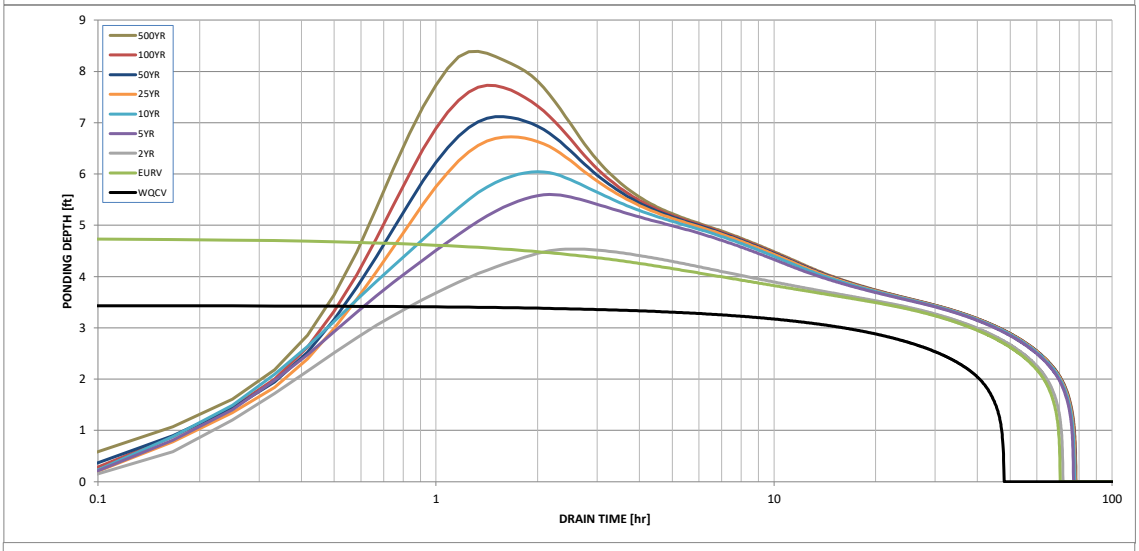
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

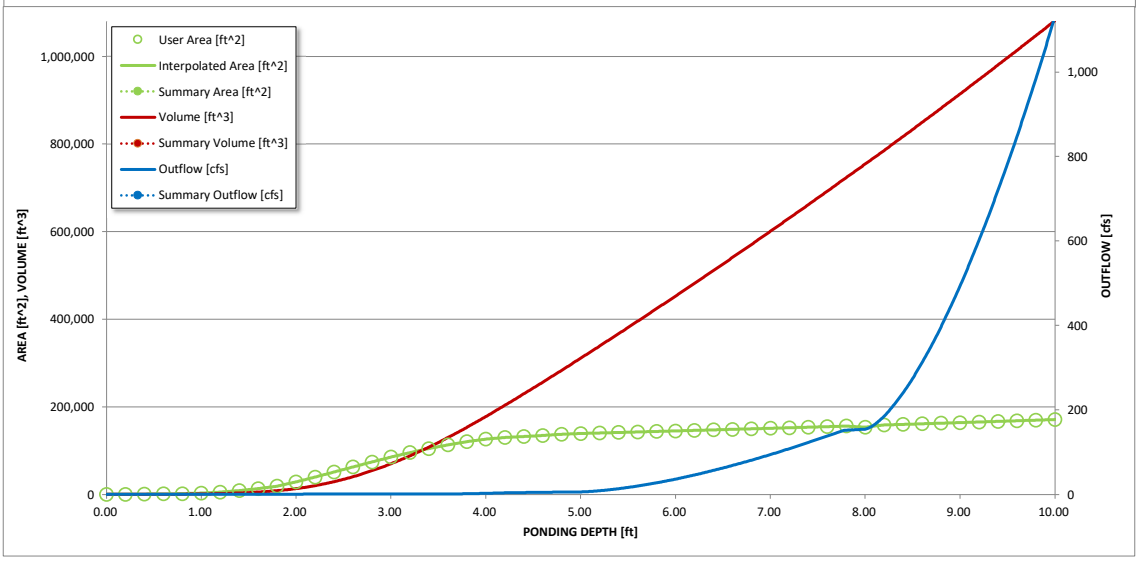
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.06	1.43	1.66	2.01	2.26	2.60	3.14
CUHP Runoff Volume (acre-ft) =	2.560	6.349	6.354	10.953	14.108	19.769	23.455	29.122	37.211
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	6.354	10.953	14.108	19.769	23.455	29.122	37.211
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	11.7	44.2	63.0	115.6	142.7	187.5	246.7
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.07	0.26	0.37	0.68	0.84	1.10	1.44
Peak Inflow Q (cfs) =	N/A	N/A	67.1	117.8	145.5	220.1	259.6	321.3	407.2
Peak Outflow Q (cfs) =	0.7	5.2	4.7	19.7	38.1	76.2	102.3	148.0	238.0
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.4	0.6	0.7	0.7	0.8	1.0
Structure Controlling Flow =	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	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	0.1	0.4	0.8	1.1	1.6	1.7
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) =	46	65	67	69	68	65	63	59	55
Time to Drain 99% of Inflow Volume (hours) =	**47**	68	70	74	74	73	72	71	69
Maximum Ponding Depth (ft) =	3.44	4.76	4.54	5.60	6.05	6.73	7.12	7.73	8.39
Area at Maximum Ponding Depth (acres) =	2.44	3.14	3.07	3.27	3.33	3.42	3.48	3.57	3.67
Maximum Volume Stored (acre-ft) =	2.572	6.373	5.660	9.070	10.522	12.819	14.165	16.313	18.719

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.14	0.89
	0:15:00	0.00	0.00	1.76	3.59	4.46	3.33	4.46	4.40	6.74
	0:20:00	0.00	0.00	9.14	14.83	18.62	12.03	14.44	15.73	22.06
	0:25:00	0.00	0.00	27.07	48.30	62.94	32.67	41.43	49.13	70.63
	0:30:00	0.00	0.00	49.26	90.13	114.79	98.08	120.31	142.85	191.44
	0:35:00	0.00	0.00	63.18	113.41	141.24	170.36	204.20	246.85	319.40
	0:40:00	0.00	0.00	67.09	117.84	145.50	209.89	249.01	304.69	388.94
	0:45:00	0.00	0.00	64.36	111.34	137.38	220.13	259.57	321.26	407.23
	0:50:00	0.00	0.00	59.26	103.40	128.05	212.03	249.71	312.45	395.65
	0:55:00	0.00	0.00	54.48	95.77	118.96	200.70	236.35	297.91	377.03
	1:00:00	0.00	0.00	50.25	88.06	110.64	185.93	219.11	280.95	355.66
	1:05:00	0.00	0.00	47.03	81.88	104.45	172.10	203.21	265.35	336.33
	1:10:00	0.00	0.00	43.87	76.57	99.19	159.27	188.43	247.79	314.51
	1:15:00	0.00	0.00	40.33	71.04	93.91	146.34	173.50	226.20	287.75
	1:20:00	0.00	0.00	36.72	64.85	87.27	132.48	157.22	202.07	257.39
	1:25:00	0.00	0.00	33.22	58.56	79.05	118.09	140.06	177.14	225.64
	1:30:00	0.00	0.00	30.22	53.07	71.05	104.16	123.47	154.36	196.71
	1:35:00	0.00	0.00	28.04	49.22	64.94	91.92	109.10	135.32	172.79
	1:40:00	0.00	0.00	26.46	45.86	60.08	82.76	98.28	121.00	154.64
	1:45:00	0.00	0.00	25.12	42.36	55.78	75.16	89.25	109.17	139.52
	1:50:00	0.00	0.00	23.88	38.97	51.83	68.52	81.33	98.64	126.04
	1:55:00	0.00	0.00	22.29	35.73	47.96	62.46	74.10	89.06	113.76
	2:00:00	0.00	0.00	20.37	32.61	43.74	56.82	67.34	80.09	102.23
	2:05:00	0.00	0.00	18.05	28.86	38.56	50.37	59.63	70.41	89.77
	2:10:00	0.00	0.00	15.45	24.59	32.76	43.14	50.98	60.09	76.43
	2:15:00	0.00	0.00	12.92	20.32	27.04	35.91	42.35	49.90	63.29
	2:20:00	0.00	0.00	10.51	16.30	21.76	28.99	34.12	40.12	50.70
	2:25:00	0.00	0.00	8.34	12.72	17.14	22.65	26.58	31.03	39.06
	2:30:00	0.00	0.00	6.52	9.84	13.55	16.92	19.85	22.91	28.90
	2:35:00	0.00	0.00	5.20	7.89	11.06	12.74	15.07	17.12	21.81
	2:40:00	0.00	0.00	4.27	6.50	9.14	9.90	11.76	13.10	16.79
	2:45:00	0.00	0.00	3.53	5.36	7.52	7.77	9.25	10.02	12.90
	2:50:00	0.00	0.00	2.93	4.40	6.15	6.10	7.26	7.62	9.83
	2:55:00	0.00	0.00	2.42	3.59	4.98	4.79	5.71	5.76	7.44
	3:00:00	0.00	0.00	2.00	2.92	4.01	3.76	4.47	4.31	5.58
	3:05:00	0.00	0.00	1.65	2.36	3.21	2.96	3.51	3.27	4.24
	3:10:00	0.00	0.00	1.36	1.90	2.55	2.36	2.79	2.60	3.36
	3:15:00	0.00	0.00	1.11	1.51	2.00	1.87	2.21	2.07	2.67
	3:20:00	0.00	0.00	0.89	1.19	1.56	1.48	1.74	1.66	2.14
	3:25:00	0.00	0.00	0.69	0.90	1.21	1.15	1.35	1.30	1.67
	3:30:00	0.00	0.00	0.52	0.67	0.91	0.87	1.02	0.98	1.26
	3:35:00	0.00	0.00	0.37	0.47	0.65	0.63	0.74	0.71	0.91
	3:40:00	0.00	0.00	0.25	0.32	0.44	0.44	0.51	0.49	0.61
	3:45:00	0.00	0.00	0.15	0.20	0.27	0.27	0.32	0.30	0.38
	3:50:00	0.00	0.00	0.08	0.11	0.14	0.15	0.17	0.16	0.20
	3:55:00	0.00	0.00	0.03	0.05	0.06	0.06	0.07	0.06	0.07
	4:00:00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.
The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]

Site Layout

SCM Design, Version 4.01 (December 2024)

Designer: Matthew Eberly
Company: EMK Consultants
Date: April 29, 2025
Project: Dawson Trails - Filing 2 Infrastructure
Location: Pond B1

SITE LAYOUT INFO (User Input in Blue Cells)

Water Quality Event (WQE): 0.60 inches

Outfall ID	B1											
Total Tributary Area (ft^2)	970,560											
Total Tributary Area (ac)	22.28											
Imperviousness (%)	40.0%											
MS4 Design Standard	WQCV											
SCM Type	EDB											

Notes:

OUTFALL RESULTS

SCM Worksheet Name	EDB_B1											
Untreated Area (ft^3)	0											
Default WQCV (ft^3)	14,545											
Optional Override WQCV (ft^3)												
WQCV Reduction (ft^3)	0											
Remaining WQCV (ft^3)	14,545											
WQCV Reduction (%)	0%											
Design WQCV of SCM (ft^3)	0											
Pollutant Removal (ft^3)	0											
Untreated WQCV (ft^3)	14,545											

TOTAL SITE RESULTS (Sums results from all Outfalls)

Total Site Area	970,560	ft^2	22.28	acres
Treated Area	970,560	ft^2	22.28	acres
Untreated Area	0	ft^2	0.00	acres
Total Site Imperviousness	40.0%	%		
Default (or Override) WQCV	14,545	ft^3	0.334	acre-feet
Remaining WQCV	14,545	ft^3	0.334	acre-feet
WQCV Reduction	0%	%		
Design WQCV	0	ft^3	0.000	acre-feet
Untreated WQCV	14,545	ft^3	0.334	acre-feet

Extended Detention Basin (EDB)

SCM Design, Version 4.01 (December 2024)

Designer:	**Matthew Eberly**
Company:	**EMK Consultants**
Date:	**April 29, 2025**
Project:	**Dawson Trails - Filing 2 Infrastructure**
Location:	**Pond B1**
Outfall ID:	**B1**

1. Inlet and Forebay

A) Is RPA (GB/GS) used for Runoff Reduction upstream of SCM? NO

Define inflow points for all areas tributary to the SCM below.

B) Inflow Points contributing to SCM (max 8)

Inflow Design Point ID	East							
Tributary Area to Inflow Point (ft^2)	776,448							
Imperviousness above Inflow Point (%)	40.0%							
Default WQCV for Inflow Point (ft^3)	11,636							
Optional Override WQCV for Inflow Point (ft^3)								
WQCV Reduction above Inflow Point (ft^3)	0							
Remaining WQCV at Inflow Point (ft^3)	11,636							
Will pretreatment be provided with a Sedimentation MTD (HDS)	NO							
Paired Pretreatment HDS Worksheet Name	--							
Sheet or Concentrated Flow	Conc							

C) Sheet Flow

Select sheet flow inflow feature	--							
Is Concrete Edger used?	--							
Spacing between slots, recommend ≤ 2 ft on center (ft)	--							
Slot Opening Length, recommend 1.5 (in)	--							
Select type of blind swale used to distribute flow	--							
Select energy dissipation method for level spreader	--							
Height of drop, recommend 2 to 3 (in)	--							
Is concrete mowing strip provided to facilitate maintenance?	--							

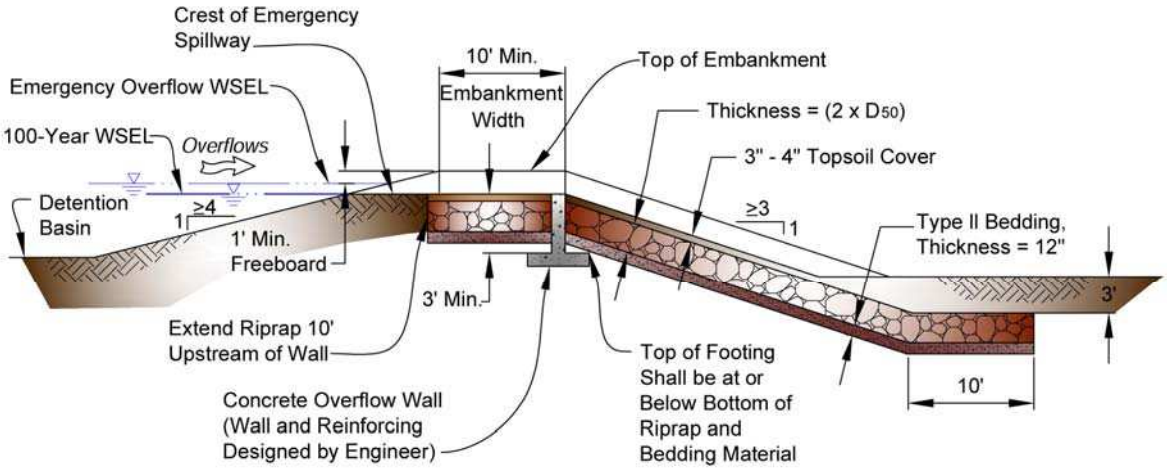
D) Concentrated Flow

Select concentrated flow inflow feature	Pipe							
Is downspout extension needed to bridge backfill zone?	--							
Depth of gutter flow line depression for curb opening, recommend 3 (in)	--							
Curb opening inlet width (ft)	--							
Height of drop to sediment pad/forebay, recommend ≥ 1 (in)	--							
Select energy dissipation method for downspouts and/or curb openings.	--							
Select energy dissipation method for swales, channels, and piped outfalls	Impact							

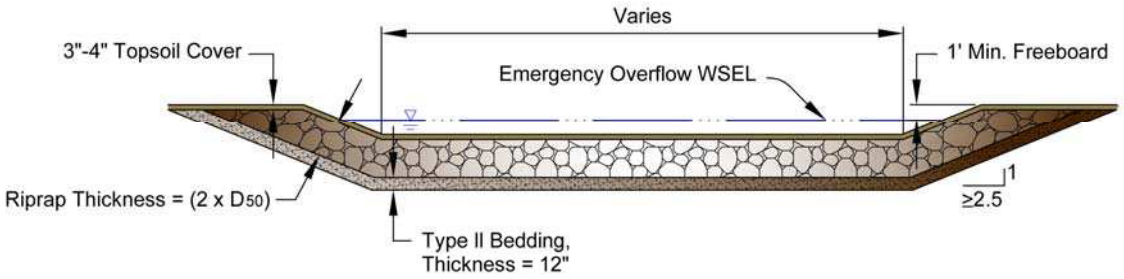
v) Forebay

Impervious area tributary to concentrated inflow location (ft^2)	310,579							
Forebay Type (Concrete Sediment Pad sufficient for Imp Area ≤ 2 acre)	Forebay							
Minimum Forebay Volume (ft^3)	116							
Design Forebay Volume (ft^3)	337							
Maximum Forebay Depth (in)	18.00							
Design Forebay Depth (in)	15.00							
Rectangular Weir Notch Width to Empty Forebay in 5-minutes (in)	2.56							
Design Notch Width (in)	3.00							
Forebay Drain Time (minutes)	4.3							

FIGURE 13-7
EMBANKMENT PROTECTION DETAILS AND ROCK SIZING CHART

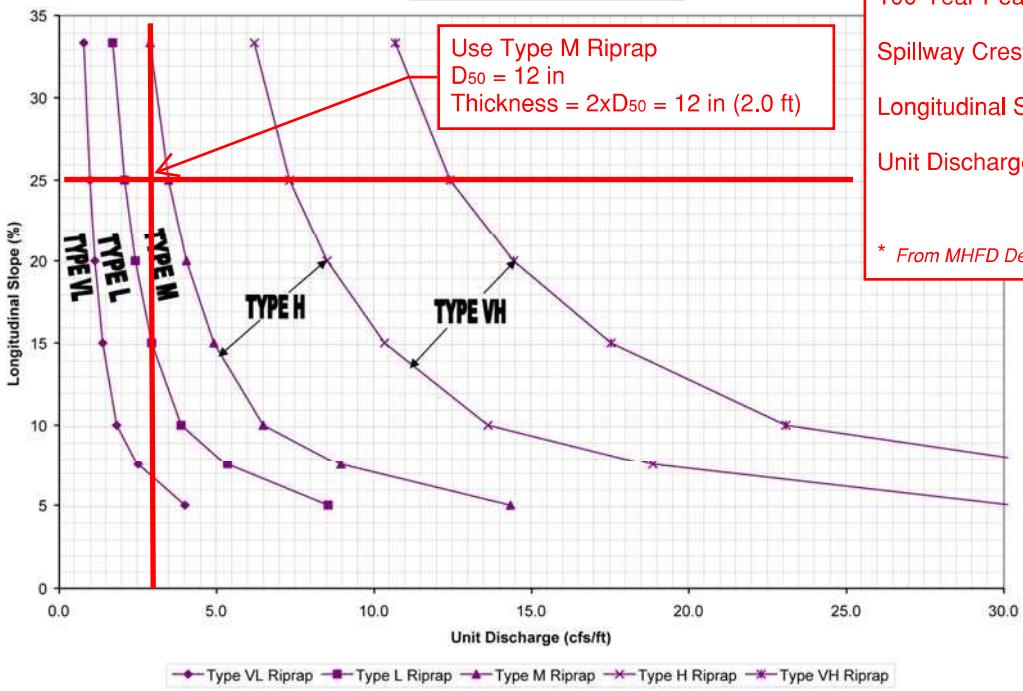


EMERGENCY SPILLWAY PROFILE



RIPRAP DESIGNATION
VL (D_{50} = 6 IN)
L (D_{50} = 9 IN)
M (D_{50} = 12 IN)
H (D_{50} = 18 IN)
VH (D_{50} = 24 IN)

SPILLWAY CHANNEL AT CREST AND DOWNSTREAM SIDE OF EMBANKMENT



100-Year Peak Inflow* = 311.5 CFS

Spillway Crest Length* = 106 FT

Longitudinal Slope = 25%

Unit Discharge = 311.5/106 = 3.0 CFS/FT

* *From MHFD Detention Workbook*

Notes:

1) *Place and compact 12" Type II Granular Bedding only under Void-Filled Riprap (typical per USDCM Vol. 1, Ch. 8, Figure 8-34).*

2) *If Type VL Riprap is calculated, use Type L (typical per USDCM Vol. 2, Ch. 9, Figure 9-38).*

Permanent Water Quality Determination Worksheet (Taken from 2019 SDDTCM Sections 13.1.4 and 13.1.5)

Project: Infrastructure 1 **CRW#** **Applicant:** ACM Dawson Trails JV LLC

Section	Questions	Response	Check those that apply	Instructions
1	**Non-applicable Sites**			
	Will the project result in a temporary disturbance of greater than one acre?	No	☐	Proceed to next line.
		Yes	☑	Proceed to section 2.
	Is the project part of a larger common plan of development or sale where multiple separate and distinct construction activities may be taking place at different times on different schedules, but remain related and are within 1/4 mile of each other? (A common plan of development will generally be documented on a site development plan, master plan, or equivalent, for the property/project)	No	☐	Proceed to next line.
		Yes	☐	Proceed to section 2.
	Is the project within the Cherry Creek Watershed?	Yes	☐	Exclusions do not apply. Permanent water quality is required per Control Regulation 72.7.
		No	☐	Permanent water quality is not required. No further action is required.
2	**Applicable Site Types and Exclusions by Variance**			
	Does the project have more than 35% impervious area on the existing site?	No	☑	Project is an applicable Development Site. Proceed to section 3.
		Yes	☐	Proceed to next line.
	Does the project have greater than 75% impervious area on the existing site?	No	☐	Project is an applicable Redevelopment Site. Proceed to section 3.
		Yes	☐	Proceed to next line.
	Will 100% of the runoff from the existing and proposed site be captured and treated for permanent water quality?	Yes	☐	Document in drainage report. No further action required.
		No	☐	Proceed to next line.
	Do any other water quality exclusions apply to the site?	No	☐	Portions of the project are excluded. Proceed with design in accordance with Constrained Redevelopment standards and apply for **variance** for Constrained Redevelopment Sites.
		Yes	☐	Proceed to next section. Following approval of other variances, design remaining site in accordance with Constrained Redevelopment standards and apply for **variance** for Constrained Redevelopment Sites.
3	**Applicable Sites with Other Exclusions by Variance**			
3.1	**Category 1: Roadways, bridges and trails only**			
3.1.1	Is the project a bike or pedestrian trail?	Yes	☐	Proceed to next line.
		No	☑	Proceed to 3.1.2.
	Is the trail for a roadway?	Yes	☐	Proceed to 3.1.2.
		No	☐	Project is excluded. Submit **variance** for Trails Excluded from Permanent Water Quality Requirements.
3.1.2	Is the project primarily used for parking or access to parking?	Yes	☐	This exclusion does not apply. Permanent water quality is required.
		No	☑	Proceed to 3.1.3.
3.1.3	Does the project add impervious area?	No	☐	Project is excluded. Submit **variance** for Pavement Management Sites Excluded from Permanent Water Quality Requirements.
		Yes	☑	Proceed to 3.1.4.

3.1.4	Does the project add more than 8.25 feet of paved width at any location to the existing roadway?	No	☐	Project is excluded. Submit **variance** for Roadway Redevelopment Sites Excluded from Permanent Water Quality Requirements.
		Yes	☑	Proceed to next line.
	Does the project add more than one acre of paved area per mile to an existing roadway?	No	☐	Project is excluded. Submit **variance** for Roadway Redevelopment Sites Excluded from Permanent Water Quality Requirements.
		Yes	☑	Proceed to next line.
	Does the project increase the width by two times or more, on average, of the original roadway area?	No	☐	Existing areas of site are excluded only. Submit **variance** for Existing Roadway Surfaces Only Excluded from Permanent Water Quality Requirements.
		Yes	☑	This exclusion does not apply. Permanent water quality is required.
3.2	**Category 2: Non-residential and non-commercial projects only**			
3.2.1	Is the project associated with oil and gas exploration, production, processing, or treatment operations or transmission facilities, including activities necessary to prepare a site for drilling and the movement and placement of drilling equipment?	Yes	☐	Project is excluded. Submit **variance** for Oil and Gas Exploration Sites Excluded from Permanent Water Quality Requirements.
		No	☐	Proceed to 3.2.2.
3.2.2	Is the project for stream stabilization?	Yes	☐	Project is excluded. Submit **variance** for Stream Stabilization Sites Excluded from Permanent Water Quality Requirements.
		No	☐	Proceed to 3.2.3.
3.2.3	Is the project for installation or maintenance of underground utilities or infrastructure that does not permanently alter the terrain, ground cover, or drainage patterns from those present prior to the construction activity including activities to install, replace or maintain utilities under roadways or other paved areas that return the surface to the same condition?	Yes	☐	Project is excluded. Submit **variance** for Aboveground and Underground Utilities Excluded from Permanent Water Quality Requirements.
		No	☐	Proceed to 3.2.4.
3.2.4	Is the project on undeveloped land (land with no human-made structures such as buildings or pavement) that will remain undeveloped after the project?	Yes	☐	Project is excluded. Submit **variance** for Sites with Land Disturbances to Undeveloped Land that will Remain Undeveloped Excluded from Permanent Water Quality Requirements.
		No	☐	Proceed to 3.2.5.
3.2.5	Will the post-project condition result in surface water discharge during the 80th percentile storm runoff event?	No	☐	Project is excluded. Submit **study** along with **variance** for Non-residential and Non-commercial Infiltration Conditions Excluded from Permanent Water Quality Requirements.
		Yes	☐	This exclusion does not apply. Permanent water quality is required.
3.3	**Category 3: Residential and Commercial projects**			
3.3.1	Is the project a single-family residential lot, or agricultural zoned lands, greater than or equal to 2.5 acres in size per dwelling unit?	Yes	☐	Proceed to next line.
		No	☐	Proceed to 3.3.2.
	Is the project site greater than 10% impervious?	No	☐	Project is excluded. Submit **variance** for Large Lot Single Family Sites Excluded from Permanent Water Quality Requirements.
		Yes	☐	Proceed to next line.
	Is the project site greater than 20% impervious?	Yes	☐	This exclusion does not apply. Permanent water quality is required.
		No	☐	Proceed to next line.
	Will the post-project condition result in surface water discharge during the 80th percentile storm runoff event?	No	☐	Project is excluded. Submit **study** along with **variance** for Large Lot Single Family Sites Excluded from Permanent Water Quality Requirements.
		Yes	☐	This exclusion does not apply. Permanent water quality is required.

3.3.2	Will 100% of the runoff from the residential or commercial site be captured?	Yes	□	This exclusion does not apply. Permanent water quality is required.
		No	□	Proceed to next line.
	Is all or a portion of the site undeveloped or will it remain undeveloped after construction?	Yes	□	This portion of the project is excluded. Submit **variance** for Sites with Land Disturbance to Undeveloped Land that will Remain Undeveloped Excluded from Permanent Water Quality Requirements. Proceed to next line.
		No	□	Proceed to next line.
	Is the remaining untreated impervious area greater than 20% of the site?	Yes	□	This exclusion does not apply. Permanent water quality is required.
		No	□	Proceed to next line.
	Is the remaining untreated impervious area greater than one acre?	Yes	□	This exclusion does not apply. Permanent water quality is required.
		No	□	Proceed to next line.
	Is it practicable to capture runoff from portions of the site that will not drain to a control measure?	No	□	Document justification demonstrating that it is not practicable to capture runoff from this portion of the site in the **drainage report**. No further action is needed.
		Yes	□	This exclusion does not apply. Permanent water quality is required.

Summary of Water Quality Conformance to MS4 Permit

The purpose of this worksheet is to document conformance with the Town of Castle Rock's MS4 permit with regard to permanent water quality on land disturbance projects.

Project Name Dawson Trails Filing 2

Project Owner ACM Dawson Trails JV LLC

Project Location Southwest of the new Crystal Valley Interchange

ToCR Project Number CD23-0045

Total Site Area 445 +/- **acres**

Total Size of Common Plan of Development 445 +/- **acres**

Check all that apply:

- ☑ **Project within Plum Creek Basin**
- ☐ **Project within Cherry Creek Basin**

Estimated construction completion date December 2026

---

1. The water quality control measure(s) for applicable development sites shall meet one of the following base design standards as per the SDDTCM Section 14.4. Please select all design standards that were applied to meet conformance with the MS4 on this site.

   - ☑ WQCV standard
   - ☐ Pollutant removal standard
   - ☐ Runoff reduction standard
   - ☐ Applicable site draining to regional WQVC control measure (accepts drainage prior to discharging to WOTS)
   - ☑ Applicable site draining to regional WQVC control facility (with receiving pervious area control measure upstream of WOTS)
   - ☐ Constrained redevelopment sites standard
     - Imperviousness of existing site _____/_____(Imp. Ac/Site Ac) =____%
     - Variance required TCV No. _____
   - ☐ Existing control measure with WQCV per previous criteria standards
     - Reference Construction Permit No. _____
   - ☐ Cherry Creek Basin only, choose one: ☐ Tier 1 ☐ Tier 2 ☐ Tier 3
   - ☐ No control measures provided (See Permanent WQ Worksheet for applicability)

Development Services
100 N. Wilcox Street
Castle Rock, CO 80104
720-733-2200 FAX 720-733-2231

NO. TCV25-00xx

DATE 4/28/25

TECHNICAL CRITERIA VARIANCE APPLICATION

DEVELOPMENT Dawson Trails Filing 2

LEGAL DESCRIPTION OF SUBJECT PROPERTY

DAWSON TRAILS FILING 2 INFRASTRUCTURE
LOCATED IN PORTIONS OF SECTIONS 21, 22, 27 AND 28, TOWNSHIP 8 SOUTH,
RANGE 67 WEST OF THE 6TH PRINCIPAL MERIDIAN, TOWN OF CASTLE ROCK, COUNTY OF DOUGLAS, STATE OF COLORADO.

VARIANCE REQUESTED:

Code Section(s) ToCR Storm Drainage Criteria Sec 12.2.3 ------->

Chapter 12. Open Channel Design

GRADE CONTROL DROP HEIGHT CRITERIA

Capacity of Grade Control Structure	Maximum Drop Height (feet)
Less than 2-year future discharge	1.5
Between 2-year and 100-year	2.5
100-year and greater	4.0

Describe the Variance Requested

We want to use these larger drops on the North Dawson Tributary:
1)10' drop is proposed just downstream of Dawson Trails Blvd going into Pond A1
2) 8' drop is proposed just upstream of the Blanca Peak Parkway box culvert crossing
3) 8' drop is proposed downstream of Pond A1 before BNSF bridge

1. Describe the exceptional situation or condition that exists

The drops on either side of Pond A1 are required to get the volume needed in Pond A1. Dawson Trails Blvd exists as well as the railroad and cannot be adjusted. The drop upstream of Blanca Peak Parkway is needed to keep the proposed regional trail out of the drop structure.

2. Describe the difficulty or hardship that would be created by a strict enforcement of the code

Changes to the landuse plan would be needed to adjust the pond area.

3. Describe why there would not be any adverse impact on public health, safety and welfare

The proposed grouted boulders will safely dissipate energy down the proposed drop. No adverse impacts are anticipated to safety, health and welfare.

Additional Information:

1. *Attach an improvement survey.*
2. *Attach a drawing showing the intended uses.*
3. *Provide any other information helpful to discussion.*

PROPERTY OWNER

Name: Westside Investment Partners, Inc.

Address: 4100 E Mississippi Ave, Suite 500

Glendale, CO 80246

Phone #: 303-984-9800

Fax #: _____

APPLICANT'S REPRESENTATIVE (If applicable)

Name: EMK Consultants, Inc.

Address: 7006 S. Alton Way, Bldg, F

Centennial, CO 80112

Phone: 303-694-1520

Fax: 303-694-1617

_____
Signature of Applicant

For Staff Use Only

Staff Recommendation: Approved ☐ Yes ☐ No

_____
Signature

- ☐ Public Works Director
- ☐ Director of Castle Rock Water
- ☐ Parks & Recreation Director
- ☐ Development Services Director

_____
Date

Comments

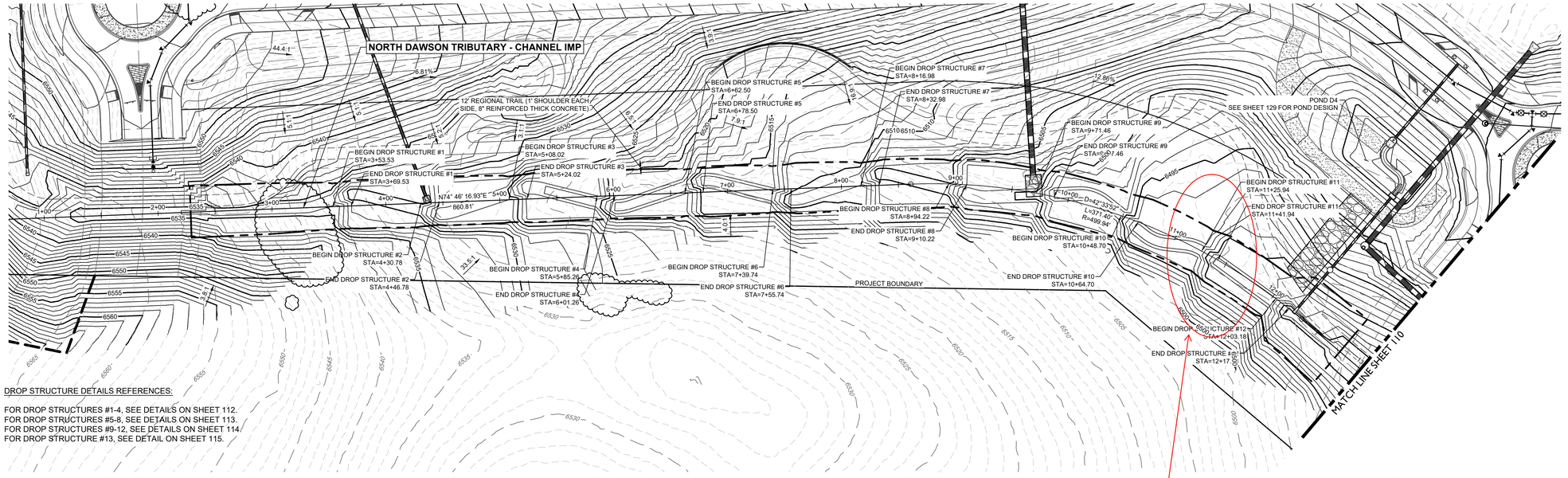
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Conditions of Acceptance

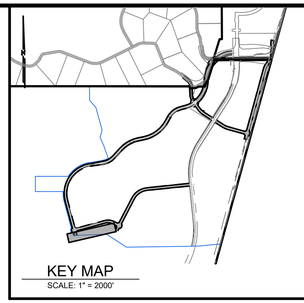
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DROP STRUCTURE DETAILS REFERENCES:

FOR DROP STRUCTURES #1-4, SEE DETAILS ON SHEET 112.
FOR DROP STRUCTURES #5-8, SEE DETAILS ON SHEET 113.
FOR DROP STRUCTURES #9-12, SEE DETAILS ON SHEET 114.
FOR DROP STRUCTURE #13, SEE DETAIL ON SHEET 115.



0 50' 100'
1 inch = 50 ft.

