FINAL
DRAINAGE REPORT

FOR

FEDERAL BOULEVARD/US 6
INTERCHANGE IMPROVEMENTS
PROJECT NO. IM 088A-024

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JANUARY 7, 2011

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Certification Statement

This report for the drainage design of Federal Boulevard/US 6 Interchange Improvements was prepared by me (or under my supervision) in accordance with the provisions of City and County of Denver Storm Drainage Design and Technical Criteria, and was designed to comply with the provisions thereof. I understand that the City and County of Denver does not, and will not, assume liability for drainage facilities designed by others.

By: _____

Licensed Professional Engineer State of Colorado No. 25746

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1.0 INTRODUCTION

This Drainage Report presents the drainage concepts, final hydrologic, hydraulic and design calculations for drainage facilities associated with the Federal Boulevard bridge replacement and widening over US 6 and related ramp improvements. The drainage improvements will provide water quality features and conveyance facilities for the ramps and for the widening of Federal Boulevard. This report is prepared in accordance with the Colorado Department of Transportation (CDOT) *Drainage Design Manual*, the City and County of Denver (CCD) *Storm Drainage Design & Technical Criteria Manual*, the Urban Drainage Flood Control District (UDFCD) *Urban Storm Drainage Criteria Manual*, and standard engineering practices.

Design of the drainage improvements has been coordinated with two ongoing projects along Federal Boulevard north and south of the subject project. From Alameda to 5th Avenue, Wilson & Company prepared construction documents for widening of Federal Boulevard for CDOT. From West 7th Avenue to Howard Place the Planning and Environmental (PEL) study and preliminary design has been completed by Felsburg Holt & Ullevig for CCD. The PEL has been accepted by CDOT and the Federal Highway Administration (FHA).

2.0 GENERAL LOCATION AND DESCRIPTION

2.1 Location

The overall project area, shown in Figure 1, is located in the south half of Section 5 and the north half of Section 8, Township 4 South, Range 68 West of the Sixth Principal Meridian in the City and County of Denver, Colorado. The project will include roadway improvements along Federal Boulevard from West 5th Avenue to West 7th Avenue and ramp improvements to US 6. Storm sewer will be extended along the US 6 north access road from Canosa Court to the Platte River.

Denver Park's Barnum Park East, located at the southeast corner of the Federal Boulevard/US 6 Interchange, will be affected by this project and will be redesigned pursuant to the Environmental Impact Statement and pending intergovernmental agreement between CDOT and CCD. The project area is surrounded by portions of P.T. Barnums Subdivision and Ellerman's Addition on the west, and Burns City View Addition on the east.

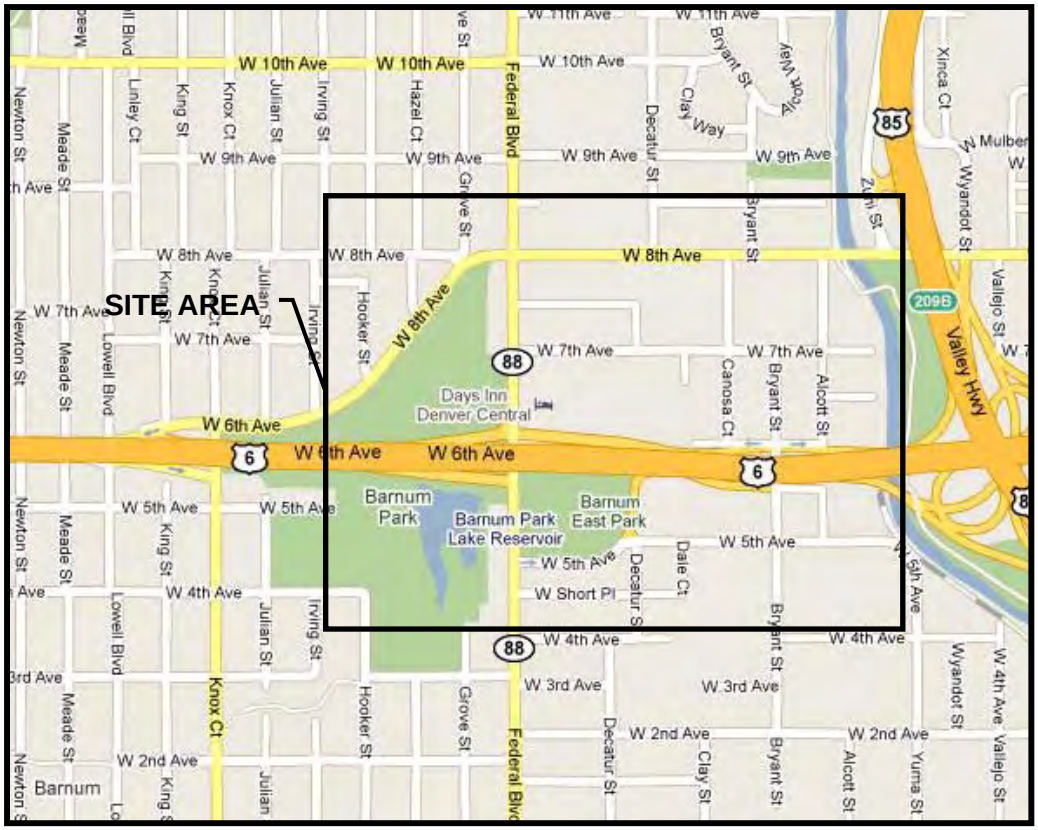

Figure 1: Vicinity Map

2.2 Description of Property

The study area includes commercial/retail, park, and residential land uses. The topography in the site vicinity generally slopes to the east to the South Platte River, with slopes ranging from 0.3 to 15 percent. The existing ground cover in areas of new pavement is primarily grass, in the Barnum Park area. Conversely, in this same area, existing pavement will be abandoned and reverted to grass and/or park usage. The remainder of the project site is fully developed and consists mostly of pavement, roofs and landscape areas. The SCS Soil Survey does not have data for the project area. It was therefore assumed that the drainage area soils belong to the Hydrologic Soils Group C, soil that is poorly drained and has a moderately high runoff potential.

Weir Gulch runs from the southwest to the northeast just west of the project area. Weir Gulch flows through Barnum Lake, located at the southwest corner of Federal Boulevard and US 6, then under US 6 before continuing north. There are no major existing irrigation facilities in the project area.

The project area lies partially within the 500-year floodplain of the South Platte River. This is due to the fact that the US 6 bridge is currently undersized. During major storm events the river overtops the bridge and floods the properties on the west side of the river. See Appendix B for the Flood Insurance Rate Maps.

The project is located in existing right-of-ways, or right-of-ways that will be acquired.

3.0 MAJOR DRAINAGE BASINS AND SUB-BASINS

3.1 Major Basin Description

The project is located within the Weir Gulch (4900-01) and 1st and Federal (0064-02) basins identified in the City and County of Denver Storm Drainage Master Plan (June 2009).

Several reports have studied the project area. Major Drainageway Planning Sanderson Gulch/ Weir Gulch was prepared by Frasier & Gingery in August 1972. The South Platte River Hydrologic Study: Chatfield Dam to Sand Creek by Merrick & Company (1983) and the South Platte River: Denver Metropolitan Area: Sand Creek to Oxford Ave by Wright Water Engineers Flood Hazard Area Delineation (FHAD) Report (1985) studied the South Platte River within the project area.

The Flood Insurance Rate Map (FIRM) for Denver County, Colorado, panel number FM0800460182G, dated November 17, 2005, shows that the subject site is partially located in a Zone X (shaded), areas of 0.2-percent-annual-chance floodplain, areas of 1-percent-annual-chance (base flood) sheet flow flooding with average depths of less than 1 foot, areas of base flood stream flooding with a contributing drainage area of less than 1 square mile, or areas protected from the base flood by levees. The FIRM panel is included in Appendix B.

Existing and planned uses in the study area are the same. No irrigation facilities are located within the project area.

3.2 Sub-basin Description

Within the project area, storm water runoff is collected at three main outfall locations in existing conditions.

The north portion of the project area, which includes the northwest on-ramp to US 6 from Federal Boulevard and the area of Federal Boulevard north of the bridge crest over US 6, drains north to inlets located at 8th Avenue. This storm sewer system drains to Weir Gulch.

Barnum Lake is the second outfall location. The portion of Federal Boulevard south of the crest over US 6 drains to a grate inlet at the west end of West 5th Avenue on the west side of Federal Boulevard, between the southwest ramp and the BBB Mart Fine Jewelry. This grate inlet drains directly to Barnum Lake (Design Point 4, see Appendix A for the Drainage Plans).

Runoff from West 5th Avenue east of Federal Boulevard is collected by a storm sewer system that ties into the US 6 storm sewer where the on-ramp meets US 6. The 5th Avenue storm sewer and the US 6 storm sewer systems run to the intersection of Bryant Street and Alcott Street before ultimately discharging into the South Platte River.

Offsite flows from US 6 west of the project area are intercepted by grate inlets along US 6 before reaching the project area. Evaluating the capacity of the existing US 6 storm sewer system was not in the scope of this study. It is assumed that the storm system in US 6 is adequate to convey the major and minor storm events.

4.0 DRAINAGE FACILITY DESIGN

4.1 General Concept

Runoff from the project area will consist of two main systems. The area north of US 6 (North system) and the remainder of the project area (South System) will drain to a water quality detention pond located north of US 6 and west of Canosa Court (US 6 Pond). The US 6 Pond will outfall to the South Platte River. Runoff from the east end of the Slip Ramp will be treated by a Stormceptor.

In the Preliminary Design Report dated May 18, 2010, it was contemplated that the Federal Boulevard/US 6 project would construct the storm sewer shown in the PEL north in Federal Boulevard to a water quality pond located east of Federal Boulevard and north of 8th Avenue. Additional analysis completed by Olsson Associates, subsequent to the preliminary drainage report, showed that the US 6 and Federal project could provide the storm sewer routing and the required water quality capture volume needed to satisfy CDOT's MS4 permit requirements within the US 6 and Federal project limits. Therefore, CDOT decided to not include the storm sewer north of 7th Avenue and the 8th Avenue water quality pond in the US 6 and Federal construction project. This allowed the US 6 and Federal project to move forward without the extensive utility potholing, coordination and relocation needed to construct a new storm sewer north of 7th Avenue, which resulted in project cost savings.

Drainage plans depicting the planned drainage improvements, supporting calculations and reference materials are included in the appendices.

4.2 Design Criteria

4.2.1 Criteria Reference

The drainage improvements were evaluated in accordance with the Colorado Department of Transportation *Drainage Design Manual* (DDM), the City and County of Denver *Storm Drainage Design & Technical Criteria Manual* (SDDTCM), and the Urban Drainage Flood Control District *Urban Storm Drainage Criteria Manual* (USDCM).

4.2.2 Hydrologic Criteria and Analysis

The Rational Method model was used to estimate the peak runoff rates for the 5- and 100-year storms. This method is defined as follows:

$$Q = CIA$$

where: Q = Peak Discharge in Cubic Feet per Second (cfs)

C = Runoff Coefficient

I = Rainfall Intensity in Inches per Hour

A = Drainage Area in Acres

The design storm frequencies used to evaluate the proposed improvements were the 5-year, 50-year and 100- year storms. One-hour point rainfall values of 1.34, 2.25 and 2.57 inches

were used to calculate the 5-, 50- and 100-year rainfall intensities. Values were obtained from Table 5.1 in the SDDTCM. A Water Quality storm event was also used, with a one-hour point rainfall value of 0.5 inches.