PROFILE
HORIZ: 1" = 50'
VERT: 1" = 5'

LEGEND

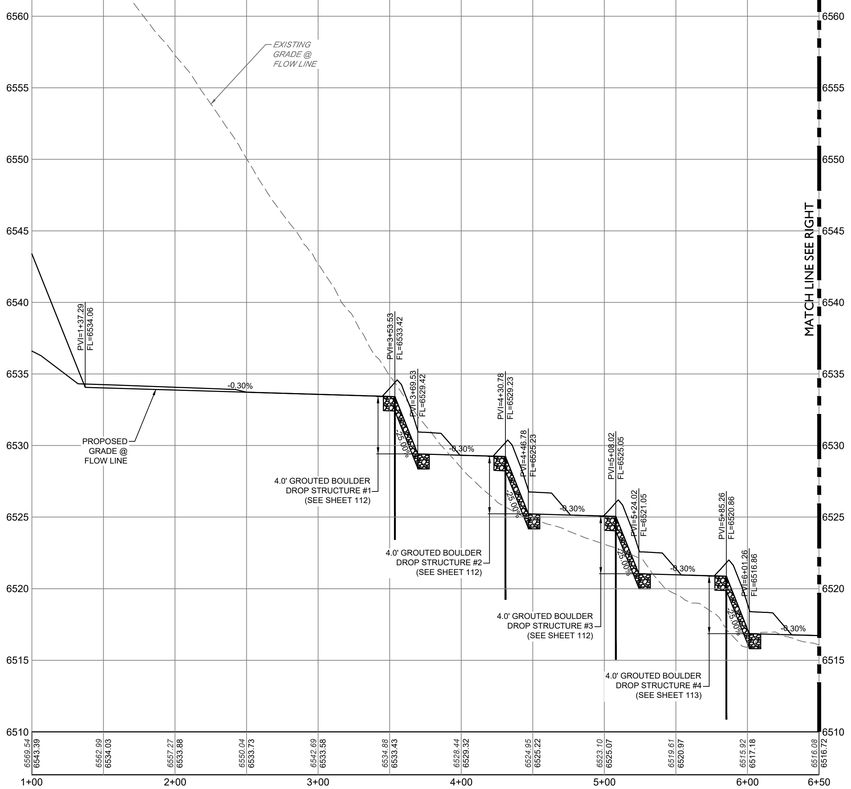
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- RIGHT OF WAY (R.O.W.)
- CENTERLINE
- PROJECT BOUNDARY
- PROPOSED CURB & GUTTER
- PROPOSED SANITARY & STUB OUT
- EXISTING SANITARY & STUB OUT
- SANITARY SERVICE
- WATER SERVICE
- PROPOSED WATER & STUB OUT
- EXISTING WATER & STUB OUT
- PROPOSED STORM & STUB OUT
- EXISTING STORM & STUB OUT
- FUTURE STORM & STUB OUT
- STORM MAJOR HGL
- STORM MINOR HGL
- STORM UNDERDRAIN

EXISTING / PROPOSED

- STORM MANHOLES
- STORM INLETS
- FES, FOREBAY, & TRICKLE CHANNEL
- OUTLET STRUCTURE
- CRUSHER FINES MAINTENANCE ACCESS
- RIPRAP
- BLOCK NUMBER
- 100 YEAR FLOODPLAIN
- WETLAND

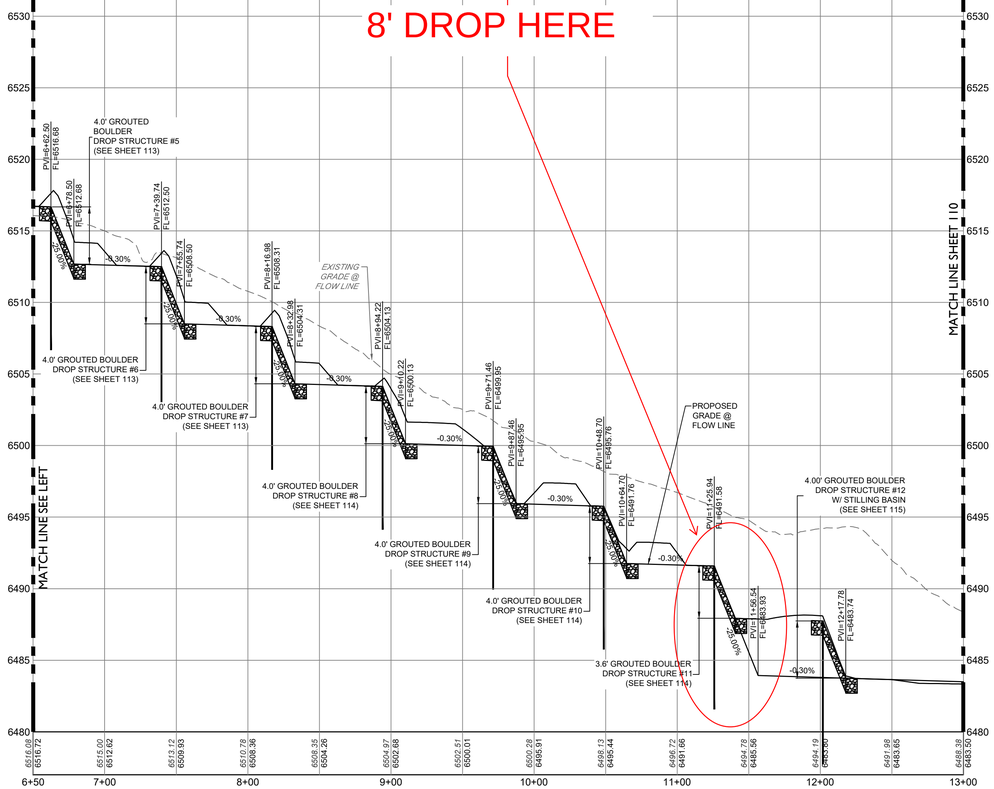
NORTH DAWSON TRIBUTARY - CHANNEL IMP

(1+00-6+50)



NORTH DAWSON TRIBUTARY - CHANNEL IMP

(6+50-13+00)



BASIS OF BEARINGS

SEE COVER SHEET FOR BASIS OF BEARINGS & BENCHMARK.

PROFESSIONAL ENGINEER CERTIFICATION

I HEREBY AFFIRM THAT THESE FINAL CONSTRUCTION PLANS WERE PREPARED UNDER MY DIRECT SUPERVISION, IN ACCORDANCE WITH ALL APPLICABLE TOWN OF CASTLE ROCK AND STATE OF COLORADO STANDARDS AND STATUTES, RESPECTIVELY, AND THAT I AM FULLY RESPONSIBLE FOR ALL DESIGN AND REVISIONS RELATIVE TO SAID PLANS.

GARY A. WALTER — DATE
STATE OF COLORADO # 42246

TOWN APPROVAL BLOCK

TOWN OF CASTLE ROCK APPROVAL
PLANS ARE HEREBY APPROVED FOR ONE YEAR FROM DATE OF DEVELOPMENT SERVICES APPROVAL.

APPROVED BY:

DEVELOPMENT SERVICES — DATE

EMK CONSULTANTS, INC.
ENGINEERING SURVEYING
LAND DEVELOPMENT
SERVICES AND SOLUTIONS
7006 SOUTH ALTON WAY, BLDG. F
CENTENNIAL, COLORADO 80112-2019
(303)694-1520
www.EMKc.com

Know what's below. Call before you dig. 811

#	REVISION DESCRIPTION	DATE	BY
1	1ST SUBMITTAL	10/31/23	JF
2	2ND SUBMITTAL	8/23/24	BG
3	3RD SUBMITTAL	12/23/24	GW

DAWSON TRAILS - FILING 2 INFRASTRUCTURE

CASTLE ROCK, COLORADO

CONSTRUCTION DOCUMENTS
N. DAWSON TRIBUTARY CHANNEL P&P (1 OF 3)

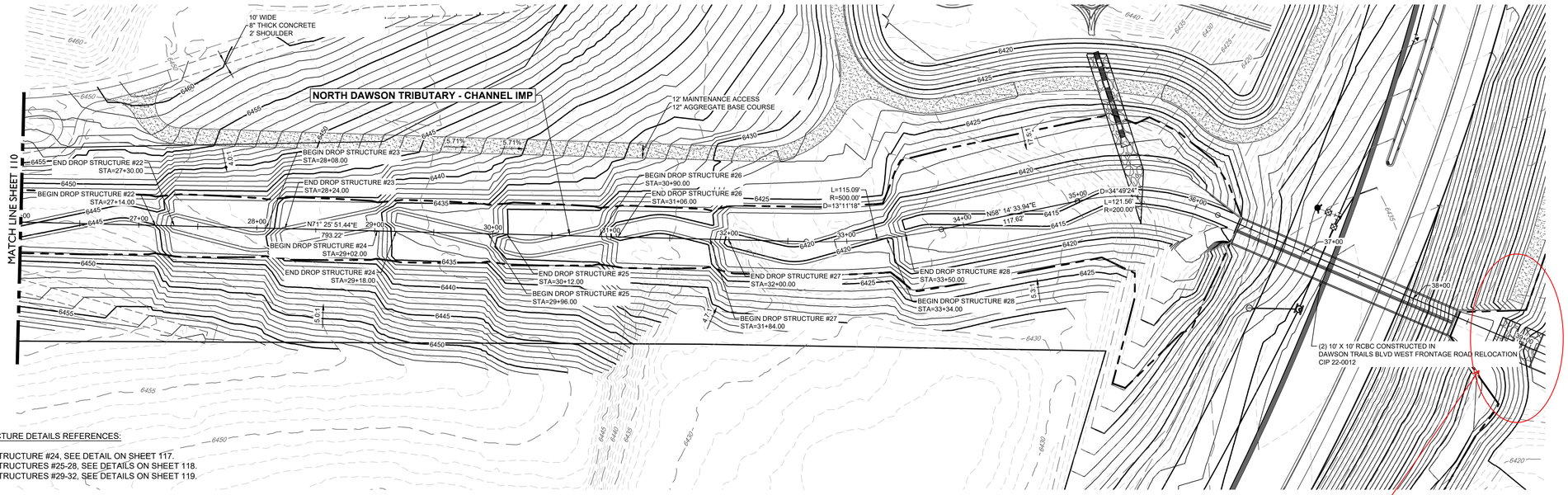
WESTSIDE

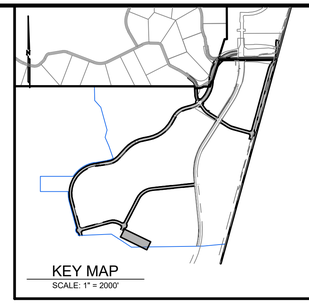
DESIGNED BY: DO
DRAWN BY: DL
CHECKED BY: GAW

JOB NO. 13466.00

SHEET 109 OF 297

4/23/2025 4:48 PM X:\20-224 Dawson\Civil\CAD\Plans\INFRA1\CDs CHANNEL P&P - NORTH DAWSON TRIBUTARY.dwg





0 50' 100'

1 inch = 50 ft.

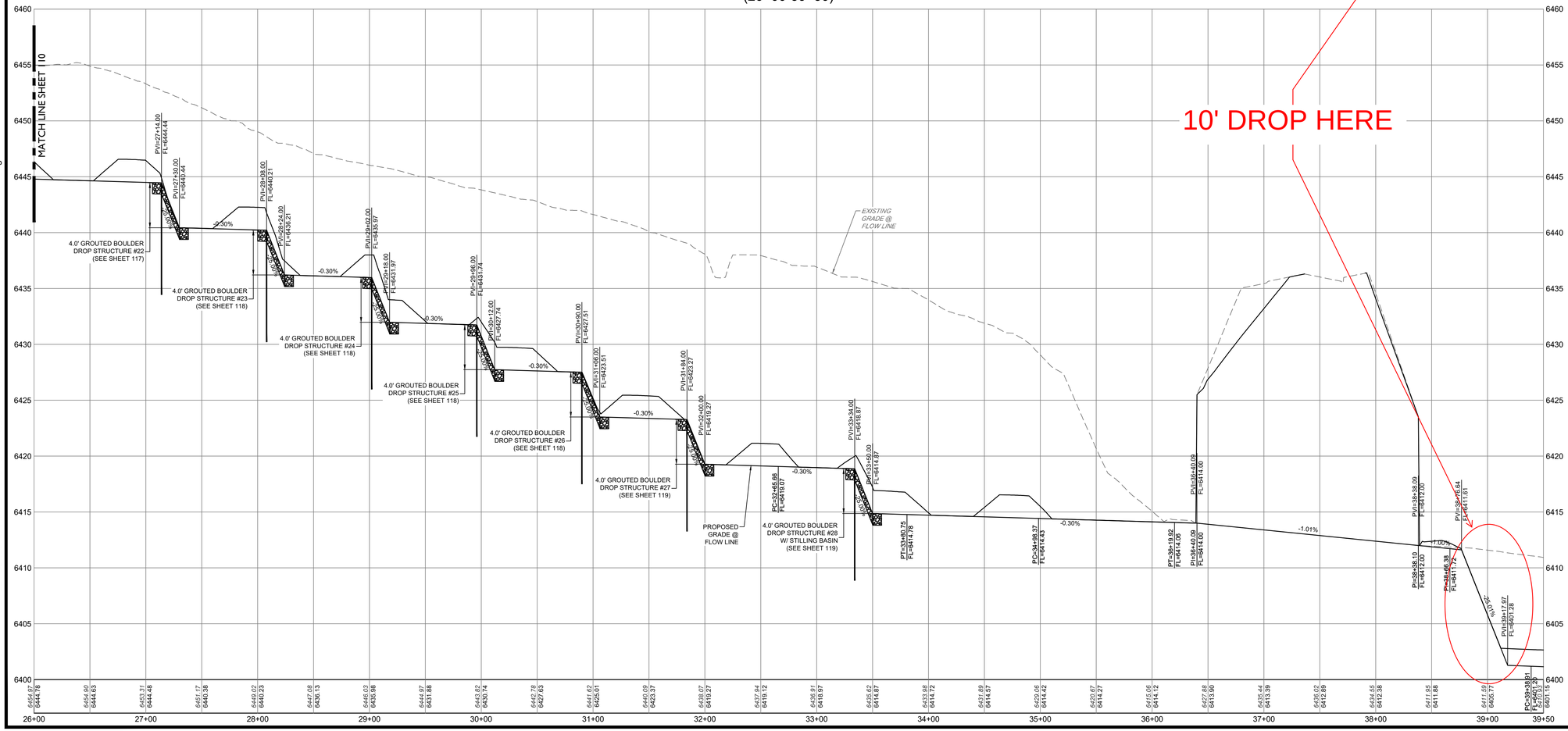
PROFILE
HORIZ: 1" = 50'
VERT: 1" = 5'

DROP STRUCTURE DETAILS REFERENCES:

FOR DROP STRUCTURE #24, SEE DETAIL ON SHEET 117.
FOR DROP STRUCTURES #25-28, SEE DETAILS ON SHEET 118.
FOR DROP STRUCTURES #29-32, SEE DETAILS ON SHEET 119.

NORTH DAWSON TRIBUTARY - CHANNEL IMP

(26+00-39+50)



LEGEND

- EASEMENT
- RIGHT OF WAY (R.O.W.)
- CENTERLINE
- PROJECT BOUNDARY
- PROPOSED CURB & GUTTER
- PROPOSED SANITARY & STUB OUT
- EXISTING SANITARY & STUB OUT
- SANITARY SERVICE
- WATER SERVICE
- PROPOSED WATER & STUB OUT
- EXISTING WATER & STUB OUT
- PROPOSED STORM & STUB OUT
- EXISTING STORM & STUB OUT
- FUTURE STORM & STUB OUT
- STORM MAJOR HGL
- STORM MINOR HGL
- STORM UNDERDRAIN

EXISTING / PROPOSED

- STORM MANHOLES
- STORM INLETS
- FES, FOREBAY, & TRICKLE CHANNEL
- OUTLET STRUCTURE
- CRUSHER FINES MAINTENANCE ACCESS
- RIPRAP
- BLOCK NUMBER
- 100 YEAR FLOODPLAIN
- WETLAND

BASIS OF BEARINGS

SEE COVER SHEET FOR BASIS OF BEARINGS & BENCHMARK.

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STATE OF COLORADO # 42246

TOWN APPROVAL BLOCK

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APPROVED BY:

DEVELOPMENT SERVICES — DATE

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ENGINEERING SURVEYING
LAND DEVELOPMENT
SERVICES AND SOLUTIONS
7006 SOUTH ALTON WAY, BLDG. F
CENTENNIAL, COLORADO 80112-2019
(303)694-1520
www.EMKC.com

Know what's below. Call before you dig. 811

#	REVISION DESCRIPTION	DATE	BY
1	1ST SUBMITTAL	10/31/23	JF
2	2ND SUBMITTAL	8/23/24	BG
3	3RD SUBMITTAL	12/23/24	GW

DAWSON TRAILS - FILING 2 INFRASTRUCTURE
CASTLE ROCK, COLORADO
CONSTRUCTION DOCUMENTS
N. DAWSON TRIBUTARY CHANNEL P&P (3 OF 3)

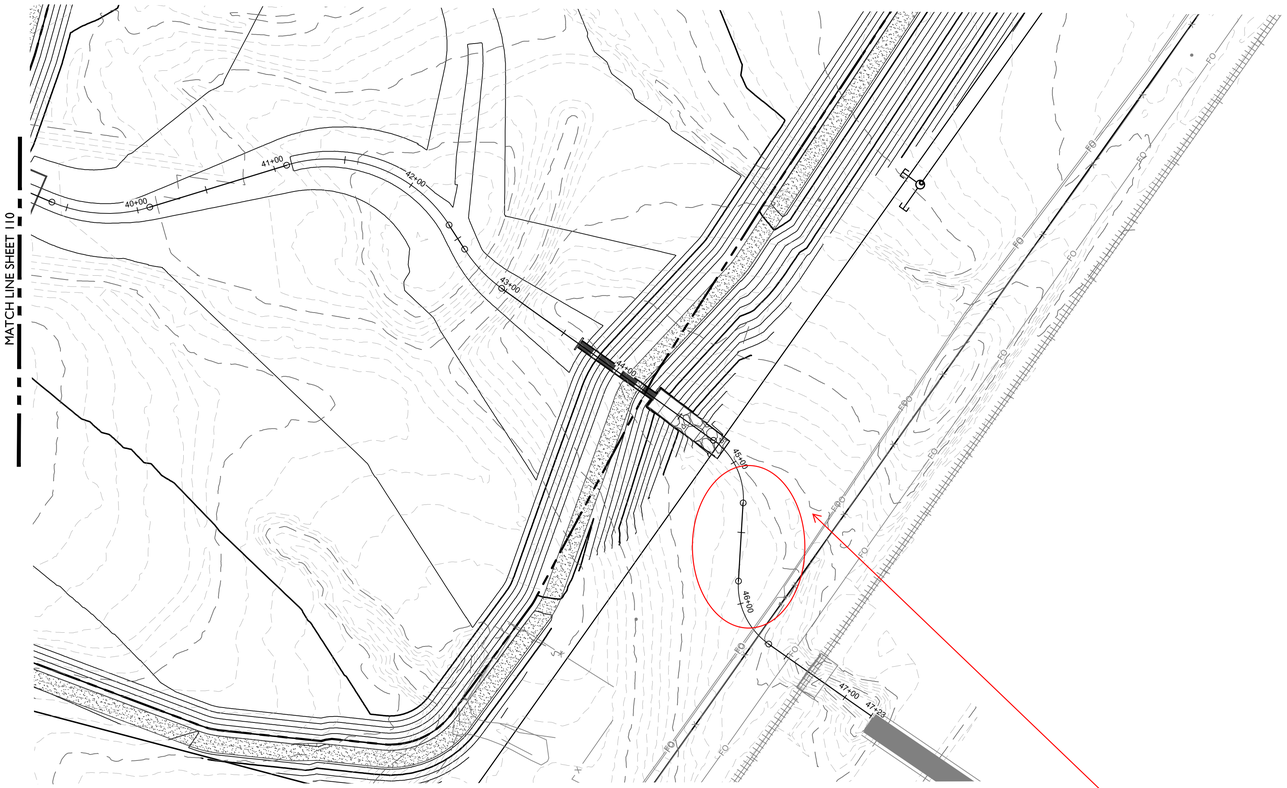
WESTSIDE

DESIGNED BY: DO
DRAWN BY: DL
CHECKED BY: GAW

JOB NO. 13466.00

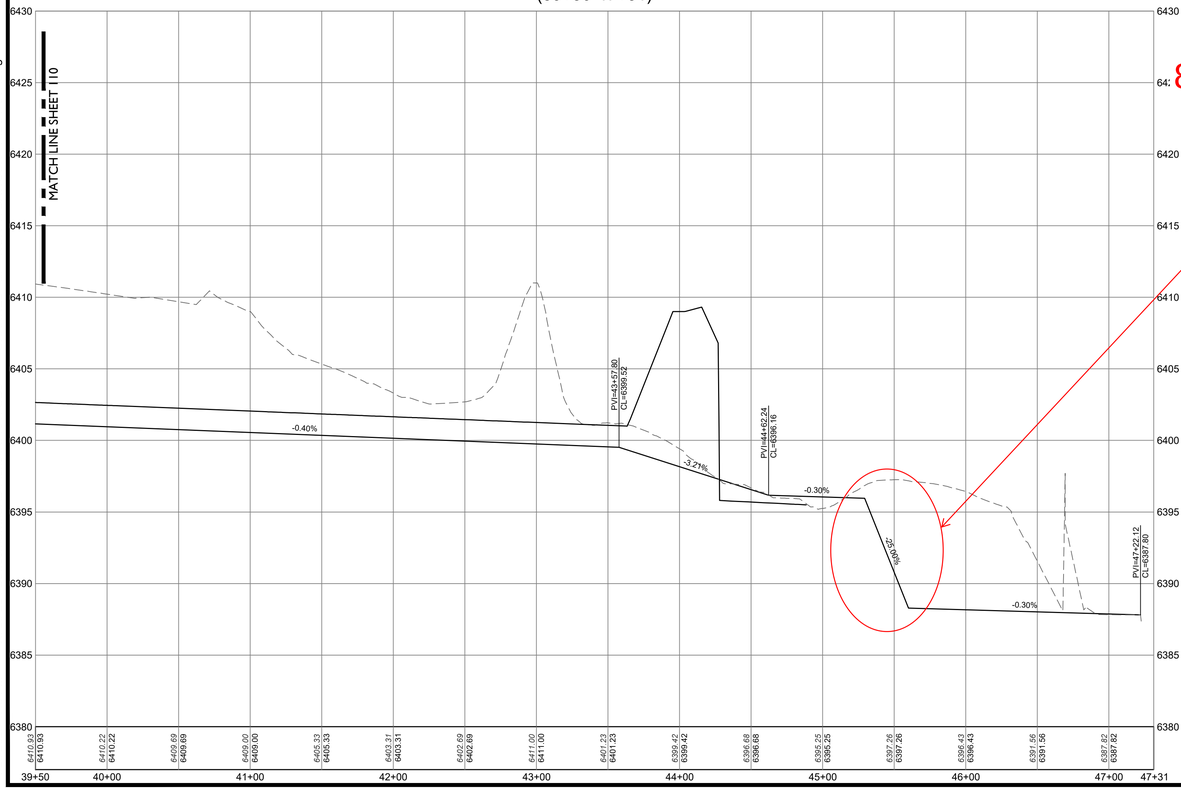
SHEET 111 OF 297

4/23/2025 4:48 PM X:\20-224 Dawson\Civil\CAD\Plans\INFRA\CDs CHANNEL P&P - NORTH DAWSON TRIBUTARY.dwg

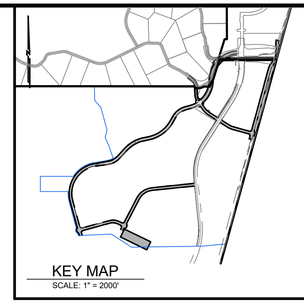


NORTH DAWSON TRIBUTARY - CHANNEL IMP

(39+50-47+31)



8' DROP HERE



0 50' 100'

1 inch = 50 ft.

PROFILE
HORIZ: 1" = 50'
VERT: 1" = 5'

DROP STRUCTURE DETAILS REFERENCES:

FOR DROP STRUCTURE #24, SEE DETAIL ON SHEET 117.
FOR DROP STRUCTURES #25-28, SEE DETAILS ON SHEET 118.
FOR DROP STRUCTURES #29-32, SEE DETAILS ON SHEET 119.

LEGEND

- EASEMENT
- RIGHT OF WAY (R.O.W.)
- CENTERLINE
- PROJECT BOUNDARY
- PROPOSED CURB & GUTTER
- PROPOSED SANITARY & STUB OUT
- EXISTING SANITARY & STUB OUT
- SANITARY SERVICE
- WATER SERVICE
- PROPOSED WATER & STUB OUT
- EXISTING WATER & STUB OUT
- PROPOSED STORM & STUB OUT
- EXISTING STORM & STUB OUT
- FUTURE STORM & STUB OUT
- STORM MAJOR HGL
- STORM MINOR HGL
- STORM UNDERDRAIN

EXISTING / PROPOSED

- STORM MANHOLES
- STORM INLETS
- FES, FOREBAY, & TRICKLE CHANNEL
- OUTLET STRUCTURE
- CRUSHER FINES MAINTENANCE ACCESS
- RIPRAP
- BLOCK NUMBER
- 100 YEAR FLOODPLAIN
- WETLAND

BASIS OF BEARINGS

SEE COVER SHEET FOR BASIS OF BEARINGS & BENCHMARK.

PROFESSIONAL ENGINEER CERTIFICATION

I HEREBY AFFIRM THAT THESE FINAL CONSTRUCTION PLANS WERE PREPARED UNDER MY DIRECT SUPERVISION, IN ACCORDANCE WITH ALL APPLICABLE TOWN OF CASTLE ROCK AND STATE OF COLORADO STANDARDS AND STATUTES, RESPECTIVELY; AND THAT I AM FULLY RESPONSIBLE FOR ALL DESIGN AND REVISIONS RELATIVE TO SAID PLANS.

GARY A. WALTER — DATE
STATE OF COLORADO # 42246

TOWN APPROVAL BLOCK

TOWN OF CASTLE ROCK APPROVAL
PLANS ARE HEREBY APPROVED FOR ONE YEAR FROM DATE OF DEVELOPMENT SERVICES APPROVAL.

APPROVED BY:

DEVELOPMENT SERVICES — DATE

EMK CONSULTANTS, INC.
ENGINEERING SURVEYING
LAND DEVELOPMENT
SERVICES AND SOLUTIONS
7006 SOUTH ALTON WAY, BLDG. F
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1	1ST SUBMITTAL	10/31/23	JF
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DAWSON TRAILS - FILING 2 INFRASTRUCTURE
CASTLE ROCK, COLORADO

CONSTRUCTION DOCUMENTS
CHANNEL P&P - NORTH DAWSON TRIBUTARY - 106

WESTSIDE

DESIGNED BY: DO
DRAWN BY: DL
CHECKED BY: GAW

JOB NO. 13466.00

SHEET 111A OF 297

CHANNEL P&P - NORTH DAWSON TRIBUTARY.dwg
X:\20-224 Dawson\Civil\CAD\Plans\INFRA1\CDs
4/23/2025 4:49 PM

Appendix D - Referenced Material

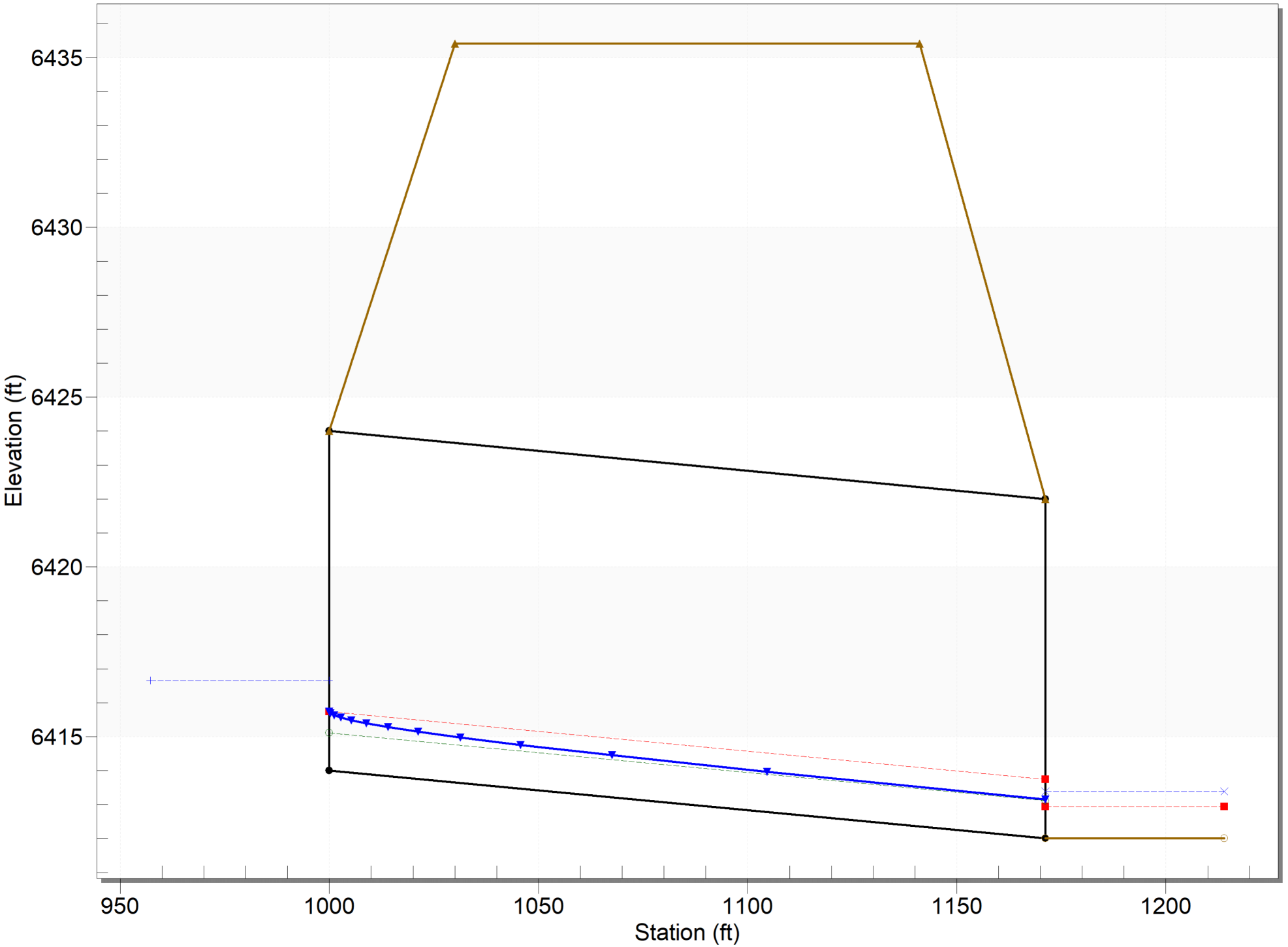
Gambel Ridge and Douglas Lane FHAD

Gambel Ridge and Douglas Lane Master Plan

North and South Dawson Watershed Master Plan

Crossing - North Dawson Main Culvert, Design Discharge - 261.0 cfs (100 YR FHAD)

Culvert - North Dawson Main Culvert, Culvert Discharge - 261.0 cfs



Culvert Crossing: North Dawson Culvert Crossing - Existing

Culvert Summary Table - North Dawson Stream Crossing - Existing

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth(ft)	Outlet Control Depth(ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
261.00	261.00	6427.09	4.19	1.26	1-S2n	1.62	2.77	1.74	3.98	15.03	2.44

Geometry

Inlet Elevation:	6422.90 ft
Outlet Elevation:	6420.00 ft
Culvert Length:	192.95 ft
Culvert Slope:	0.0150
Culvert Rise:	10.00 ft
Culvert Span:	10.00 ft

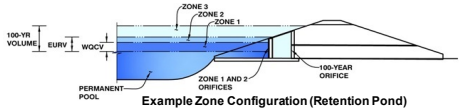
Outlet Control:	Full Flow

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: DAWSON TRAILS BLVD

Basin ID: Pond B



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB		**Note: L / W Ratio > 8**
Watershed Area =	4.83	acres	**L / W Ratio = 9.46**
Watershed Length =	1,411	ft	
Watershed Length to Centroid =	455	ft	
Watershed Slope =	0.010	ft/ft	
Watershed Imperviousness =	100.00%	percent	
Percentage Hydrologic Soil Group A =	0.0%	percent	
Percentage Hydrologic Soil Group B =	0.0%	percent	
Percentage Hydrologic Soil Groups C/D =	100.0%	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) =	0.201	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	0.483	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 1.06 in.) =	0.422	acre-feet	1.06 inches
5-yr Runoff Volume (P1 = 1.43 in.) =	0.583	acre-feet	1.43 inches
10-yr Runoff Volume (P1 = 1.66 in.) =	0.682	acre-feet	1.66 inches
25-yr Runoff Volume (P1 = 1.69 in.) =	0.695	acre-feet	inches
50-yr Runoff Volume (P1 = 2.26 in.) =	0.942	acre-feet	2.26 inches
100-yr Runoff Volume (P1 = 2.6 in.) =	1.089	acre-feet	2.60 inches
500-yr Runoff Volume (P1 = 3.14 in.) =	1.323	acre-feet	inches
Approximate 2-yr Detention Volume =	0.394	acre-feet	
Approximate 5-yr Detention Volume =	0.553	acre-feet	
Approximate 10-yr Detention Volume =	0.641	acre-feet	
Approximate 25-yr Detention Volume =	0.604	acre-feet	
Approximate 50-yr Detention Volume =	0.731	acre-feet	
Approximate 100-yr Detention Volume =	0.766	acre-feet	

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.201	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.282	acre-feet
Zone 3 (100yr + 1 / 2 WQCV - Zones 1 & 2) =	0.384	acre-feet
Total Detention Basin Volume =	0.867	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	

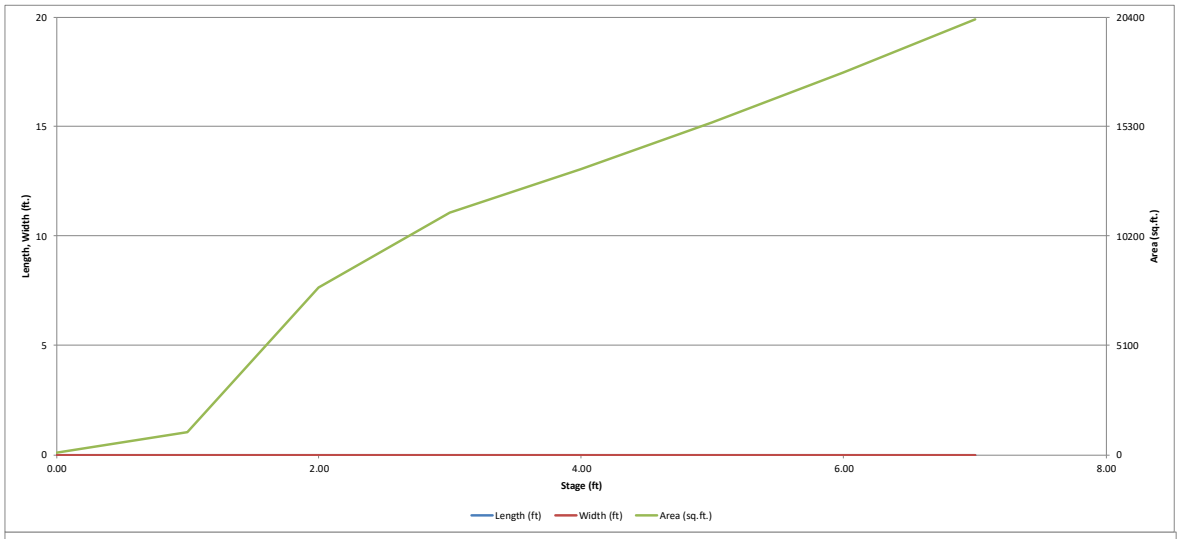
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	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

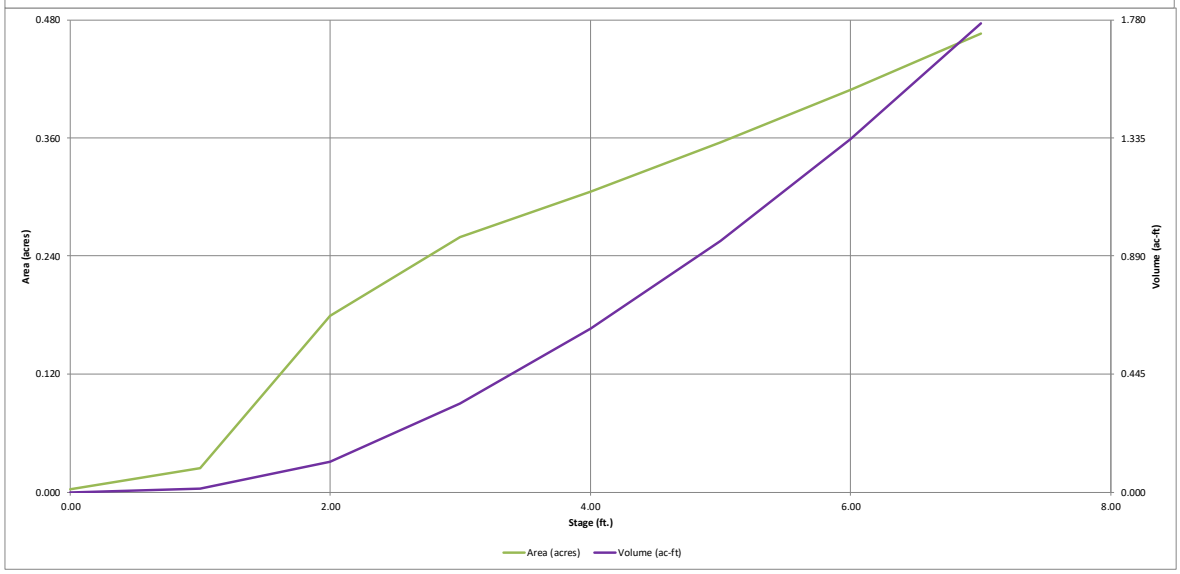
Depth Increment = 0.50 ft

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	--	--	--	125	0.003		
6416	--	1.00	--	--	--	1,061	0.024	593	0.014
6417	--	2.00	--	--	--	7,791	0.179	5,019	0.115
6418	--	3.00	--	--	--	11,294	0.259	14,561	0.334
6419	--	4.00	--	--	--	13,308	0.306	26,863	0.617
6420	--	5.00	--	--	--	15,475	0.355	41,254	0.947
6421 (SPILLWAY)	--	6.00	--	--	--	17,809	0.409	57,897	1.329
6422 (BERM)	--	7.00	--	--	--	20,302	0.466	76,952	1.767