The time of concentration is required to select the appropriate rainfall intensity. The time of concentration was calculated using equations from Section 2.4 of the Runoff chapter of the USDCM. The resultant time found using these equations is compared to the time of concentration for urbanized basins, which is also calculated using an equation from Section 2.4. The lesser of the two times is used to determine the rainfall intensity, with a minimum allowable time of concentration equal to five minutes. Runoff coefficients were determined using the percent imperviousness, NRCS hydrologic soil group, and Table RO-3 from the USDCM. Equation 5.1 from the SDDTCM was used to determine the rainfall intensities for each sub-basin. Flowmaster was used to calculate pipe flow velocities and travel times. Table 7.4 from the DDM was used to calculate overland flow travel times for the 100-year storm event. Hydrologic calculations are included with this report in Appendix C.

The SDDTCM criterion was used for one-hour point rainfall depths. Also referenced was the criterion that the time of concentration to the first design point in an urban area shall be a maximum of 10 minutes, in conjunction with the CDOT criterion that the minimum time of concentration shall be 5 minutes. The times of concentration used in the Rational Method calculations were adjusted accordingly to fit within these parameters.

4.2.3 Hydraulic Criteria and Analysis

Criteria from the DDM were used for spread widths, gutter depths, and inlet design for Federal Boulevard and the Federal/US 6 ramps. Federal Boulevard is classified as an arterial roadway, and for design purposes, the ramps were also classified as arterials. For the storm sewer inlets on Federal Boulevard and W. 5th Avenue, SDDTCM criteria were used.

Table 13.2 in the DDM states that for a sag point in an arterial, a design frequency of 50 years and a design spread width of “Shoulder + 3 ft” should be used. This criterion was used for design points 5 (southwest ramp), 7 (Federal Boulevard), and 15 (US 6 Eastbound). US 6 is classified as an interstate highway, so the CDOT criterion that “water shall not go out into the traveled lane more than 4 feet for the 100-year storm” was used for design points located on US 6.

The SDDTCM was used for spread widths, gutter depths, and inlet design of West 5th Avenue, which in proposed conditions will be classified as a collector. Table 7.1 states that the allowable use of streets for minor storm runoff for a collector is:

- no curb overtopping, and
- flow spread must leave at least one lane free of water, with 5 feet on either side of the street crown.

Table 7.2 states that the allowable use of streets for major storm runoff for a collector is:

> “residential dwellings, public, commercial and industrial buildings shall not be less than 12 inches above the 100-year water surface elevation at the ground line or lowest water entry into the building. The depth of water over the gutter flow line shall not exceed 12 inches.”

The 100-year criterion is not met in existing conditions. The proposed drainage improvements will improve the current situation, but will not fully comply with this criterion.

Proposed roadway design prepared by CDOT was used to evaluate the capacity of the proposed storm sewers and streets. Street hydraulics and inlet capture efficiency were calculated using UD-Inlet Version 2.14c. This Microsoft Excel-based program allows the user to input the specific curb and gutter geometry, street cross slope and longitudinal slope, street width, and roughness coefficients to determine the actual flow depth and spread for a given runoff. It then compares the flow depth and spread for the given runoff event to the allowable flow depth and spread. The program also allows the user to input specific inlet geometry such as throat width and length, clogging factor, and local depression to determine the inlet capture efficiency. These calculations have been included in Appendix D.

Existing and proposed storm sewers were analyzed using Hydraflow Storm Sewers Extension for AutoCAD Civil 3D. The storm sewers were evaluated in three different sections: the north system to US 6 Pond, the south system to the US 6 Pond, and the outfall system from the US 6 Pond which discharges into the South Platte River. Flows were entered manually, based on the Rational Method calculations. The proposed storm sewers were sized to carry the 5-year flows, with the exception that sump inlets within CDOT jurisdictions were sized to carry the 50-year flows. See Appendix E for the storm sewer analysis results.

4.3 Specific Details

4.3.1 Existing Stormwater Facilities

In existing conditions, runoff from the west half of Federal Boulevard south of US 6 is collected by a grate inlet located at the west end of West 5th Avenue and drains to Barnum Lake at the southwest corner of the Federal & US 6 Interchange.

Runoff from the east half of Federal between US 6 and West 5th Avenue flows south, and rounds the corner into the Barnum Park East parking lot as well as down West 5th Avenue. At the south end of the project area, there is a high point on Federal between W 5th Avenue and W Short Place. From that high point to W 5th Avenue, runoff flows north and east to W 5th Avenue. South of the high point, runoff flows south and directed parallel to Federal by a street pan at W Short Pl, so that the flows will continue south. Flows greater than low flow events may round the corner down W Short Pl. Curb inlets along West 5th Avenue, including a grate inlet in the Barnum Park East parking lot, flow into an existing storm sewer system that runs to the north under the existing onramp to US 6 Eastbound. This system ties into the existing US 6 storm sewer system at an existing vane grate inlet at Design Point 38 (see Preliminary Detailed Drainage Plans, Appendix A).

An existing storm sewer system runs along US 6 between the eastbound and westbound lanes that intercepts runoff at grate inlets located along each side of the highway. This system ties into the Weir Gulch culvert at Design Point 51, which runs under US 6 at the west extents of the project. Additional inlets pick up runoff at design points 33 and 34. As-built drawings (see References) show these inlets originally draining to a storm sewer that runs to the north into Weir Gulch. It is assumed that in existing conditions, this system either ties into the box culvert to the west, or runs north to drain to Weir Gulch. From there onto the east, the runoff from US 6 is collected by a storm sewer system that runs to the east. This system collects flows from the east and westbound lanes of US 6 from Federal Boulevard to Bryant Street as well as the

northeast ramp. These flows are conveyed by a storm sewer which runs to the southeast ramp at Bryant Street, and ultimately outfalls at the South Platte River to the east.

To the north, there are three existing curb inlets on the west side of the intersection of 8th Avenue with Federal Boulevard. In existing conditions, these inlets pick up flows from Federal Boulevard north of US 6 to 8th Avenue and drain to Weir Gulch.

4.3.2 Proposed Stormwater Facilities

In proposed conditions, the minor storm (5-year) runoff will be conveyed by six systems. The north system and the south system discharge to the US 6 pond. A third system diverts the water quality storm event flows from US 6 at design point 33 to the US 6 storm sewer system, which at the slip ramp is then diverted to the US 6 Pond. Two more systems include the Stormceptor System at the Slip Ramp at Bryant Street, and an extension of the storm sewer as designed by Wilson at Federal Blvd and W Short Place. The final system provides an outfall from the US 6 Pond to the South Platte River.

The north system will include inlets at the northwest ramp, the northeast ramp and along Federal Boulevard between US 6 and 7th Avenue. The inlets at the northwest ramp and at 7th Avenue are located in sump conditions and, in accordance with CDOT criteria, have been sized for the 50-year storm event. The north system runs down the northeast ramp and outfalls at the US 6 Pond.

The south system includes multiple laterals. The first lateral collects runoff from the southwest ramp, reconfigured southeast ramp, and the portion of Federal from US 6 to West 5th Avenue. The inlets at the southwest ramp (509L) and the inlet located on the east side of Federal Boulevard (106R) are located in sump conditions and, in accordance with CDOT criteria, have been sized for the 50-year storm event. Two additional inlets (906R and 906L) are located in West 5th Avenue on the west side of Federal Boulevard. Inlet 906L will be a Denver Triple No. 16 and a Single No. 16 in combination, in order to intercept all flows and avoid a conflict with a retaining wall on the south side of W 5th Avenue. This lateral runs east along the south curb line of the southeast ramp, where three additional Type R inlets are located.

The second lateral of the south system collects runoff from West 5th Avenue and Barnum Park East. Four inlets located along West 5th Avenue and two inlets in sump locations on Decatur Street tie into a manhole located in the intersection of Decatur Street and West 5th Avenue. This system runs north within the existing southeast ramp right of way. The future redesign of Barnum Park will have the ability to connect the park drainage system to the storm sewer, which is sized to accommodate flows from this off-site area. It was assumed for the hydrologic calculations that the redesign will have a similar percent imperviousness. This lateral of the south system connects to the first lateral at Structure 616C, on the southeast ramp.

The third lateral of the south system collects runoff from the slip ramp and a portion of US 6 and the southeast ramp just west of Bryant Street. Four vane grate inlets will be located along the retaining wall on the south side of the slip ramp. The inlet located on the north side of the slip ramp at Design Point 18 (Structure 721L) is the lowest inlet of the south system, and will control the grade profile. All flows from the existing US 6 storm system will be intercepted at Structure 721C. The inlet at Design Point 15 (Structure 619R), located on eastbound US 6, will be sized to collect the 50-year storm in order to prevent cross flows across the slip ramp. The three inlets located on US6 are CDOT Type R inlets to accommodate the 2’ curb and gutter. This third lateral ties into the first and second lateral at a manhole (Structure 619C) located in the median

between the slip ramp and eastbound US 6. At this location, a pipe will be jacked under east and westbound US 6 to the north side of the highway, and will outfall into the US 6 pond. See appendices A and E for the proposed storm sewer layout.

The third system is designed to divert the water quality storm event flows from sub-basins WG1 and WG2, which originally flowed into Weir Gulch to the north. The flows will be intercepted at Structure 1106L and will flow east, tying into the existing US 6 system at Structure 1109C. Larger storm event flows will continue north to Weir Gulch. Structure 1106L will be a modified vane grate inlet (see details in Appendix G). The diverted flows will be intercepted at the slip ramp, where they will flow through the south system under US 6 into the detention pond.

The fourth system will capture and provide water quality for runoff from the east end of the slip ramp. Runoff will be captured by a Denver Single No. 16 Combination inlet (Structure 724R) on the south side of the ramp, and will flow north to a Stormceptor System before tying into the existing storm system at Structure 725C.

The fifth system will be an extension of the storm sewer system at Federal Blvd and 5th Avenue, as designed by Wilson. The vertical profile of Federal Boulevard at 5th Avenue will be raised with this project, moving the high point in the profile to the north and necessitating an adjustment of an inlet location. If not moved, the inlet will be located at the high point and will not capture any flows. Assuming that the project to the south will be constructed first, the inlet described as C-1 in the 5th to Alameda plans will need to move to the northeast corner of W Short Place and Federal Boulevard. Inlet C-1 will be replaced with a manhole, and a 12” Ductile Iron Pipe (DIP) will extend to the south to the new inlet location. The DIP was chosen to match the pipe size and type of the pipe under Federal from Wilson’s MH-21 to Inlet C-1. The new inlet will be placed at the south extent of this project. If coordination between the projects can be achieved, the inlet location ideally should be at the curb return, 20 feet farther south.

The final storm sewer network is the outfall from the US 6 Pond to the South Platte River. An outlet structure from the US 6 Pond will release the WQCV and will control the 10- and 100-year flows from the pond (see Figure 10). The outfall will be a 4’x2’ Reinforced Concrete Box Culvert, and will run southeast to the north access road of US 6, where it will change direction at a precast bend and run due east at a 0.3% slope along the road to the South Platter River. Riser access manholes will be provided every 400 feet for maintenance access. The outfall will include a grouted boulder rundown to protect the embankment. The detail is included in Appendix F. The rundown plan and details will be submitted to Urban Drainage and Flood Control District for maintenance eligibility. The water, gas, and other utility lines in the access road will need to be adjusted during construction of the outfall storm sewer. See appendices A and E for the proposed storm sewer layout.

A retaining wall will be constructed on the south side of the slip ramp as it nears Bryant Street. At this location (Structures 717R, 718R, 719R, and 720R), CDOT 36” vane grate inlets will be used. All inlets located on Federal Boulevard and W 5th Avenue will be Denver No. 14 inlets, and all other inlets located on the ramps will be CDOT type R inlets. See Table 1 for a summary of inlet types and sizes.

Table 1 - Inlet Summary

Design Point	Structure ID	Inlet Type	Number of Inlets	Length (ft)
1	906L	Denver Triple No. 16 and Single No. 16 Open Throat Inlet with Adjustable Curb Box	2	N/A
3	906R	Denver Type 14	1	6
5	509L	CDOT Type R	1	10
7	106R	Denver Type 14	1	6
8	610R	CDOT Type R	1	5
9	613R	CDOT Type R	1	5
10	615R	CDOT Type R	1	10
11	717R	CDOT 36” Vane Grate	1	N/A
12	718R	CDOT 36” Vane Grate	1	N/A
13	719R	CDOT 36” Vane Grate	1	N/A
14	720R	CDOT 36” Vane Grate	1	N/A
15	619R	CDOT Type R	1	5
16	620R	CDOT Type R	1	5
17	621R	CDOT Type R	1	5
18	721L	CDOT Type R	1	10
20	724R	Denver Single No. 16 Combination Open Throat Inlet with Adjustable Curb Box	1	N/A
33	1106L	CDOT 36” Vane Grate	1	3
60	413R	CDOT Type R	1	5
61	112L	Denver Type 14	1	6
62	113L	Denver Type 14	1	6
63	115L	Denver Type 14	1	6
64	117L	Denver Type 14	1	6
65	112R	Denver Type 14	1	6
66	113R	Denver Type 14	1	6
67	114R	Denver Type 14	1	6
68	116R-1	Denver Type 14	1	9
69	116R-2	Denver Type 14	1	6
70	313L	CDOT Type R	1	10
71	316L	CDOT Type R	1	10
80	210L	CDOT Type C	1	N/A
92	208L	Denver Type 14	1	9
93	208R	Denver Type 14	1	9
94	811L	Denver Type 14	1	9
95	211L	Denver Type 14	1	9
96	211R	Denver Type 14	1	6

4.3.3 Water Quality

The US 6 pond will provide the water quality capture volume for the project. It is located on a parcel of land on the north side of US 6 which CDOT has acquired (Lot AP-104). The grading for this pond will tie in to the embankment to the west at elevation 5212 feet, and the bottom of the pond will be located at elevation 5202.50 feet. The pond grading will include an embankment on the north and east sides to provide the necessary detention volume. An emergency overflow spillway at elevation 5211 will be located on the east embankment adjacent to the US 6 access road.

The US 6 Pond is sized to provide water quality for sub-basins SW1 through SW3, SE1 through SE10, OS-9, SR1, SR2, BPE1, BPE2, 5TH1 through 5TH7, NW1, NF1 through NF9, NE1, NE2, WQ1, EB1 through EB4, and WB1 through WB7, which have a total area of 40.79 acres. These sub-basins comprise water quality basin 1 (WQ1) shown on Figure 10. The water quality capture volume for the US 6 Pond is 0.92 acre-feet.

Water quality for the widening and resurfacing of US 6 west of the Federal Boulevard bridge will be provided by diverting the water quality storm event runoff at Structure 1106L. This modified Vane Grate inlet will include an orifice plate to direct the water quality storm runoff into a proposed storm sewer pipe which will run to the east and join the existing US 6 storm sewer network at Structure 1109C. Flow greater than the water quality storm will be conveyed in the existing storm sewer, which flows under the northwest ramp to Weir Gulch. Water quality will then be provided by diverting the entire flow from the US 6 storm system at Structure 721 C at the slip ramp. A new manhole will intercept all flows and the existing pipe downstream of this manhole up to the 36” line in the slip ramp will be removed. Tributary to this diversion manhole is all of the area west of Bryant on US 6 to Federal Boulevard. The US 6 Pond is sized to provide water quality for this entire area.

Two areas within the project area will not be routed to a water quality pond. Sub-basins SR3 and SR4 (WQ-2, see Figure 10) drain to existing inlets at Design Points 19 and 20 on the slip ramp. The inlet at Design Point 19 will be removed, and a Stormceptor will be added at the east end of the slip ramp. The system will tie back into the existing storm sewer system at Structure 725C, on the existing 18” storm line in Bryant Street. Sub-basin WQ3 represents the back side of the US 6 Pond embankment. Although this area is located within the project limits, it cannot be routed back into the pond for treatment. This sloped area will be vegetated and maintained as a Grass Buffer BMP. The final area not routed to the US 6 Pond is represented by WQ-4 (see Figure 10). Runoff from this area flows beyond inlets located at the extents of the new curb line. Work in this area will consist of milling and overlaying the existing street and is exempt from treatment due to the overlay exemption.

Runoff from the area represented by WQ-5 (see Figure 10) at the south end of Federal Boulevard within project limits will be captured by the storm sewer system associated with the 5th to Alameda project to the south. Water quality will be provided by the Barnum Lake Water Quality Pond.

The pavement comprising the existing southeast onramp to US 6 will be reverted back to Denver Parks, and converted to grass and/or parks usage. This area will be graded back to a swale so that existing drainage patterns will be maintained. Drainage from this area will be collected and tied in to the south system at Structures 615R and/or 210L. Either inlet can be extended or tied into to accommodate drainage designs for the park.

The storm sewer in Federal Boulevard, the storm sewer in 5th Avenue and the storm sewer in Barnum Park will be maintained by CCD. The US 6 Pond, Stormceptor system, and the storm sewer in US 6 and ramps will be maintained by CDOT.

The Best Management Practices (BMPs) associated with this project includes the US 6 water quality pond (designed as an extended detention basin), Grass Buffer, and the Stormceptor System at the terminus of the project on the southwest ramp.

CDOT's MS4 permit requires that permanent BMPs be provided for significant highway modifications. Water quality treatment will be provided for 13.39 acres of impervious project area and 10.36 acres of impervious non-project area. The treated impervious area is 177% of the impervious area that is required to be treated.

4.4 Circumstances Influencing Design

CDOT requires that inlets placed in sumps must be sized for the 50-year storm event. Design Points 5 (Structure 509L, southwest ramp), Design Point 7 (Structure 106R, northbound Federal Boulevard), Design Point 68 (Structure 116R-1, 7th & Federal), Design Point 69 (Structure 116R-2, 7th & Federal), and Design Point 60 (Structure 413R, northwest ramp) will be in sump locations in proposed conditions. In order to eliminate cross flows across the southeast ramp, Design Point 15 (Structure 619R) is also designed as a sump inlet. The Rational Method was used to calculate the 50-year flows, which were used with the Hydraflow model to verify that the proposed storm sewer system can adequately convey the 50-year storm.

The proposed storm sewer line running from the southwest ramp under Federal Boulevard will be designed in conjunction with the water mains in Federal Boulevard that will be relocated as part of the project.

The US 6 Pond storm sewer outfall was designed with special considerations. In order to provide 4-inches of clearance above the brick sanitary sewer line near the Platte River the storm sewer was designed with less than the recommended 0.5% slope. T-base manholes, reinforced concrete box culverts (RCBC) and a minimum pipe slope of 0.30% were used. . Potholing this sanitary line was unsuccessful due to riprap in the area, therefore this line will need to be field located before the outfall is constructed. Assumed invert elevations of the sanitary line were taken from as-built drawings.

4.5 Waivers From Criteria

SDDTCM 9.3 – Pipe Size: minimum allowable pipe diameter for inlet laterals is 15-inch. The inlet lateral pipe from inlet structure 100R located on the east side of Federal, north of Short Place is proposed to be 12-inch ductile iron pipe. This lateral is modification to the lateral shown on the Federal Boulevard Improvement Project, Alameda to 6th Avenue. The pipe matches the size and material used for that project.

5.0 CONCLUSIONS

The Federal Boulevard and US 6 project will include five storm sewer systems, one water quality pond, a Stormceptor System, and an outfall storm sewer to the South Platte River.

The proposed improvements conform to CDOT and CCD drainage criteria.

6.0 REFERENCES

Urban Storm Drainage Criteria Manual, Urban Drainage and Flood Control District, Revised April 2008.

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South Platte River Hydrologic Study, Chatfield Dam to Sand Creek, Urban Drainage and Flood Control District and Merrick & Company, May 1983.

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As Constructed Plan and Profile of Completed Federal Aid Project No. U 012-2(13), State Highway No. 182, City and County of Denver, Department of Highways, State of Colorado, 29 November 1967.

Plan and Profile of Proposed Federal Aid Project No. U 012-2(7), State Highway No. 182, City and County of Denver, Colorado Department of Highways, 21 August 1962.

Plan and Profile of Proposed Federal Aid Project No. U 012-2(3), State Highway No. 182, City and County of Denver, Colorado Department of Highways, 31 July 1956.

APPENDIX A

Preliminary Overall and Detailed Drainage Plans

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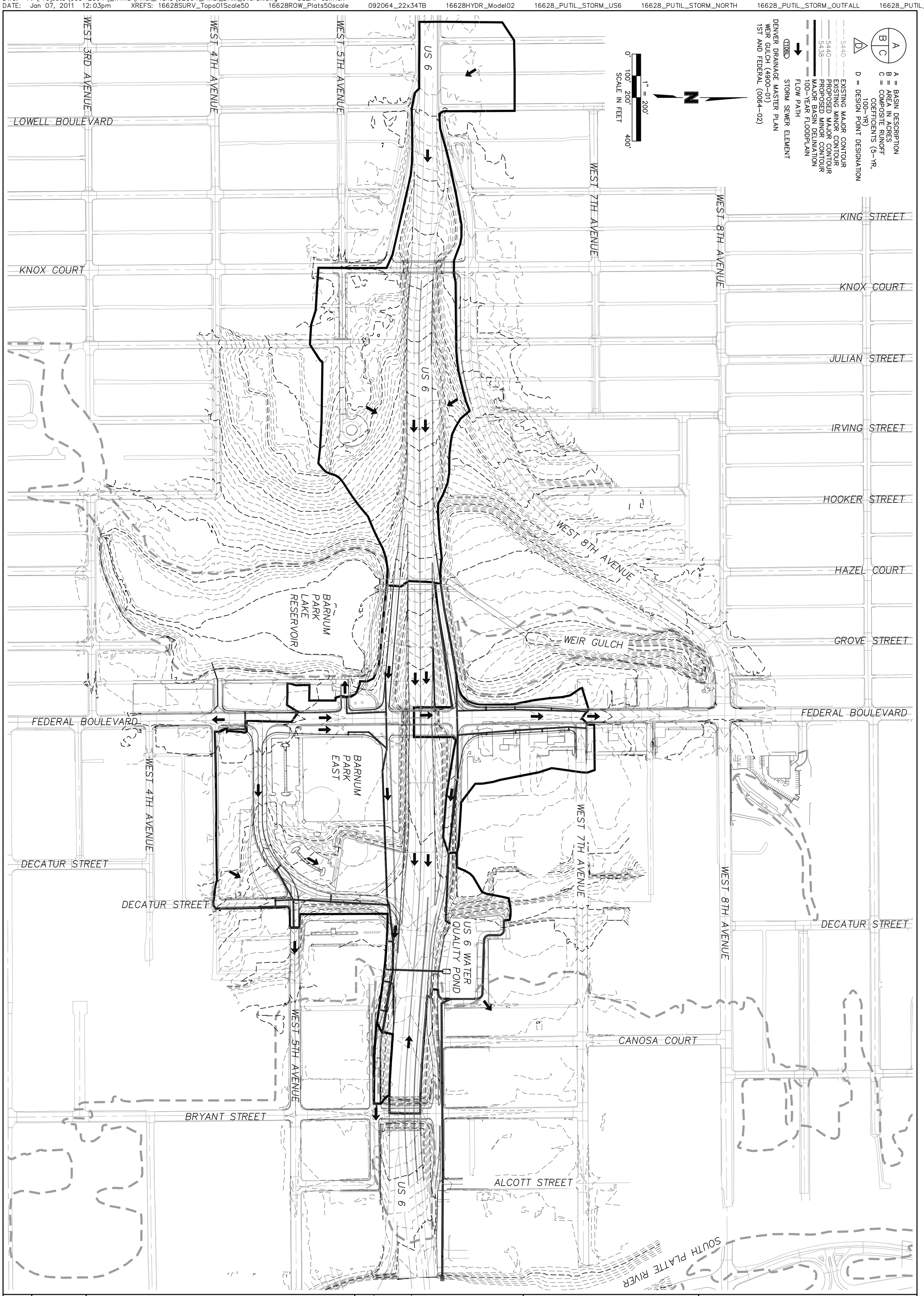