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)



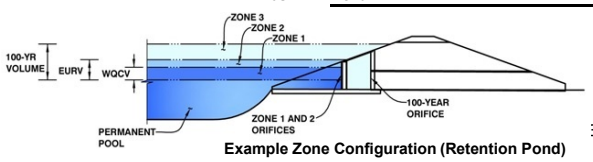


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: DAWSON TRAILS BLVD

Basin ID: Pond B



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.44	0.201	Orifice Plate
Zone 2 (EURV)	3.55	0.282	Circular Orifice
3 (100+1/2WQCV)	4.77	0.384	Weir&Pipe (Restrict)
Total (all zones)		0.867	

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

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	5.139E-03	ft^2
Depth at top of Zone using Orifice Plate =	2.44	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	9.80	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.74	sq. inches (diameter = 15/16 inch)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.81	1.63					
Orifice Area (sq. inches)	0.74	0.74	0.74					

	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)

	Zone 2 Circular	Not Selected			Zone 2 Circular	Not Selected	
Invert of Vertical Orifice =	2.44	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	0.00	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	3.55	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	0.03	N/A	feet
Vertical Orifice Diameter =	0.62	N/A	inches				

Calculated Parameters for Vertical Orifice

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

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.55	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	4.30	N/A	feet
Overflow Weir Front Edge Length =	3.00	N/A	feet	Overflow Weir Slope Length =	3.09	N/A	feet
Overflow Weir Grate Slope =	4.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	26.72	N/A	
Horiz. Length of Weir Sides =	3.00	N/A	feet	Overflow Grate Open Area w/o Debris =	6.46	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	3.23	N/A	ft^2
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			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 =	0.24	N/A	ft^2
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.17	N/A	feet
Restrictor Plate Height Above Pipe Invert =	3.50		inches	Half-Central Angle of Restrictor Plate on Pipe =	0.91	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=	0.31	feet
Spillway Crest Length =	24.00	feet	Stage at Top of Freeboard =	6.06	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.41	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	1.35	acre-ft

Calculated Parameters for Spillway

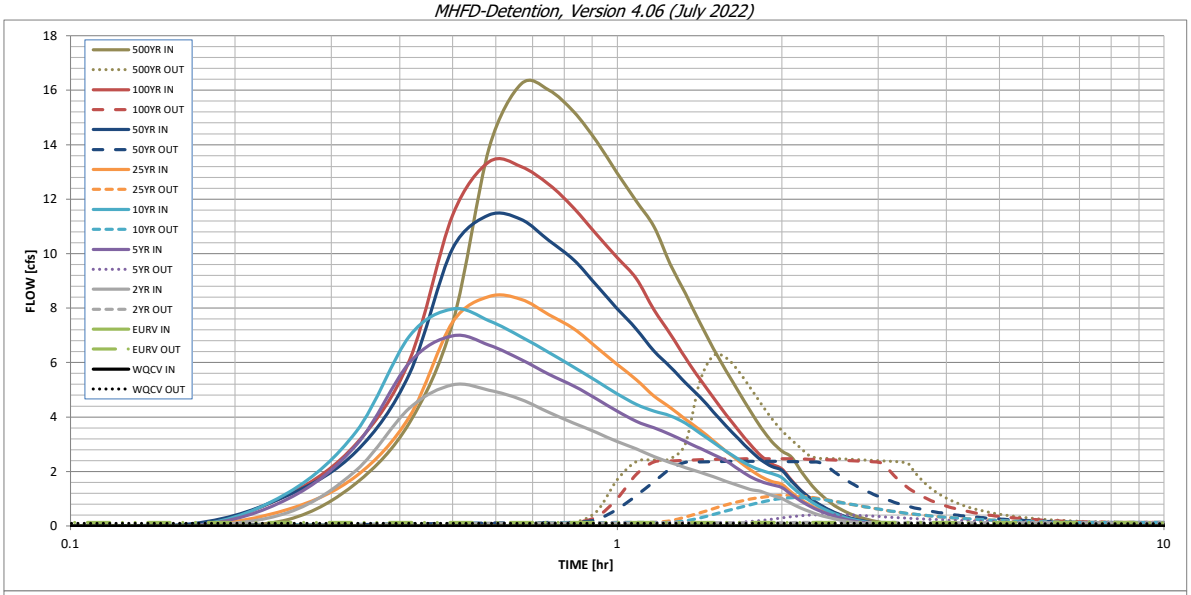
Routed Hydrograph Results

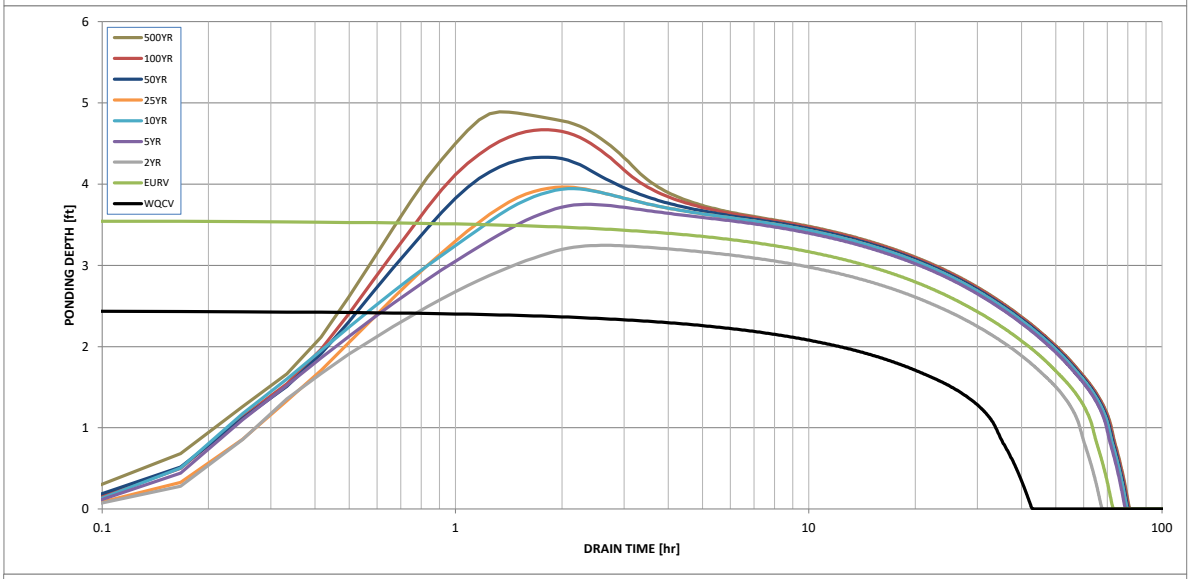
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

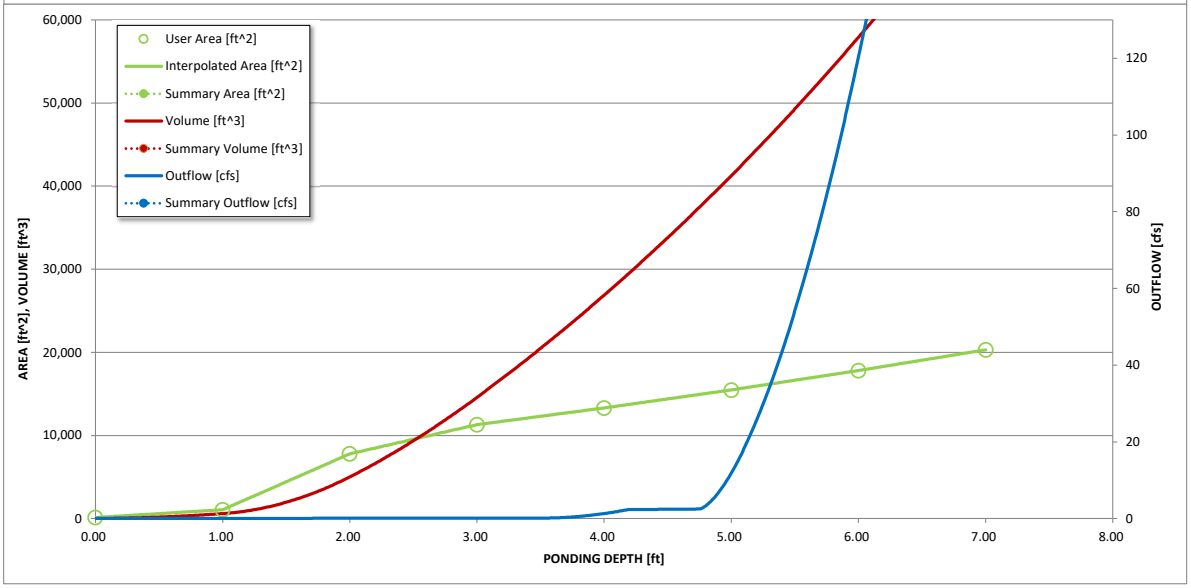
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.06	1.43	1.66	1.69	2.26	2.60	3.14
CUHP Runoff Volume (acre-ft) =	0.201	0.483	0.422	0.583	0.682	0.695	0.942	1.089	1.323
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.422	0.583	0.682	0.695	0.942	1.089	1.323
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.3	1.0	1.4	1.9	3.3	4.3	5.7
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.06	0.21	0.30	0.39	0.68	0.90	1.18
Peak Inflow Q (cfs) =	N/A	N/A	5.2	7.0	8.0	8.4	11.4	13.4	16.2
Peak Outflow Q (cfs) =	0.1	0.1	0.1	0.4	1.0	1.1	2.4	2.5	6.3
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.4	0.7	0.6	0.7	0.6	1.1
Structure Controlling Flow =	Plate	Overflow Weir 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	0.0	0.1	0.2	0.3	0.4	0.4
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	63	59	69	69	68	67	66	65
Time to Drain 99% of Inflow Volume (hours) =	**40**	68	63	74	74	74	73	73	72
Maximum Ponding Depth (ft) =	2.44	3.55	3.24	3.75	3.94	3.96	4.33	4.67	4.89
Area at Maximum Ponding Depth (acres) =	0.21	0.28	0.27	0.29	0.30	0.30	0.32	0.34	0.35
Maximum Volume Stored (acre-ft) =	0.202	0.484	0.398	0.539	0.598	0.604	0.720	0.829	0.905

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

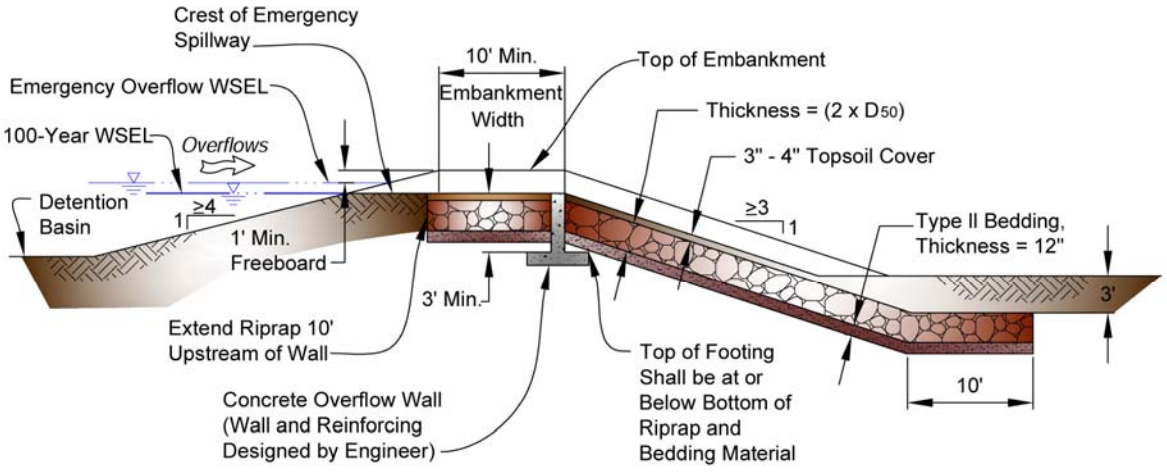
Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

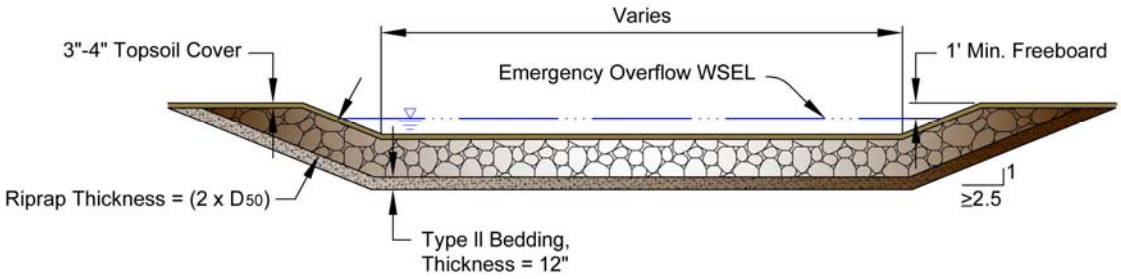
The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.04	0.24
	0:15:00	0.00	0.00	0.49	0.99	1.22	0.61	1.13	1.16	1.58
	0:20:00	0.00	0.00	2.05	2.97	3.47	1.84	2.74	3.02	3.79
	0:25:00	0.00	0.00	4.32	5.99	6.96	4.01	5.58	6.07	7.45
	0:30:00	0.00	0.00	5.18	6.98	7.96	7.48	10.19	11.41	13.88
	0:35:00	0.00	0.00	4.98	6.64	7.54	8.42	11.42	13.37	16.23
	0:40:00	0.00	0.00	4.64	6.11	6.95	8.32	11.26	13.19	16.00
	0:45:00	0.00	0.00	4.17	5.57	6.37	7.76	10.48	12.54	15.20
	0:50:00	0.00	0.00	3.78	5.14	5.83	7.24	9.76	11.66	14.12
	0:55:00	0.00	0.00	3.43	4.66	5.32	6.56	8.84	10.71	12.96
	1:00:00	0.00	0.00	3.10	4.21	4.85	5.93	7.98	9.85	11.93
	1:05:00	0.00	0.00	2.83	3.84	4.46	5.37	7.23	9.08	11.00
	1:10:00	0.00	0.00	2.55	3.60	4.22	4.78	6.43	7.94	9.61
	1:15:00	0.00	0.00	2.33	3.36	4.04	4.35	5.84	7.05	8.53
	1:20:00	0.00	0.00	2.14	3.10	3.77	3.91	5.26	6.17	7.46
	1:25:00	0.00	0.00	1.97	2.85	3.41	3.53	4.74	5.39	6.51
	1:30:00	0.00	0.00	1.80	2.61	3.06	3.12	4.18	4.71	5.69
	1:35:00	0.00	0.00	1.64	2.38	2.74	2.74	3.66	4.08	4.93
	1:40:00	0.00	0.00	1.48	2.08	2.45	2.39	3.19	3.50	4.23
	1:45:00	0.00	0.00	1.34	1.81	2.21	2.07	2.77	2.99	3.61
	1:50:00	0.00	0.00	1.26	1.63	2.05	1.81	2.42	2.57	3.10
	1:55:00	0.00	0.00	1.12	1.51	1.92	1.63	2.18	2.28	2.75
	2:00:00	0.00	0.00	1.01	1.41	1.77	1.53	2.04	2.09	2.53
	2:05:00	0.00	0.00	0.82	1.15	1.45	1.23	1.65	1.67	2.02
	2:10:00	0.00	0.00	0.65	0.91	1.16	0.97	1.30	1.31	1.58
	2:15:00	0.00	0.00	0.52	0.73	0.93	0.77	1.03	1.02	1.24
	2:20:00	0.00	0.00	0.41	0.58	0.73	0.61	0.81	0.79	0.96
	2:25:00	0.00	0.00	0.33	0.46	0.58	0.48	0.64	0.62	0.74
	2:30:00	0.00	0.00	0.25	0.35	0.44	0.37	0.49	0.48	0.57
	2:35:00	0.00	0.00	0.20	0.27	0.34	0.28	0.38	0.37	0.44
	2:40:00	0.00	0.00	0.15	0.21	0.26	0.22	0.29	0.28	0.34
	2:45:00	0.00	0.00	0.12	0.16	0.20	0.17	0.22	0.22	0.27
	2:50:00	0.00	0.00	0.09	0.12	0.15	0.13	0.17	0.17	0.20
	2:55:00	0.00	0.00	0.06	0.08	0.11	0.09	0.13	0.12	0.15
	3:00:00	0.00	0.00	0.04	0.06	0.07	0.06	0.09	0.09	0.10
	3:05:00	0.00	0.00	0.02	0.03	0.05	0.04	0.05	0.05	0.07
	3:10:00	0.00	0.00	0.01	0.02	0.02	0.02	0.03	0.03	0.04
	3:15:00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

FIGURE 13-7
EMBANKMENT PROTECTION DETAILS AND ROCK SIZING CHART

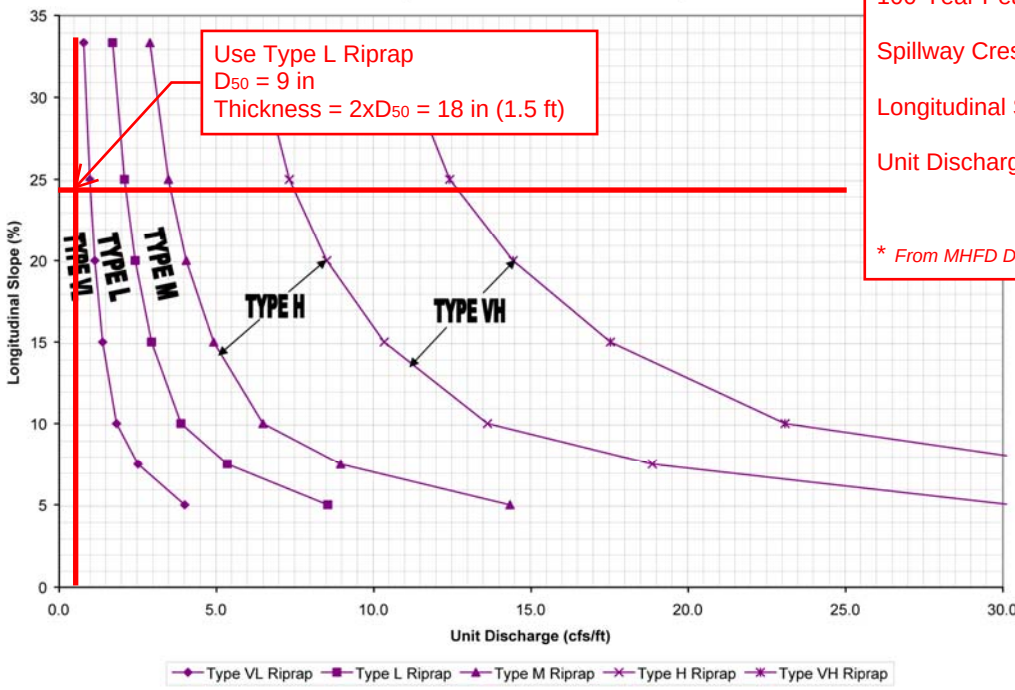


EMERGENCY SPILLWAY PROFILE



RIPRAP DESIGNATION
VL (D_{50} = 6 IN)
L (D_{50} = 9 IN)
M (D_{50} = 12 IN)
H (D_{50} = 18 IN)
VH (D_{50} = 24 IN)

SPILLWAY CHANNEL AT CREST AND DOWNSTREAM SIDE OF EMBANKMENT



100-Year Peak Inflow* = 13.4 CFS

Spillway Crest Length* = 24.0 FT

Longitudinal Slope = 24.0%

Unit Discharge =13.4/24.0 = 0.56 CFS/FT

* *From MHFD Detention Workbook*

Notes:

1) *Place and compact 12" Type II Granular Bedding only under Void-Filled Riprap (typical per USDCM Vol. 1, Ch. 8, Figure 8-34).*

2) *If Type VL Riprap is calculated, use Type L (typical per USDCM Vol. 2, Ch. 9, Figure 9-38).*

Appendix D - Referenced Material

Gambel Ridge and Douglas Lane FHAD

Gambel Ridge and Douglas Lane Master Plan

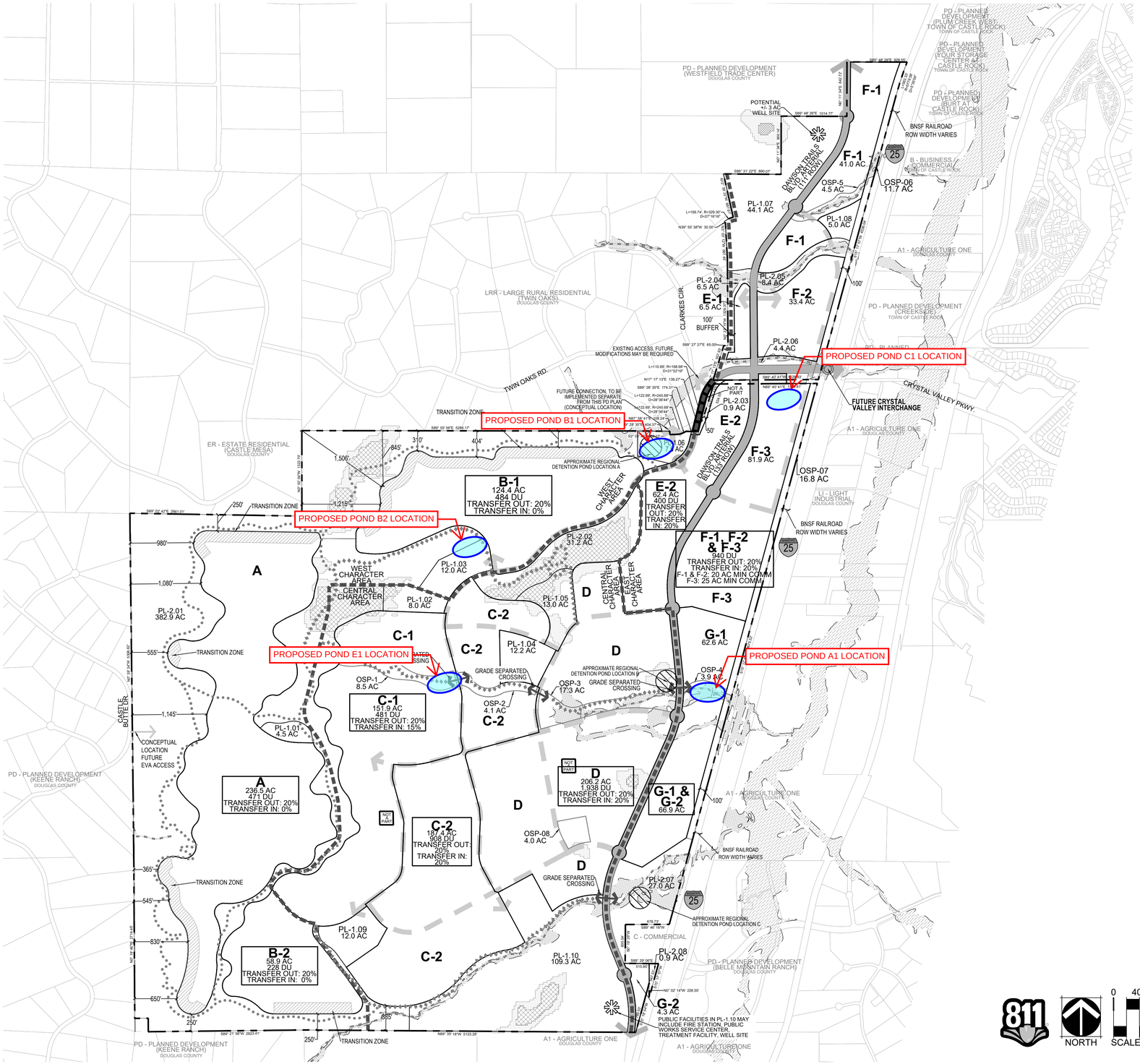
North and South Dawson Watershed Master Plan

DAWSON TRAILS

PLANNED DEVELOPMENT PLAN AND ZONING REGULATIONS

(AN AMENDMENT TO THE DAWSON RIDGE PRELIMINARY P.U.D SITE PLAN AND A PORTION OF THE WESTFIELD TRADE CENTER PRELIMINARY P.U.D. SITE PLAN)

TWO PARCELS OF LAND BEING ALL OF SECTION 28 AND PORTIONS OF SECTIONS 15, 21, 22, 27, 29, 32, 33 & 34, TOWNSHIP 8 SOUTH, RANGE 67 WEST OF THE SIXTH PRINCIPAL MERIDIAN, TOWN OF CASTLE ROCK, COUNTY OF DOUGLAS, STATE OF COLORADO



OPEN SPACE AND PUBLIC LAND SUMMARY

	ACREAGE	% OF TOTAL
PUBLIC LAND		
PL-1 (DEDICATED TO TOWN)	227.6	**11.0%**
OPEN SPACE		
PL-2 (DEDICATED TO TOWN)	462.2	22.4%
OSP (PRIVATE)	70.8	3.4%
SUBTOTAL	*533.0*	*25.8%*
FUTURE OPEN SPACE (1)	215.0	10.4%
OPEN SPACE TOTAL	**748.0**	**36.2%**
OPEN SPACE AND PUBLIC LAND TOTAL	**975.6**	**47.3%**

NOTE: (1) FUTURE OPEN SPACE DESIGNATION (PL-1, PL-2, OSP) TO BE DETERMINED AT TIME OF PLAT.

LEGEND

- PROPERTY BOUNDARY
- PLANNING AREA BOUNDARY
- CHARACTER AREA BOUNDARY
- MAJOR DRAINAGEWAY
- TRANSITION ZONE
- MODERATE SKYLINE
- MINOR SKYLINE
- 100 YEAR FLOODPLAIN (TOWN OF CASTLE ROCK)
- PROPOSED ARTERIAL RIGHT OF WAY
- FUTURE COLLECTOR RIGHT OF WAY
- 5' NATURAL SURFACE TRAIL
- 10' HARD SURFACE TRAIL
- 100 YEAR FLOODPLAIN (FEMA)

CHECKED BY: MB, SW
DRAWN BY: DJ, JR

NORTH SCALE 1" = 800' (0, 400, 800, 1,600)

DAWSON TRAILS PLANNED DEVELOPMENT PLAN | PROJECT NO. PDP21-0001

PLANNER/LANDSCAPE ARCHITECT
NORRIS DESIGN
Planning | Landscape Architecture | Branding
1101 Bannock Street
Denver, Colorado 80204
P 303.892.1166
www.norris-design.com

APPLICANT:
WESTSIDE INVESTMENT PARTNERS
4100 E. MISSISSIPPI AVE
SUITE 500
DENVER, CO 80246
303-984-9800

ENGINEER & SURVEYOR:
CORE CONSULTANTS, INC.
LIVEYOURCORE.COM
CORE CONSULTANTS
3473 S. BROADWAY
ENGLEWOOD, CO 80113
303-730-5960

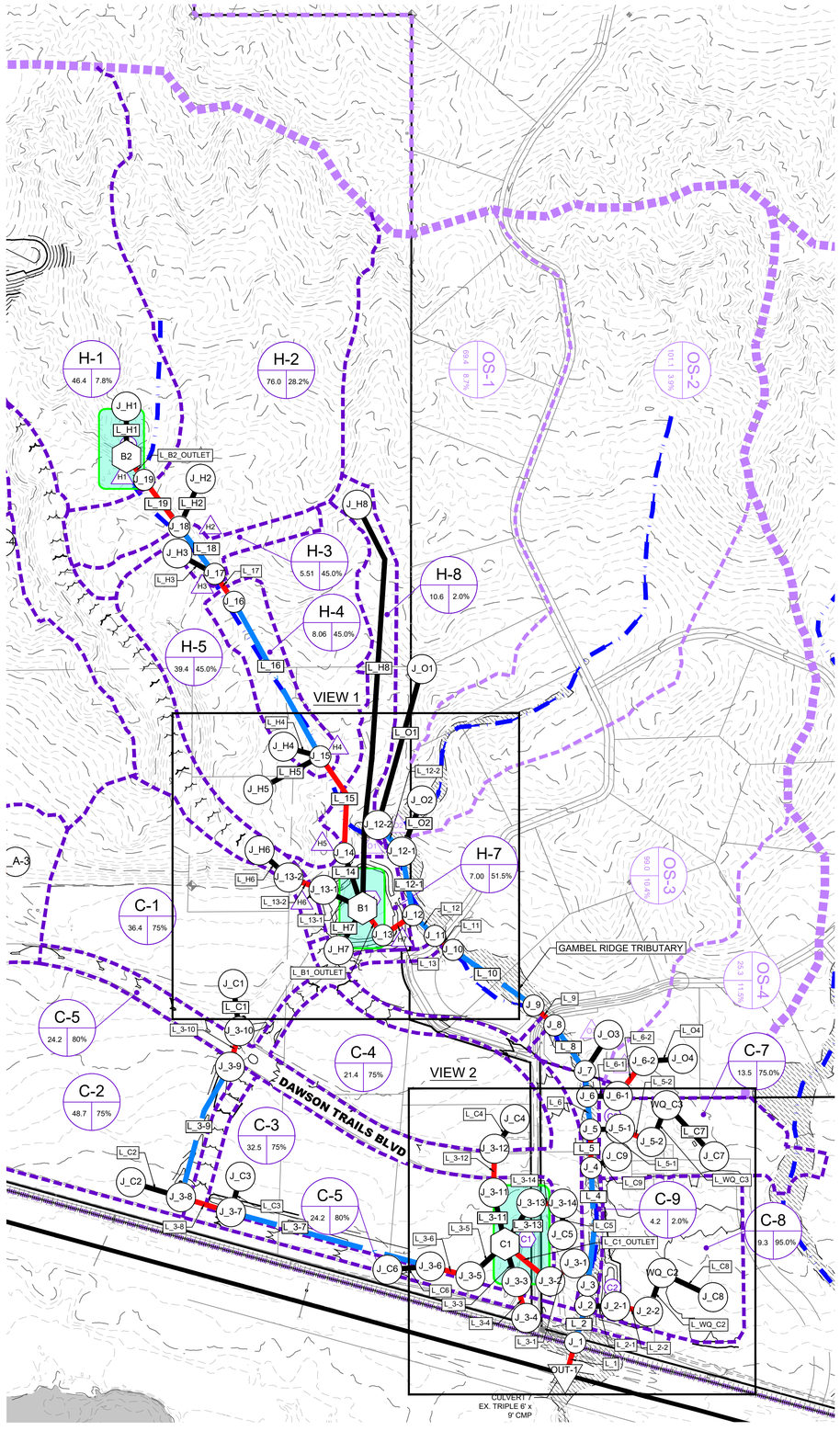
DAWSON TRAILS

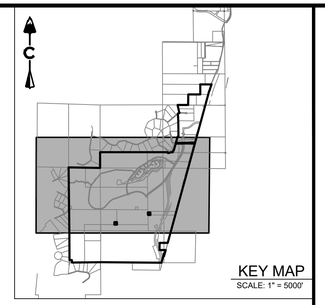
DAWSON TRAILS
PLANNED DEVELOPMENT PLAN AND ZONING REGULATIONS
(AN AMENDMENT TO THE DAWSON RIDGE PRELIMINARY P.U.D SITE PLAN AND A PORTION OF THE WESTFIELD TRADE CENTER PRELIMINARY P.U.D. SITE PLAN)

DATE:
PDP-01 07/08/2021
PDP-02 12/03/2021
PDP-03 04/13/2022
PDP-04 05/27/2022
PDP-05 06/09/2022

SHEET TITLE:
OVERALL PD PLAN

SHEET 3 OF 20





LEGEND

- OUTFALL DESIGNATION
- DESIGN POINT/JUNCTION DESIGNATION
- POND DESIGNATION
- PIPE/CHANNEL DESIGNATION
- JUNCTION/NODE DESIGNATION
- DUMMY LINK
- PROPOSED STORM SEWER
- PROPOSED CHANNEL

0 400' 800'

1 inch = 400 ft.

LEGEND

EXISTING	PROPOSED	
X 00.0 00.0%	X 00.0 00.0%	BASIN DESIGNATION / AREA (AC) / IMPERVIOUSNESS
X	X	DESIGN POINT
		DIRECTIONAL FLOW ARROW
		EMERGENCY OVERFLOW ROUTE
		PROPOSED DRAINAGE BASIN
		EXISTING DRAINAGE BASIN
	5280	PROPOSED MAJOR CONTOUR
	5279	PROPOSED MINOR CONTOUR
	5280	EXISTING MAJOR CONTOUR
	5279	EXISTING MINOR CONTOUR
		EASEMENT
		RIGHT OF WAY (R.O.W.)
		CENTERLINE
		PROJECT BOUNDARY
		PROPOSED STORM & STUB OUT
		EXISTING STORM & STUB OUT
		100-YEAR FEMA FLOODPLAIN
		100-YEAR TOWN FLOODPLAIN

NOTES:

1. DRAINAGE BASINS AND POND LOCATIONS ARE APPROXIMATE.
2. POND CONFIGURATIONS AND LOCATIONS ARE CONCEPTUAL AND MAY CHANGE DUE TO FIELD CONDITIONS AND/OR FINAL SITE CONFIGURATIONS.
3. THE SITE LIES WITHIN FEMA FLOOD ZONE X.
4. TOWN 100-YEAR FLOODPLAINS ASSOCIATED WITH THE SOUTH DAWSON, NORTH DAWSON, GAMBEL RIDGE, AND GAMBEL RIDGE NORTH TRIBUTARIES WILL BE RE-EVALUATED BY A FLOODPLAIN MODIFICATION STUDY.
5. EFFORTS WILL BE MADE TO STABILIZE, PROTECT, AND PRESERVE THE MAJOR DRAINAGEWAYS ON-SITE. IMPACTS WILL BE LIMITED TO IMPROVEMENTS IN THE AREAS OF DISCHARGES FROM THE PROPOSED DETENTION FACILITIES AND AS IDENTIFIED IN THE MASTER DRAINAGE PLANS FOR THE DRAINAGEWAYS. THE IMPROVEMENTS WILL CONFORM TO THE TOWN OF CASTLE ROCK STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA MANUAL. THESE IMPROVEMENTS WILL BE DESIGNED TO MITIGATE EROSION AND PRESERVE THE NATURAL CHARACTER AND HISTORICAL DRAINAGE PATTERNS TO THE GREATEST EXTENT FEASIBLE.
6. THE INTERCHANGE AT TERRITORIAL ROAD, CRYSTAL VALLEY PARKWAY, AND I-25 (CVI) IS A TOWN, COUNTY AND STATE PROJECT. CHANNEL IMPROVEMENTS FOR THE GAMBLE RIDGE MAJOR DRAINAGEWAY THROUGH THE SITE WILL BE PART OF THE CVI PROJECT.