FIGURE 2

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PRELIMINARY
OVERALL DRAINAGE PLAN

FEDERAL BOULEVARD & US 6
INTERCHANGE IMPROVEMENT

DENVER, COLORADO 2010

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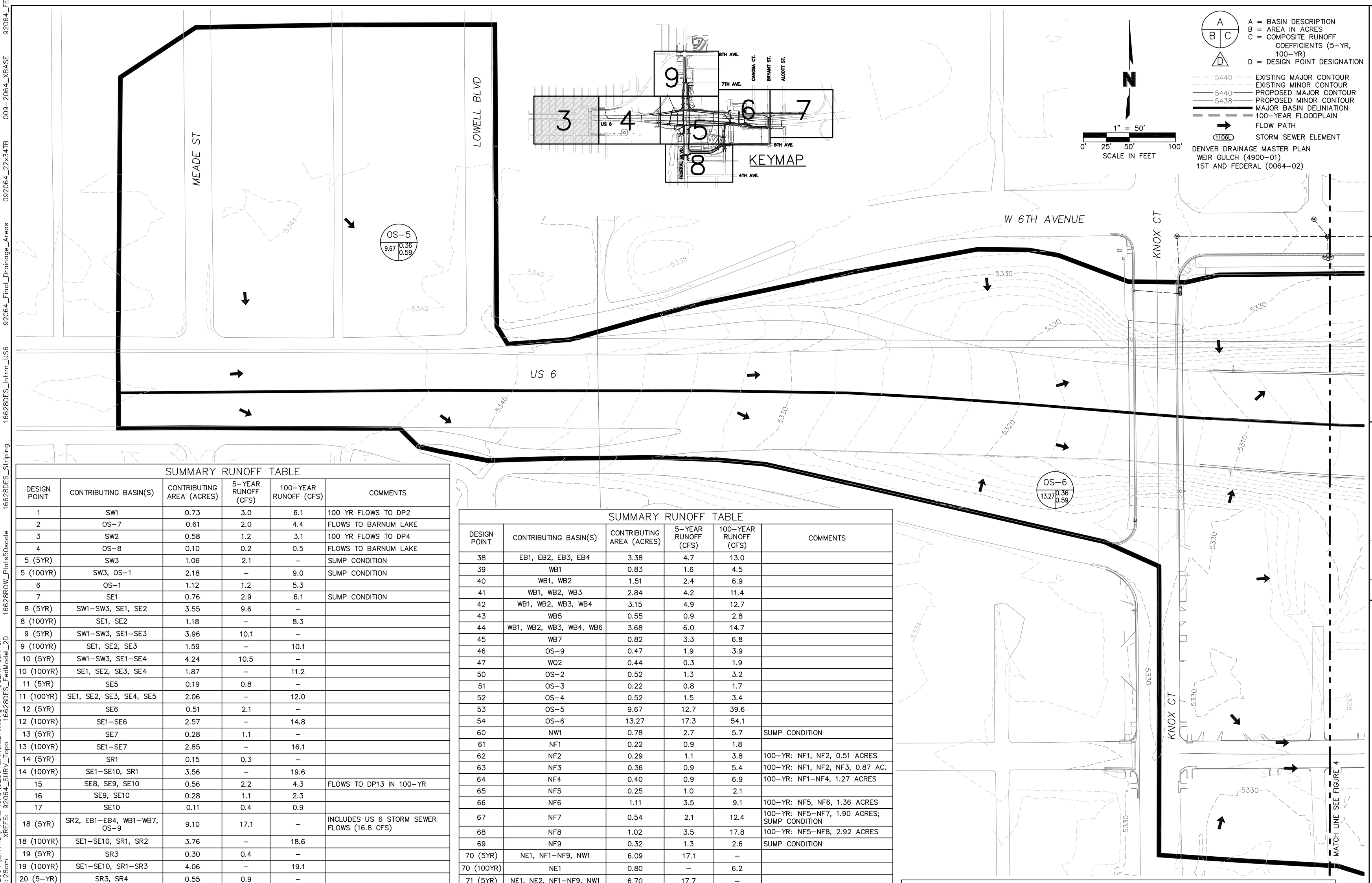

SUMMARY RUNOFF TABLE

DESIGN POINT	CONTRIBUTING BASIN(S)	CONTRIBUTING AREA (ACRES)	5-YEAR RUNOFF (CFS)	100-YEAR RUNOFF (CFS)	COMMENTS
1	SW1	0.73	3.0	6.1	100 YR FLOWS TO DP2
2	OS-7	0.61	2.0	4.4	FLOWS TO BARNUM LAKE
3	SW2	0.58	1.2	3.1	100 YR FLOWS TO DP4
4	OS-8	0.10	0.2	0.5	FLOWS TO BARNUM LAKE
5 (5YR)	SW3	1.06	2.1	–	SUMP CONDITION
5 (100YR)	SW3, OS-1	2.18	–	9.0	SUMP CONDITION
6	OS-1	1.12	1.2	5.3	
7	SE1	0.76	2.9	6.1	SUMP CONDITION
8 (5YR)	SW1-SW3, SE1, SE2	3.55	9.6	–	
8 (100YR)	SE1, SE2	1.18	–	8.3	
9 (5YR)	SW1-SW3, SE1-SE3	3.96	10.1	–	
9 (100YR)	SE1, SE2, SE3	1.59	–	10.1	
10 (5YR)	SW1-SW3, SE1-SE4	4.24	10.5	–	
10 (100YR)	SE1, SE2, SE3, SE4	1.87	–	11.2	
11 (5YR)	SE5	0.19	0.8	–	
11 (100YR)	SE1, SE2, SE3, SE4, SE5	2.06	–	12.0	
12 (5YR)	SE6	0.51	2.1	–	
12 (100YR)	SE1-SE6	2.57	–	14.8	
13 (5YR)	SE7	0.28	1.1	–	
13 (100YR)	SE1-SE7	2.85	–	16.1	
14 (5YR)	SR1	0.15	0.3	–	
14 (100YR)	SE1-SE10, SR1	3.56	–	19.6	
15	SE8, SE9, SE10	0.56	2.2	4.3	FLOWS TO DP13 IN 100-YR
16	SE9, SE10	0.28	1.1	2.3	
17	SE10	0.11	0.4	0.9	
18 (5YR)	SR2, EB1-EB4, WB1-WB7, OS-9	9.10	17.1	–	INCLUDES US 6 STORM SEWER FLOWS (16.8 CFS)
18 (100YR)	SE1-SE10, SR1, SR2	3.76	–	18.6	
19 (5YR)	SR3	0.30	0.4	–	
19 (100YR)	SE1-SE10, SR1-SR3	4.06	–	19.1	
20 (5-YR)	SR3, SR4	0.55	0.9	–	
20 (100YR)	SE1-SE10, SR1-SR4	4.31	–	19.4	
32	WQ1	2.96	2.7	13.6	
33	WG1	0.54	1.2	3.1	WQ STORM DIVERTED
34	WG2	0.65	1.3	3.5	
35	EB1	0.87	1.6	4.6	
36	EB1, EB2	1.54	2.4	7.0	
37	EB1, EB2, EB3	2.51	3.6	10.4	

SUMMARY RUNOFF TABLE

DESIGN POINT	CONTRIBUTING BASIN(S)	CONTRIBUTING AREA (ACRES)	5-YEAR RUNOFF (CFS)	100-YEAR RUNOFF (CFS)	COMMENTS
38	EB1, EB2, EB3, EB4	3.38	4.7	13.0	
39	WB1	0.83	1.6	4.5	
40	WB1, WB2	1.51	2.4	6.9	
41	WB1, WB2, WB3	2.84	4.2	11.4	
42	WB1, WB2, WB3, WB4	3.15	4.9	12.7	
43	WB5	0.55	0.9	2.8	
44	WB1, WB2, WB3, WB4, WB6	3.68	6.0	14.7	
45	WB7	0.82	3.3	6.8	
46	OS-9	0.47	1.9	3.9	
47	WQ2	0.44	0.3	1.9	
50	OS-2	0.52	1.3	3.2	
51	OS-3	0.22	0.8	1.7	
52	OS-4	0.52	1.5	3.4	
53	OS-5	9.67	12.7	39.6	
54	OS-6	13.27	17.3	54.1	
60	NW1	0.78	2.7	5.7	SUMP CONDITION
61	NF1	0.22	0.9	1.8	
62	NF2	0.29	1.1	3.8	100-YR: NF1, NF2, 0.51 ACRES
63	NF3	0.36	0.9	5.4	100-YR: NF1, NF2, NF3, 0.87 AC.
64	NF4	0.40	0.9	6.9	100-YR: NF1-NF4, 1.27 ACRES
65	NF5	0.25	1.0	2.1	
66	NF6	1.11	3.5	9.1	100-YR: NF5, NF6, 1.36 ACRES
67	NF7	0.54	2.1	12.4	100-YR: NF5-NF7, 1.90 ACRES; SUMP CONDITION
68	NF8	1.02	3.5	17.8	100-YR: NF5-NF8, 2.92 ACRES
69	NF9	0.32	1.3	2.6	SUMP CONDITION
70 (5YR)	NE1, NF1-NF9, NW1	6.09	17.1	–	
70 (100YR)	NE1	0.80	–	6.2	
71 (5YR)	NE1, NE2, NF1-NF9, NW1	6.70	17.7	–	
71 (100YR)	NE1, NE2	1.41	–	8.9	
80	BPE1	2.03	5.1	12.2	
81	BPE2	6.22	5.3	23.5	
90	5TH1	1.12	2.7	6.6	FLOWS TO DP 92
91	5TH2	0.96	1.9	5.2	FLOWS TO DP 93
92	5TH1, 5TH3	1.59	3.2	8.5	
93	5TH2, 5TH4	2.45	3.6	11.6	

SUMMARY RUNOFF TABLE

DESIGN POINT	CONTRIBUTING BASIN(S)	CONTRIBUTING AREA (ACRES)	5-YEAR RUNOFF (CFS)	100-YEAR RUNOFF (CFS)	COMMENTS
94	5TH5, OS-10	1.81	3.1	9.4	SUMP CONDITION
95	5TH6	0.24	0.6	1.4	
96	5TH7	0.10	0.4	0.8	
97	OS-10	0.49	1.4	3.2	

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FEDERAL BOULEVARD & US 6
INTERCHANGE IMPROVEMENT

DENVER, COLORADO

2010

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approved by: DK
QA/QC by:
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drawing no.:
date: 01.07.11

FIGURE
3

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A = BASIN DESCRIPTION
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D = DESIGN POINT DESIGNATION

5440 EXISTING MAJOR CONTOUR
EXISTING MINOR CONTOUR
5440 PROPOSED MAJOR CONTOUR
5438 PROPOSED MINOR CONTOUR
MAJOR BASIN DELINIATION
100-YEAR FLOODPLAIN
FLOW PATH
1106L STORM SEWER ELEMENT

DENVER DRAINAGE MASTER PLAN
WEIR GULCH (4900-01)
1ST AND FEDERAL (0064-02)

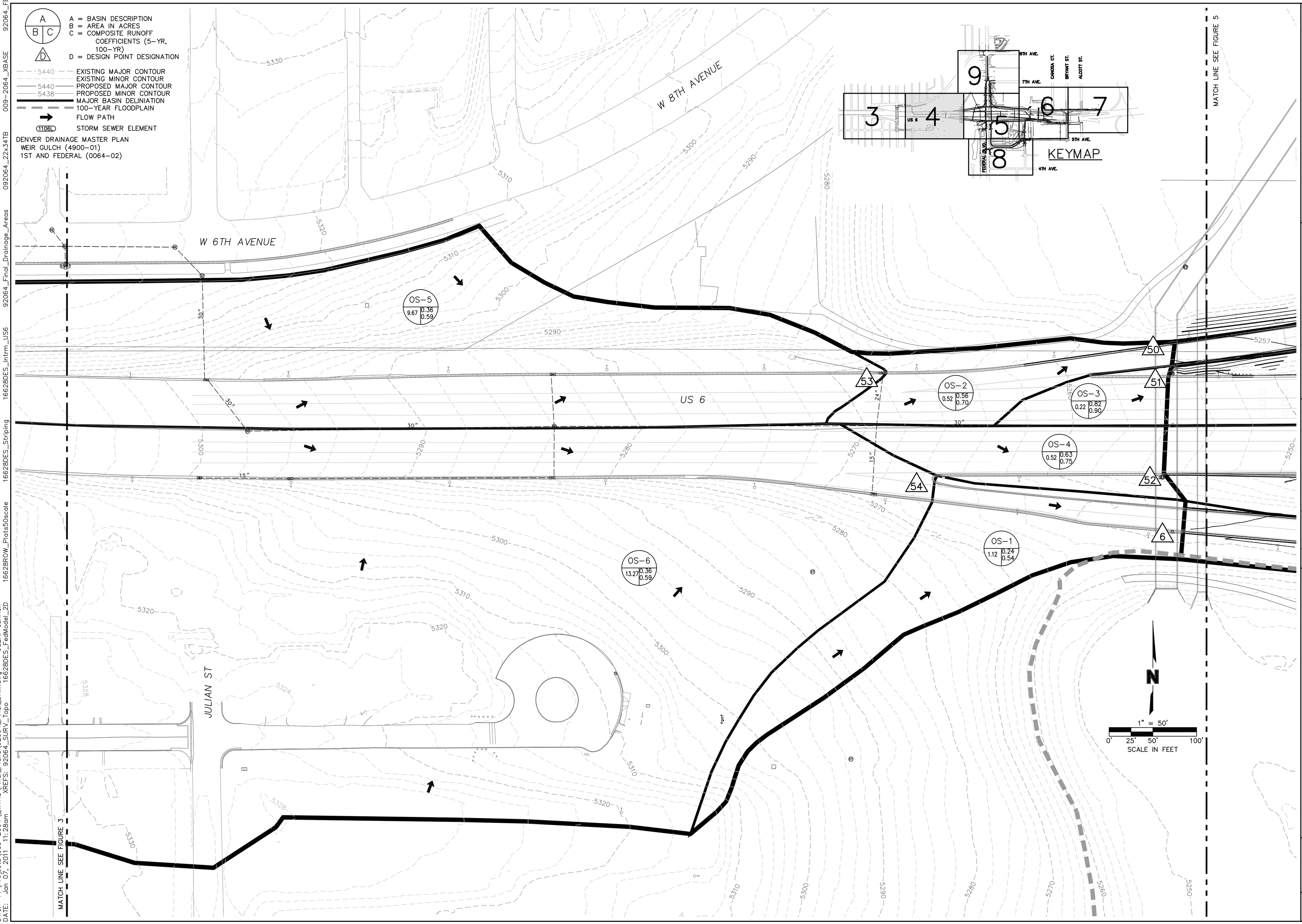

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FIGURE
4

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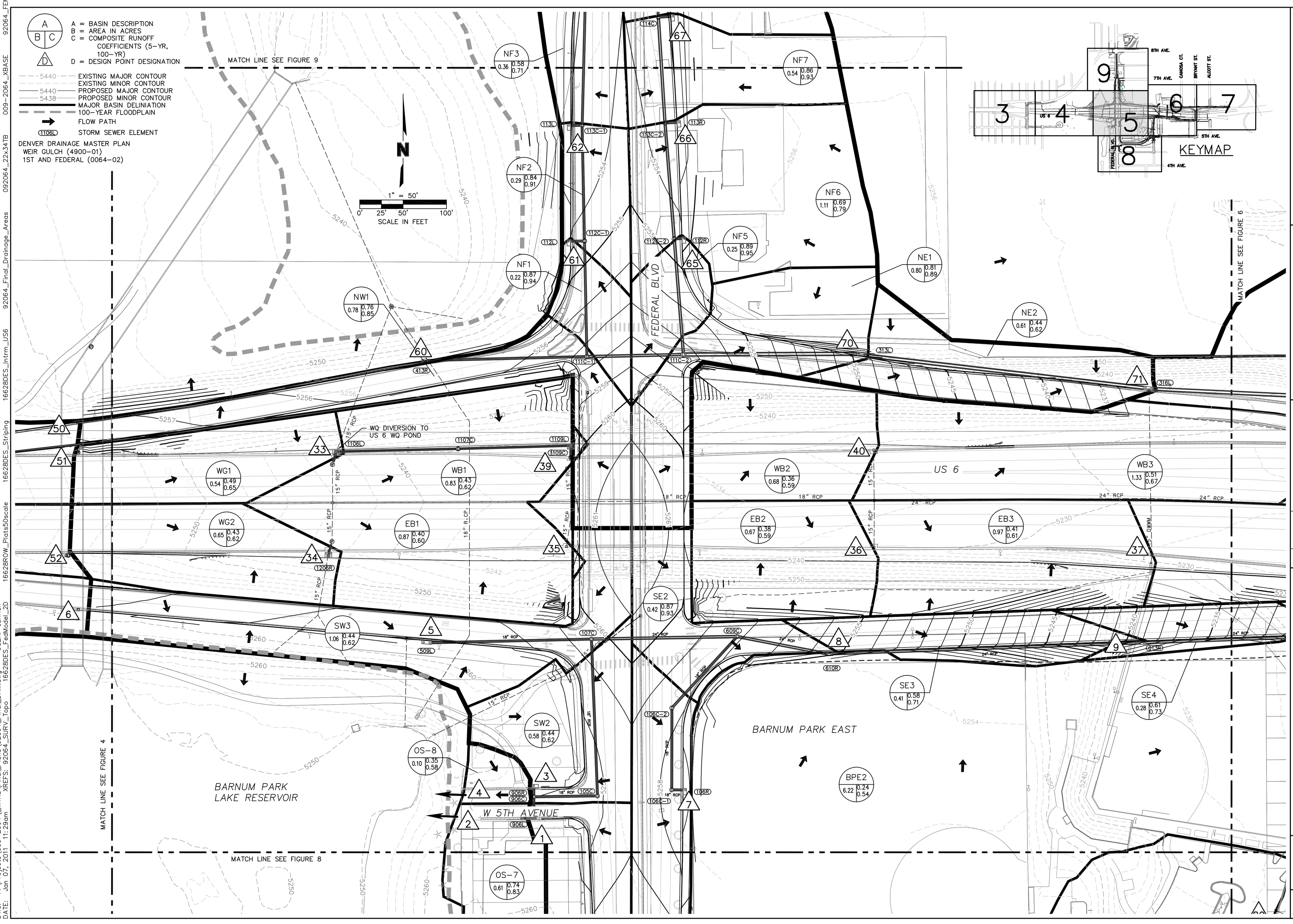

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FIGURE
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DENVER DRAINAGE MASTER PLAN
WEIR GULCH (4900–01)
1ST AND FEDERAL (0064–02)

	WATER SURFACE ELEVATION (FEET)	VOLUME (ACRE–FT)	RELEASE RATE (CFS)
WATER QUALITY CAPTURE VOLUME	5205.44	0.92	*
5–YR + WQCV	5207.11	2.59	6.93
100–YR + WQCV	5208.75	4.62	40.79

*OUTLET WORKS WQCV ORIFICE PLATE DESIGNED TO RELEASE WQCV OVER 40 HOURS.