LAND DEVELOPMENT
ENERGY
PUBLIC INFRASTUCTURE

CORE CONSULTANTS. INC.
3473 S. BROADWAY
ENGLEWOOD, CO 80113
303.703.4444
LIVEYOURCORE.COM

CORE

Know what's below. Call before you dig. 811

#	REVISION DESCRIPTION	DATE	BY
1	1ST SUBMITTAL	10/09/2023	JCK

DAWSON TRAILS - FILING 2 INFRASTRUCTURE

CASTLE ROCK, COLORADO

PHASE III DRAINAGE REPORT
PROPOSED BASIN D SWMM MAP

NOT FOR CONSTRUCTION

DESIGNED BY: JCK
DRAWN BY: EKT
CHECKED BY:

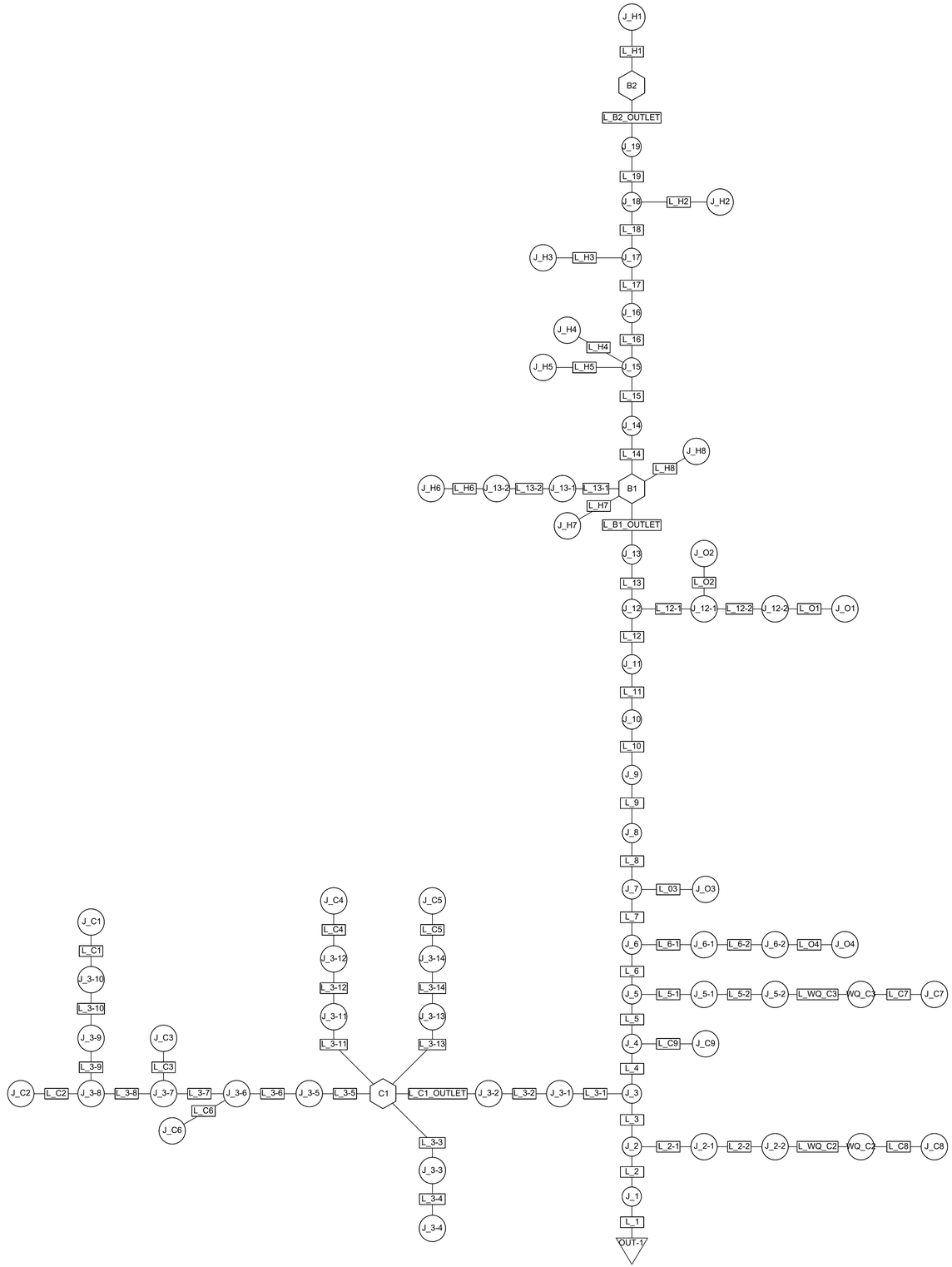
JOB NO. 20-224

SHEET 1 OF 1

2022-10-25 (9:44 AM) Emily Townsend X:\20-224 Dawson\Civil\CAD\Plans_Overall\Master Drainage Report Proposed Overall SWMM Map - Master.dwg

2021-09-11 (4:30 PM) X:\20-224 Dawson\Civil\CAD\Plans_Overall\Master Drainage Report Proposed Overall SWMM Map - Master.dwg

GAMBEL RIDGE TRIBUTARY



LEGEND

- X — OUTFALL DESIGNATION
- X — DESIGN POINT/JUNCTION DESIGNATION
- X — POND DESIGNATION
- X — PIPE/CHANNEL DESIGNATION
- X — JUNCTION/NODE DESIGNATION

0 400' 800'

1 inch = 400 ft.

CORE CONSULTANTS. INC.
3473 S. BROADWAY
ENGLEWOOD, CO 80113
303.703.4444
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LAND DEVELOPMENT
ENERGY
PUBLIC INFRASTUCTURE

Know what's below. Call before you dig. 811

#	REVISION DESCRIPTION	DATE	BY
1	1ST SUBMITTAL	10/09/2023	JCK

DAWSON TRAILS - FILING 2 INFRASTRUCTURE
CASTLE ROCK, COLORADO

PHASE III DRAINAGE REPORT
SWMM LINK TREE DIAGRAM

NOT FOR CONSTRUCTION

DESIGNED BY: JCK
DRAWN BY: EKT
CHECKED BY: ____

JOB NO. 20-224

SHEET 1 OF 1

2022-10-25 (9:44 AM) Justin Keller X:\20-224 Dawson\Civil\CAD\Plans_Overall\Master Drainage Report Proposed Overall SWMM Link Tree Map - Master.dwg

2021-09-11 (4:30 PM) X:\20-224 Dawson\Civil\CAD\Plans_Overall\Master Drainage Report Proposed Overall SWMM Link Tree Map - Master.dwg

EPA
United States
Environmental Protection
Agency

EPA/600/R-14/413b
Revised September 2015
www2.epa.gov/water-research

Storm Water Management Model User's Manual Version 5.1





Office of Research and Development
Water Supply and Water Resources Division

A.11 Culvert Entrance Loss Coefficients

Type of Structure and Design of Entrance	Coefficient
• **Pipe, Concrete**	
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls:	
Socket end of pipe (groove-end)	0.2
Square-edge	0.5
Rounded (radius = D/12)	0.2
Mitered to conform to fill slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7 ° or 45 ° bevels	0.2
Side- or slope-tapered inlet	0.2
• **Pipe or Pipe-Arch. Corrugated Metal**	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square-edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7 ° or 45 ° bevels	0.2
Side- or slope-tapered inlet	0.2
• **Box, Reinforced Concrete**	
Headwall parallel to embankment (no wingwalls):	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of D/12 or B/12 or beveled edges on 3 sides	0.2
Wingwalls at 30 ° to 75 ° to barrel:	
Square-edged at crown	0.4
Crown edge rounded to radius of D/12: or beveled top edge	0.2
Wingwall at 10 ° to 25 ° to barrel:	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides):	
Square-edged at crown	0.7
Side- or slope-tapered inlet	0.2

*Note: "End Sections conforming to fill slope," made of either metal or concrete, are the sections commonly available from manufacturers. From limited hydraulic tests they are

equivalent in operation to a headwall in both inlet and outlet control. Some end sections, incorporating a closed taper in their design have a superior hydraulic performance. These latter sections can be designed using the information given for the beveled inlet.

Source: Federal Highway Administration (2005). *Hydraulic Design of Highway Culverts*, Publication No. FHWA-NHI-01-020.

B.7 Conduit Properties

Name	User-assigned conduit name.
Inlet Node	Name of node on the inlet end of the conduit (normally the end at higher elevation).
Outlet Node	Name of node on the outlet end of the conduit (normally the end at lower elevation).
Description	Click the ellipsis button (or press Enter) to edit an optional description of the conduit.
Tag	Optional label used to categorize or classify the conduit.
Shape	Click the ellipsis button (or press Enter) to edit the geometric properties of the conduit's cross-section.
Max. Depth	Maximum depth of the conduit's cross-section (feet or meters).
Length	Conduit length (feet or meters).
Roughness	Manning's roughness coefficient (*n*) (see Section A.7 for closed conduit values or Section A.8 for open channel values).
Inlet Offset	Depth or elevation of the conduit invert above the node invert at the upstream end of the conduit (feet or meters). See note below.
Outlet Offset	Depth or elevation of the conduit invert above the node invert at the downstream end of the conduit (feet or meters). See note below.
Initial Flow	Initial flow in the conduit (flow units).
Maximum Flow	Maximum flow allowed in the conduit (flow units) – use 0 or leave blank if not applicable.
Entry Loss Coeff.	Head loss coefficient associated with energy losses at the entrance of the conduit. For culverts, refer to Table A11.
Exit Loss Coeff.	Head loss coefficient associated with energy losses at the exit of the conduit. For culverts, use a value of 1.0
Avg. Loss Coeff.	Head loss coefficient associated with energy losses along the length of the conduit.
Seepage Loss Rate	Rate of seepage loss into surrounding soil (inches or millimeters per hour).
Flap Gate	***YES*** if a flap gate exists that prevents backflow through the conduit, or ***NO*** if no flap gate exists.
Culvert Code	If the conduit is a culvert subject to possible inlet flow control click the ellipsis button (or press Enter) to select a code number for its inlet geometry from those listed in Appendix A10

set of one hour design point rainfall values, indicated in Table 6-1, apply to the Town.

TABLE 6-1
1-HOUR POINT RAINFALL VALUES FOR
THE TOWN OF CASTLE ROCK (INCHES)

2- YR	5-YR	10-YR	50-YR	100-YR
1.06	1.43	1.66	2.26	2.60

The one-hour rainfall depths are the basis of the Town's intensity-duration rainfall curves and are used to formulate design storm distributions.

6.1.2 Intensity-Duration Curves. Rainfall intensity based on storm duration for a variety of storm return periods can be found on Figure 6-1 at the end of this chapter. These curves were developed using distribution factors provided in the NOAA Atlas and also provided in Table RA-4 of the UDFCD Manual. These Intensity-Duration curves are based on Equation RA-3 in the Rainfall Section of the UDFCD Manual.

6.1.3 Six-hour Rainfall. In order to use the Colorado Urban Hydrograph Procedure (CUHP), two, three or six-hour rainfall distributions are required, depending on watershed area. Table RA-1 in the UDFCD Manual summarizes storm durations, area adjustments, and incremental rainfall depths to be used in CUHP based on watershed area. The UD-Raincurve Spreadsheet included in the UDFCD Manual shall be used to generate the rainfall distribution curves necessary for a CUHP model. In order to generate these distribution curves, the one-hour and six-hour rainfall depths for the design return periods are necessary. Since the Town of Castle Rock is not located within UDFCD boundaries, the rainfall depth-duration-frequency curves provided in the UDFCD Manual do not provide rainfall values for the entire Town. Therefore these values are provided in these Criteria. The 1-hour point values can be found in Table 6-1 of this chapter. The six-hour point values are as follows:

TABLE 6-2
6-HOUR POINT RAINFALL VALUES FOR
THE TOWN OF CASTLE ROCK (INCHES)

2- YR	5-YR	10-YR	50-YR	100-YR
1.5	2.0	2.2	3.0	3.4

The UD-Raincurve spreadsheet shall be used for all portions of the Town. Once the rainfall distribution curves are generated using the UDFCD UD-Raincurve Spreadsheet, the CUHP model is to be set up following the procedures provided in the Runoff chapter in Volume 1 of the UDFCD Manual.

6.2 Selecting a Method to Estimate Runoff

Two primary methods for estimating storm runoff, peak flow rates and total volumes are used in the Town.

- Rational Method
- CUHP/SWMM

The Rational Method is a simpler approach generally used for smaller sub-watersheds where hydrograph information is not required. CUHP and SWMM are computer models that are typically run sequentially; CUHP generates runoff hydrographs from individual subwatersheds and SWMM combines and routes individual hydrographs through channels and detention basins. Additional information on the CUHP and SWMM computer programs is provided in the UDFCD Manual.

Table 6-3 compares the Rational Method with CUHP/SWMM and provides information useful for selecting one of the approaches for a particular project. Additional information on each method is provided in Sections 6.3 and 6.4, respectively.

TABLE 6-3
COMPARISON OF HYDROLOGICAL METHODS

	Is the Rational Method Applicable?	Is CUHP/SWMM Applicable?
Hydrologic Information Desired:		
Runoff peak discharge	Yes	Yes
Combining peak flows from separate sub-watersheds	Yes	Yes
Runoff volume (V=I*A*Duration)	Yes	Yes
Runoff hydrograph	No	Yes
Watershed Size (Acres)[1]		
0 to 5	Yes	No
5 to 90	Yes	Yes[2]
90 to 160	Yes	Yes
160 to 3,000	No	Yes
Greater than 3,000	No	Yes

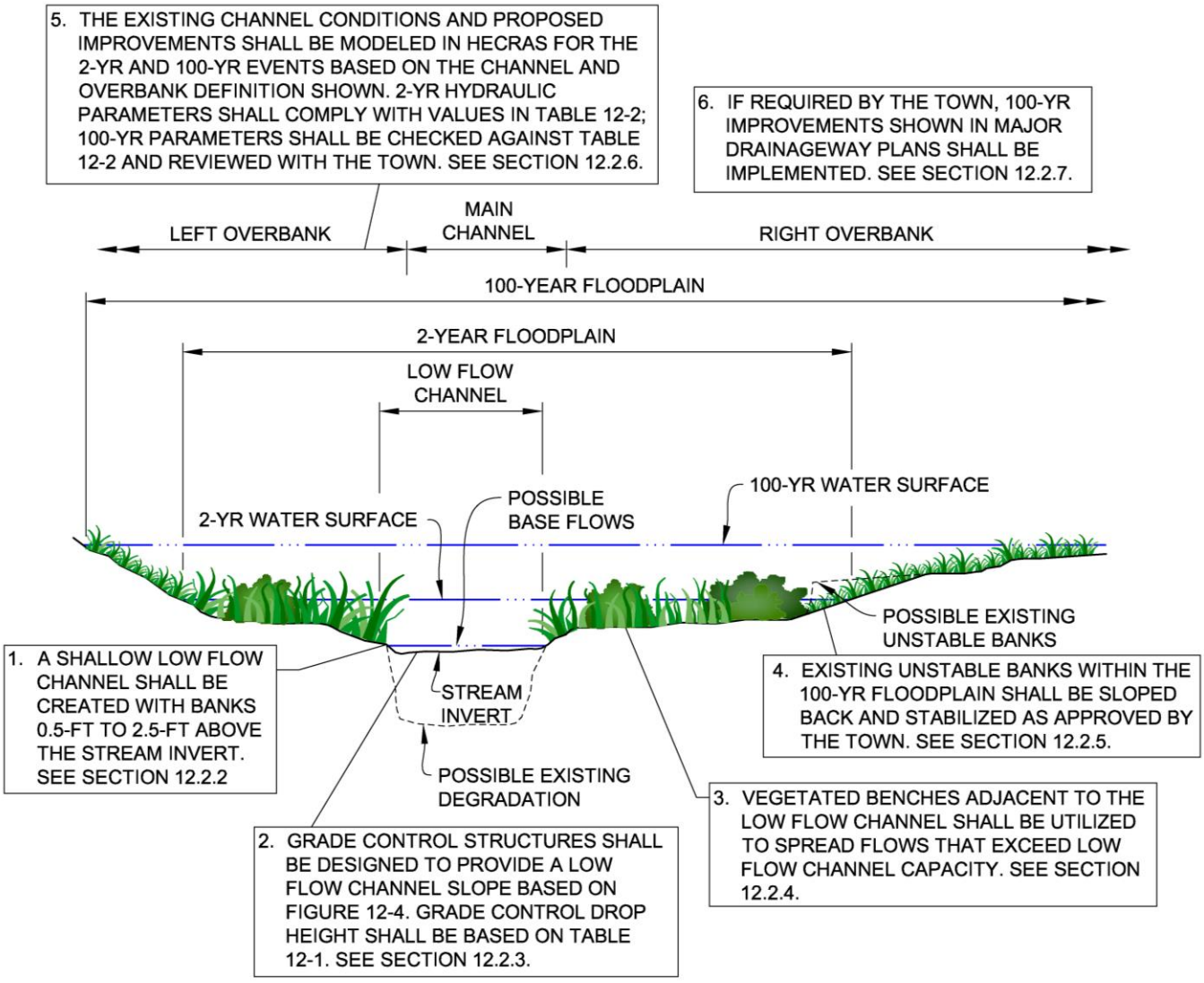
[1] Subdividing watersheds into smaller sub-watersheds may be desirable to obtain runoff information at multiple design points or to accurately model areas of different character. The maximum sub-watershed size shall be approximately 130-acres in accordance with the Town master planning guidance. Methods to combine flows from individual sub-watersheds are discussed in Sections 6.3 and 6.4.

[2] Time of concentration must be estimated and entered into CUHP.

As shown in Table 6-3, either the Rational Method or CUHP/SWMM may be used for watershed sizes from 5 to 160-acres. The following considerations may direct the user to one or the other of these methods.

- If no detention facilities are planned or if detention facilities are to be sized using simplified methods shown in Chapter 13 Storage, hydrograph information is not required and the Rational Method would be the simpler of the two methods.

FIGURE 12-3
DESIGN ELEMENTS ASSOCIATED WITH MAJOR DRAINAGEWAY STABILIZATION



These six steps are discussed in the following sections and comprise the recommended design approach for preserving, restoring, or constructing natural, healthy drainageways. Designers shall address these six elements and submit their proposed approach for drainageway stabilization to the Town for review and approval.

12.2.2 Create Shallow Base Flow Channel. One of the primary design tasks is to preserve or establish a base flow channel that is appropriately sized in relation to the adjacent overbank geometry. In general, shallow baseflow channels with adjacent, well-vegetated overbank benches function best to spread out and dissipate the energy associated with flood flows. The top of baseflow channel

banks shall be established in the range of 0.5-feet to 2.5-feet above the channel invert. This may require filling degraded, incised channels, excavating overbank benches adjacent to the base flow channel, or some combination of the two. Usually, filling a degraded channel is the option that results in the least disturbance to existing floodplain vegetation.

Sometimes, it may be difficult to raise up the invert of a degraded channel. Existing storm sewer outfalls may have been installed near the bottom of the incised channel and constrain how much the channel bed can be raised. It may be necessary to remove the downstream end of low storm sewer outfalls and reconstruct them at a higher elevation. Raising the invert may cause a rise in a critical floodplain elevation if the regulatory floodplain was based on the degraded channel condition (it is recommended that floodplains be determined for restored, not degraded channel conditions, as discussed in Section 12.2.6). There may be a need for compensatory excavation in another portion of the floodplain of offset any rise in the floodplain caused by filling in the eroded base flow channel.

The width of the base flow channel shall approximate the existing base flow channel width in the design reach or in stable reference reaches upstream or downstream, as approved by the Town. It is normal that a baseflow channel exhibit a degree of meandering and sinuosity in natural channels. Constructed channels shall feature a meander pattern typical of natural channels.

Besides indicating width, depth and sideslope information for the base flow channel, the designer shall estimate the capacity of the baseflow channel as a percentage of the 100-year event. Typically, the brimful capacity of the base flow channel will be less than 1.0-percent of the 100-year discharge for large streams systems such as Cherry Creek upstream of the reservoir and up to approximately three to four percent of the 100-year flow for drainageways just over 130 acres.

The base flow channel is typically unvegetated if a constant baseflow or frequent ephemeral flow is present, or vegetated with riparian or wetland species if baseflows are less frequent.

12.2.3 Establish Longitudinal Slope Using Grade Control Structures. If the expected long-term equilibrium slope of the baseflow channel is less than the longitudinal slope of the adjacent overbanks, grade control structures are required to enable the baseflow channel to adopt a “stairstep” profile without exceeding the baseflow channel depths discussed above. The maximum drop height of grade control structures shall conform to Table 12-1. The design of grade control structures is covered further in Section 12.4.

TABLE 12-3
HYDRAULIC DESIGN CRITERIA FOR GRASS-LINED CHANNELS

Design Item	Major Drainage Section (UDFCD Manual)	Grass: Erosive Soils	Grass: Erosion Resistant Soils
Maximum 100 year velocity	3.2.1	5.0 ft/sec	7.0 ft/sec
Minimum Mannings "n" for capacity check	Table MD-3	0.035	0.035
Maximum Mannings "n" for velocity check	Table MD-3	0.03	0.03
Maximum Froude number	3.2.1	0.5	0.8
Maximum Depth – outside Low flow zone	3.2.2	5.0 ft	5.0 ft.
Maximum channel longitudinal slope	3.2.3.1	0.6%	0.6%
Maximum side slope	3.2.3.2	4H:1V	4H:1V
Maximum centerline radius for a bend[1]	3.2.4	2 x top width	2 x top width
Minimum freeboard [3]	3.2.5	2.0 ft[2]	2.0 ft[2]

[1] Use 100 ft. if top width is less than 100 ft.
[2] Freeboard criteria have been modified from Table MD-2 and apply to the lowest adjacent habitable structure's lowest floor.
[3] Add superelevation to the normal water surface to set freeboard at bends.

12.3.3 Composite Channels (Wetlands Bottom Channels). As described in Section 4.2 of the Major Drainage chapter in Volume 1 of the UDFCD Manual, there are circumstances where the use of a composite channel may be required or preferred. Composite channels shall be designed with reference to Section 4.2 of the Major Drainage Chapter and Section 10.0 of the Structural BMP chapters in Volume 3 of the UDFCD Manual, respectively. However, riprap bank protection will generally not be required in wetland bottom channels.

12.3.4 Bioengineered Channels. Elements of bioengineered channels as described in Section 4.5 of the Major Drainage chapter in Volume 1 of the UDFCD Manual may be used in the design or stabilization of natural channels.

12.3.5 Riprap-Lined and Concrete-Lined Channels. The use of riprap-lined or concrete-lined channels is generally discouraged, but they will be considered for Minor Drainageways on a case-by case basis. Design criteria for concrete-lined and riprap-lined channels are provided in Section 4.3 and 4.4 of the Major Drainage chapter in Volume 1 of the UDFCD Manual.

12.4 Grade Control Structures

Grade control structures, such as check structures or drop structures, provide for energy dissipation and are used to establish flatter equilibrium slopes and moderate flow velocities in the upstream channel reach, as discussed in Sections 12.1.2 and 12.2.3.

Table 6-3. Recommended percentage imperviousness values

Land Use or Surface Characteristics	Percentage Imperviousness (%)
Business:	
Downtown Areas	95
Suburban Areas	75
Residential lots (lot area only)**:**	
Single-family	
2.5 acres or larger	12
0.75 – 2.5 acres	20
0.25 – 0.75 acres	30
0.25 acres or less	45
Apartments	75
Industrial:	
Light areas	80
Heavy areas	90
Parks, cemeteries	10
Playgrounds	25
Schools	55
Railroad yard areas	50
Undeveloped Areas:	
Historic flow analysis	2
Greenbelts, agricultural	2
Off-site flow analysis (when land use not defined)	45
Streets:	
Paved	100
Gravel (packed)	40
Drive and walks	90
Roofs	90
Lawns, sandy soil	2
Lawns, clayey soil	2

Table 8-2. Minimum dimensions for naturalized channels[1]

Bankfull Channel Depth, ft	Minimum Bankfull Channel Width, ft	Minimum Floodplain Terrace Width (average each side), ft
0.5	6	6
1.0	10	8
1.5	14	10
2.0	18	12
2.5	24	16
3.0	30	20

[1] Values are based on a desired entrenchment ratio between 3 and 4. Based on several scenarios modeled in HEC-RAS, the values in this table, when paired with the criteria in Table 8-3, produce generally favorable hydraulics.

As in natural streams, channel vegetation and roughness will increase over time and long-term sediment deposition could raise the bed of the channel. Therefore, conservatively high roughness values should be used for assessing flow depths (per Section 7.0) and a freeboard of 18 inches or more should be considered.

5.4 Maintain Natural Planform Geometry

The planform of naturalized channels can be created to emulate features of natural reference reaches. As was discussed in Section 4.4, natural streams offer variety and complexity in form; they are seldom straight and uniform. Outer banks move in and out and bank heights, slopes, and widths vary. Bankfull channels exhibit a degree of meandering and sinuosity, moving right and left across a section in an alternating manner. The shape of the low-flow channel varies, tending to widen slightly in bends and narrow in riffles between bends; side slopes tend to steepen at the outside of bends and flatten as point bars form on the inside of bends. All of these characteristics can be reflected in naturalized channels.

Care should be taken to avoid sharp bends in the channel. A radius of curvature at least two times the channel top width is recommended, although ratios of three or four times top width are preferable.

5.5 Develop Grade Control Strategy to Manage Longitudinal Slope

If the grading adjacent to a channel can be made to match the design slope of the channel, the need for drop structures may be eliminated. If the adjacent grade is steeper than the design slope, grade control in the channel will be necessary. For small channels, grade control structures will most often extend across the full channel section and the grade of the floodplain terraces will typically be configured to match the design slope of the bankfull channel invert. Section 4.4 should be referred to for design guidance regarding the height and spacing of drop structures.

2.2.2 Geometry

Table 9-1 below summarizes the specific design and geometric parameters applicable to drop structures designed using the simplified design procedures. Additional discussion is provided in the sections following for some of the specific parameters summarized in the table. Graphical depiction of the geometric parameters listed in Table 9-1 can be found in Figure 9-11 through 9-14 for GSB drop structures and Figures 9-16 through 9-21 for SC drop structures.

Table 9-1. Design criteria for drop structures using simplified design procedures

Design Parameter	Requirement to Use Simplified Design Procedures	
	GSB Drop Structure	SC Drop Structure
Maximum Net Drop Height (H_d)	5 feet[1]	
Maximum Unit Discharge over any Portion of Drop Width	35 cfs per foot of drop width (see Section 2.2.3)	
Maximum Longitudinal Slope (Steepest Face Slope)	4(H):1(V) (see Section 2.2.4 for additional discussion)	
Minimum Stilling Basin Depression (D_b)	1 foot (see Section 2.2.6 for additional discussion and requirements for non-cohesive soils)	2 feet (see Section 2.2.6 for additional discussion and requirements for non-cohesive soils)
Minimum Length of Approach Riprap (L_a):	8 feet	
Minimum Stilling Basin Length (L_b):	Determine using Figure 9-1 (see Section 2.2.4)	
Minimum Stilling Basin Width (B)	same as crest width	
Minimum Cutoff Wall Depth	6 feet (for cohesive soils only, see Section 2.2.6 for additional discussion)	
Minimum Length of Riprap Downstream of Stilling Basin	10 feet	
Minimum D_{50} for Approach and Downstream Riprap	12 inches	
Minimum Boulder Size for Drop Structure	Per Figure 9-1	N/A

[1]This is considered a large drop structure and is only appropriate where site specifics do not accommodate installation of smaller drop structures. Urban Drainage and Flood Control District (UDFCD) recommends the height of the drop structure not exceed 3 feet.

Discretizing large catchments into smaller ones:

Discretizing large catchments into smaller ones often results in increased unit discharges. The following recommendations can help eliminate the effect of the increase to provide more realistic hydraulic routing through the conveyance network in the EPA SWMM:

- Carefully estimate the effective longitudinal channel slope instead of relying on the elevations at the two ends of each routing element. If there are drop structures or other forms of vertical offsets in the channel reach, the effective channel slope between drops should be used rather than an overall reach slope between endpoints.
- Select the irregular natural channel option in the SWMM conduit cross-section editor to accurately represent actual channel cross-sections rather than selecting general geometric channels. This will ensure a more accurate wetted perimeter.
- Use appropriate Manning's n values that are reflective of the nuances in channel geometry and other flow controls along its reaches, namely those recommended in Section 7.2.3 of the *Open Channels* Chapter of the USDCM by following these guidelines:
  - For lined channels and pipes, increase Manning's n value by 25% over what would normally be used for the design as described in Section 4.2.2 below.
  - For grass-lined, riprap-lined and natural channels use the higher range of the values for the appropriate type of channel reach as recommended in Table B.2. Manning's Roughness Coefficients for Various Boundaries of the FHWA publication HDS-4, Introduction to Highway Hydraulics.
  - Whenever HEC-RAS sections are available, use the roughness coefficients for the main channel and overbanks from those studies unless the values obtained from item 3.b above are higher.

4.2.2 Step 2: Estimate Coefficients and Functional/Tabular Characteristic of Storage and Outlets

For hydrologic routing through conveyance elements such as pipes, gutters, and channels, the resistance (Manning's n) coefficients should not necessarily be the same as those used in performing hydraulic design calculations. As a general rule, it was found that increasing the "typical" values of Manning's n by approximately 25 percent was appropriate when using UDSWM in the past and should be appropriate for use in SWMM as well. Thus, if a pipe is estimated to have $n = 0.013$ for hydraulic calculations, it is appropriate to use $n = 0.016$ in SWMM.

When modeling the hydrologic routing of natural streams, grass-lined channels, or riprap-lined channels in Colorado, estimate Manning's n for SWMM using Equation 6-8 (Jarrett 1984 and 1985).

$$n = 0.393\, S^{0.38} R^{-0.16} \qquad \text{Equation 6-8}$$

Where:

n = Manning's roughness coefficient
S = friction slope (ft/ft)

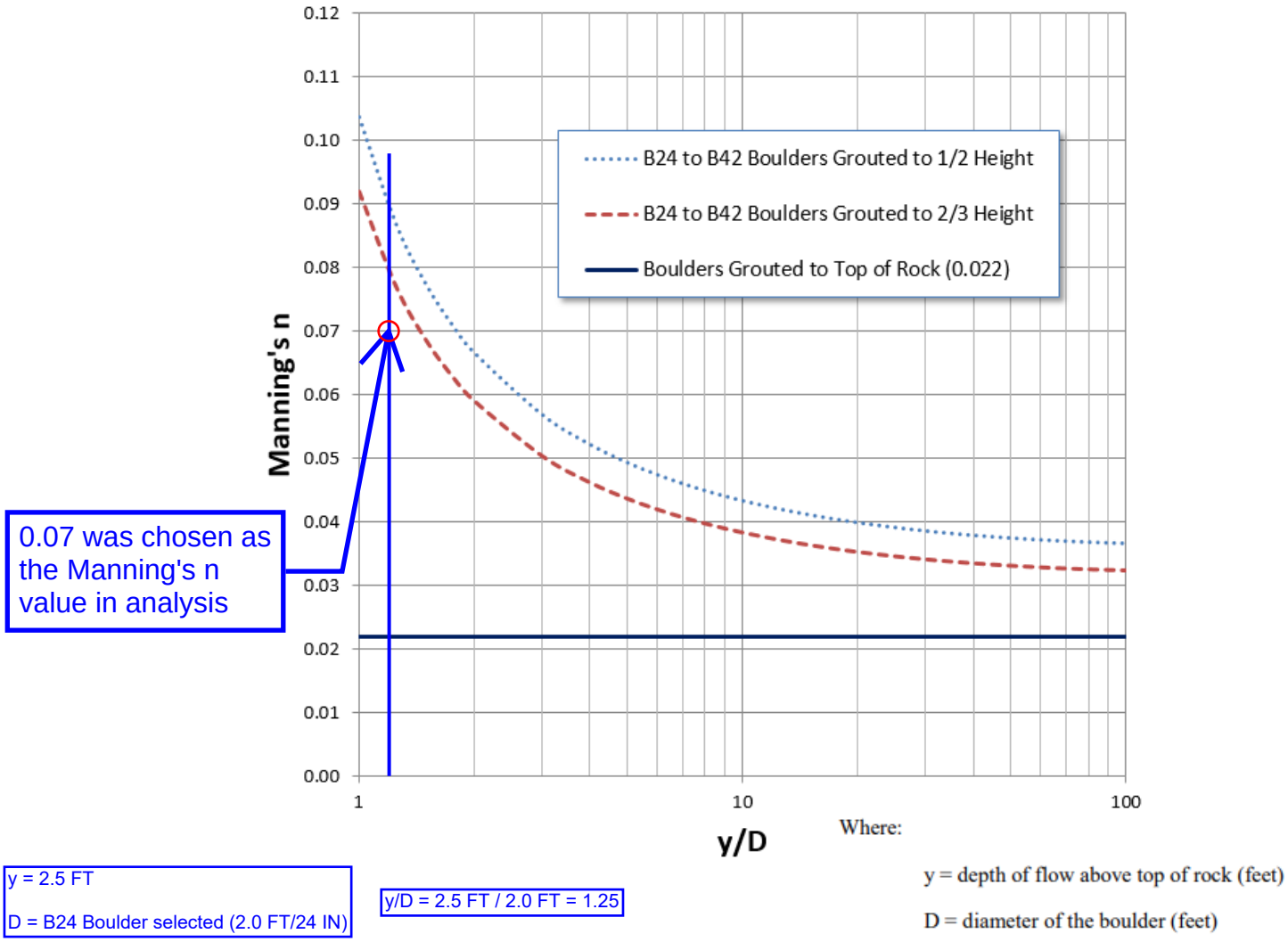


Figure 9-3. Recommended Manning's n for flow over B24 to B42 grouted boulders

Using a stepped grouted rock placement and grouting only the lower ½ of the rock on the drop face creates a significantly higher Manning's n roughness coefficient and, as a result, greater flow depth and lower velocity, reducing the boulder size needed to have a stable structure. Refer to Section 2.6.3 for discussion on boulder sizing for GSB drop structures.

2.3.4 Hydraulic Jump Formation

Once the location and geometry of the drop structure cross sections have been determined, evaluate the HEC-RAS model for the design flow under both subcritical and supercritical flow conditions. To minimize the stilling basin length, use a downstream tailwater depth great enough to force a hydraulic jump to start near the toe of the drop face. This requires that the specific force of the downstream tailwater be greater than the specific force of the supercritical flow at the toe of the drop. The tailwater is modeled by a subcritical water surface (M1 backwater or M2 drawdown curve) profile analysis that starts from a downstream control point and works upstream to the drop structure basin. Model the depth and specific force at the toe of the drop by a supercritical water surface (S2 drawdown curve) profile analysis starting at the crest of the drop and running down the drop face.

f_o = The final infiltration rate (in/hr)

e = Natural logarithm base.

α = decay coefficient (1/second)

t = Time from f_i (seconds)

The coefficients and initial and final infiltration values are site specific and depend on the soil and vegetative cover complex. It is possible to develop these values for each site if sufficient rainfall-runoff observations are made. However, such an approach is rarely practical. Soil type is the most important factor in determining the infiltration rate. When the soil has a large percentage of well-graded fines, the infiltration rate is low. In some cases of extremely tight soil there may be, from a practical standpoint, essentially no infiltration. If the soil has several layers or horizons, the least permeable layer near the surface will control the maximum infiltration rate. The soil cover also plays an important role in determining the infiltration rate. Vegetation, lawn grass in particular, tends to increase infiltration by loosening the soil near the surface. Other factors affecting infiltration rates include slope of land, temperature, quality of water, age of lawn and soil compaction. Since 1977, the District has analyzed a considerable amount of rainfall-runoff data. Based on this analysis, the values in Table B-1 are recommended for use within the District with CUHP. The NRCS Hydrologic Soil Groups C and D occur most frequently within the District; however, areas of NRCS Group A and B soils are also common. Consult NRCS soil surveys for appropriate soil classifications. Urbanization can increase or decrease the total amount of infiltration.

Table B-1: Recommended Horton's Equation Parameters

NRCS Hydrologic Soil Group	Infiltration Rate (in/hr)		Decay Coefficient (α)
	Initial (f_i)	Final (f_o)	
A	5.0	1.0	0.0007
B	4.5	0.6	0.0018
C	3.0	0.5	0.0018
D	3.0	0.5	0.0018

Horton's equation gives an infiltration rate. This must be integrated over a length of time to get the total amount of infiltration. CUHP numerically integrates Horton's equation using the trapezoidal rule, as shown in Figure B-4. The amount infiltrated can never be greater than the total amount of rainfall. When the infiltration capacity is greater than the total available rainfall, infiltration should be limited to the total available rainfall and the excess infiltration capacity should be discarded.

Table B-2: Typical Depression Losses for Various Land Covers

Land Cover	Typical Range (in)	Recommended Value (in)
Impervious		
Large paved areas	0.05 – 0.15	0.1
Roofs, flat	0.1 – 0.3	0.1
Roofs, sloped	0.05 – 0.1	0.05
Pervious		
Lawn/Grass	0.2 – 0.5	0.35
Wooded Areas & Open Fields	0.2 – 0.6	0.40

Effective Precipitation Algorithm

The algorithm for determining effective precipitation is described below.