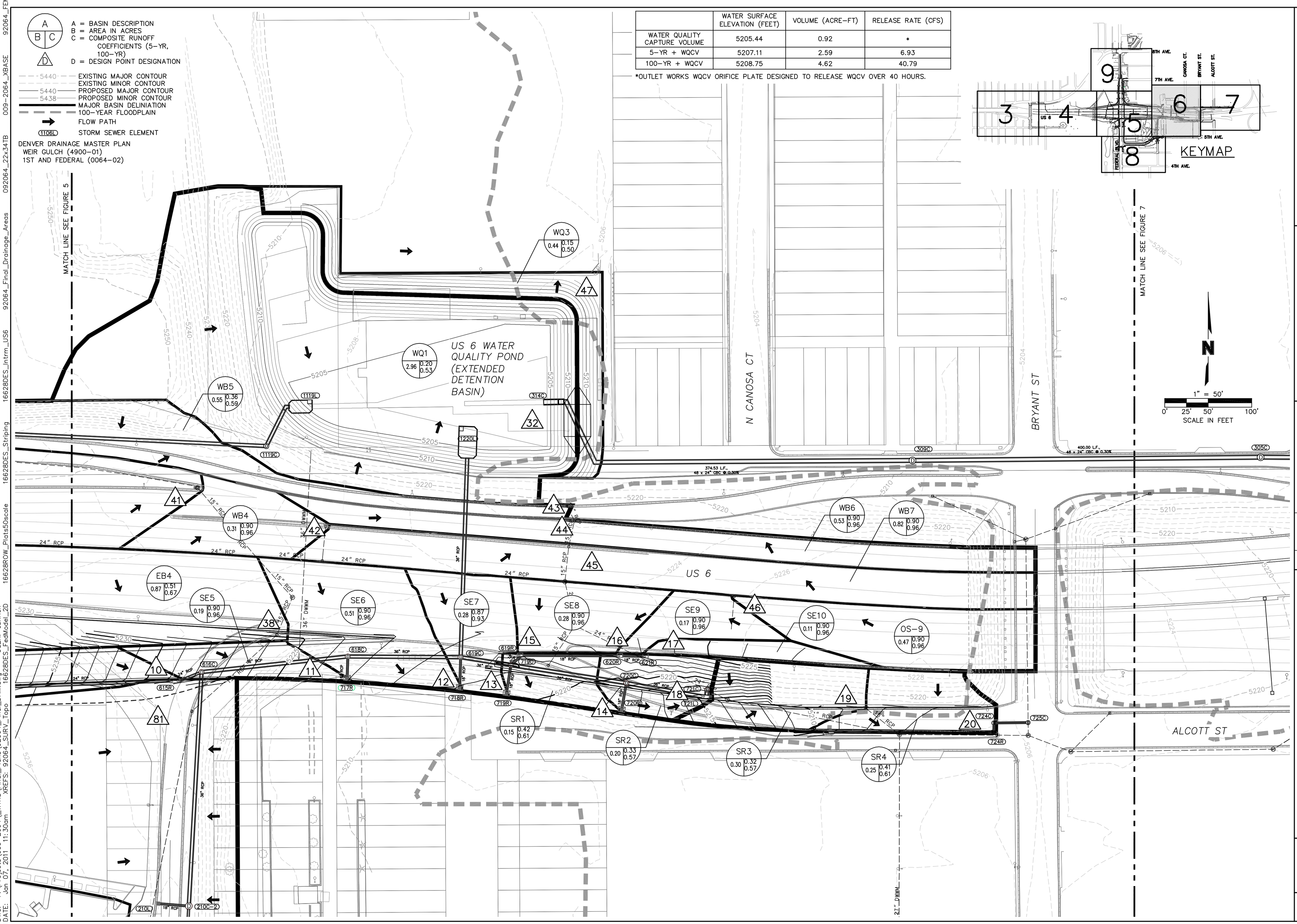

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FIGURE
6

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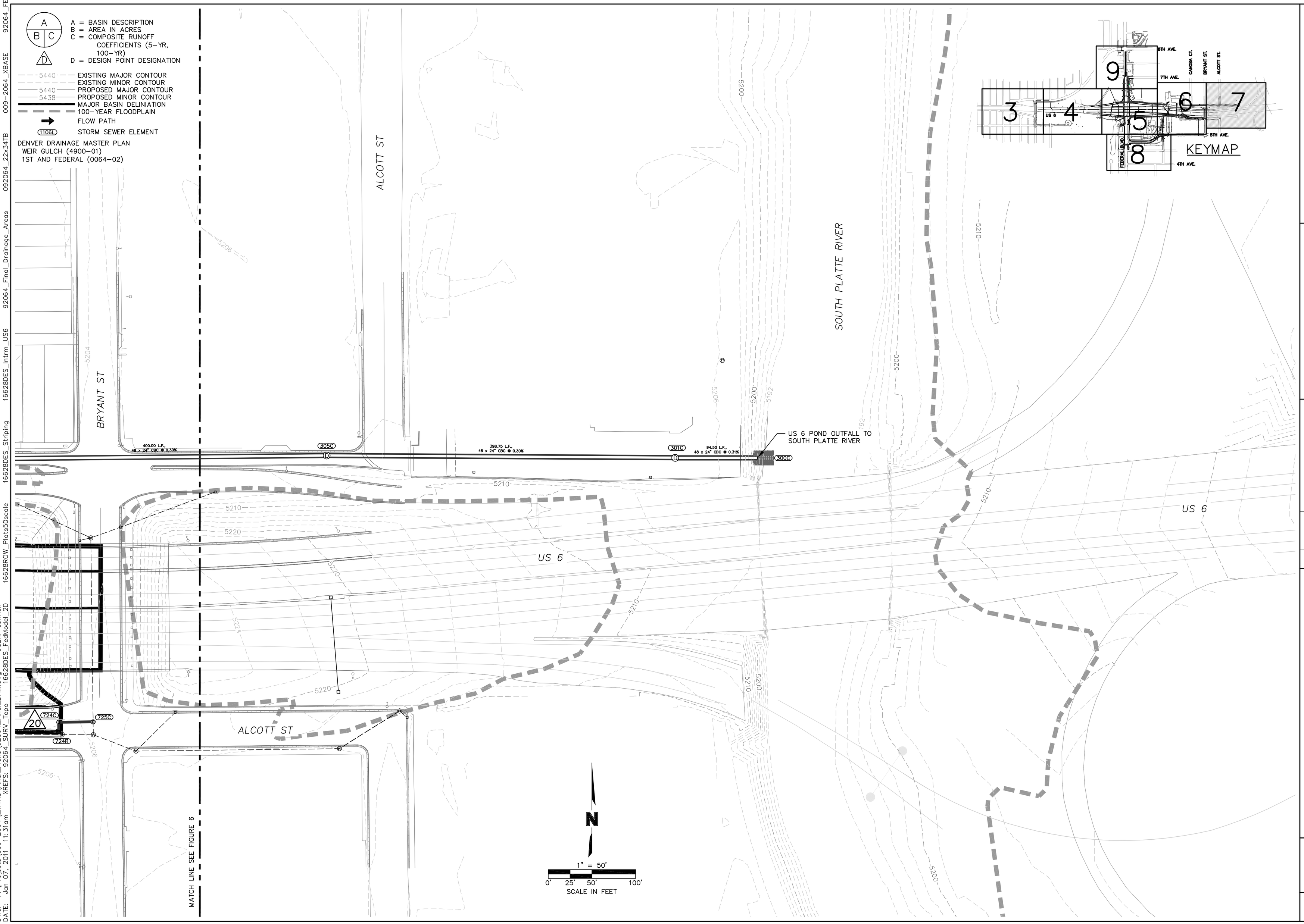

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FIGURE
7

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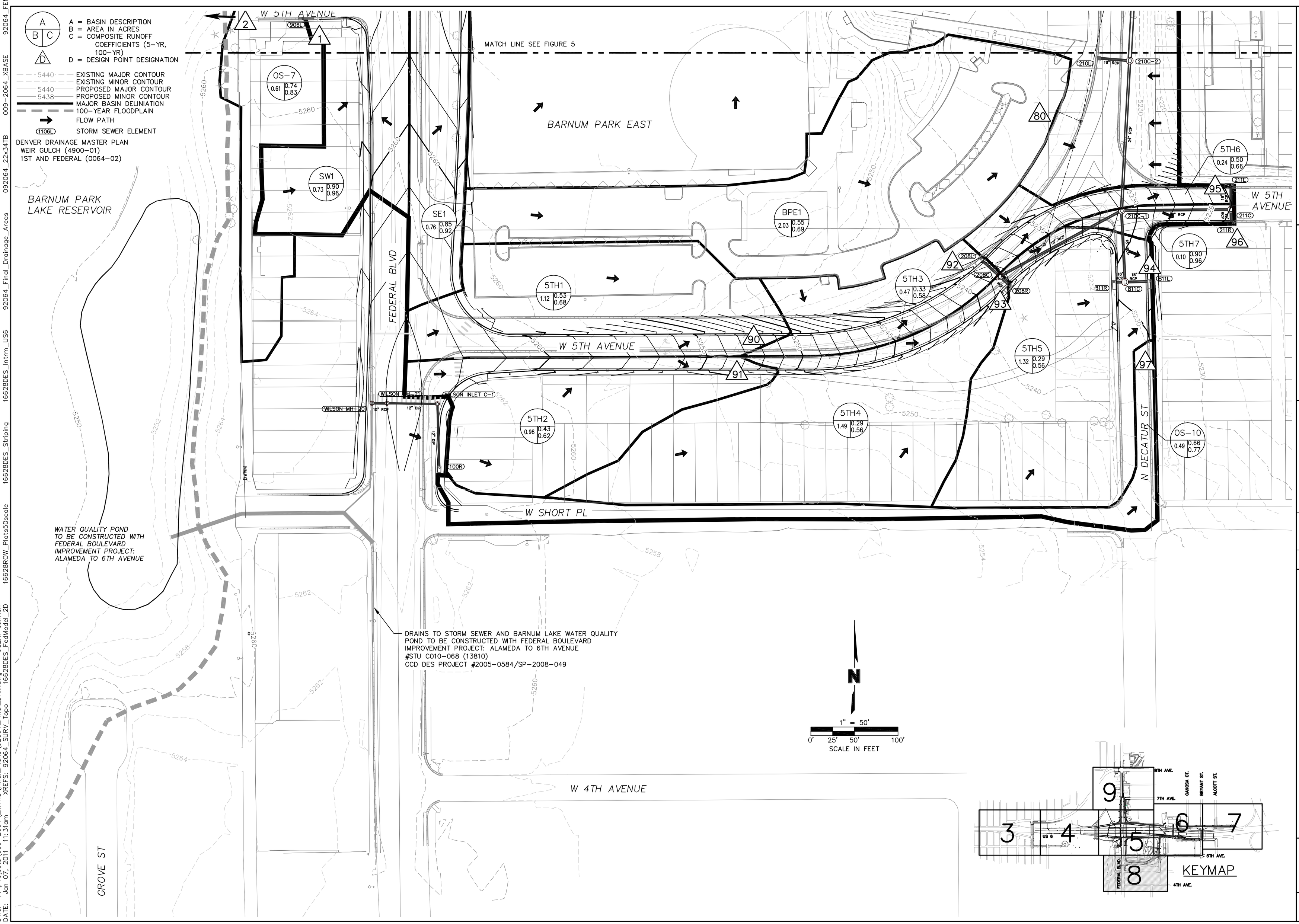

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FIGURE
8

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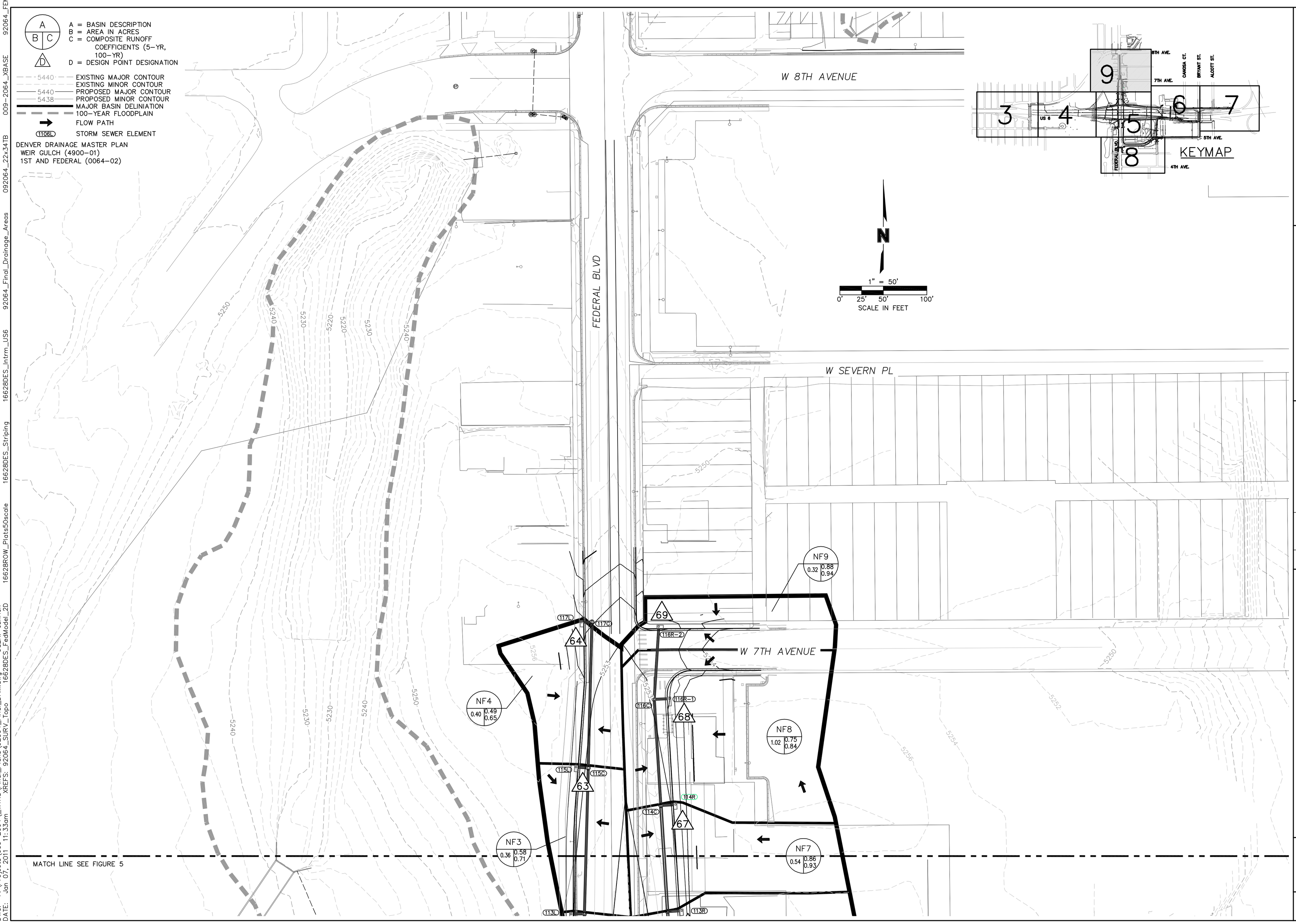