1. Determine the effective precipitation for the entire impervious area. This is done by determining the remaining impervious depression storage for the subcatchment, as shown in Equation B-9. The additional amount held in depression storage for the current time step is taken to be either the incremental precipitation for the current time step, or the remaining depression storage, whichever is less. This is mathematically described in Equation B-10. The effective precipitation is then calculated using Equation B-11.

$$D_{max,I,t} = D_{max,I,0} - \sum_{n=1}^{t-1} D_{I,n} \qquad \textbf{Eqn. B-9}$$

$$D_{I,t} = min\begin{Bmatrix} P_t \\ D_{max,I,t} \end{Bmatrix} \qquad \textbf{Eqn. B-10}$$

$$P_{eff,I,t} = 0.95\left(\frac{I}{100\%}\right)\left(P_t - D_{I,t}\right) \qquad \textbf{Eqn. B-11}$$

Where:

$D_{max,I,t}$ = The remaining capacity of the impervious depression storage for the current time step (in).

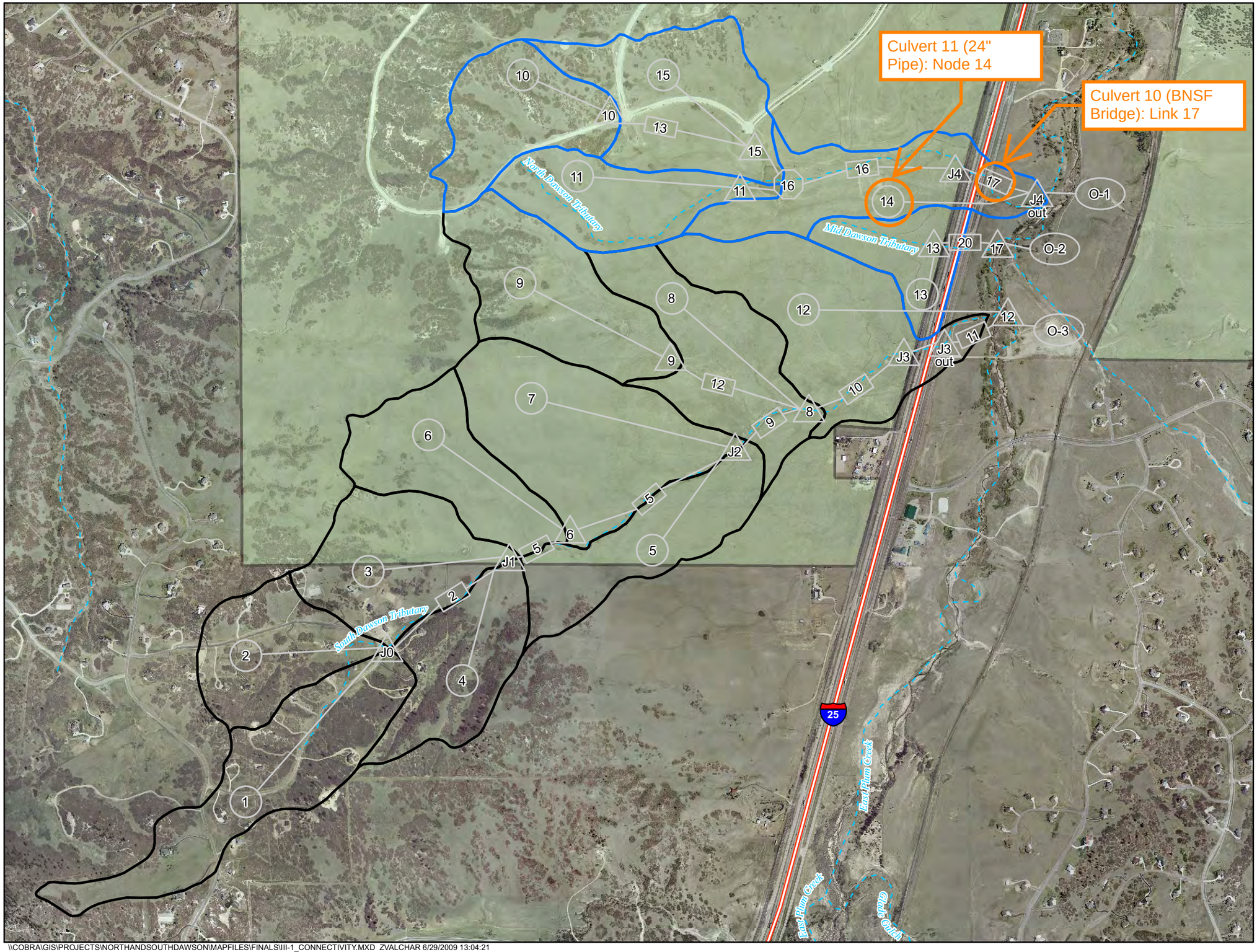
$D_{max,I,0}$ = The maximum impervious depression storage, as determined from Table B-2.

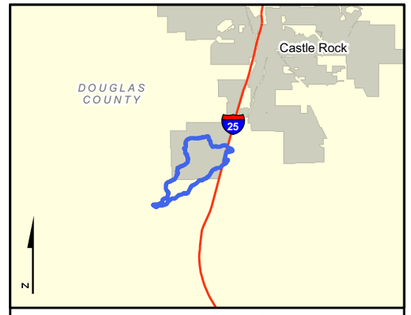
$D_{I,t}$ = The amount of water held in impervious depressions for the current time step (in).

P_t = The incremental precipitation of the time step (in).

I = The imperviousness of the subcatchment (percent)

$P_{eff,I,t}$ = The total effective precipitation for the impervious area for the time step (in).





Watershed Location

Legend

- Perennial Streams and Creeks
- North Dawson
- South Dawson
- Castle Rock Town Boundary
- Outfall Identification
- Conveyance Element
- Sub Basin Identification
- Storage Element
- Design Point or Junction

N
W E
S

0 600 1,200
Feet

Figure III-1
North Dawson/South Dawson Watershed Master Plan
Watershed Connectivity

CH2MHILL

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IV. Problem Areas

The evaluation of existing problem areas is based on an assessment of each facility's ability to meet fundamental performance criteria based on the fully developed future conditions hydrologic conditions in the three basic categories presented in **Table IV-1**.

TABLE IV-1

Alternative Evaluation Criterion

Category	Description
Stream Stability	Stream stability was determined with a qualitative and quantitative analysis performed prior to the alternatives analysis. Areas identified under this category include channel incision, bank erosion, and locations where the existing channel grade is steeper than the stable channel grade.
Infrastructure Issues	Infrastructure issues were determined based on the conveyance capacity of the bridges and culverts within the study area. The conveyance capacity was determined using a detailed HEC-RAS model of each tributary as well as a CulvertMaster model of each individual culvert. Infrastructure improvements are necessary when the hydraulic structure cannot pass the 100-year event under fully developed future conditions.
Flooding Issues	Flooding issues include any areas where the 100-year floodplain extends outside the channel banks and threatens private property or causes a potential hazard situation. In some situations, undersized infrastructure may cause flooding issues.

South and North Dawson through the study area was separated into the seven (7) and three (3) defined reaches respectively as described previously. The reaches are identical to the reaches presented in a previously prepared companion document "*North and South Dawson Watershed Master Plan Stream Stability Report*" submitted by CH2M HILL in February of 2009. For each reach, the facilities were assessed against the criteria and problem areas noted.

It is understood that some of the categories may overlap. For example, a conveyance problem may also be associated with an infrastructure problem, or an aesthetic problem may be associated with a stream stability problem. **Figure IV-1** presents a plan view of the existing facility condition for North Dawson and **Figures IV-2 and IV-3** present the plan views of the existing facility condition for North Dawson evaluated with the criteria in **Table IV-1**.

Problem Area Description

The analysis of the existing stream network using the criteria presented in Table IV-1 identified a number of concerns and issues for each tributary.

North Dawson

Reach 1 – Outfall into East Plum Creek to I-25 Corridor

The channel is well defined with a sandy bottom and some instability in the channel. One of the two outfalls for North Dawson, the south outfall a 36 –inch CMP under I-25 is undercut and eroded at the downstream side. The northern channel outfall from the crossing under I-25 lacks an energy dissipater.

Infrastructure is undersized under the Town of Castle Rock Criteria for roadway culverts. The 7-foot CMP under the private access road downstream of the Frontage Road is undersized for the existing 100-year flows but passes existing and future 10-year flows. This is adequate for rural driveways within the Town of Castle Rock. The 8-foot by 4-foot Concrete Box Culvert (CBC) under I-25 has a capacity of 400 cfs and can pass the existing flows for the entire upstream watershed but is undersized for the 100-year future flows. The secondary flow path, a 3 foot by 3 foot CBC that transitions to a 3 foot CMP has a capacity of 40 cfs and is undersized for both the existing and future developed conditions if the entire flow from the North Dawson basin is routed to it.

There are no flooding related issues within this reach. The 100-year floodplain is contained within the channel banks and does not affect any private properties.

Reach 2 – I-25 Corridor to Existing Stock Pond

This reach has few instability issues. There are multiple split flow conditions resulting from stock ponds overtopping and the stock pond spillways not releasing the flow to the historic channel. The overflow from the stock pond has caused significant erosion of the downstream embankment face.

The BNSF Bridge is has a capacity of approximately 400 cfs and can pass the 100-year existing flows but is undersized for the 100-year future flows.

A number of split flow conditions resulting from stock ponds with no formalized outlet structures create potential flooding issues. The upper stock pond does not release flows to the historic channel. The flow is released into the spillway channel that then splits and enters a second stock pond farther downstream. The flow from this stock pond releases to a third stock pond before reaching the outlet under I-25.



One of the Stock Ponds Causing Split Flow Conditions

Reach 3 – Existing Stock Pond to Upstream Study Limit

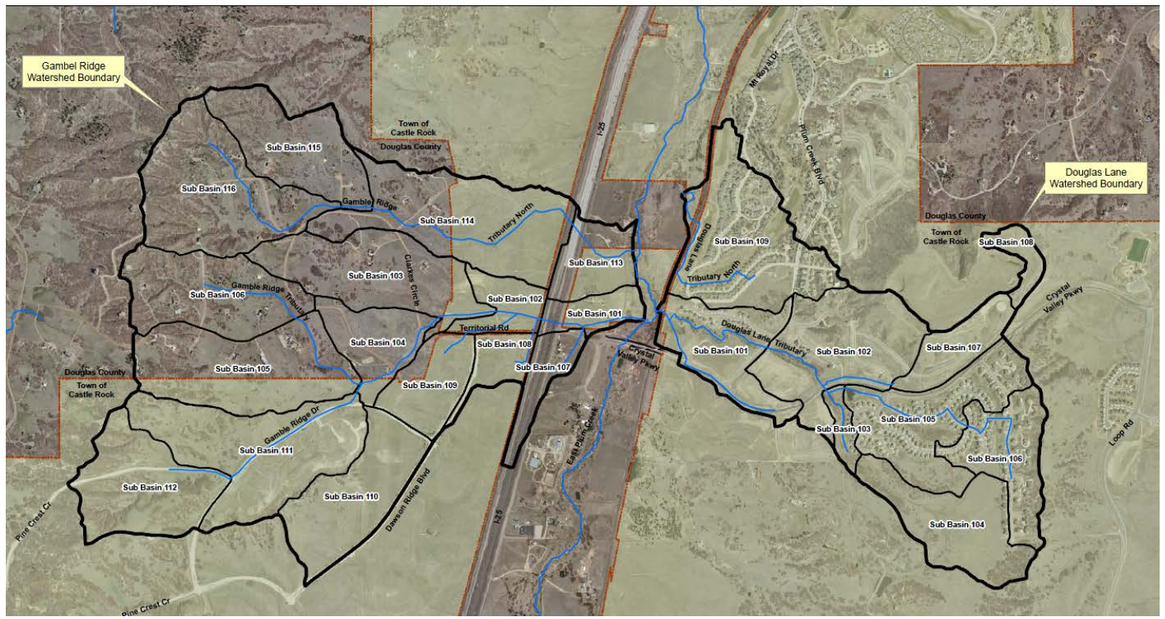
Directly upstream of the stock pond is a large head cut at the outfall to the Dawson Ridge storm sewer system. Upstream of the storm sewer, there are multiple small head cuts in the channel. The current

Table B-5 SWMM5 Design Point Flow Summary

SWWM5 Design Point	Future Peak Flow Rates						Existing Peak Flow Rates						Percent Difference from Future to Existing					
	2-yr Future (cfs)	5-yr Future (cfs)	10-yr Future (cfs)	25-yr Future (cfs)	50-yr Future (cfs)	100-yr Future (cfs)	2-yr Existing (cfs)	5-yr Existing (cfs)	10-yr Existing (cfs)	25-yr Existing (cfs)	50-yr Existing (cfs)	100-yr Existing (cfs)	2-yr (cfs)	5-yr (cfs)	10-yr (cfs)	25-yr (cfs)	50-yr (cfs)	100-yr (cfs)
1	4	25	37	69	91	115	4	25	37	69	91	115	0%	0%	0%	0%	0%	0%
2	5	24	35	60	78	97	5	24	35	60	78	97	0%	0%	0%	0%	0%	0%
3	8	32	44	74	95	117	1	20	30	55	73	92	84%	37%	32%	25%	23%	21%
4	1	16	25	47	62	80	1	16	25	47	62	80	0%	0%	0%	0%	0%	0%
5	29	161	226	395	135	162	0	104	161	309	55	71	100%	35%	29%	22%	59%	56%
6	35	133	188	328	424	533	12	101	151	279	366	466	65%	24%	20%	15%	14%	13%
7	89	156	189	251	305	359	3	27	40	72	94	121	97%	83%	79%	72%	69%	66%
8	230	433	553	858	1,096	1,353	15	165	256	490	652	841	94%	62%	54%	43%	40%	38%
9	84	142	173	227	275	321	0	22	34	63	84	107	100%	85%	80%	72%	69%	67%
10	87	143	172	218	260	299	5	26	37	61	79	99	95%	82%	79%	72%	70%	67%
11	52	86	104	138	166	195	0	11	17	33	45	58	100%	87%	83%	76%	73%	70%
12	298	542	680	1,029	1,309	1,620	19	189	292	555	740	955	94%	65%	57%	46%	43%	41%
13	62	97	116	144	171	194	8	26	34	51	64	79	87%	74%	71%	65%	62%	60%
14	205	359	440	613	753	902	7	63	98	187	252	329	97%	82%	78%	70%	67%	64%
15	146	246	296	392	478	569	8	46	67	120	159	203	95%	82%	77%	69%	67%	64%
16	197	333	400	530	643	764	8	56	84	153	203	261	96%	83%	79%	71%	68%	66%
17	62	97	115	143	170	193	8	26	34	51	64	79	87%	74%	71%	65%	62%	59%
J-1	15	88	130	239	312	396	9	80	120	224	295	376	37%	10%	8%	6%	5%	5%
J-2	125	258	347	572	739	921	12	129	199	380	505	648	90%	50%	43%	34%	32%	30%
J-3	229	432	552	857	1,094	1,351	15	164	255	489	651	840	94%	62%	54%	43%	40%	38%
J-4	180	310	376	510	623	740	6	53	81	150	200	258	97%	83%	78%	71%	68%	65%
J-0	9	49	70	126	164	208	9	49	70	126	164	208	0%	0%	0%	0%	0%	0%

FLOOD HAZARD AREA DELINEATION

GAMBEL RIDGE AND DOUGLAS LANE TRIBUTARY WATERSHEDS



Project Sponsor:

TOWN OF CASTLE ROCK

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ponds that are modeled. All storage elements in EPA SWMM are a unique four-digit number that ends in 8 (ie. XXX8).

The stage-area and stage-discharge curves were obtained from the available drainage reports for each detention pond. The water quality storage volume and release rates were not included in the development of the baseline hydrology (unless specified otherwise by the drainage report). The detention pond rating curves can be located in Appendix B Table B-8 Detention Pond Characteristics.

DIVERSION ANALYSIS

There are several dividers included within the EPA SWMM model so that the existing infrastructure can be accurately modeled and provide representative peak flows to all downstream design points. At locations where the pipe capacity was exceeded, trapezoidal sections were added as overflows to prevent inadvertent detention. The "cutoff" pipe capacity was set at 90% of the maximum pipe capacity generated by EPA SWMM using the "overflow" function. This approach minimizes the instabilities in the model that often reports inaccurate peak flows and provides a conservative approach. Each overflow consists of the routing element number with an "o" at the end (ie. XXXXo).

3.5 RESULTS OF ANALYSIS

Peak flows were developed using the rainfall information, subwatershed hydrologic parameters and drainage system conveyance characteristics. The peak flows were calculated for the 2-, 5-, 10-, 25-, 50-, 100- and 500-year return period storm events and for the existing and future land use conditions.

The Gambel Ridge and Douglas Lane Tributary watersheds peak flows are included in Appendix B, Table B-9, CUHP Subwatershed Peak Flows - Gambel Ridge Tributary and Table B-10, CUHP Subwatershed Peak Flows - Douglas Lane Tributary. The routed peak flows at each design point are summarized for each watershed and can be located in Appendix B, Table B-11 Peak Flow Summary Table - Gambel Ridge Tributary and Table B-12 Peak Flow Summary Table - Douglas Lane Tributary.

The Peak Flow Summary Tables at Key Design Points, Tables 3-5 and 3-6 below, illustrate the peak flows at several key locations in the drainageways for the Gambel Ridge and Douglas Lane Tributaries.

Table 3-5 Gambel Ridge and Gambel Ridge North Tributary Peak Flow Summary Table at Key Design Points

Design Point	Location	Drainage Area		10-Year		50-Year		100-Year		500-Year	
				Existing	Future	Existing	Future	Existing	Future	Existing	Future
		(acres)	(sq.mi.)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
1010	Outfall to East Plum Creek D/S Study Limits (Gambel Outfall)	727.9	1.14	305	757	741	1378	977	1720	1324	2243
1110	Gamble Ridge Drive North	197.4	0.31	100	296	224	517	290	639	390	826
1130	Outfall to East Plum Creek D/S Study Limits (North Outfall)	336.1	0.53	87	185	273	378	380	504	533	693
1020	Upstream of Railroad and I-25 Crossing	681.3	1.06	278	708	682	1286	901	1604	1224	2092
1140	Upstream of Railroad and I-25 Crossing	300.8	0.47	77	143	241	332	334	444	467	608
1150	Upstream of Clarkes Circle and Briscoe Lane	184.2	0.29	69	69	177	177	234	234	317	317
1040	Downstream of Territorial Road and Clarkes Circle	427.6	0.67	186	383	443	733	581	921	785	1212
1120	Gamble Ridge Drive North and Pine Crest Circle	79.8	0.12	42	127	95	224	123	272	166	353
1100	Gamble Ridge Drive North and Dawson Ridge Boulevard	76.1	0.12	43	206	92	308	119	362	159	451

Table 3-6 Douglas Lane Peak Flow Summary Table at Key Design Points

Design Point	Location	Drainage Area		10-Year		50-Year		100-Year		500-Year	
				Existing	Future	Existing	Future	Existing	Future	Existing	Future
		(acres)	(sq.mi.)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
1010	Outfall to East Plum Creek D/S Study Limits	530.6	0.83	127	150	393	478	612	707	870	988
1012	Heckendorf Detention Basin Outflow	530.6	0.83	127	150	393	478	612	707	870	988
1014	Heckendorf Detention Basin Inflow	530.6	0.83	232	292	465	564	720	849	1051	1225
1018	Heckendorf Detention Basin	530.6	0.83	232	292	465	564	720	849	1051	1225
1020	Plum Creek Boulevard	468.3	0.73	173	207	368	466	620	734	904	1046
1030	Crystal Valley Parkway	279.0	0.44	72	97	231	308	390	478	552	671
1050	Crystal Valley Detention Basin Out	197.0	0.31	50	56	160	205	286	331	418	476
1052	Crystal Valley Detention Basin In	197.0	0.31	157	187	292	335	368	419	473	534
1058	Crystal Valley Detention Basin	197.0	0.31	157	187	292	335	368	419	473	534
1090	Outfall to East Plum Creek D/S Study Limits	113.1	0.18	113	141	213	255	265	314	341	400

Several hydrographs at key locations for the 100-year existing and future land use conditions can be found in Appendix B, Table B-13 Gambel Ridge Tributary Hydrographs and Table B-14 Douglas Lane Tributary Hydrographs. A majority of the hydrographs were found to have sharp peaks which could be greatly reduced by implementing detention ponds.

3.6 PREVIOUS STUDIES

Numerous drainage studies have been performed as development has occurred in each watershed. However, there has not been a recent comprehensive drainage study that incorporates the entire Gambel Ridge Tributary. A comprehensive study was completed for Douglas Lane Tributary for the design of the Heckendorf Detention Pond that was constructed as part of the Heckendorf Ranch Filing 2 development. The peak flow comparison tables below summarize the peak flows from this baseline hydrology and selected drainage reports.

Table 3-7 below presents a 100-year peak flow comparison between the Gambel Ridge Tributary baseline hydrology results to the Dawson Ridge Filing No. 2 and No. 11 drainage reports at key design points.

Table 3-7 Gambel Ridge Tributary 100-Year Peak Flow Comparison Table

Design Point	Location	RESPEC 2013		Dawson Ridge Filing No. II	Final Drainage Study for Dawson Ridge Filing No. 2
		Existing	Future	Future	Historic
		(cfs)	(cfs)	(cfs)	(cfs)
1110	Gamble Ridge Drive North	290	639	192	
1050		531	874		499

Overall, the Gambel Ridge Tributary peak flows for this study vary considerably from existing studies. The percentage differences range from 6% to 232%. Several potential reasons for the wide range in peak flows are presented below.

- Differences in drainage areas between the existing reports and this baseline hydrology report.
- Difficulty in locating similarly developed peak flows in the drainage reports. Many reports have similar design points but there are no downstream peak flows reported.
- Poor or missing routing maps in the existing drainage reports to enable comparisons at similar locations.

4.1 INTRODUCTION

A hydraulic analysis was performed for the tributaries to estimate the hydraulic capacities of the existing waterways and drainage structures. The hydraulics of the drainageways were analyzed using the United States Army Corps of Engineers (USACE) HEC-RAS 4.1.0 modeling program. The post-development land-use condition peak discharges were modeled for the 10-, 50, 100-, and 500-year events. The geometry and physical condition of the existing drainage conveyance system were modeled.

4.2 EVALUATION OF EXISTING FACILITIES

Detailed field survey was obtained of all existing drainage structures on the Gambel Ridge and Douglas Lane Tributaries. The survey information was then used to define the structure types and geometries in the HEC-RAS program. Table 4-1 describes drainage structures included in the hydraulic analysis. Photographs of all structures are included in Appendix C.

Table 4-1 Major Crossing Structure Inventory

Tributary	Street Name	Roadway Classification	HEC-RAS Station	Size	Type
Douglas Lane	Railroad Bridge	Railroad	87.2212	22' (w) opening	Concrete Bridge
Douglas Lane	Plum Creek Boulevard	Collector	2428.302	2-72"	RCP
Douglas Lane	Crystal Valley Parkway	Collector	3697.874	2-72"	RCP
Gambel Ridge North	I-25	Arterial	1142.626	10' (w) x 8' (h)	RCPA
Gambel Ridge North	Railroad	Railroad	1289.289	11' (w) x 7' (h)	CMPA
Gambel Ridge	I-25	Arterial	1706.496	10' (w) x 6' (h)	CBC
Gambel Ridge	Railroad	Railroad	1830.03	3 - 9' (w) x 6' (h)	CMPA
Gambel Ridge	Clarkes Circle	Collector	3943.826	4.5' (w) x 2.8' (h)	CMPA
Gambel Ridge	Twin Oaks Road	Collector	4768.087	2 - 4.3' (w) x 3' (h)	CMPA

All crossings on the Gambel Ridge Tributary are subject to overtopping during the 10-, 50-, 100-, and 500-year flood events, while all crossings on the Douglas Lane Tributary have sufficient capacity to convey flows during the 10-, 50-, 100-, and 500-year flood events.

Table 4-2, Existing Facilities tabulates each culvert crossing, the capacity and expected flows tributary upstream of each location.

Table 4-2 Existing Facilities

Tributary	Street Name	HEC-RAS Station	Size	Type	Pipe Capacity (cfs)	Source	Design Point	100-Year (cfs) Existing	100-Year (cfs) Future
Douglas Lane	Railroad Bridge	87.2212	22' (w) opening	Concrete Bridge	988	HEC-RAS	1020	620.3	733.9
Douglas Lane	Plum Creek Boulevard	2428.302	2-72"	RCP	1046	HEC-RAS	1020	620.3	733.9
Douglas Lane	Crystal Valley Parkway	3697.874	2-72"	RCP	671	HEC-RAS	1030	389.6	477.7
Gambel Ridge North	I-25	1142.626	10' (w) x 8' (h)	RCPA	467	HEC-RAS	1140	333.8	444.2
Gambel Ridge North	Railroad	1289.289	11' (w) x 7' (h)	CMPA	467	HEC-RAS	1140	333.8	444.2
Gambel Ridge	I-25	1706.496	10' (w) x 6' (h)	CBC	650-700	HEC-RAS	1020	901.3	1604.2
Gambel Ridge	Railroad	1830.03	3 - 9' (w) x 6' (h)	CMPA	650-700	HEC-RAS	1020	901.3	1604.2
Gambel Ridge	Clarkes Circle	3943.826	4.5' (w) x 2.8' (h)	CMPA	80	HEC-RAS	1040	580.6	921.2
Gambel Ridge	Twin Oaks Road	4768.087	2 - 4.3' (w) x 3' (h)	CMPA	80	HEC-RAS	1050	530.5	874.3

When the pipe capacity was equal to or greater than the 500-year future flows, the pipe capacity was set to that event.

HEC-RAS was used to determine the capacity of each crossing in the Gambel Ridge and Douglas Lane Tributary watersheds.

Douglas Lane culverts appear to be in good condition and have adequate capacity to convey the 500-year future event. The capacities of the culverts in Gambel Ridge are inadequate to convey the 100-year event and as you can see in Table 4-2 in many cases cannot convey the 10-year event.

4.3 HYDRAULIC PARAMETERS

Hydraulic cross sections were developed using the Town's 2-foot contour interval topographic data supplemented by Town field survey and design and as-built information. The cross sections developed for input into the HEC-RAS model were obtained from the project topographic mapping using Autodesk Civil Design software. All cross sections were stationed left to right looking downstream. Cross section spacing was established to adequately define the drainageway hydraulic conditions along with the floodplain boundary. Cross sections were included in the model at locations of all substantial vertical or horizontal changes in the channel shape, geometry, or slope. In addition, hydraulic cross sections were included near the entrance and exit of all drainage structures.

The following Manning's "n" roughness coefficient parameters used in the hydraulic model were determined based on guidelines in the HEC-RAS Hydraulic Reference Manual and visual inspection during site visits:

	"n" VALUES	
	CHANNEL	OVERBANKS
Gambel Ridge	0.040-0.045	0.040-0.045
Gambel Ridge North	0.040-0.045	0.040-0.045
Douglas Lane	0.040	0.060

Contraction and expansion coefficients of 0.1 and 0.3 respectively were used for all cross sections except for at the entrance and exit of drainage structures where 0.3 and 0.5 were used. Using the project mapping, the hydraulic length between cross sections was established for the main channel along with the left and right over-banks.

The following photos illustrate our justification on Manning' n values used.

Reference F - p69

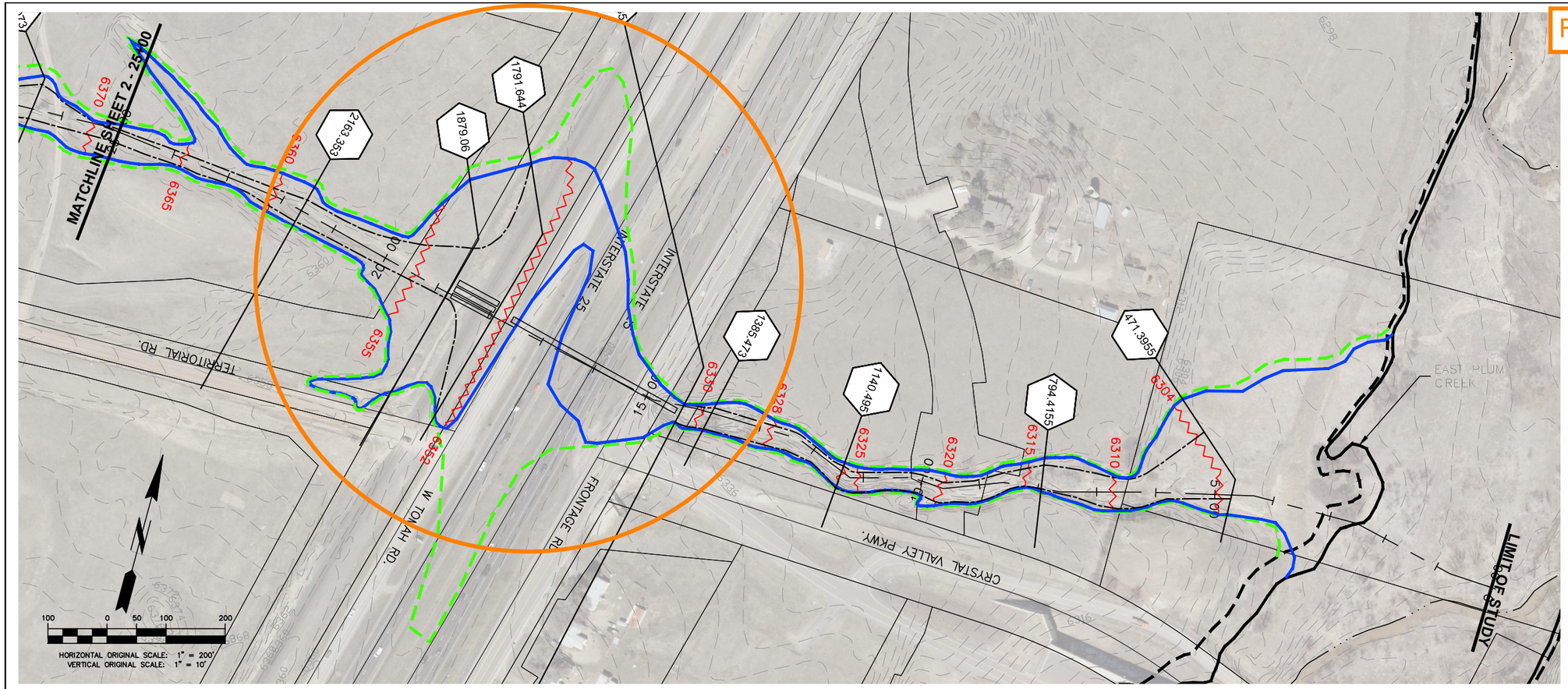
HEC-RAS OUTPUT SUMMARY TABLE
Gambel Ridge

River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
471.3955	10-yr	757	6301.3	6302.76	6302.76	6303.13	0.023441	6.01	166.25	210.18	0.93
471.3955	50-yr	1378	6301.3	6303.12	6303.12	6303.66	0.023663	7.12	244.79	219.89	0.97
471.3955	100-yr	1720	6301.3	6303.29	6303.29	6303.91	0.023985	7.64	281.31	223.94	1
471.3955	500-yr	2243	6301.3	6303.54	6303.54	6304.26	0.023104	8.17	338.04	229.88	1
471.3955	Culv Cap	757	6301.3	6302.76	6302.76	6303.13	0.023441	6.01	166.25	210.18	0.93
794.4155	10-yr	757	6309.07	6312.36	6312.36	6313.47	0.019022	9.58	94.76	43.88	0.96
794.4155	50-yr	1378	6309.07	6313.52	6313.52	6314.98	0.01713	11.28	151.31	52.84	0.97
794.4155	100-yr	1720	6309.07	6314.04	6314.04	6315.66	0.016585	11.98	179.58	56.53	0.97
794.4155	500-yr	2243	6309.07	6314.75	6314.75	6316.56	0.015802	12.83	221.52	61.6	0.97
794.4155	Culv Cap	757	6309.07	6312.36	6312.36	6313.47	0.019022	9.58	94.76	43.88	0.96
1140.495	10-yr	757	6320.76	6324.3	6324.3	6325.45	0.016973	9.73	95.52	42.39	0.93
1140.495	50-yr	1378	6320.76	6325.5	6325.5	6327.02	0.015926	11.52	152.3	52.32	0.94
1140.495	100-yr	1720	6320.76	6326.06	6326.06	6327.71	0.015306	12.19	183.06	57.71	0.94
1140.495	500-yr	2243	6320.76	6326.82	6326.82	6328.61	0.014407	12.95	229.46	65	0.94
1140.495	Culv Cap	757	6320.76	6324.3	6324.3	6325.45	0.016973	9.73	95.52	42.39	0.93
1385.473	10-yr	757	6323.27	6327.62		6328.28	0.008222	7.44	122.85	44.65	0.66
1385.473	50-yr	1378	6323.27	6328.9		6329.88	0.00874	9.26	185.32	52.87	0.71
1385.473	100-yr	1720	6323.27	6329.44		6330.58	0.009065	10.07	214.94	56.3	0.74
1385.473	500-yr	2243	6323.27	6330.12		6331.51	0.0097	11.21	254.66	60.58	0.78
1385.473	Culv Cap	757	6323.27	6327.62		6328.28	0.008222	7.44	122.85	44.65	0.66
1434.485	10-yr	708	6324.11	6328.47	6328.47	6329.97	0.023797	9.84	71.94	24.23	1.01
1434.485	50-yr	1286	6324.11	6330.12	6330.12	6331.98	0.022138	10.93	117.7	32.21	1.01
1434.485	100-yr	1604	6324.11	6330.87	6330.87	6332.8	0.021523	11.14	143.94	37.77	1.01
1434.485	500-yr	2092	6324.11	6331.78	6331.78	6333.85	0.020287	11.56	181.26	44.87	1
1434.485	Culv Cap	650	6324.11	6328.27	6328.27	6329.72	0.02415	9.68	67.16	23.48	1.01
1706.496		Culvert									
1791.644	10-yr	708	6342.8	6352.22	6346.3	6352.26	0.000196	1.57	510.29	383.86	0.12
1791.644	50-yr	1286	6342.8	6352.93	6347.51	6352.99	0.000328	2.2	814.01	471.24	0.16
1791.644	100-yr	1604	6342.8	6353.04	6348.02	6353.13	0.000456	2.63	866.49	479.96	0.19
1791.644	500-yr	2092	6342.8	6353.32	6348.71	6353.44	0.000583	3.06	1005.18	500.69	0.21
1791.644	Culv Cap	650	6342.8	6351.82	6346.17	6351.86	0.000218	1.59	409.13	80.74	0.12
1830.031		Culvert									
1879.06	10-yr	708	6344.67	6353.01	6346.89	6353.04	0.000122	1.69	579.72	163.33	0.1
1879.06	50-yr	1286	6344.67	6353.84	6347.85	6353.93	0.000312	2.88	759.64	318.8	0.17
1879.06	100-yr	1604	6344.67	6354.02	6348.3	6354.16	0.000445	3.48	826.91	397.13	0.2
1879.06	500-yr	2092	6344.67	6354.29	6348.91	6354.47	0.000603	4.13	938.01	425.93	0.23
1879.06	Culv Cap	650	6344.67	6352.55	6346.77	6352.58	0.000109	1.54	521.52	98.85	0.1
2163.353	10-yr	708	6354.02	6356.92	6356.92	6357.88	0.015331	9.19	96.85	52.64	0.96
2163.353	50-yr	1286	6354.02	6357.9	6357.9	6359.15	0.01421	10.8	155.42	66.27	0.97
2163.353	100-yr	1604	6354.02	6358.38	6358.38	6359.71	0.013355	11.33	189.53	75.29	0.96
2163.353	500-yr	2092	6354.02	6358.99	6358.99	6360.45	0.012869	12.14	239.06	89.24	0.97
2163.353	Culv Cap	650	6354.02	6356.8	6356.8	6357.72	0.015287	8.93	90.98	51.02	0.95
2652.073	10-yr	708	6369.23	6371.86	6371.86	6372.71	0.016441	8.79	102.5	63.07	0.98
2652.073	50-yr	1286	6369.23	6372.78	6372.78	6373.84	0.014603	10.2	168.52	82.45	0.97
2652.073	100-yr	1604	6369.23	6373.15	6373.15	6374.33	0.014768	10.98	200.97	93.94	0.99
2652.073	500-yr	2092	6369.23	6373.67	6373.67	6374.98	0.014536	11.87	255.51	116.94	1.01
2652.073	Culv Cap	650	6369.23	6371.76	6371.76	6372.57	0.016599	8.58	95.89	61.1	0.98
3000	10-yr	414	6377.69	6379.58	6379.58	6380.21	0.018474	7.45	68.26	55.69	0.98
3000	50-yr	815	6377.69	6380.33	6380.33	6381.2	0.017291	9.11	116.92	74.08	1.01
3000	100-yr	1030	6377.69	6380.7	6380.7	6381.61	0.016074	9.61	146.76	88.02	0.99
3000	500-yr	1361	6377.69	6381.47	6381.47	6382.16	0.011045	9.32	259.31	206.54	0.85
3000	Culv Cap	414	6377.69	6379.58	6379.58	6380.21	0.018474	7.45	68.26	55.69	0.98
3500	10-yr	414	6387.62	6389.49	6389.49	6390.11	0.018446	7.4	68.75	55.94	0.98
3500	50-yr	815	6387.62	6390.24	6390.24	6391.09	0.016832	8.95	115.91	69.62	0.99
3500	100-yr	1030	6387.62	6390.56	6390.56	6391.51	0.016381	9.55	138.98	75.54	1
3500	500-yr	1361	6387.62	6391	6391	6392.07	0.015886	10.37	175.18	87.37	1.01
3500	Culv Cap	414	6387.62	6389.49	6389.49	6390.11	0.018446	7.4	68.75	55.94	0.98