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FIGURE
9

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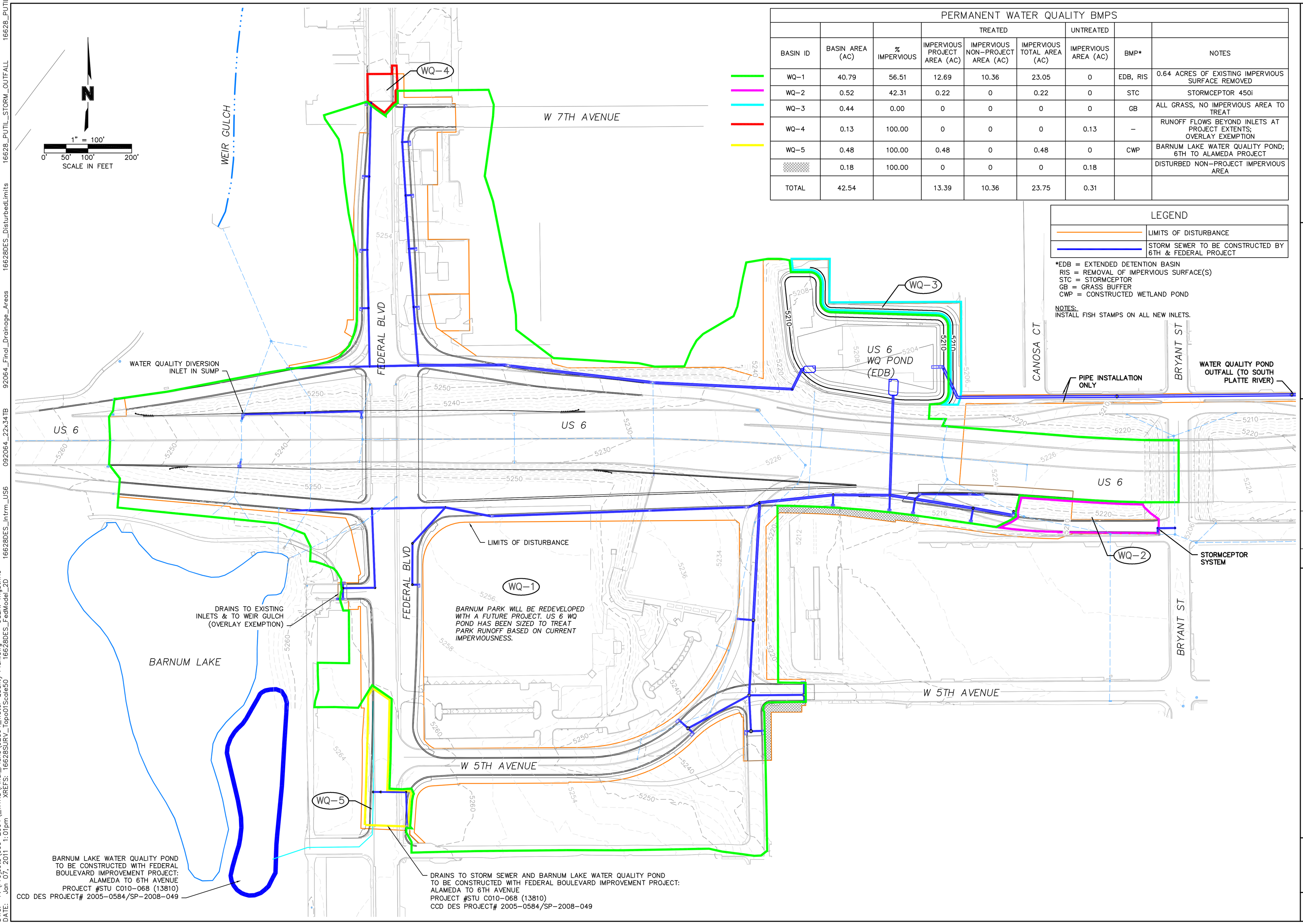


PERMANENT WATER QUALITY BMPS

BASIN ID	BASIN AREA (AC)	% IMPERVIOUS	TREATED: IMPERVIOUS PROJECT AREA (AC)	TREATED: IMPERVIOUS NON-PROJECT AREA (AC)	TREATED: IMPERVIOUS TOTAL AREA (AC)	UNTREATED: IMPERVIOUS AREA (AC)	BMP*	NOTES
WQ-1	40.79	56.51	12.69	10.36	23.05	0	EDB, RIS	0.64 ACRES OF EXISTING IMPERVIOUS SURFACE REMOVED
WQ-2	0.52	42.31	0.22	0	0.22	0	STC	STORMCEPTOR 450i
WQ-3	0.44	0.00	0	0	0	0	GB	ALL GRASS, NO IMPERVIOUS AREA TO TREAT
WQ-4	0.13	100.00	0	0	0	0.13	–	RUNOFF FLOWS BEYOND INLETS AT PROJECT EXTENTS; OVERLAY EXEMPTION
WQ-5	0.48	100.00	0.48	0	0.48	0	CWP	BARNUM LAKE WATER QUALITY POND; 6TH TO ALAMEDA PROJECT
	0.18	100.00	0	0	0	0.18		DISTURBED NON-PROJECT IMPERVIOUS AREA
TOTAL	42.54		13.39	10.36	23.75	0.31		

LEGEND

	LIMITS OF DISTURBANCE
	STORM SEWER TO BE CONSTRUCTED BY 6TH & FEDERAL PROJECT

*EDB = EXTENDED DETENTION BASIN
RIS = REMOVAL OF IMPERVIOUS SURFACE(S)
STC = STORMCEPTOR
GB = GRASS BUFFER
CWP = CONSTRUCTED WETLAND POND

NOTES:
INSTALL FISH STAMPS ON ALL NEW INLETS.

OLSSON ASSOCIATES
143 Union Boulevard, Suite 700
Lakewood, CO 80228-1825
TEL 720.962.6072
FAX 720.962.6195
www.olssonassociates.com

REV. NO.	DATE	REVISIONS DESCRIPTION

REVISIONS

WATER QUALITY CONCEPT PLAN

FEDERAL BOULEVARD & US 6 INTERCHANGE IMPROVEMENT

DENVER, COLORADO

2010

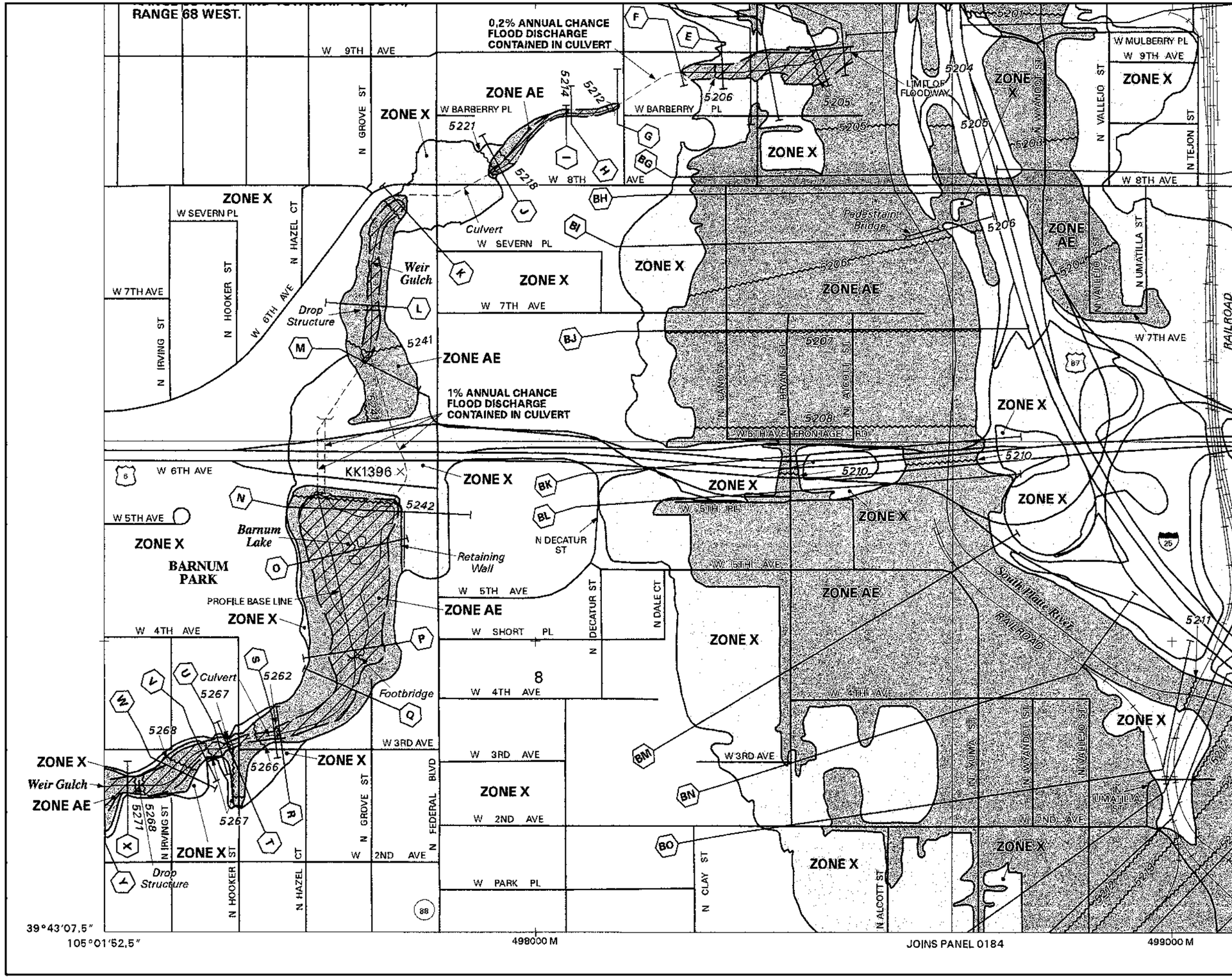
drawn by: MG
checked by: DK/DO
approved by: DK
QA/QC by:
project no.: 009-2064
drawing no.:
date: 01.07.11

FIGURE 10

DWG: F:\Projects\009-2064_WTRS\Final_Plans\92064_Water Quality Plan.dwg USER: mguthrie
DATE: Jan 07, 2011 1:01pm XREFS: 16628SURV_Topo01Scale50 16628DES_FedModel_2D 16628DES_Intrm_US6 16628DES_DisturbedLimits 92064_Final_Drainage_Areas 092064_22x34TB 16628_PUTIL_STORM_OUTFALL 16628_PUTIL_ST

APPENDIX B

Flood Insurance Rate Map



National Flood Insurance Program at (800) 638-6620.