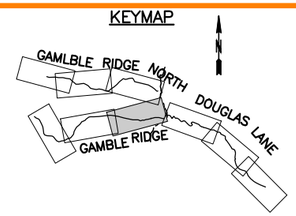
HEC-RAS OUTPUT SUMMARY TABLE
Gambel Ridge

River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
3906.503	10-yr	414	6400.38	6402.99	6402.99	6403.62	0.014403	6.75	71.23	61.31	0.87
3906.503	50-yr	815	6400.38	6403.83	6403.83	6404.56	0.01163	7.76	138.25	101.93	0.83
3906.503	100-yr	1030	6400.38	6404.12	6404.12	6404.91	0.011416	8.23	170.82	118.63	0.83
3906.503	500-yr	1361	6400.38	6404.59	6404.59	6405.37	0.010045	8.49	234.14	156.42	0.8
3906.503	Culv Cap	414	6400.38	6402.99	6402.99	6403.62	0.014403	6.75	71.23	61.31	0.87
3943.826		Culvert									
3996.147	10-yr	414	6400.59	6405.88	6403.6	6405.95	0.000827	2.39	222.47	151.41	0.23
3996.147	50-yr	815	6400.59	6406.4	6404.66	6406.56	0.001553	3.6	310.35	184.14	0.32
3996.147	100-yr	1030	6400.59	6406.62	6405.43	6406.82	0.00184	4.07	353.12	195.47	0.35
3996.147	500-yr	1361	6400.59	6406.93	6405.87	6407.17	0.002194	4.65	413.92	208.69	0.39
3996.147	Culv Cap	414	6400.59	6405.88	6403.6	6405.95	0.000827	2.39	222.47	151.41	0.23
4428.602	10-yr	383	6415.07	6416.27	6416.27	6416.62	0.021633	6.07	85.83	123.33	0.99
4428.602	50-yr	733	6415.07	6416.67	6416.67	6417.14	0.021183	7.28	139.84	153.53	1.03
4428.602	100-yr	921	6415.07	6416.85	6416.85	6417.36	0.020215	7.65	169.22	169.24	1.02
4428.602	500-yr	1212	6415.07	6417.09	6417.09	6417.65	0.019491	8.19	212.97	193.61	1.02
4428.602	Culv Cap	80	6415.07	6415.69	6415.69	6415.86	0.022653	3.93	26.61	79.4	0.9
4711.959	10-yr	383	6419.43	6421.77	6421.77	6422.57	0.017935	7.18	54.58	39.72	0.95
4711.959	50-yr	733	6419.43	6422.83	6422.83	6423.58	0.010162	7.4	122.55	88.6	0.78
4711.959	100-yr	921	6419.43	6423.12	6423.12	6423.93	0.010146	7.89	149.33	98.07	0.79
4711.959	500-yr	1212	6419.43	6423.39	6423.39	6424.4	0.01181	8.99	177.23	109.36	0.86
4711.959	Culv Cap	80	6419.43	6420.57	6420.38	6420.82	0.013474	3.97	20.17	22.6	0.74
4768.087		Culvert									
4822.813	10-yr	373	6420.5	6424.27	6422.85	6424.47	0.0029	3.6	114.34	99.11	0.4
4822.813	50-yr	698	6420.5	6425.4	6423.75	6425.55	0.001742	3.44	270.78	178.91	0.33
4822.813	100-yr	874	6420.5	6425.77	6424.59	6425.92	0.001605	3.54	343.32	211.3	0.32
4822.813	500-yr	1148	6420.5	6426.18	6424.93	6426.33	0.001576	3.76	434.82	237.32	0.32
4822.813	Culv Cap	80	6420.5	6421.74	6421.46	6421.96	0.010498	3.72	21.51	21.95	0.66
5154.495	10-yr	373	6428.9	6430.42	6430.42	6430.92	0.02023	6.78	68.54	68.75	0.99
5154.495	50-yr	698	6428.9	6430.96	6430.96	6431.65	0.018568	8.04	109.22	80.11	1
5154.495	100-yr	874	6428.9	6431.19	6431.19	6431.97	0.018259	8.57	128.27	84.18	1.01
5154.495	500-yr	1148	6428.9	6431.54	6431.54	6432.41	0.01711	9.14	158.39	89.93	1
5154.495	Culv Cap	80	6428.9	6429.62	6429.62	6429.85	0.025498	4.47	21.51	46.42	0.97
5483.639	10-yr	373	6441.54	6442.6	6442.6	6442.98	0.024034	5.98	77.59	104.17	1.02
5483.639	50-yr	698	6441.54	6443.01	6443.01	6443.53	0.021611	7.05	123.59	119.99	1.03
5483.639	100-yr	874	6441.54	6443.19	6443.19	6443.78	0.021219	7.54	145.4	126.79	1.04
5483.639	500-yr	1148	6441.54	6443.45	6443.45	6444.11	0.020156	8.09	179.16	136.59	1.03
5483.639	Culv Cap	80	6441.54	6442.03	6442.03	6442.2	0.028947	3.91	25.6	76.71	0.99
5983.639	10-yr	35	6459.05	6459.63	6459.63	6459.83	0.028101	3.76	10.12	26.6	0.97
5983.639	50-yr	89	6459.05	6459.99	6459.99	6460.3	0.022197	4.88	21.07	34.61	0.94
5983.639	100-yr	117	6459.05	6460.12	6460.12	6460.48	0.021942	5.33	25.57	36.83	0.96
5983.639	500-yr	158	6459.05	6460.3	6460.3	6460.71	0.020337	5.75	32.39	39.98	0.95
5983.639	Culv Cap	35	6459.05	6459.63	6459.63	6459.83	0.028101	3.76	10.12	26.6	0.97
6483.639	10-yr	35	6476.88	6477.41	6477.41	6477.58	0.026667	3.62	11.3	34.12	0.94
6483.639	50-yr	89	6476.88	6477.71	6477.71	6477.97	0.022806	4.67	23.12	44.32	0.94
6483.639	100-yr	117	6476.88	6477.82	6477.82	6478.12	0.02228	5.06	28.24	47.29	0.96
6483.639	500-yr	158	6476.88	6477.97	6477.97	6478.31	0.021237	5.48	35.5	51.2	0.96
6483.639	Culv Cap	35	6476.88	6477.41	6477.41	6477.58	0.026667	3.62	11.3	34.12	0.94
6983.639	10-yr	35	6493.33	6493.7	6493.7	6493.81	0.029956	3.17	13.68	58.12	0.95
6983.639	50-yr	89	6493.33	6493.9	6493.9	6494.08	0.027662	4.15	27.23	74.65	0.99
6983.639	100-yr	117	6493.33	6493.99	6493.99	6494.19	0.026173	4.43	33.74	80.98	0.98
6983.639	500-yr	158	6493.33	6494.09	6494.09	6494.32	0.025339	4.81	42.24	88.15	0.99
6983.639	Culv Cap	35	6493.33	6493.7	6493.7	6493.81	0.029956	3.17	13.68	58.12	0.95

Reference F - p79



KEYMAP

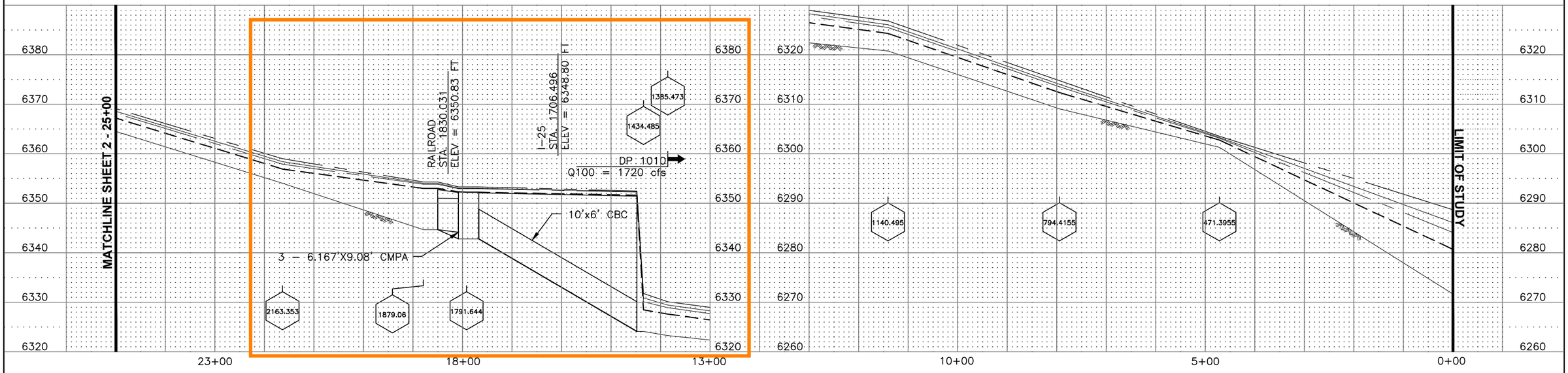


PLAN LEGEND

- XXXX — CROSS SECTION
- 100–YEAR FLOODPLAIN
- 500–YEAR FLOODPLAIN
- FLOODWAY
- BFE
- EXISTING CONTOURS

PROFILE LEGEND

- XXXX — CROSS SECTION
- 500–YEAR FLOODPLAIN
- 100–YEAR FLOODPLAIN
- 50–YEAR FLOODPLAIN
- 10–YEAR FLOODPLAIN
- EXISTING GROUND



NAME: Z:\Castle Rock\TCR Planning Studies\CAD\Dwg-Fhad\Gambel Ridge FHAD P & P.dwg
PLOT DATE: Jul 25, 2014 1:12pm

NO.	DATE	DESCRIPTION	BY

DESIGNED WPF DATE 7/8/13
DRAWN ACT DATE 7/8/13
CHECKED RCO DATE 7/8/13

RESPEC WATER & NATURAL RESOURCES
720 S. COLORADO BLVD. SUITE 410S
DENVER, CO 80246
PH: (303) 757–3655

PROJECT NO. _____

TOWN OF CASTLE ROCK COLORADO

TOWN OF CASTLE ROCK

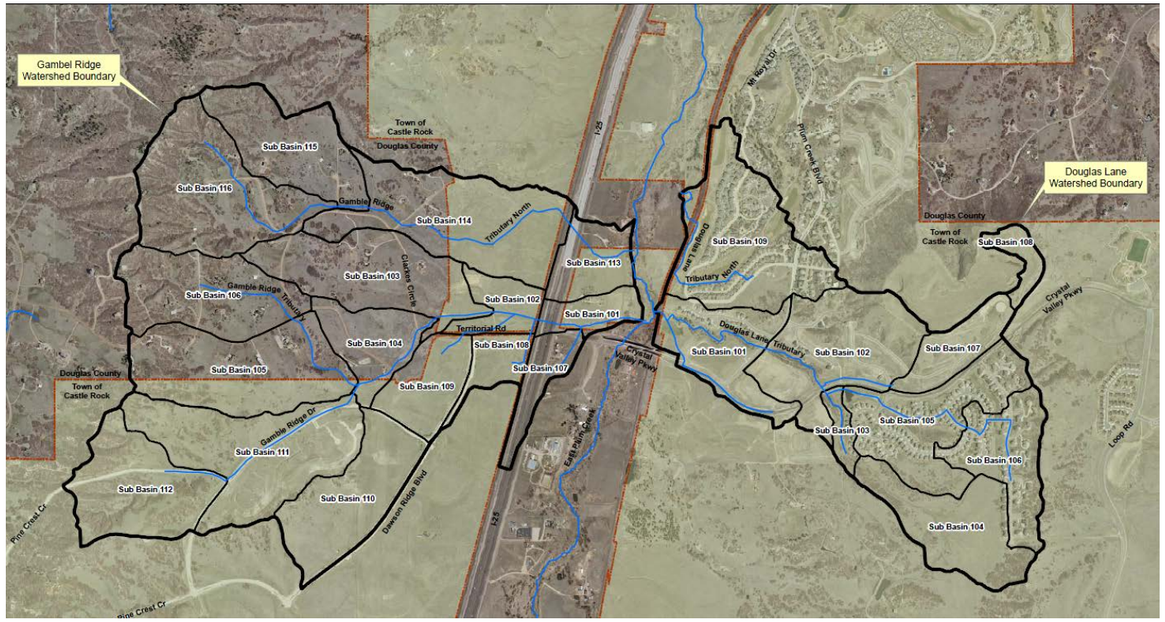
GAMBEL RIDGE FLOOD HAZARD AREA DELINEATION

PLAN AND PROFILE 0+00 TO 25+00

FIGURE 1 OF 6

Reference G - Cover

GAMBEL RIDGE AND DOUGLAS LANE TRIBUTARY WATERSHEDS MASTER PLAN



Project Sponsor:

TOWN OF CASTLE ROCK

Prepared by:

RESPEC CONSULTING & SERVICES

720 South Colorado Boulevard
Suite 410 S
Denver, Colorado 80246
phone (303) 757-3655
fax (303) 300-1635

July 2014

NOTES:
1. PLEASE SEE ALTERNATIVES PLAN COVER SHEET FOR LEGEND AND GENERAL NOTES.
2. SEE DETAIL SHEET FOR ENGINEERED CHANNEL GEOMETRY AND DROPS DETAILS.
3. BUFFER ZONE AREA SHOWN IS DEFINED BY A 20' OFFSET OF THE 100-YEAR FLOODPLAIN BOUNDARY.
4. PROPOSED ALIGNMENT AS SHOWN HAS THE LEAST AMOUNT OF IMPACT. FINAL CHANNEL ALIGNMENT WILL BE DETERMINED BASED ON FUTURE ZONING DEVELOPMENT AND MAY CHANGE FROM SHOWN.

Reference G - p11

Project Limits

REACH 3 – PRIORITY 2
ENGINEERED CHANNEL-B (SEE NOTE 2, 4)
(PROPOSED)
L = 2038 FEET
8 GROUTED SLOPING BOULDER DROP STRUCTURES 5 FEET HIGH
1 GROUTED SLOPING BOULDER DROP STRUCTURES 7 FEET HIGH
(PROPOSED)
DP1020,Q100 (FUT) = 160 CFS
Q100 (ALT1) = 630 CFS

REACH 4 – PRIORITY 1
ON-LINE FULL SPECTRUM REGIONAL DETENTION POND (PROPOSED)
4.5'X2.8' CMPA (EXISTING)
CAPACITY = 80 CFS
6'X6' CBC OUTLET STRUCTURE (PROPOSED)
L = 100 FEET
V100 = 27.0 ACRE-FEET (PROPOSED)
APPROXIMATE SURFACE AREA = 4.0 ACRE
DEPTH = 8 FEET
DP1040, Q100 (FUT) = 921 CFS
QOUT (ALT 1) = 400 CFS

REACH 1 – PRIORITY 1
REMOVE DEBRIS IN EXISTING CHANNEL

REACH 1 – PRIORITY 2
ENGINEERED CHANNEL-A (SEE NOTE 2, 4)
(PROPOSED)
L = 1410 FEET
6 GROUTED SLOPING BOULDER DROP STRUCTURES 5 FEET HIGH (PROPOSED
DP1010, Q100 (ALT1) = 1720 CFS
Q100 (ALT1) = 702 CFS

Reach to be partly improved with Crystal Valley Pkwy

REACH 3 – PRIORITY 2
ENGINEERED CHANNEL-C (1)
L = 250 FEET (PROPOSED)
ROW = 27 FEET

REACH 2
NO IMPROVEMENTS REQUIRED
10'X6' CBC (EXISTING)
CAPACITY 650-700 CFS
3-9'X6' CMPA (EXISTING)
CAPACITY 650-700 CFS
DP1020, Q100 (FUT) = 1604 CFS
Q100 (ALT 1) = 630 CFS

REACH 4 – PRIORITY 3
MAINTAIN NATURAL FLOODPLAIN BUFFER (SEE NOTE 3) AND CHANNEL SECTION.
BIOENGINEERED IMPROVEMENTS SHALL INCLUDE SOIL LOGS, VOID-FILLED RIPRAP, PLANTINGS AND OTHER BIO-ENGINEERED MEASURES AS APPROVED BY THE TOWN, INSTALLED (AS NEEDED) TO REPAIR AND STABILIZE THE CHANNEL.

REACH 4 – PRIORITY 1
14'X6' CBC (PROPOSED)
L = 50 FEET
DP1050, Q100 (FUT) = 874 CFS

REACH 3 – PRIORITY 1
PROPOSED ON-LINE FULL SPECTRUM SUBREGIONAL DETENTION POND
ROAD OVERTOPPING (EXISTING)
72" RCP OUTLET STRUCTURE (PROPOSED)
L = 100 FEET
V100 = 13.4 ACRE-FEET (PROPOSED)
APPROXIMATE SURFACE AREA = 2.0 ACRE
DEPTH = 8 FEET
DP1090, Q100 (FUT) = 469 CFS
QOUT (ALT1) = 180 CFS

No improvements to BNSF/I-25 crossing identified in master plan; existing capacity remains

REACH 1
REACH 2
REACH 3
REACH 4
CLARKES GR
CLARKES CI
TWIN OAKS RD
100-YEAR FLOODPLAIN
DOUGLAS COUNTY
TOWN OF CASTLE ROCK
TERRITORIAL RD
CRYSTAL VALLEY PKWY
DAWSON RIDGE
PROPOSED FUTURE ROADWAY ALIGNMENT
PROPOSED FUTURE ROADWAY ALIGNMENT
GAMBEL RIDGE DR
GAMBEL RIDGE WATERSHED BOUNDARY
BURLINGTON NORTHERN SANTA FE RAILROAD
I-25 (SB)
I-25 (NB)
TOWN OF CASTLE ROCK
DOUGLAS COUNTY
TOMAH RD
I-25 (SB)
I-25 (NB)
FRONTAGE RD
EAST PLUM CREEK
UNION PACIFIC RAILROAD

N

200 0 100 200 400
ORIGINAL SCALE: 1" = 200'

NO.	DATE	DESCRIPTION	BY

DESIGNED WPF DATE 7/8/13
DRAWN ACT DATE 7/8/13
CHECKED RCO DATE 7/8/13

RESPEC WATER & NATURAL RESOURCES
720 S. COLORADO BLVD. SUITE 410S
DENVER, CO 80246
PH: (303) 757-3655

PROJECT NO. _____

TOWN OF CASTLE ROCK COLORADO

TOWN OF CASTLE ROCK

GAMBEL RIDGE

ES-3 ALTERNATIVE 1
TWO DETENTION PONDS
(RECOMMENDED IMPROVEMENT)

FIGURE 1 OF 1

NAME: Z:\Castle Rock\TCR Planning Studies\CAD\Dwg-Alternatives\Gambel Ridge Alternatives.dwg
PLOT DATE: Jul 28, 2014 11:15am

Final Design

Interstate 25 South Express Lanes:

Castle Rock to Monument (The Gap)

Hydrology and Hydraulics Report

Prepared For:

CDOT Region 1 Hydraulics

7328 S. Revere Parkway, Suite 204A

Centennial, CO 80112

CH2M Project No.: 680954

CDOT Project No.: C 0252-475

CDOT Project Code: 22589

December 2020

Prepared By:

9191 Jamaica Street
Englewood, Colorado 80112

Contact:
Troy D. Slocum, PE, CFM
(719) 477 4942
troy.slocum@jacobs.com

Existing Crossing Culverts

The existing culverts along the Project corridor include various sizes, type, and materials. All culverts are proposed to remain along the existing culvert alignment such that the outfalls of the culverts will mimic the historical patterns. Culverts were analyzed based upon CDOT criteria for overtopping and headwater-to-depth (HW/D) ratio. Guidance for velocities were based upon CDOT criteria to maintain self-cleaning aspects for minimum velocities while mitigating high velocities using outlet protection.

Figure 2: CDOT Design Overtopping Criteria Table 7.2

Table 7.2 Table of Design Frequencies

Drainage Type		Frequency
A.	Cross Drainage	
	Multilane Roads - including interstate	
	In Urban Areas	100-year*
	In Rural Areas	50-year
	Two-Lane Roads	
	In Urban Areas	100-year
	In Rural Areas	
	Q_{50} : $\geq$ 4000 cfs	50-year
	Q_{50} < 4000 cfs	25-year
	Culvert Outlet Scour Protection	10-year
	Pedestrian Walkways and Bikeways	2 to 5-year
	Bridge Foundation Scour	100 and 500-year
B.	Parallel Drainage	
	Roadway Overtopping and Revetment	Same as for Cross Drainage
	Side Drains	2 to 10-year#
C.	Storm Drains	
	Major System	100-year
	Minor System	2 to 5-year
D.	Detour Culverts	monthly discharges for 2 to 5-year

Notes: *Urban cross culverts (not Interstate); if Q_{100} < 100 cfs, consider designing the culvert using the storm drain Minor System Frequency.
#Side drains shall not cause water to flow onto the highway at a greater probability than applies to cross drainage.

Figure 3: CDOT HW/D Criteria Table 9.3

Table 9.3 Maximum Headwater Depth to Structure Depth Ratios, HW/D.

Range of Diameter or Height or Rise, inches	Maximum HW/D
Less than 36 in.	2.0
36 in.to 60 in.	1.7
Larger than 60 in. but less than 84 in.	1.5
84 in. to less than 120 in.	1.2
120 in. or larger	1.0

V. RECOMMENDED DESIGN

Culverts

Approximately 100 culverts were analyzed to determine if they were hydraulically sufficient, of which 35 are in Package 1, and 32 in package 2. CDOT criteria requires 24-inch pipes to be upsized to at least 36 inches based upon the roadway design; however, based on CDOT guidance for this project, 24-inch pipes that are determined to be hydraulically adequate will not be upsized. CSP pipes under the mainline interstate will be replaced with RCP with the exception of one double 48-inch crossing and crossings that will be abandoned. All proposed pipe culverts, including storm drain pipes, are proposed as RCP under pay item 603.

Hydraulic analysis was performed using FHWA HY-8 culvert analysis software to determine capacity of all existing culverts. The flows were used from the proposed hydrology and accommodated roadside and median drainage that may affect flows. Locations where an inlet system tied into a mainline culvert were modeled as a single continuous culvert section. Additional flow from the inlet system tie-ins was not incorporated into the mainline analysis as the time of concentration lag factor allows the inlet systems flow to pass prior to offsite runoff reaching the respective mainline culvert. Culverts which have inlets for entrances were modelled through Bentley's MicroStation and InRoads Storm Sewer Analysis software in order to account for losses associated with the inlet and followed the same design process as above except to incorporate all structures (inlets and pipes) in the culvert network. The upstream inlets were modeled in a sump condition and clogging factor of 50% was used for conservative calculation. Final design of these culverts will reflect the sump condition. Three culvert crossings were modeled in this way in Package 1.

The frontage road culvert analysis was based upon a 25-year design flow. At MP176.75 (STA1824+42.37) and MP178.63 (STA1921+43.14), these locations were analyzed using off-site hydrology as they were part of the mainline system, thus it determined that the time of concentration lag factor would not contribute flow to this system. The remaining frontage road culvert locations began either at the existing grass median or were completely independent with no connecting mainline system. These culverts were analyzed using on-site and ditch flow.

At MP178.49 (STA1914+03.31) the culvert that passes under the frontage road is in outlet control due to topography constraints on the western limit. Water may flow full in the pipe in this segment across the frontage road; however, it is not overtopping the roadway neither at the inlet nor outlet, thus, there are no anticipated negative impacts to the travel way.

Culverts crossing the railroad and dirt roads were not analyzed as they fall outside the scope of the project. Downstream culverts that cross the frontage roads or interchange ramps will be upsized to match the upstream mainline culverts.

Outlet velocities for the culverts are generally kept between 3 and 22 feet per second. In Package 1, only the 10'x6' CBC at station 1938+26.83 (milepost 178.94) has an outlet velocity greater than 22 feet per second. An energy dissipator is proposed for this culvert to reduce the velocity from 22.79 and reduce scour downstream. The energy dissipator will be constructed as part of Package 2. In Package 3, there are four pipes with velocities greater than 22 feet per second located at 1451+97.90 (milepost 169.69), 1455+96.33 (milepost 169.77), 1462+70.70 and 1574+25.00. Concrete anchor blocks will be used in conjunction with the steep pipes for overall stability. The design was requested by CDOT to limit the use of longer riprap rundowns and convey the runoff to the bottom of the roadway embankment in the pipe system, to reduce erosion concerns at these specific locations.

In Package 2, there are 15 existing culverts deemed sufficient that need to be extended due to roadway grading. In Package 4, there are four existing culverts determined to be hydraulically sufficient that need to be extended due to roadway grading. The geometry of some extensions would cause cover issues on certain crossings, namely MP164.34 (STA1170+31.60) an existing 36-inch RCP and MP165.72 (STA1240+28.93) an existing 24inch RCP. Extending these culverts at their existing grade caused cover and grading issues on their respective upstream sides. These two crossings will need to be replaced from the median inlet to the upstream invert and have their pipe's slopes adjusted to better conform to proposed conditions.

Tapered Culverts

The existing tapered CBCs were initially analyzed using Federal Highway Administration's (FHWA) HY-8 culvert program evaluating for the design events. In HY-8, the CBCs were modeled as the smaller section, and if sufficient, would be hydraulically sufficient for the larger section. MP175.26 and MP178.94 were further analyzed after not being

sufficient based on the previous methodology. These two CBCs were modeled through EPA SWMM to incorporate the tapered geometry and were modeled as such.

In HY8, both the larger upstream section and smaller downstream section models are in inlet control. The tapered models built in EPA SWMM verified that these two locations are in inlet control, thus the upstream section is the controlling factor. The EPA SWMM models were compared to the HY-8 results of the upstream section and are reasonably close to one another. The results can be seen below in Table 3 and 4.

Table 3: Summary for MP175.26

Milepost	**Model**	**HW/D**	**HW/D Limit**
175.26	HY-8	*1.06	1.2
175.26	EPA SWMM	0.94	1.2

*Note that this value is based off the larger upstream section model in HY-8.

Table 4: Summary for MP178.94

Milepost	**Model**	**HW/D**	**HW/D Limit**
178.94	HY-8	*1.51	1.5
178.94	EPA SWMM	1.57	1.5

*Note that this value is based off the larger upstream section model in HY-8.

Due to these CBCs being in inlet control, as verified through the EPA SWMM model, it is a reasonable approach to model these sections using the upstream end through HY8 for analysis. The HY8 analysis concludes that MP 175.26 is hydraulically adequate and MP178.94 is within a reasonable HW/D range to justify hydraulic sufficiency as well.

Headwalls and Wingwalls

Headwalls and wingwalls will primarily be used for RCPs 48 inches and greater and all CBCs. Culverts smaller than 48 inches will incorporate flared end sections unless roadway slope geometry dictates otherwise. Headwalls and wingwalls will be added to Package 1 culverts in Package 2 of the Project. The contractor will be responsible for providing temporary drainage until these improvements are constructed and may be required to provide interim shoring until the proposed headwalls and wingwalls are construction.

In Package 4, the embankment grading on County Line Road encroaches into the existing channel resulting in an extension of the existing culvert at MP 163.43. This extension does not leave adequate room for the use of flared end sections; therefore, standard headwalls based on M-601-12 will be utilized at MP 163.40, MP 163.43, and MP 163.46.

Recommendations for proposed culverts can be seen in **Appendix C**.

Inlet Systems

Colorado Department of Transportation

Structure Inspection and Inventory Report (English Units)

Highway Number (ON) 5D: 025A _

Mile Post (ON)11: 177.870 mi

Bridge Name: 025A177870BL Inspection Date: 8/26/2014 Sufficiency Rating: 65.0 NA

NBI Reporting ID:	025A177870B	Hist Signif 37:	5	UW Inspection Date 93B:	
Rgn/Sectn 2E/2M:	15	Posting status 41:	A	SI Date 93C:	
Trans Region 2T	-1	Service on/un 42A/B:	1 5	Bridge Cost 94:	$ -1
County Code 3:	035	Main Mat/Desgn 43A/B:	1 19	Roadway Cost 95:	$ -1
DOUGLAS		Appr Mat/Desgn 44A/B:	0 00	Total Cost 96:	$ -1
Place Code 4:	00000	Main Spans Unit 45:	1	Year of Cost Estimate 97:	-1
non-city		Approach Spans 46:	0	Brdr Brdg Code/% 98A/B:	
Rte.(On/Under)5A:	1	Horiz Clr 47:	38.0 ft	Border Bridge Number 99	
Signing Prefix 5B:	1	Max Span 48:	8.0 ft	Defense Highway 100:	1
Level of Service 5C:	1	Str Length 49:	8.0 ft	Parallel Structure 101:	N
Directional Suffix 5E:	0	Curb Wdth L/R 50A/B:	0.0 ft 0.0 ft	Direction of Traffic 102	2
Feature Intersected 6:		Width Curb to Curb 51	0.0 ft	Temporary Structure 103	#
UNNAMED DRAINAGE		Width Out to Out 52:	435.0 ft	Highway System 104:	1
Facility Carried 7:		Deck Area:	3,476.7 sq. ft	Fed Lands Hiway 105:	_
I-25 ML		Min Clr Ovr Brdg 53:	99.99	Year Reconstructed 106	0000
Alias Str No.8A:		Min Undrclr Ref 54A:	N	Deck Type 107:	N
I-25-177.87BL		Min Undrclr 54B:	0.0 ft	Wearing Surface 108A	N
Prll Str No. 8P		Min Lat Clrnce Ref R 55A	N	Membrane 108B:	N
		Min Lat Undrclr R 55B	0.0 ft	Deck Protection 108C:	N
Location 9:		Min Lat Undrclr L 56:	0.0 ft	Truck ADT 109:	6 %
3.6 MI S OF CASTLE ROCK		Deck 58:	N	Trk Net 110:	_
Max Clr 10:	99.9 ft	Super 59:	N	Pier Protection 111:	#
BaseHiway Net12:	_	Sub 60:	N	NBIS Length 112:	N
IrsinvRout 13A	-1	Channel/Protection 61	7	Scour Critical 113:	8
IrssubRout No13B:	-1	Culvert 62:	7	Scour Watch 113M:	_
Latitude 16:	39d 19' 31"	Oprtng Rtg Method 63	5 No rating	Future ADT 114:	91,600
Longitude 17:	104d 52' 53"	Operating Rating 64:	40.0	Year of Future ADT 115	2028
Range18A:		Inv Rtng Method 65:	5	CDOT Str Type 120A:	CBC
Township18B:		Inventory Rating 66:	36.0	CDOT Constr Type 120B	02
Section18C:		Asph/Fill Thick 66T:	072 "in"	Inspection Indic 122A:	
Detour Length 19:	123.7 mi	Str. Evaluation 67:	8	Inspection Trip 122AA	
Toll Facility 20:	3	Deck Geometry 68:	N	Inspection Schedule ID:	-1
Custodian 21:	1	Undrclr Vert/Hor 69:	N	Maintenance Patrol 123	-1
Owner 22:	1	Posting 70:	5	Expansion Dev/Type124	_
Functional Class 26:	01	Waterway Adequacy 7	7	Brdg Rail Type/Mod 125A/B	-1 _
Year Built 27:	1965	Approach Alignment 72:	8	Posting Trucks 129A/B/C	0 0 0
Lanes on 28A:	8	Type of Work 75A:		Str Rating Date 130:	2/5/2010
Lanes Under 28B:	0	Work Done By 75B:		Special Equip 133:	-1
ADT 29:	55,500	Length of Improvment 76		Vert Clr N/E 134A/B/C:	_ -1.00 -1.00
Year of ADT 30:	2008	Insp Team Indicator 90B	Stantec	Vert Clr S/W 135A/B/C	_ -1.00 -1.00
Design Load 31:	5	Inspector Name 90C:	NGOQ	Vertical Clr Date:	1/1/1901
Apr Rdwy Width 32:	128.0 ft	Frequency 91:	48 months	Weight Limit Color: 139	_
Median 33:	2	FC Frequency 92A:		Str Billing Type:	
Skew 34:	0.00 °	UW Frequency 92B:		Userkey 1 - System:	MINORS
Structure Flared 35:	0	SI Frequency 92C:		Userkey 7-Update Indic	
Sfty Rail 36a/b/c/d:	1 1 1 1	FC Inspection Date 93A:			
Rail ht36h:	00 "in"				

Inspector Name: NGOQ

Colorado Department of Transportation
Structure Inspection and Inventory Report (English Units)

Element Inspection Report

Elm/Env	Description	Units	Total Qty	% in 1	CS 1	% in 2	CS 2	% in 3	CS 3	% in 4	CS 4	% in 5	CS 5
241/1	Concrete Culvert	(LF)	435	99 %	432	0 %	0	1 %	3	0 %	0	0 %	0
327/1	Culvert Wingwalls	(EA)	4	100 %	4	0 %	0	0 %	0	0 %	0	0 %	0
335/1	Culvert Headwalls	(EA)	2	100 %	2	0 %	0	0 %	0	0 %	0	0 %	0
600/1	Genl Remarks	(EA)	1	100 %	1	0 %	0	0 %	0	0 %	0	0 %	0

Elem/Env	Description	Element Notes
241/1	Concrete Culvert	8 ft x 4 ft cast-in-place concrete box culvert with 2 to 6 ft cover - (2) 1/4 inch wide cracks with rust stains and reinforcing exposed with moderate section loss at joints near both drop inlets. Vertical crack at construction joint at 2/3 point with exposed and corroded rebar. 30 inches of freeboard at inlet tapering to 48 inches at midway. Crosses ML I-25 and both frontage roads.
327/1	Culvert Wingwalls	Concrete, flared, at inlet and outlet.
335/1	Culvert Headwalls	Concrete at inlet and outlet.
600/1	Genl Remarks	2nd cell entrance is concreted over at inlet.

Bridge Notes

GPS RT: LAT N39 degrees 19 minutes 29.7 seconds LONG W104 degrees 52 minutes 49.7 seconds

Colorado Department of Transportation
Structure Inspection and Inventory Report (English Units)

Inspection Notes

Date 8/26/2014 -
Temp: 76 Degrees Time: 3:30 PM Weather: Partly cloudy, breeze

Scope:

☑ **NBI:** ☑ **Element:** ☐ **Underwater:** ☐ **Fracture Critical:** ☐ **Other:** **Type:** Regular NBI

Team Leader Inspection Check-off:

☐ FCM's
☐ Posting Signs
☐ Essential Repair Verification
☐ Vertical Clearance
☐ Stream Bed Profile

Inspection Team:

Inspection Date: 08/26/2014

Inspector: NGOQ

Quyen Ngo Digitally signed by Quyen Ngo Date: 2014.09.25 11:11:18 -06'00'

Inspector (Team Leader)

Colorado Department of Transportation

Structure Inspection and Inventory Report (English Units)

Highway Number (ON) 5D: 025A _

Mile Post (ON)11: 178.940 mi

Bridge Name: 025A178940BL Inspection Date: 8/27/2014 Sufficiency Rating: 65.0 NA

NBI Reporting ID:	025A178940B	Hist Signif 37:	5			UW Inspection Date 93B:	
Rgn/Sectn 2E/2M:	15	Posting status 41:	A			SI Date 93C:	
Trans Region 2T	-1	Service on/un 42A/B:	1	5		Bridge Cost 94:	$ -1
County Code 3:	035	Main Mat/Desgn 43A/B:	1	19		Roadway Cost 95:	$ -1
DOUGLAS		Appr Mat/Desgn 44A/B:	0	00		Total Cost 96:	$ -1
Place Code 4:	00000	Main Spans Unit 45:	1			Year of Cost Estimate 97:	-1
non-city		Approach Spans 46:	0			Brdr Brdg Code/% 98A/B:	
Rte.(On/Under)5A:	1	Horiz Clr 47:	38.0 ft			Border Bridge Number 99:	
Signing Prefix 5B:	1	Max Span 48:	10.0 ft			Defense Highway 100:	1
Level of Service 5C:	1	Str Length 49:	10.0 ft			Parallel Structure 101:	N
Directional Suffix 5E:	0	Curb Wdth L/R 50A/B:	0.0 ft	0.0 ft		Direction of Traffic 102:	2
Feature Intersected 6:		Width Curb to Curb 51:	0.0 ft			Temporary Structure 103:	#
UNNAMED DRAINAGE		Width Out to Out 52:	261.0 ft			Highway System 104:	1
Facility Carried 7:		Deck Area:	2,604.9 sq. ft			Fed Lands Hiway 105:	_
I-25 ML		Min Clr Ovr Brdg 53:	99.99			Year Reconstructed 106:	0000
Alias Str No.8A:		Min Undrclr Ref 54A:	N			Deck Type 107:	N
I-25-178.94BL		Min Undrclr 54B:	0.0 ft			Wearing Surface 108A:	N
Prll Str No. 8P		Min Lat Clrnce Ref R 55A:	N			Membrane 108B:	N
		Min Lat Undrclr R 55B:	0.0 ft			Deck Protection 108C:	N
Location 9:		Min Lat Undrclr L 56:	0.0 ft			Truck ADT 109:	6 %
2.6 MI S OF CASTLE ROCK		Deck 58:	N			Trk Net 110:	_
Max Clr 10:	99.9 ft	Super 59:	N			Pier Protection 111:	#
BaseHiway Net12:	_	Sub 60:	N			NBIS Length 112:	N
IrsinvRout 13A	-1	Channel/Protection 61:	5			Scour Critical 113:	8
IrssubRout No13B:	-1	Culvert 62:	7			Scour Watch 113M:	_
Latitude 16:	39d 20' 22"	Oprtng Rtg Method 63:	5 No rating			Future ADT 114:	91,600
Longitude 17:	104d 52' 34"	Operating Rating 64:	40.0			Year of Future ADT 115:	2028
Range18A:		Inv Rtng Method 65:	5			CDOT Str Type 120A:	CBC
Township18B:		Inventory Rating 66:	36.0			CDOT Constr Type 120B:	02
Section18C:		Asph/Fill Thick 66T:	072 "in"			Inspection Indic 122A:	
Detour Length 19:	123.7 mi	Str. Evaluation 67:	7			Inspection Trip 122AA:	
Toll Facility 20:	3	Deck Geometry 68:	N			Inspection Schedule ID:	-1
Custodian 21:	1	Undrclr Vert/Hor 69:	N			Maintenance Patrol 123:	-1
Owner 22:	1	Posting 70:	5			Expansion Dev/Type124:	_
Functional Class 26:	01	Waterway Adequacy 71:	7			Brdg Rail Type/Mod 125A/B:	-1 _
Year Built 27:	1965	Approach Alignment 72:	8			Posting Trucks 129A/B/C:	0 0 0
Lanes on 28A:	8	Type of Work 75A:				Str Rating Date 130:	2/5/2010
Lanes Under 28B:	0	Work Done By 75B:				Special Equip 133:	-1
ADT 29:	55,500	Length of Improvment 76:				Vert Clr N/E 134A/B/C:	_ -1.00 -1.00
Year of ADT 30:	2008	Insp Team Indicator 90B:	Stantec			Vert Clr S/W 135A/B/C:	_ -1.00 -1.00
Design Load 31:	5	Inspector Name 90C:	NGOQ			Vertical Clr Date:	1/1/1901
Apr Rdwy Width 32:	128.0 ft	Frequency 91:	48 months			Weight Limit Color: 139:	_
Median 33:	2	FC Frequency 92A:				Str Billing Type:	
Skew 34:	0.00 °	UW Frequency 92B:				Userkey 1 - System:	MINORS
Structure Flared 35:	0	SI Frequency 92C:				Userkey 7-Update Indic:	
Sfty Rail 36a/b/c/d:	1 1 1 1	FC Inspection Date 93A:					
Rail ht36h:	28 "in"						

Inspector Name: NGOQ

Colorado Department of Transportation
Structure Inspection and Inventory Report (English Units)

Element Inspection Report

Elm/Env	Description	Units	Total Qty	% in 1	CS 1	% in 2	CS 2	% in 3	CS 3	% in 4	CS 4	% in 5	CS 5
241/1	Concrete Culvert	(LF)	261	95 %	249	2 %	5	3 %	7	0 %	0	0 %	0
327/1	Culvert Wingwalls	(EA)	4	100 %	4	0 %	0	0 %	0	0 %	0	0 %	0
335/1	Culvert Headwalls	(EA)	2	100 %	2	0 %	0	0 %	0	0 %	0	0 %	0
361/1	Scour Smart Flag	(EA)	1	100 %	1	0 %	0	0 %	0	0 %	0	0 %	0
502/1	ChannProtMatCond	(EA)	1	100 %	1	0 %	0	0 %	0	0 %	0	0 %	0

Elem/Env	Description	Element Notes
241/1	Concrete Culvert	10 ft W x 6 ft H from inlet to near median, then tapers to 7 ft W x 6 ft H from median to outlet cast-in-place concrete box culvert with 2 to 6 ft cover - (8) hairline cracks in bottom of top slab parallel to centerline of roadway with (6) rust stains. Insufficent cover exposing reinforcing at drop inlet portion. Spall with exposed and corroded reinforcing near drop inlet. 11 ft 6 inch drop structure inside CBC 20 ft from outlet.
327/1	Culvert Wingwalls	Concrete, flared, at inlet and outlet. Exposed up to 21 inches footing at east wingwalls.
335/1	Culvert Headwalls	Concrete at inlet and outlet.
361/1	Scour Smart Flag	Up to 21 inches exposed bottom slab and wingwall footing. Previous noted: Concrete apron slab at outlet with spillway previously severely undermined - Repaired between 2005 and 2010 inspections.
502/1	ChannProtMatCond	Concrete apron slab at outlet with spillway previously severely undermined - Repaired between 2005 and 2010 inspections.

Bridge Notes

GPS RT: LAT N39 degrees 20 minutes 21.5 seconds LONG W104 degrees 52 minutes 30.3 seconds

Highway Number (ON) 5D: 025A

Mile Post (ON)11: 178.940 mi

Colorado Department of Transportation
Structure Inspection and Inventory Report (English Units)

Inspection Notes

Date 8/27/2012 -
Temp: 57 Degrees Time: 7:45 AM Weather: Cloudy, breeze

Scope:

☑ **NBI:** ☑ **Element:** ☐ **Underwater:** ☐ **Fracture Critical:** ☐ **Other:** **Type:** Regular NBI

Team Leader Inspection Check-off:

☐ FCM's
☐ Posting Signs
☐ Essential Repair Verification
☐ Vertical Clearance
☐ Stream Bed Profile

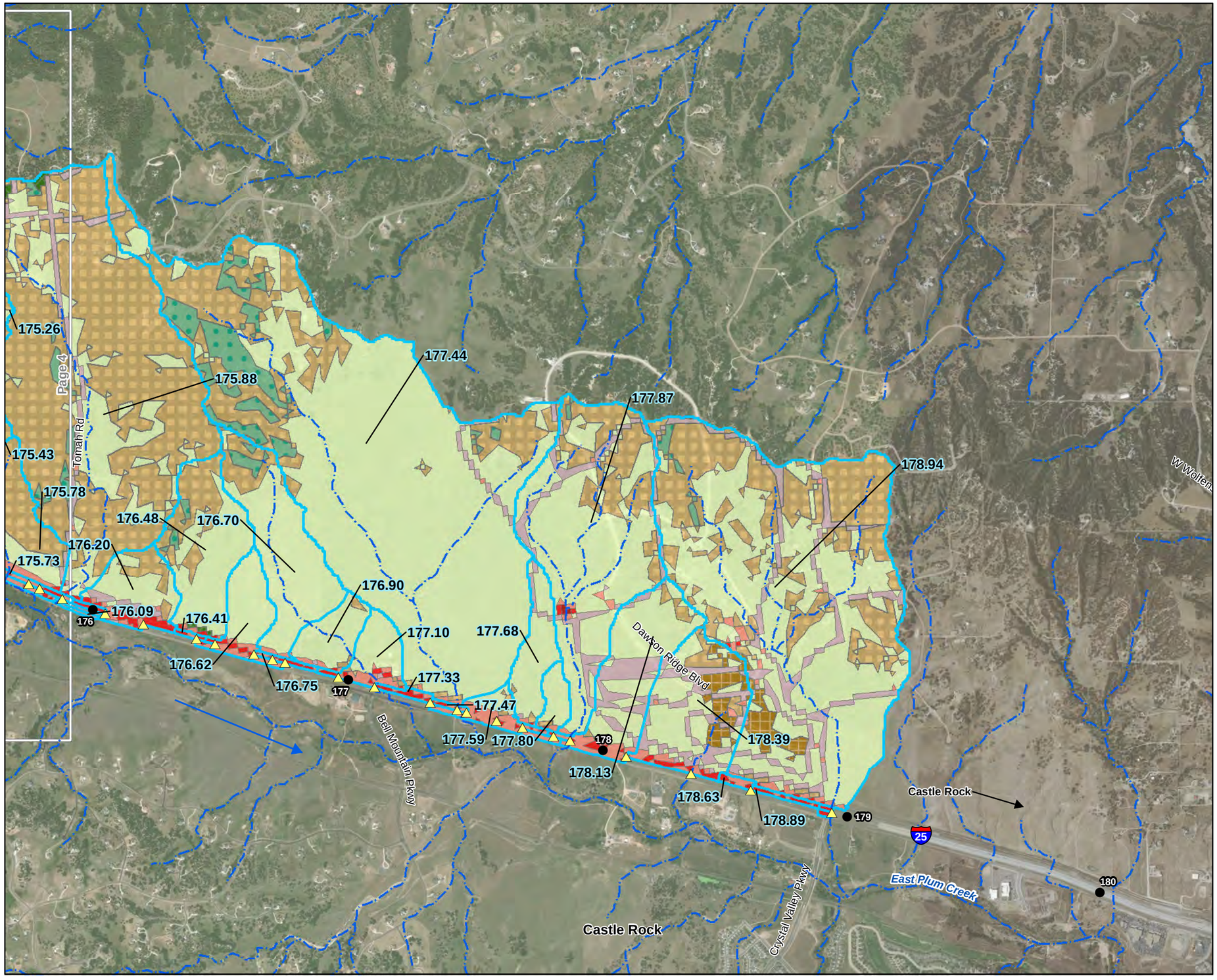
Inspection Team:

Inspection Date: 08/27/2014

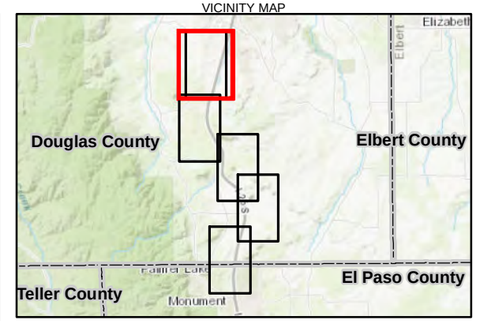
Inspector: NGOQ

Quyen Ngo Digitally signed by Quyen Ngo Date: 2014.09.25 11:13:01 -06'00'

Inspector (Team Leader)



VICINITY MAP



LEGEND

- Milepost
- Culvert Crossing
- East Plum Creek Bridge
- County Boundary
- Match Line
- National Hydrography Dataset Flowline
- Direction of Flow
- Proposed Basin Area
- 161.65 Basin Name/Milepost of Crossing Culvert

Land Cover

- Open Water
- Developed, Open Space
- Developed, Low Intensity
- Developed, Medium Intensity
- Developed, High Intensity
- Barren Land (Rock/Sand/Clay)
- Deciduous Forest
- Evergreen Forest
- Shrub/Scrub
- Grassland/Herbaceous
- Cultivated Crops
- Emergent Herbaceous Wetlands

Source:
- National Land Cover Database, 2011
- National Hydrography Dataset - USGS 2017

N

0 2,000
Feet

PAGE 5
Proposed Condition Land Cover Map
I-25 South GAP Project
February 2018

COLORADO Department of Transportation

Project: I-25 Gap Package 1
Description: Hydrology Summary

Project No. 680954
Calculated by: JC

Station	MP	Area (ac)	C and CN							Point Precipitation (in) and Rainfall Intensity (in/hr)										Flows (cfs)			Method Used
			NRCS Soil Type A	NRCS Soil Type B	NRCS Soil Type C	NRCS Soil Type D	C5	C50	C100	Tc (mins)	1hr (5yr)	1hr (50yr)	1hr (100yr)	6hr (5yr)	6hr (50yr)	6hr (100yr)	I5	I50	I100	Q5	Q50	Q100	
1593+85.70	172.41	100	25.7%	74.3%	0.0%	0.0%	0.15	0.39	0.46	51							1.6	2.6	2.9	24	99	136	Rational
1671+36.74	173.87	253	42.0%	38.3%	14.8%	4.9%	0.20	0.39	0.46	46	1.4	2.1	2.6	2.2	3.0	3.4				80	236	307	CUHP
1676+22.96	173.97	3	0.0%	100.0%	0.0%	0.0%	0.86	0.89	0.90	6							4.5	7.2	8.3	13	22	25	Rational
1689+73.03	174.22	301	35.9%	29.4%	33.1%	1.6%	0.22	0.42	0.49	49	1.4	2.1	2.6	2.2	3.0	3.4				130	357	459	CUHP
1707+11.07	174.54	5	31.8%	68.2%	0.0%	0.0%	0.86	0.88	0.89	11							3.7	5.9	6.8	16	26	30	Rational
1711+29.10	174.62	283	33.5%	43.5%	23.0%	0.0%	0.02	0.26	0.35	84	1.4	2.1	2.6	2.2	3.0	3.4				36	221	305	CUHP
1725+20.60	174.88	32	4.9%	11.1%	83.9%	0.0%	0.26	0.52	0.58	28							2.3	3.7	4.2	20	61	79	Rational
1738+13.34	175.13	5	0.0%	0.0%	100.0%	0.0%	0.86	0.88	0.89	8							4.1	6.5	7.5	18	29	34	Rational
1745+14.68	175.26	602	22.7%	3.0%	73.8%	0.6%	0.04	0.32	0.41	94	1.4	2.1	2.6	2.2	3.0	3.4				124	533	716	CUHP
1748+05.31	175.32	1	0.0%	0.0%	100.1%	0.0%	0.86	0.88	0.89	9							4.1	6.5	7.5	4	6	7	Rational
1754+58.25	175.43	40	0.0%	0.0%	100.0%	0.0%	0.14	0.46	0.54	42							1.8	2.9	3.3	11	53	72	Rational
1761+97.61	175.58	4	0.0%	0.0%	100.1%	0.0%	0.86	0.88	0.89	11							3.8	6.0	6.9	13	21	24	Rational
1770+46.52	175.73	4	0.0%	0.0%	100.1%	0.0%	0.86	0.88	0.89	10							3.9	6.2	7.1	15	24	28	Rational
1772+87.19	175.78	76	0.0%	0.0%	100.0%	0.0%	0.16	0.47	0.55	41							1.9	2.9	3.4	23	106	142	Rational
1777+86.29	175.88	594	4.4%	19.2%	65.9%	10.5%	0.06	0.39	0.48	130	1.4	2.1	2.6	2.2	3.0	3.4				128	431	576	CUHP
1786+96.49	176.09	3	0.0%	0.0%	100.0%	0.0%	0.86	0.88	0.89	9							4.0	6.3	7.2	10	17	20	Rational
1794+90.79	176.20	52	0.0%	0.0%	89.5%	10.5%	0.28	0.54	0.60	22							2.7	4.2	4.9	39	118	153	Rational
1805+97.32	176.41	2	0.0%	0.0%	0.0%	100.1%	0.86	0.88	0.89	12							3.6	5.7	6.6	5	8	9	Rational
1809+86.22	176.48	102	0.0%	59.7%	4.9%	35.4%	0.04	0.37	0.46	56							1.5	2.4	2.7	6	90	130	Rational
1817+96.42	176.62	38	0.0%	29.0%	1.1%	69.9%	0.16	0.46	0.54	41							1.8	2.9	3.3	11	51	69	Rational
1821+81.30	176.70	116	0.0%	19.9%	25.3%	54.8%	0.05	0.40	0.49	75							1.2	2.0	2.3	7	90	127	Rational
1824+42.37	176.75	3	0.0%	61.0%	39.0%	0.0%	0.86	0.89	0.90	12							3.6	5.7	6.5	9	15	18	Rational
1835+53.16	176.90	33	0.0%	37.8%	61.6%	0.6%	0.08	0.40	0.49	33							2.1	3.4	3.9	5	45	64	Rational
1843+04.34	177.10	32	0.0%	68.9%	31.1%	0.0%	0.22	0.49	0.56	24							2.5	4.0	4.6	18	62	82	Rational
1854+69.45	177.33	4	0.0%	94.0%	6.0%	0.0%	0.85	0.88	0.89	18							3.0	4.7	5.4	10	16	18	Rational
1860+30.28	177.44	819	0.0%	23.3%	55.6%	21.1%	0.04	0.39	0.48	173	1.4	2.1	2.6	2.2	3.0	3.4				159	557	751	CUHP
1862+19.82	177.47	2	0.0%	32.2%	67.8%	0.0%	0.86	0.88	0.89	9							4.1	6.5	7.5	6	10	12	Rational
1868+52.25	177.53	19	0.0%	8.9%	87.4%	3.6%	0.55	0.70	0.74	11							3.7	5.8	6.7	39	78	95	Rational
1873+93.89	177.68	44	0.0%	50.1%	21.0%	28.9%	0.13	0.44	0.52	57							1.5	2.4	2.7	9	46	63	Rational
1880+37.61	177.80	15	0.0%	100.0%	0.0%	0.0%	0.04	0.36	0.46	41							1.8	2.9	3.3	1	16	23	Rational
1883+78.77	177.87	264	0.0%	16.9%	73.7%	9.5%	0.13	0.44	0.53	95	1.4	2.1	2.6	2.2	3.0	3.4				74	206	269	CUHP
1895+49.32	178.13	100	0.0%	43.8%	17.2%	39.0%	0.28	0.53	0.60	38							1.9	3.1	3.5	53	163	211	Rational
1908+95.31	178.39	111	0.0%	66.3%	32.0%	1.7%	0.28	0.53	0.60	35							2.0	3.2	3.7	63	190	246	Rational
1921+43.14	178.63	3	0.0%	100.0%	0.0%	0.0%	0.85	0.88	0.89	13							3.4	5.4	6.3	9	15	17	Rational
1935+41.68	178.89	3	0.0%	88.3%	11.7%	0.0%	0.86	0.89	0.90	15							3.3	5.2	5.9	9	15	18	Rational
1938+26.83	178.94	623	4.8%	53.8%	41.4%	0.0%	0.10	0.40	0.49	112	1.4	2.1	2.6	2.2	3.0	3.4				170	533	698	CUHP

Reference K - p510

HY-8 Culvert Analysis Report 177.80 Existing

Site Data - 177.80 Existing (2'x2' Box)

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 6388.11 ft
Outlet Station: 304.00 ft
Outlet Elevation: 6377.50 ft
Number of Barrels: 1

Culvert Data Summary - 177.80 Existing (2'x2' Box)

Barrel Shape: Concrete Box
Barrel Span: 2.00 ft
Barrel Rise: 2.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0130
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall
Inlet Depression: None

Tailwater Channel Data - 177.80 Existing (2x2 Box)

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 6.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0349
Channel Manning's n: 0.0300
Channel Invert Elevation: 6377.50 ft

Roadway Data for Crossing: 177.80 Existing (2x2 Box)

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 6393.86 ft
Roadway Surface: Paved
Roadway Top Width: 136.00 ft

Table 1 - Culvert Summary Table: 177.80 Existing (2'x2' Box)

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
10 year	4.00	4.00	6388.94	0.827	0.0*	1-S2n	0.258	0.499	0.258	0.201	7.748	2.933
50 year	16.00	16.00	6390.22	2.109	0.0*	5-S2n	0.665	1.257	0.665	0.443	12.034	4.651
100 year	23.00	23.00	6390.96	2.853	0.0*	5-S2n	0.866	1.601	0.866	0.541	13.285	5.207

Table 2 - Downstream Channel Rating Curve (Crossing: 177.80 Existing (2x2 Box))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
4.00	6377.70	0.20	2.93	0.44	1.22
16.00	6377.94	0.44	4.65	0.96	1.37
23.00	6378.04	0.54	5.21	1.18	1.40

Table 3 - Summary of Culvert Flows at Crossing: 177.80 Existing (2x2 Box)

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	177.80 Existing (2'x2' Box) Discharge (cfs)	Roadway Discharge (cfs)	Iterations
6388.94	10 year	4.00	4.00	0.00	1
6390.22	50 year	16.00	16.00	0.00	1
6390.96	100 year	23.00	23.00	0.00	1
6393.86	Overtopping	40.81	40.81	0.00	Overtopping

****

Straight Culvert

Inlet Elevation (invert): 6388.11 ft, Outlet Elevation (invert): 6377.50 ft

Culvert Length: 304.19 ft, Culvert Slope: 0.0349

****

HY-8 Culvert Analysis Report 177.80 Proposed

Site Data - 177.80 Proposed 36"

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 6388.11 ft
Outlet Station: 304.00 ft
Outlet Elevation: 6371.60 ft
Number of Barrels: 1

Culvert Data Summary - 177.80 Proposed 36"

Barrel Shape: Circular
Barrel Diameter: 3.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0130
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Tailwater Channel Data - 177.80 Proposed 36"

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 6.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0349
Channel Manning's n: 0.0300
Channel Invert Elevation: 6371.60 ft

Roadway Data for Crossing: 177.80 Proposed 36"

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 6393.86 ft
Roadway Surface: Paved
Roadway Top Width: 136.00 ft

Reference K - p513

Table 1 - Culvert Summary Table: 177.80 Proposed 36"

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
10 year	4.00	4.00	6388.93	0.816	0.0*	1-S2n	0.321	0.620	0.321	0.201	9.508	2.933
50 year	16.00	16.00	6389.86	1.751	0.0*	1-S2n	0.632	1.275	0.632	0.443	14.241	4.651
100 year	23.00	23.00	6390.32	2.208	0.0*	1-S2n	0.759	1.543	0.759	0.541	15.786	5.207

Table 2 - Downstream Channel Rating Curve (Crossing: 177.80 Proposed 36")

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
4.00	6371.80	0.20	2.93	0.44	1.22
16.00	6372.04	0.44	4.65	0.96	1.37
23.00	6372.14	0.54	5.21	1.18	1.40

Culvert 11.5

Table 3 - Summary of Culvert Flows at Crossing: 177.80 Proposed 36"

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	177.80 Proposed 36" Discharge (cfs)	Roadway Discharge (cfs)	Iterations
6388.93	10 year	4.00	4.00	0.00	1
6389.86	50 year	16.00	16.00	0.00	1
6390.32	100 year	23.00	23.00	0.00	1
6393.86	Overtopping	69.55	69.55	0.00	Overtopping

****

Straight Culvert

Inlet Elevation (invert): 6388.11 ft, Outlet Elevation (invert): 6371.60 ft

Culvert Length: 304.45 ft, Culvert Slope: 0.0543

****

HY-8 Culvert Analysis Report 177.87 Existing

Site Data - 177.87 Existing (8'x4')

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 6384.70 ft
Outlet Station: 287.00 ft
Outlet Elevation: 6382.25 ft
Number of Barrels: 1

Culvert Data Summary - 177.87 Existing (8'x4')

Barrel Shape: Concrete Box
Barrel Span: 8.00 ft
Barrel Rise: 4.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0130
Culvert Type: Straight
Inlet Configuration: Square Edge (30-75º flare) Wingwall
Inlet Depression: None

Tailwater Channel Data - 177.87 Existing (8'x4')

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 16.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0085
Channel Manning's n: 0.0800
Channel Invert Elevation: 6382.25 ft

Roadway Data for Crossing: 177.87 Existing (8'x4')

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 6392.81 ft
Roadway Surface: Paved
Roadway Top Width: 136.00 ft

Reference K - p515

Table 1 - Culvert Summary Table: 177.87 Existing (8'x4')

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
10 year	99.00	99.00	6387.28	2.582	0.0*	1-S2n	1.191	1.682	1.191	1.923	10.391	2.173
50 year	206.00	206.00	6389.00	4.304	1.889	5-S2n	1.956	2.741	2.040	2.818	12.623	2.681
100 year	269.00	269.00	6390.12	5.422	3.779	5-S2n	2.357	3.275	2.470	3.225	13.611	2.886

Table 2 - Downstream Channel Rating Curve (Crossing: 177.87 Existing (8'x4'))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
99.00	6384.18	1.92	2.17	1.02	0.32
206.00	6385.07	2.82	2.68	1.49	0.33
269.00	6385.48	3.22	2.89	1.71	0.34

Culvert 10.5

Table 3 - Summary of Culvert Flows at Crossing: 177.87 Existing (8'x4')

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	177.87 Existing (8'x4') Discharge (cfs)	Roadway Discharge (cfs)	Iterations
6387.28	10 year	99.00	99.00	0.00	1
6389.00	50 year	206.00	206.00	0.00	1
6390.12	100 year	269.00	269.00	0.00	1
6392.81	Overtopping	382.86	382.86	0.00	Overtopping

****

Straight Culvert

Inlet Elevation (invert): 6384.70 ft, Outlet Elevation (invert): 6382.25 ft

Culvert Length: 287.01 ft, Culvert Slope: 0.0085

****

HY-8 Culvert Analysis Report 178.13 Existing

Site Data - 178.13 Existing 4'x4'

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 6369.64 ft
Outlet Station: 274.00 ft
Outlet Elevation: 6365.41 ft
Number of Barrels: 1

Culvert Data Summary - 178.13 Existing 4'x4'

Barrel Shape: Concrete Box
Barrel Span: 4.00 ft
Barrel Rise: 4.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0130
Culvert Type: Straight
Inlet Configuration: Square Edge (30-75º flare) Wingwall
Inlet Depression: None

Tailwater Channel Data - 178.13 Existing 4'x4'

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 10.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0154
Channel Manning's n: 0.0300
Channel Invert Elevation: 6365.52 ft

Roadway Data for Crossing: 178.13 Existing 4'x4'

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 6381.39 ft
Roadway Surface: Paved
Roadway Top Width: 136.00 ft

Reference K - p517

Table 1 - Culvert Summary Table: 178.13 Existing 4'x4'

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
10 year	65.00	65.00	6372.73	3.087	0.0*	1-S2n	1.293	2.017	1.347	0.945	12.067	4.992
50 year	163.00	163.00	6376.27	6.629	4.052	5-S2n	2.563	3.722	2.672	1.542	15.248	6.539
100 year	211.00	211.00	6378.90	9.258	7.177	5-S2n	3.139	4.000	3.282	1.760	16.075	7.033

Table 2 - Downstream Channel Rating Curve (Crossing: 178.13 Existing 4'x4')

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
65.00	6366.46	0.94	4.99	0.91	1.02
163.00	6367.06	1.54	6.54	1.48	1.09
211.00	6367.28	1.76	7.03	1.69	1.11

Culvert 9.5

Table 3 - Summary of Culvert Flows at Crossing: 178.13 Existing 4'x4'

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	178.13 Existing 4'x4' Discharge (cfs)	Roadway Discharge (cfs)	Iterations
6372.73	10 year	65.00	65.00	0.00	1
6376.27	50 year	163.00	163.00	0.00	1
6378.90	100 year	211.00	211.00	0.00	1
6381.39	Overtopping	247.45	247.45	0.00	Overtopping

****

Straight Culvert

Inlet Elevation (invert): 6369.64 ft, Outlet Elevation (invert): 6365.41 ft

Culvert Length: 274.03 ft, Culvert Slope: 0.0154

****

Reference K - p518

HY-8 Culvert Analysis Report 178.39 Existing

Site Data - 178.39 Existing (4'x3')

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 6357.33 ft
Outlet Station: 314.00 ft
Outlet Elevation: 6347.16 ft
Number of Barrels: 1

Culvert Data Summary - 178.39 Existing (4'x3')

Barrel Shape: Concrete Box
Barrel Span: 4.00 ft
Barrel Rise: 3.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0130
Culvert Type: Straight
Inlet Configuration: Square Edge (30-75º flare) Wingwall
Inlet Depression: None

Tailwater Channel Data - 178.39 Existing (4'x3')

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 4.50 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0324
Channel Manning's n: 0.0300
Channel Invert Elevation: 6347.16 ft

Roadway Data for Crossing: 178.39 Existing (4'x3')

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 6362.14 ft
Roadway Surface: Paved
Roadway Top Width: 136.00 ft

Table 1 - Culvert Summary Table: 178.39 Existing (4'x3')

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
10 year	83.00	83.00	6361.17	3.839	0.0*	5-S2n	1.182	2.374	1.182	1.193	17.551	7.502
50 year	190.00	110.77	6362.55	5.219	0.0*	5-S2n	1.453	2.877	1.523	1.763	18.182	9.327
100 year	246.00	113.64	6362.72	5.386	0.0*	5-S2n	1.481	2.927	1.549	1.984	18.340	9.971

Table 2 - Downstream Channel Rating Curve (Crossing: 178.39 Existing (4'x3'))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
83.00	6348.35	1.19	7.50	2.41	1.49
190.00	6348.92	1.76	9.33	3.56	1.57
246.00	6349.14	1.98	9.97	4.01	1.60

Table 3 - Summary of Culvert Flows at Crossing: 178.39 Existing (4'x3')

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	178.39 Existing (4'x3') Discharge (cfs)	Roadway Discharge (cfs)	Iterations
6361.17	10 year	83.00	83.00	0.00	1
6362.55	50 year	190.00	110.77	79.02	6
6362.72	100 year	246.00	113.64	132.29	4
6362.14	Overtopping	103.32	103.32	0.00	Overtopping

****

Straight Culvert

Inlet Elevation (invert): 6357.33 ft, Outlet Elevation (invert): 6347.16 ft

Culvert Length: 314.16 ft, Culvert Slope: 0.0324

****

Reference K - p520

HY-8 Culvert Analysis Report 178.39 Proposed

Site Data - 178.39 Proposed 3-48"

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 6357.34 ft
Outlet Station: 287.01 ft
Outlet Elevation: 6349.00 ft
Number of Barrels: 3

Culvert Data Summary - 178.39 Proposed 3-48"

Barrel Shape: Circular
Barrel Diameter: 4.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0130
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Tailwater Channel Data - 178.39 Proposed 3-48"

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 4.50 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0324
Channel Manning's n: 0.0300
Channel Invert Elevation: 6349.00 ft

Roadway Data for Crossing: 178.39 Proposed 3-48"

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 6362.14 ft
Roadway Surface: Paved
Roadway Top Width: 136.00 ft

Reference K - p521

Table 1 - Culvert Summary Table: 178.39 Proposed 3-48"

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
10 year	83.00	83.00	6359.48	2.136	0.0*	1-S2n	0.882	1.553	0.882	1.193	12.946	7.502
50 year	190.00	190.00	6360.95	3.610	0.0*	1-S2n	1.350	2.398	1.350	1.763	16.384	9.327
100 year	246.00	246.00	6361.68	4.340	0.0*	5-S2n	1.552	2.741	1.627	1.984	16.502	9.971

Table 2 - Downstream Channel Rating Curve (Crossing: 178.39 Proposed 3-48")

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
83.00	6350.19	1.19	7.50	2.41	1.49
190.00	6350.76	1.76	9.33	3.56	1.57
246.00	6350.98	1.98	9.97	4.01	1.60

Culvert 8.5

Table 3 - Summary of Culvert Flows at Crossing: 178.39 Proposed 3-48"

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	178.39 Proposed 3-48" Discharge (cfs)	Roadway Discharge (cfs)	Iterations
6359.48	10 year	83.00	83.00	0.00	1
6360.95	50 year	190.00	190.00	0.00	1
6361.68	100 year	246.00	246.00	0.00	1
6362.14	Overtopping	277.82	277.82	0.00	Overtopping

****

Straight Culvert

Inlet Elevation (invert): 6357.34 ft, Outlet Elevation (invert): 6349.00 ft

Culvert Length: 287.13 ft, Culvert Slope: 0.0291

****

HY-8 Culvert Analysis Report 178.94 Existing

Site Data - 178.94 Existing (10'x6')

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 6342.55 ft
Outlet Station: 323.00 ft
Outlet Elevation: 6324.22 ft
Number of Barrels: 1

Culvert Data Summary - 178.94 Existing (10'x6')

Barrel Shape: Concrete Box
Barrel Span: 10.00 ft
Barrel Rise: 6.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0130
Culvert Type: Straight
Inlet Configuration: Square Edge (30-75º flare) Wingwall
Inlet Depression: None

Tailwater Channel Data - 178.94 Existing (10'x6')

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 12.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0568
Channel Manning's n: 0.0600
Channel Invert Elevation: 6324.22 ft

Roadway Data for Crossing: 178.94 Existing (10'x6')

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 6352.04 ft
Roadway Surface: Paved
Roadway Top Width: 136.00 ft

Reference K - p527

Table 1 - Culvert Summary Table: 178.94 Existing (10'x6')

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
10 year	238.00	238.00	6346.40	3.849	0.0*	1-S2n	0.964	2.601	1.005	1.787	23.678	6.957
100 year	698.00	698.00	6351.62	9.070	0.0*	5-S2n	1.959	5.329	2.223	3.070	31.400	9.363

Table 2 - Downstream Channel Rating Curve (Crossing: 178.94 Existing (10'x6'))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
238.00	6326.01	1.79	6.96	6.33	1.07
698.00	6327.29	3.07	9.36	10.88	1.16

Culvert 7.5

Table 3 - Summary of Culvert Flows at Crossing: 178.94 Existing (10'x6')

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	178.94 Existing (10'x6') Discharge (cfs)	Roadway Discharge (cfs)	Iterations
6346.40	10 year	238.00	238.00	0.00	1
6351.62	100 year	698.00	698.00	0.00	1
6352.04	Overtopping	726.76	726.76	0.00	Overtopping

****

Straight Culvert

Inlet Elevation (invert): 6342.55 ft, Outlet Elevation (invert): 6324.22 ft

Culvert Length: 323.52 ft, Culvert Slope: 0.0567

****

Stormwater Management Facility Operation and Maintenance (O&M) General Guidelines

Town of Castle Rock - Castle Rock Water
Stormwater Division

175 Kellogg Court
Castle Rock, CO 80109
720-733-6011

Reference:

This manual is adapted from the following documents:

Douglas County, Colorado, STORMWATER MANAGEMENT FACILITY OPERATION AND MAINTENANCE MANUAL, October 2010

Town of Parker, Colorado, STORMWATER PERMANENT BEST MANAGEMENT PRACTICES (PBMP) LONG-TERM OPERATION AND MAINTENANCE MANUAL, October 2004

Urban Drainage and Flood Control District, URBAN STORM DRAINAGE CRITERIA MANUAL, VOLUME 3, November 2010

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Stormwater Management Facility
Operation and Maintenance (O&M) Standard Guidelines

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Stormwater Management Facility
Operation and Maintenance (O&M) Standard Guidelines

I. Background

This document provides General Guidelines and Standard Operating Procedures (SOPs) for Operation and Maintenance (O&M) of stormwater facilities. Additional information regarding O&M of site specific features may be found on approved Construction Drawings and in the Phase III Drainage Report.

A. Compliance with the Town of Castle Rock Storm Drainage Design and Technical Criteria Manual

Owners or managers of developed property located within the incorporated limits of Castle Rock are required to comply with the Town's Storm Drainage Design and Technical Criteria Manual (Storm Manual) adopted by reference in accordance with Ordinance 2012-16 of the Municipal Code. The purpose of the ordinance is to ensure property owners follow proper operation and maintenance procedures for stormwater management facilities located on their sites. Requirements for inspection and maintenance are located in these O&M Standard Guidelines. Additional information can be obtained by contacting the Town's Utilities Department Stormwater Division at 720-733-6011.

B. Preventive and Prompt Maintenance Activities Reduce Overall Maintenance Costs

The most effective way to maintain your stormwater facility is to prevent pollutants from entering the facility in the first place. Common pollutants include sediment, trash and debris, chemicals, pet wastes, runoff from stored materials, illicit discharges into the storm drainage system and many others. A thorough maintenance program will include measures to address these potential contaminants, and will save money and time in the long run. Key points to consider in your maintenance program include:

- Educate employees/residents on how their actions impact water quality and how they can help reduce maintenance costs.
- Keep properties, streets, curb & gutters and parking lots free of trash, debris and lawn clippings.
- Ensure the proper disposal of hazardous wastes and chemicals.
- Plan lawn care to minimize the use of chemicals and pesticides.
- Sweep or blow grass clippings from paved surfaces and put the clippings in a compost pile or back on the lawn.
- Be aware of automobiles leaking fluids. Use absorbents such as clay cat litter to soak up drippings and dispose of properly.

- Re-vegetate disturbed and bare areas to maintain vegetative stabilization.
- Clean out the upstream components of the storm drainage system, including inlets, storm sewers and outfalls.
- Do not store materials outdoors (including landscaping materials) unless they are properly protected from stormwater runoff.

II. General Description of Stormwater Management Facilities

The following are brief descriptions of commonly used stormwater management facilities. For more detailed information refer to the Town's Storm Manual Chapters 12-14.

A. Volume Reduction Facilities (Filtration BMPs)

1. Grass Buffers and Swales – Grass buffers are densely vegetated strips of grass designed to provide filtration, infiltration and settling to reduce runoff pollutants through sheet flow over the grass. Grass swales are densely vegetated trapezoidal or triangular channels designed to slow runoff, promote infiltration and facilitate sedimentation while limiting erosion. Buffers differ from swales in that they are designed to accommodate overland sheet flow rather than concentrated or channelized flow.
2. Permeable Pavement Systems – Permeable pavement consists of a permeable pavement layer, usually underlain by gravel and sand layers, designed to promote volume reduction, provide treatment and slow release of water quality capture volume (WQCV). Uses include parking lots and low traffic areas to accommodate vehicles while facilitating stormwater infiltration near its source.

B. Water Quality and Flood Control Facilities

1. Extended Detention Basins (EDBs) – EDBs are sedimentation basins with forebays, micropools and a slow release outlet designed to detain stormwater for many hours after storm runoff ends. The basins are considered to be "dry" because the majority of the basin is designed not to have a significant permanent pool of water remaining between runoff events.
2. Porous Landscape Detention (Rain Gardens or Bioretention) – Porous landscape detention (PLD) is depressed landscaped areas designed to capture and filter or infiltrate the WQCV through an engineered granular filtration layer. PLDs are often landscaped with ornamental grasses and shrubs.
3. Sand Filter Basins – Sand filter basins consist of a surcharge zone underlain by a sand bed with an underdrain system. Stormwater runoff accumulates in the surcharge zone and gradually infiltrates into the underlying sand bed. The underdrain system gradually dewaters the sand bed and discharges the runoff.

4. Retention Ponds and Constructed Wetland Ponds – Retention ponds, "wet ponds", have a permanent pool of water with additional capacity designed to capture and slowly release the WQCV. Constructed wetland ponds are shallow retention ponds designed to permit the growth of wetland plants such as rushes, willows and cattails, and slow runoff allowing time for sedimentation, filtering and biological uptake.
5. Underground BMPs and Storage – Underground stormwater BMPs include proprietary and non-proprietary devices installed below ground that provide water quality treatment via sedimentation, screening, filtration, hydrodynamic separation and other physical and chemical processes. These may be in the form of a vault, storm drain insert and/or pipe galleries.

C. Open Channels

1. Stabilized Channels – Stabilized channels utilize grade control structures as a means of establishing a mild slope for the baseflow channel and arresting stream degradation. Severe bends or cut banks may also need to be stabilized. Stabilized Channels may be grass-lined, riprap, concrete or a combination thereof.
2. Constructed Wetland Channels – Constructed wetlands channels have wetland bottoms which use dense natural vegetation to slow runoff and promote biological uptake and settling of sediment.

III. Ownership and Easements

Maintenance responsibility lies with the owner of the land, except as modified by specific agreement. Maintenance responsibility shall be defined on Final Plats and Final Development Plans. The property owner or designee shall be responsible for the maintenance of all drainage facilities including inlets, pipes, culverts, channels, ditches, hydraulic structures, and detention basins located on their land unless modified by specific agreement. Maintenance access for all facilities must be adequate for the anticipated maintenance vehicles and equipment and should be shown on the Final Plats and Final Development Plans. The Operation and Maintenance Manual, as described in Section 4.6 of the Town's Storm Manual, shall define those entities responsible for the maintenance and management of stormwater facilities. If the property owner fails to maintain a facility, the Town will complete maintenance and charge the owner at 1.25 times the cost of maintenance.

Drainage easements are required in order to ensure for the proper construction, maintenance and access to drainage improvements that have the potential to affect the public drainage system and other properties. Drainage easements shall be granted to the Town for inspection and maintenance purposes and shall be shown on the Drainage Plan, Final Plat and Site Improvement Plan, as applicable. The drainage easement shall state that the Town has the right of access on the easements for inspection and maintenance purposes. In general,

easements are required for detention or retention ponds, water quality enhancement ponds and other Best Management Practice facilities, storm sewers, swales, channels, parking lot areas that convey runoff from adjacent properties (blanket type easements), major drainageways and floodplains. Easement requirements are specific to the type of stormwater management facility and are discussed in more detail in later chapters.

Refer to Section 4.6 of the Storm Manual for more information on maintenance responsibility (ownership) and easements, respectively.

IV. Access

Refer to approved Plat, Drainage Plan and/or Site Plan for location of designated maintenance access. Contact the Town's Utilities Department Stormwater Division at 720-733-6011 with any questions regarding access to a facility.

V. Safety

Keep safety considerations at the forefront of inspection and maintenance procedures at all times. Likely hazards should be anticipated and avoided. Never enter a confined space (outlet structure, manhole, etc) without proper training or equipment. A confined space should never be entered without at least one additional person present.

If a highly toxic or flammable substance is discovered, the inspector(s) should leave the immediate area and contact the **Town's Fire Department** at **911**. If there is any question about a substance, leave the area immediately and contact the **Town's Fire Department** at **303-660-1066**. Also, never open a sealed container to check the contents.

Potentially dangerous (e.g., fuel, chemicals, hazardous materials) substances found in the areas **must be** referred to the **Town's Fire Department** immediately for response by the Hazardous Materials Unit. The emergency contact number is **303-660-1066**.

Vertical drops may be encountered in areas located within and around the facility. Avoid walking on top of retaining walls or other structures that have a significant vertical drop. If a vertical drop is identified within the stormwater management facility that is greater than 48" in height, make the appropriate note/comment on the maintenance inspection form.

If any hazard is found within the facility area that poses an immediate threat to public safety, contact the Town's Fire Department immediately!

VI. Field Inspection Equipment

It is imperative that the appropriate equipment is taken to the field with the inspector(s). This is to ensure the safety of the inspector and allow the inspections to be performed as efficiently as possible. Below is a list of the equipment that may be necessary to perform the inspections of a Stormwater Management Facilities:

- Town Approved Drainage Report and Construction Drawings
- Typical Inspection & Maintenance Requirements (See Appendix B)
- Protective clothing and boots
- Safety equipment (vest, hard hat, confined space entry equipment)
- Communication equipment
- Clipboard
- Manhole Lid Remover
- Shovel
- First Aid Kit

Some of the items identified above need not be carried by the inspector (manhole lid remover, shovel, and confined space entry equipment). However, this equipment should be available in the vehicle driven to the site.

VII. Inspecting and Maintaining Stormwater Management Facilities

The quality of stormwater discharging to waterways relies heavily on the proper operation and maintenance of permanent Best Management Practices (BMPs).

This section contains a general overview of stormwater management facility inspection, operation and maintenance guidelines. Appendix A contains Standard Operating Procedures (SOPs) for the facilities identified in Section II. Refer to the approved Drainage Report and Construction Drawings prior to performing inspections and/or maintenance.

A. Inspection Procedures

All stormwater management facilities shall be inspected by a qualified individual at a minimum of one time per year. Inspections should follow the inspection guidance found in the SOPs located in Appendix A of this manual.

B. Maintenance Procedures

Stormwater Management Facility Maintenance Programs are separated into three broad categories of work. These categories were based largely on the Urban Drainage and Flood Control District's Maintenance Program for regional drainage facilities. The categories are separated based upon the magnitude and type of the maintenance activities performed. A description of each category follows:

1. Routine Work

The majority of this work consists of regularly scheduled mowing and trash and debris pickups for stormwater management facilities during the growing season. This work also includes items such as the removal of debris/material that may be clogging the outlet structure well screens and trash racks. It may also include activities such as weed control, mosquito treatment and algae treatment. These activities normally will be performed numerous times during the year. These items can be completed without any prior notification to the Town.

2. Minor Work

   This work consists of a variety of isolated or small-scale maintenance/operational problems. Most of this work can be completed by a small crew, hand tools, and small equipment. **These items require notification, at least 7 days prior to the start of work, to the Town's Utilities Department Stormwater Division at 720-733-6011.**

3. Major Work

   This work consists of larger maintenance/operational problems and failures within the stormwater management facilities. **All of this work requires notification, at least 14 days prior to the start of work, to the Town's Utilities Department Stormwater Division at 720-733-6011 to ensure the proper maintenance is performed.** Some of this work requires that the engineering staff review the original design and construction drawings to assess the situation and assign the necessary maintenance. This work may also require more specialized maintenance equipment, design/details, surveying, or assistance through private contractors and consultants.

C. Maintenance Personnel

Maintenance personnel must be qualified to properly maintain stormwater management facilities. Inadequately trained personnel can cause additional problems resulting in additional maintenance costs.

VIII. References

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IX. Appendices

Appendix A – Standard Operating Procedures

Grass Buffers and Swales

Grass buffers and swales require maintenance of the turf cover and repair of rill or gully development. Healthy vegetation can often be maintained without using fertilizers because runoff from lawns and other areas contains the needed nutrients. Periodically inspecting the vegetation over the first few years will help to identify emerging problems and help to plan for long-term restorative maintenance needs. This section presents a summary of specific maintenance requirements and a suggested frequency of action.

Inspection

Inspect vegetation at least twice annually for uniform cover and traffic impacts. Check for sediment accumulation and rill and gully development.

Debris and Litter Removal

Remove litter and debris to prevent rill and gully development from preferential flow paths around accumulated debris, enhance aesthetics, and prevent floatables from being washed offsite. This should be done as needed based on inspection, but no less than two times per year.

Aeration

Aerating manicured grass will supply the soil and roots with air. It reduces soil compaction and helps control thatch while helping water move into the root zone. Aeration is done by punching holes in the ground using an aerator with hollow punches that pull the soil cores or "plugs" from the ground. Holes should be at least 2 inches deep and no more than 4 inches apart.

Aeration should be performed at least once per year when the ground is not frozen. Water the turf thoroughly prior to aeration. Mark sprinkler heads and shallow utilities such as irrigation lines and cable TV lines to ensure those lines will not be damaged. Avoid aerating in extremely hot and dry conditions. Heavy traffic areas may require aeration more frequently.

Mowing

When starting from seed, mow native/drought-tolerant grasses only when required to deter weeds during the first three years. Following this period, mowing of native/drought tolerant grass may stop or be reduced to maintain a length of no less than six inches. Mowing of manicured grasses may vary from as frequently as weekly during the summer, to no mowing during the winter. See the inset for additional recommendations from the CSU Extension.

CSU Extension Recommendations for Mowing Manicured Turf (Source: T. Koski and V. Skinner, 2003)

The two most important facets of mowing are mowing height and frequency. The minimum height for any lawn is 2 inches. The preferred mowing height for all Colorado species is 2.5 to 3 inches. Mowing to less than 2 inches can result in decreased drought and heat tolerance and higher incidence of insects, diseases and weeds. Mow the lawn at the same height all year. There is no reason to mow the turf shorter in late fall.

Mow the turf often enough so no more than 1/3 of the grass height is removed at any single mowing. If your mowing height is 2 inches, mow the grass when it is 3 inches tall. You may have to mow a bluegrass or fescue lawn every three to four days during the spring when it is actively growing but only once every seven to 10 days when growth is slowed by heat, drought or cold. Buffalograss lawns may require mowing once every 10 to 20 days, depending on how much they are watered.

If weather or another factor prevents mowing at the proper time, raise the height of the mower temporarily to avoid cutting too much at one time. Cut the grass again a few days later at the normal mowing height.

Irrigation Scheduling and Maintenance

Adjust irrigation schedules throughout the growing season to provide the proper irrigation application rate to maintain healthy vegetation. Less irrigation is typically needed in early summer and fall, with more irrigation needed during July and August. Native grass should not require irrigation after establishment, except during prolonged dry periods when supplemental, temporary irrigation may aid in maintaining healthy vegetation cover. Check for broken sprinkler heads and repair them, as needed. Do not overwater. Signs of overwatering and/or broken sprinkler heads may include soggy areas and unevenly distributed areas of lush growth.

Completely drain and blowout the irrigation system before the first winter freeze each year. Upon reactivation of the irrigation system in the spring, inspect all components and replace damaged parts, as needed.

Fertilizer, Herbicide, and Pesticide Application

Use the minimum amount of biodegradable nontoxic fertilizers and herbicides needed to establish and maintain dense vegetation cover that is reasonably free of weeds. Fertilizer application may be significantly reduced or eliminated by the use of mulch-mowers, as opposed to bagging and removing clippings. To keep clippings out of receiving waters, maintain a 25-foot buffer adjacent to open water areas where clippings are bagged. Hand-pull the weeds in areas with limited weed problems.

Frequency of fertilizer, herbicide, and pesticide application should be on an as-needed basis only and should decrease following establishment of vegetation. See BMP Fact Sheet S-8 in Chapter 5 for additional information. For additional information on managing vegetation in a manner that conserves water and protects water quality, see the *GreenCO Best Management Practices Manual* (www.greenco.org) for a series of Colorado-based BMP fact sheets on topics such as irrigation, plant care, and soil amendments.

Sediment Removal

Remove sediment as needed based on inspection. Frequency depends on site-specific conditions. For planning purposes, it can be estimated that 3 to 10% of the swale length or buffer interface length will require sediment removal on an annual basis.

- **For Grass Buffers**: Using a shovel, remove sediment at the interface between the impervious area and buffer.
- **For Grass Swales**: Remove accumulated sediment near culverts and in channels to maintain flow capacity. Spot replace the grass areas as necessary.

Reseed and/or patch damaged areas in buffer, sideslopes, and/or channel to maintain healthy vegetative cover. This should be conducted as needed based on inspection. Over time, and depending on pollutant loads, a portion of the buffer or swale may need to be rehabilitated due to sediment deposition. Periodic sediment removal will reduce the frequency of revegetation required. Expect turf replacement for the buffer interface area every 10 to 20 years.

Bioretention (Rain Gardens and Porous Landscape Detention)

The primary maintenance objective for bioretention, also known as porous landscape detention, is to keep vegetation healthy, remove sediment and trash, and ensure that the facility is draining properly. The growing medium may need to be replaced eventually to maintain performance. This section summarizes key maintenance considerations for bioretention.

Inspection

Inspect the infiltrating surface at least twice annually following precipitation events to determine if the bioretention area is providing acceptable infiltration. Bioretention facilities are designed with a maximum depth for the WQCV of one foot and soils that will typically drain the WQCV over approximately 12 hours. If standing water persists for more than 24 hours after runoff has ceased, clogging should be further investigated and remedied. Additionally, check for erosion and repair as necessary.

Debris and Litter Removal

Remove debris and litter from the infiltrating surface to minimize clogging of the media. Remove debris and litter from the overflow structure.

Mowing and Plant Care

- **All vegetation**: Maintain healthy, weed-free vegetation. Weeds should be removed before they flower. The frequency of weeding will depend on the planting scheme and cover. When the growing media is covered with mulch or densely vegetated, less frequent weeding will be required.

- **Grasses**: When started from seed, allow time for germination and establishment of grass prior to mowing. If mowing is required during this period for weed control, it should be accomplished with hand-held string trimmers to minimize disturbance to the seedbed. After established, mow as desired or as needed for weed control. Following this period, mowing of native/drought tolerant grasses may stop or be reduced to maintain a length of no less than 6 inches. Mowing of manicured grasses may vary from as frequently as weekly during the summer, to no mowing during the winter. See Section 4.4 for additional guidance on mowing.

Irrigation Scheduling and Maintenance

Adjust irrigation throughout the growing season to provide the proper irrigation application rate to maintain healthy vegetation. Less irrigation is typically needed in early summer and fall, while more irrigation is needed during the peak summer months. Native grasses and other drought tolerant plantings should not typically require routine irrigation after establishment, except during prolonged dry periods.

Check for broken sprinkler heads and repair them, as needed. Completely drain the irrigation system before the first winter freeze each year. Upon reactivation of the irrigation system in the spring, inspect all components and replace damaged parts, as needed.

Replacement of Wood Mulch

Replace wood mulch only when needed to maintain a mulch depth of up to approximately 3 inches. Excess mulch will reduce the volume available for storage.

Sediment Removal and Growing Media Replacement

If ponded water is observed in a bioretention cell more than 24 hours after the end of a runoff event, check underdrain outfall locations and clean-outs for blockages. Maintenance activities to restore infiltration capacity of bioretention facilities will vary with the degree and nature of the clogging. If clogging is primarily related to sediment accumulation on the filter surface, infiltration may be improved by removing excess accumulated sediment and scarifying the surface of the filter with a rake. If the clogging is due to migration of sediments deeper into the pore spaces of the media, removal and replacement of all or a portion of the media may be required. The frequency of media replacement will depend on site-specific pollutant loading characteristics. Based on experience to date in the metro Denver area, the required frequency of media replacement is not known. To date UDFCD is not aware of any rain gardens constructed to the recommendations of these criteria that have required full replacement of the growing media. Although surface clogging of the media is expected over time, established root systems promote infiltration. This means that mature vegetation that covers the filter surface should increase the life span of the growing media, serving to promote infiltration even as the media surface clogs.

Extended Detention Basins (EDBs)

EDBs have low to moderate maintenance requirements on a routine basis, but may require significant maintenance once every 15 to 25 years. Maintenance frequency depends on the amount of construction activity within the tributary watershed, the erosion control measures implemented, the size of the watershed, and the design of the facility.

Inspection

Inspect the EDB at least twice annually, observing the amount of sediment in the forebay and checking for debris at the outlet structure.

Debris and Litter Removal

Remove debris and litter from the detention area as required to minimize clogging of the outlet.

Mowing and Plant Care

When starting from seed, mow native/drought tolerant grasses only when required to deter weeds during the first three years. Following this period, mowing of native/drought tolerant grass may stop or be reduced to maintain a height of no less than 6 inches (higher mowing heights are associated with deeper roots and greater drought tolerance). In general, mowing should be done as needed to maintain appropriate height and control weeds. Mowing of manicured grasses may vary from as frequently as weekly during the summer, to no mowing during the winter. See Section 4 of this chapter for additional recommendations from the CSU Extension.

Aeration

For EDBs with manicured grass, aeration will supply the soil and roots with air and increase infiltration. It reduces soil compaction and helps control thatch while helping water move into the root zone. Aeration is done by punching holes in the ground using an aerator with hollow punches that pull the soil cores or "plugs" from the ground. Holes should be at least 2 inches deep and no more than 4 inches apart.

Aeration should be performed at least once per year when the ground is not frozen. Water the turf thoroughly prior to aeration. Mark sprinkler heads and shallow utilities such as irrigation lines and cable TV lines to ensure those lines will not be damaged. Avoid aerating in extremely hot and dry conditions. Heavy traffic areas may require aeration more frequently.

Mosquito Control

Although the design provided in this manual implements practices specifically developed to deter mosquito breeding, some level of mosquito control may be necessary if the BMP is located in close proximity to outdoor amenities.

The Town provides annual mosquito control for all public and private facilities. This program includes larvae control only. Mosquitos are more difficult to control when they are adults. This typically requires neighborhood fogging with an insecticide. Therefore, no adult mosquito

Facts on Mosquito Breeding

Although mosquitoes prefer shallow, stagnant water, they can breed within the top 6 to 8 inches of deeper pools.

Mosquitoes need nutrients and prefer shelter from direct sunlight.

Mosquitoes can go from egg to adult within 72 hours.

The most common mosquitoes in Colorado include the *Aedes Vexans* and the *Culex Tarsalis*. Both have similar needs for breeding and development.

control is provided. For questions regarding the Town's mosquito control program, please contact the Utilities Department Stormwater Division at 720-733-6011.

Irrigation Scheduling and Maintenance

Adjust irrigation throughout the growing season to provide the proper irrigation application rate to maintain healthy vegetation. Less irrigation is typically needed in early summer and fall, with more irrigation needed during July and August. Native grass and other drought tolerant plantings should not require irrigation after establishment.

Check for broken sprinkler heads and repair them, as needed. Completely drain the irrigation system before the first winter freeze each year. Upon reactivation of the irrigation system in the spring, inspect all components and replace damaged parts, as needed.

Sediment Removal from the Forebay, Trickle Channel, and Micropool

Remove sediment from the forebay and trickle channel annually. If portions of the watershed are not developed or if roadway or landscaping projects are taking place in the watershed, the required frequency of sediment removal in the forebay may be as often as after each storm event. The forebay should be maintained in such a way that it does not provide a significant source of resuspended sediment in the stormwater runoff.

Sediment removal from the micropool is required about once every one to four years, and should occur when the depth of the pool has been reduced to approximately 18 inches. Small micropools may be vacuumed and larger pools may need to be pumped in order to remove all sediment from the micropool bottom. Removing sediment from the micropool will benefit mosquito control. Ensure that the sediment is disposed of properly and not placed elsewhere in the basin.

Sediment Removal from the Basin Bottom

Remove sediment from the bottom of the basin when accumulated sediment occupies about 20% of the water quality design volume or when sediment accumulation results in poor drainage within the basin. The required frequency may be every 15 to 25 years or more frequently in basins where construction activities are occurring.

Erosion and Structural Repairs

Repair basin inlets, outlets, trickle channels, and all other structural components required for the basin to operate as intended. Repair and vegetate eroded areas as needed following inspection.

Sand Filter Basins

Sand filters have relatively low routine maintenance requirements. Maintenance frequency depends on pollutant loads in runoff, the amount of construction activity within the tributary watershed, the erosion control measures implemented, the size of the watershed, and the design of the facility.

Inspection

Inspect the detention area once or twice annually following precipitation events to determine if the sand filter is providing acceptable infiltration. Also check for erosion and repair as necessary.

Debris and Litter Removal

Remove debris and litter from detention area to minimize clogging of the media. Remove debris and litter from the overflow structure.

Filter Surface Maintenance

Scarify the top 2 inches of sand on the surface of the filter. This may be required once every two to five years depending on observed drain times. After this has been done two or three times, replenish the top few inches of the filter with clean coarse sand (AASHTO C-33 or CDOT Class C filter material) to the original elevation. Maintain a minimum sand depth of 12 inches. Eventually, the entire sand layer may require replacement.

Erosion and Structural Repairs

Repair basin inlets, outlets, and all other structural components required for the BMP to operate as intended. Repair and vegetate any eroded side slopes as needed following inspection.

Retention Ponds and Constructed Wetland Ponds

Inspection

Inspect the pond at least annually. Note the amount of sediment in the forebay and look for debris at the outlet structure.

Debris and Litter Removal

Remove debris and litter from the pond as needed. This includes floating debris that could clog the outlet or overflow structure.

Aquatic Plant Harvesting

Harvesting plants will permanently remove nutrients from the system, although removal of vegetation can also resuspend sediment and leave areas susceptible to erosion. Additionally, the plants growing on the safety wetland bench of a retention pond help prevent drowning accidents by demarking the pond boundary and creating a visual barrier. For this reason, UDFCD does not recommend harvesting vegetation completely as routine maintenance. However, aquatic plant harvesting can be performed if desired to maintain volume or eliminate nuisances related to overgrowth of vegetation. When this is the case, perform this activity during the dry season (November to February). This can be performed manually or with specialized machinery.

If a reduction in cattails is desired, harvest them annually, especially in areas of new growth. Cut them at the base of the plant just below the waterline, or slowly pull the shoot out from the base. Cattail removal should be done during late summer to deprive the roots of food and reduce their ability to survive winter.

Mosquito Control

Mosquito control may be necessary if the BMP is located in proximity to outdoor amenities.

The Town provides annual mosquito control for all public and private facilities. This program includes larvae control only. Mosquitos are more difficult to control when they are adults. This typically requires neighborhood fogging with an insecticide. Therefore, no adult mosquito control is provided. For questions regarding the Town's mosquito control program, please contact the Utilities Department Stormwater Division at 720-733-6011.

Facts on Mosquito Breeding

Although mosquitoes prefer shallow, stagnant water, they can breed within the top 6 to 8 inches of deeper pools.

Mosquitoes need nutrients and prefer shelter from direct sunlight.

Mosquitoes can go from egg to adult within 72 hours.

The most common mosquitoes in Colorado include the *Aedes Vexans* and the *Culex Tarsalis*. Both have similar needs for breeding and development.

Sediment Removal from the Forebay

Remove sediment from the forebay before it becomes a significant source of pollutants for the remainder of the pond. More frequent removal will benefit long-term maintenance practices. For dry forebays, sediment removal should occur once a year. Sediment removal in wet forebays should occur approximately once every four years or when build up of sediment results in excessive algae growth or mosquito production. Ensure that the sediment is disposed of properly and not placed elsewhere in the pond.

Sediment Removal from the Pond Bottom

Removal of sediment from the bottom of the pond may be required every 10 to 20 years to maintain volume and deter algae growth. This typically requires heavy equipment, designated corridors, and considerable expense. Harvesting of vegetation may also be desirable for nutrient removal. When removing vegetation from the pond, take care not to create or leave areas of disturbed soil susceptible to erosion. If removal of vegetation results in disturbed soils, implement proper erosion and sediment control BMPs until vegetative cover is reestablished.

For constructed wetland ponds, reestablish growth zone depths and replant if necessary.

Stabilized Channels & Constructed Wetland Channels

Inspection

Inspect the channel at least annually. Look for signs of erosion.

Debris and Litter Removal

Remove debris and litter as needed.

Aquatic Plant Harvesting

Harvesting plants will permanently remove nutrients from the system although removal of vegetation can also resuspend sediment and leave areas susceptible to erosion. For this reason, UDFCD does not recommend harvesting vegetation as routine maintenance. However, aquatic plant harvesting can be performed if desired to maintain volume or eliminate nuisances related to overgrowth of vegetation. When this is the case, perform this activity during the dry season (November to February). This can be performed manually or with specialized machinery.

If a reduction in cattails is desired, harvest them annually, especially in areas of new growth. Cut them at the base of the plant just below the waterline, or slowly pull the shoot out from the base. Cattail removal should be done during late summer to deprive the roots of food and reduce their ability to survive winter.

Sediment Removal

If the channel becomes overgrown with plants and sediment, it may need to be graded back to the original design and revegetated. The frequency of this activity is dependent on the site characteristics and should not be more than once every 10 to 20 years.

Permeable Pavement Systems

The key maintenance objective for any permeable pavement system is to know when runoff is no longer rapidly infiltrating into the surface, which is typically due to void spaces becoming clogged and requiring sediment removal. This section identifies key maintenance considerations for various types of permeable pavement BMPs.

Inspection

Inspect pavement condition and observe infiltration at least annually, either during a rain event or with a garden hose to ensure that water infiltrates into the surface. Video, photographs, or notes can be helpful in measuring loss of infiltration over time. Systematic measurement of surface infiltration of pervious concrete, Permeable Interlocking Concrete Pavers (PICP), concrete grid pavement, and porous asphalt[1] can be accomplished using ASTM C1701 Standard Test Method for Infiltration Rate of In Place Pervious Concrete.

Debris Removal, Sweeping, and Vacuuming

- **All Pavements:** Debris should be removed, routinely, as a source control measure. Typically, sites that require frequent sweeping already plan for this activity as part of their ongoing maintenance program. For example, a grocery store may sweep weekly or monthly. Depending on the season, city streets also may have a monthly plan for sweeping. This is frequently performed with a broom sweeper. Although a sweeper can be effective at removing solids and debris from the surface, it will not remove solids from the void space of a permeable pavement. Use a vacuum or regenerative air sweeper to help maintain or restore infiltration. If the pavement has not been properly maintained, a vacuum sweeper will likely be needed.

- **PICP, Concrete Grid Pavements (with aggregate infill), Pervious Concrete, and Porous Asphalt[1]:** Use a regenerative air or vacuum sweeper after any significant site work (e.g., landscaping) and approximately twice per year to maintain infiltration rates. This should be done on a warm dry day for best results. Do not use water with the sweeper. The frequency is site specific and inspections of the pavement may show that biannual vacuuming is more frequent than necessary. After vacuuming PICP and Concrete Grid Pavers, replace infill aggregate as needed.

Snow Removal

In general, permeable pavements do not form ice to the same extent as conventional pavements. Additionally, conventional liquid treatments (deicers) will not stay at the surface of a permeable pavement as needed for the treatment to be effective. Sand should not be applied to a permeable pavement as it can reduce infiltration. Plowing is the recommended snow removal process. Conventional plowing operations should not cause damage to the pavements.

- **PICP and Concrete Grid:** Deicers may be used on PICP and grid pavers; however, it may not be effective for the reason stated above. Sand should not be used. If sand is accidently used, use a vacuum sweeper to remove the sand. Mechanical snow and ice removal should be used.

- **Pervious Concrete:** Do not use liquid or solid deicers or sand on pervious concrete. Deicers can damage the concrete and sand will reduce infiltration. Mechanical snow and ice removal should be used.

- **Porous Asphalt[1]:** Use liquid or solid deicers sparingly; mechanical snow and ice removal is preferred. Do not apply sand to porous asphalt.

Full and Partial Replacement of the Pavement or Infill Material

- **PICP and Concrete Grid:** Concrete pavers, when installed correctly, should have a long service life. If a repair is required, it is frequently due to poor placement of the paver blocks. Follow industry guidelines for installation and replacement after underground repairs.

  If surface is completely clogged and rendering a minimal surface infiltration rate, restoration of surface infiltration can be achieved by removing the first ½ to 1 inch of soiled aggregate infill material with a vacuum sweeper. After cleaning, the openings in the PICP will need to be refilled with clean aggregate infill materials. Replacement of the infill is best accomplished with push brooms.

- **Porous Gravel:** Remove and replace areas of excessive wear or reduced infiltration as needed. The frequency is dependent on site characteristics including site uses, vegetation, and materials.

- **Pervious Concrete:** Partial replacement of pervious concrete should be avoided. If clogged, power washing or power blowing should be attempted prior to partial replacement because saw cutting will cause raveling of the concrete. Any patches should extend to existing isolated joints. Conventional concrete may be used in patches, provided that 90 percent of the original pervious surface is maintained.

- **Reinforced Grass:** Remove and replace the sod cover as needed to maintain a healthy vegetative cover or when the sod layer accumulates significant amount of sediment (i.e., >1.5 inches). Maintenance and routine repairs should be performed annually, with sod replacement approximately every 10 to 25 years. When replacing sod, use a high infiltration variety such as sod grown in sandy loam.

- **Porous Asphalt[1]:** Conventional asphalt may be used in patches, provided that 90 percent of the original permeable surface is maintained.

[1] Porous asphalt is considered a provisional treatment BMP pending performance testing in Colorado and is not included in this manual at the present time.

Underground BMPs

Maintenance requirements of underground BMPs can vary greatly depending on the type of BMP. Frequent inspections (approximately every three months) are recommended in the first two years in order to determine the appropriate interval of maintenance for a given BMP. This section provides general recommendations for assorted underground BMPs. For proprietary devices, the manufacturer should provide detailed maintenance requirements specific for the BMP.

Inspection

- **All Underground BMPs:** Inspect underground BMPs at least quarterly for the first two years of operation and then twice a year for the life of the BMP, if a reduced inspection schedule is warranted based on the initial two years. Specifically look for debris that could cause the structure to bypass water quality flows. Strong odors may also indicate that the facility is not draining properly. Inspection should be performed by a person who is familiar with the operation and configuration of the BMP.

- **Inlet Inserts:** Inspect inlet inserts frequently; at a minimum, inspect after every storm event exceeding 0.6 inches. Removal of flow blocking debris is critical for flood control.

Debris Removal, Cartridge Replacement, and Vacuuming

- **All Underground BMPs:** Follow the manufacturer's recommended maintenance requirements and remove any flow blocking debris as soon as possible following inspection.

- **Filter Cartridges:** Inspection of filter cartridges is recommended twice yearly. Replacement of filter cartridges is anticipated on an annual basis. Depending on site characteristics, the replacement frequency may be extended to no less than once every three years. However, semi-annual inspection should continue to ensure that proper function of the system is maintained. Maintenance is required when any of the following conditions exist:

    - If there is more than 4 inches of accumulated sediment on the vault floor.
    - If there is more than ¼ inch of accumulation on the top of the cartridge.
    - If there is more than 4 inches of standing water in the cartridge bay for more than 24 hours after the end of a rain event.
    - If the pore space between media granules is full.
    - If inspection is conducted during an average rainfall event and the system remains in bypass condition (water over the internal outlet baffle wall or submerged cartridges).
    - If hazardous material release (automotive fluids or other) is reported.
    - If pronounced scum line (≥ 1/4" thick) is present above top cap.
    - If system has not been maintained for three years.

- **Hydrodynamic Separators:** Vacuum units at least once annually and more frequently as needed, based on inspections.

Appendix B – Stormwater Facility Maintenance Inspection Forms

Typical Inspection & Maintenance Requirements

Grass Buffers and Swales

Features	Sediment Removal	Mowing/ Weed Control	Trash & Debris Removal	Erosion	Overgrown Vegetation Removal	Standing Water (mosquito/algae control)	Structure Repair
Low-flow channel							
Upper Stage							

Extended Detention Basins (EDBs)

EDB Features	Sediment Removal	Mowing/ Weed Control	Trash & Debris Removal	Erosion	Overgrown Vegetation Removal	Standing Water (mosquito/algae control)	Structure Repair
Inflow Points (outfalls)							
Forebay							
Low-flow channel							
Bottom Stage							
Micropool							
Outlet Works							
Emergency Spillway							
Upper Stage							
Embankment							

Rain Gardens and Porous Landscape Detention (PLDs)

PLD Features	Sediment Removal	Mowing Weed control	Trash & Debris Removal	Erosion	Overgrown Vegetation Removal	Removal/ Replacement	Structure Repair
Inflow Points							
Landscaping							
Filter Media							
Underdrain System							
Overflow Outlet Works							
Embankment							

Sand Filter Basin (SFBs)

SFB Features	Sediment Removal	Mowing Weed control	Trash & Debris Removal	Erosion	Overgrown Vegetation Removal	Removal/ Replacement	Structure Repair
Inflow Points/ Splitter Box							
Sedimentation Chamber							
Filter Media							
Underdrain System							
Overflow Outlet Works							
Embankment							

Retention Ponds and Constructed Wetland Ponds

EDB Features	Sediment Removal	Mowing/ Weed Control	Trash & Debris Removal	Erosion	Overgrown Vegetation Removal	Standing Water (mosquito/algae control)	Structure Repair
Inflow Points (outfalls)							
Forebay							
Low-flow channel							
Bottom Stage							
Permanent Pool							
Outlet Works							
Emergency Spillway							
Upper Stage							
Embankment							

Constructed Wetland Channels

EDB Features	Sediment Removal	Mowing/ Weed Control	Trash & Debris Removal	Erosion	Overgrown Vegetation Removal	Standing Water (mosquito/algae control)	Structure Repair
Inflow Points (outfalls)							
Bottom Stage							
Permanent Pool							
Upper Stage							

Permeable Pavement Systems

PLD Features	Sediment Removal	Mowing Weed control	Trash & Debris Removal	Erosion	Overgrown Vegetation Removal	Removal/ Replacement	Structure Repair
Inflow Points							
Landscaping							
Filter Media							
Underdrain System							
Overflow Outlet Works							
Embankment							

Note: For more information regarding facility features refer to the Town's Storm Manual or UDFCD Urban Storm Drainage Criteria Manual.