MAP SCALE 1" = 500'

250 0 500 1000 FEET

PANEL 0182G

FIRM

FLOOD INSURANCE RATE MAP

CITY AND COUNTY OF DENVER, COLORADO

PANEL 182 OF 300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
DENVER, CITY AND COUNTY OF	080046	0182	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 0800460182G

MAP REVISED: NOVEMBER 17, 2005

Federal Emergency Management Agency

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

APPENDIX C

Hydrologic Calculations

EXISTING COMPOSITE RUNOFF COEFFICIENTS

PROJECT NAME: 6th & Federal Drainage
PROJECT NUMBER: 009-2064

DATE: 10/28/2010

CALCULATED BY: MEG
CHECKED BY: DLO/DPK

FILE NAME: Rational 6th & Federal Existing.xls

SURFACE TYPE	PAVED	ROOF	GRASS	GRAVEL
5-YEAR COEFF.	0.90	0.75	0.15	0.35
100-YEAR COEFF.	0.96	0.83	0.50	0.58
PERCENT IMPERVIOUS	100.00	90.00	-	40.00

DESIGN BASIN	DESIGN POINT	TOTAL AREA (AC)	PAVED AREA (AC)	ROOF AREA (AC)	GRASS AREA (AC)	GRAVEL AREA (AC)	% I	C_5	C_{100}
WG1	33	0.54	0.34	0.00	0.20	0.00	62.96	0.62	0.79
WG2	34	0.66	0.33	0.00	0.33	0.00	50.00	0.53	0.73
EB1	35	0.92	0.43	0.00	0.49	0.00	46.74	0.50	0.72
EB2	36	0.64	0.32	0.00	0.32	0.00	50.00	0.53	0.73
EB3	37	0.74	0.44	0.00	0.30	0.00	59.46	0.60	0.77
WB1	39	0.87	0.43	0.00	0.44	0.00	49.43	0.52	0.73
WB2	40	0.81	0.34	0.00	0.47	0.00	41.98	0.46	0.69
WB3	41	1.22	0.79	0.00	0.43	0.00	64.75	0.64	0.80
Total on-site area		6.40	3.42	0.00	2.98	0.00		0.55	0.75

STANDARD FORM SF-2
EXISTING TIME OF CONCENTRATION

PROJECT NAME: 6th & Federal Drainage
PROJECT NUMBER: 009-2064

CALCULATED BY: MEG
CHECKED BY: DPK

DATE: 10/28/2010

SUB-BASIN DATA			INITIAL/OVERLAND Ti			TRAVEL TIME Tt				Tc CHECK (URBANIZED BASINS)			FINAL	Remarks
BASIN	AREA	C5	L	S	Ti	L	S	VEL.	Tt	COMP Tc	TOTAL	MIN.Tc	Tc	
ID	(AC)		(FT)	(%)	(MIN)	(FT)	(%)	(FPS)	(MIN)	(MIN)	LENGTH (FT)	(MIN)	(MIN)	
WG1	0.54	0.62	50	4.0	3.8	265	4.4	4.2	1.1	4.9	315		5.0	GUTTER
WG2	0.66	0.53	50	4.0	4.6	260	4.3	4.1	1.0	5.7	310		5.7	GUTTER
EB1	0.92	0.50	50	4.5	4.6	330	3.4	3.7	1.5	6.1	380		6.1	GUTTER
EB2	0.64	0.53	50	2.7	5.3	370	1.2	2.2	2.8	8.1	420		8.1	GUTTER
EB3	0.74	0.60	50	2.3	4.9	335	1.0	2.0	2.8	7.7	385		7.7	GUTTER
WB1	0.87	0.52	50	4.5	4.5	330	3.3	3.6	1.5	6.0	380		6.0	GUTTER
WB2	0.81	0.46	50	2.6	5.9	360	1.0	2.0	3.0	8.9	410		8.9	GUTTER
WB3	1.22	0.64	50	2.2	4.6	565	1.0	2.0	4.7	9.3	615		9.3	GUTTER

NOTES: $Ti=1.8*(1.1-C5)*L^{0.5})/(S^{0.33})$ Tt=L/60V (V From Fig. 7.2, CDOT DDM) Tc Check= 10+L/180

OLSSON ASSOCIATES

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 5-YEAR

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. 5.1, Denver Criteria manual, 2006

PROJECT NAME: 6th & Federal Drainage — CALCULATED BY: MEG — P_1 = 1.34 inches — Table 5.1, Denver Criteria manual, 2006 — DATE: 10/28/2010

PROJECT NUMBER: 009-2064 — CHECKED BY: DPK

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Calculated using FlowMaster with Manning's n = 0.015
	34		WG2	0.66	0.53	5.7	0.35	4.39	1.5													
WG1, WG2	33		WG1	0.54	0.62	5.0	0.34	4.55	1.5	6.0	0.68	4.32	2.9			1.5	2.20	18	100	4.90	0.3	Tt from DP34 to DP33
	35		EB1	0.92	0.50	6.1	0.46	4.29	2.0													
	36		EB2	0.64	0.53	8.1	0.34	3.92	1.3										350	2.1	2.8	Tt from DP 35 to 36 Gutter. S=1.2%
EB1, EB2	36									8.9	0.80	3.79	3.0									
	37		EB3	0.74	0.60	7.7	0.44	3.99	1.8										315	2.0	2.6	Tt from DP 36 to 37 Gutter. S=1.0%
EB1, EB2, EB3	37									11.5	1.24	3.42	4.2									
	39		WB1	0.87	0.52	6.0	0.45	4.32	2.0													
	40		WB2	0.81	0.46	8.9	0.38	3.79	1.4										350	2.0	2.9	Tt from DP 39 to 40 Gutter. S=1.0%
WB1, WB2	40									8.9	0.83	3.79	3.1									
	41		WB3	1.22	0.64	9.3	0.78	3.73	2.9										550	2.0	4.6	Tt from DP 40 to 41 Gutter. S=1.0%
WB1, WB2, WB3	41									13.5	1.61	3.19	5.1									

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 50-YEAR (FOR SUMP INLETS ONLY)

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. 5.1, Denver Criteria manual, 2006

PROJECT NAME: 6th & Federal Drainage CALCULATED BY: MEG P_1 = 2.25 inches Table 5.1, Denver Criteria manual, 2006 DATE: 10/28/2010

PROJECT NUMBER: 009-2064 CHECKED BY: DPK

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)	Tt	Remarks
	33		WG1	0.54	0.79	5.0	0.43	7.63	3.3													
WG1, WG2	34		WG2	0.66	0.73	5.7	0.48	7.37	3.6	5.9	0.91	7.29	6.6			3.3	2.20	18	100	1.84	0.9	Tt from DP33 to DP34
	35		EB1	0.92	0.72	6.1	0.66	7.20	4.7													
	36		EB2	0.64	0.73	8.1	0.47	6.58	3.1										350	2.1	2.8	Tt from DP 35 to 36 Gutter. S=1.2%
EB1, EB2	36									8.9	1.13	6.36	7.2									
	37		EB3	0.74	0.77	7.7	0.57	6.71	3.8										315	2.0	2.6	Tt from DP 36 to 37 Gutter. S=1.0%
EB1, EB2, EB3	37									11.5	1.70	5.74	9.7									
	39		WB1	0.87	0.73	6.0	0.63	7.25	4.6													
	40		WB2	0.81	0.69	8.9	0.56	6.36	3.6										350	2.0	2.9	Tt from DP 39 to 40 Gutter. S=1.0%
WB1, WB2	40									8.9	1.19	6.36	7.6									
	41		WB3	1.22	0.80	9.3	0.97	6.26	6.1										550	2.0	4.6	Tt from DP 40 to 41 Gutter. S=1.0%
WB1, WB2, WB3	41									13.5	2.17	5.36	11.6									

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 100-YEAR

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. 5.1, Denver Criteria manual, 2006

PROJECT NAME: 6th & Federal Drainage — CALCULATED BY: MEG — P_1 = 2.57 inches — Table 5.1, Denver Criteria manual, 2006 — DATE: 10/28/2010

PROJECT NUMBER: 009-2064 — CHECKED BY: DPK

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)	Tt	Remarks
	33	WG1	0.54	0.79	5.0	0.43	8.72	3.7													
	34	WG2	0.66	0.73	5.7	0.48	8.42	4.1	5.8	0.91	8.37	7.6			3.7	2.20	18	100	2.10	0.8	Tt from DP33 to DP34
	35	EB1	0.92	0.72	6.1	0.66	8.23	5.4													
	36	EB2	0.64	0.73	8.1	0.47	7.52	3.5										350	2.1	2.8	Tt from DP 35 to 36 Gutter. S=1.2%
EB1, EB2	36								8.9	1.13	7.26	8.2									
	37	EB3	0.74	0.77	7.7	0.57	7.66	4.4										315	2.0	2.6	Tt from DP 36 to 37 Gutter. S=1.0%
EB1, EB2, EB3	37								11.5	1.70	6.56	11.1									
	39	WB1	0.87	0.73	6.0	0.63	8.28	5.2													
	40	WB2	0.81	0.69	8.9	0.56	7.27	4.1										350	2.0	2.9	Tt from DP 39 to 40 Gutter. S=1.0%
WB1, WB2	40								8.9	1.19	7.26	8.7									
	41	WB3	1.22	0.80	9.3	0.97	7.15	7.0										550	2.0	4.6	Tt from DP 40 to 41 Gutter. S=1.0%
WB1, WB2, WB3	41								13.5	2.17	6.12	13.3									

PROPOSED COMPOSITE RUNOFF COEFFICIENTS

PROJECT NAME: 6th & Federal Drainage
PROJECT NUMBER: 009-2064
DATE: 1/7/2011
CALCULATED BY: MEG
CHECKED BY: DPK
FILE NAME: Rational 6th & Federal Proposed.xls

			IMPERVIOUSNESS					SOIL TYPE			RUNOFF COEFF.		
DESIGN BASIN	DESIGN POINT	TOTAL AREA (AC)	PAVED AREA (AC) 100	ROOF AREA (AC) 90	GRASS AREA (AC) 0	GRAVEL AREA (AC) 40	% I	Percent of Total Area A	Percent of Total Area B	Percent of Total Area C/D	C_5	C_{50}	C_{100}
SW1	1	0.73	0.73	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.90	0.96	0.96
SW2	3	0.58	0.33	0.00	0.25	0.00	56.90	0.0	0.0	100.0	0.44	0.60	0.62
SW3	5	1.06	0.61	0.00	0.45	0.00	57.26	0.0	0.0	100.0	0.44	0.60	0.62
SE1	7	0.76	0.74	0.00	0.02	0.00	97.37	0.0	0.0	100.0	0.85	0.92	0.92
SE2	8	0.42	0.41	0.00	0.01	0.00	98.33	0.0	0.0	100.0	0.87	0.93	0.93
SE3	9	0.41	0.31	0.00	0.10	0.00	75.61	0.0	0.0	100.0	0.58	0.70	0.71
SE4	10	0.28	0.22	0.00	0.06	0.00	78.57	0.0	0.0	100.0	0.61	0.72	0.73
SE5	11	0.19	0.19	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.90	0.96	0.96
SE6	12	0.51	0.51	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.90	0.96	0.96
SE7	13	0.28	0.28	0.00	0.01	0.00	98.21	0.0	0.0	100.0	0.87	0.93	0.93
SE8	15	0.28	0.28	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.90	0.96	0.96
SE9	16	0.17	0.17	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.90	0.96	0.96
SE10	17	0.11	0.11	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.90	0.96	0.96
SR1	14	0.15	0.08	0.00	0.07	0.00	53.33	0.0	0.0	100.0	0.42	0.58	0.61
SR2	18	0.20	0.07	0.00	0.13	0.00	35.00	0.0	0.0	100.0	0.33	0.54	0.57
SR3	19	0.30	0.10	0.00	0.20	0.00	33.33	0.0	0.0	100.0	0.32	0.53	0.57
SR4	20	0.25	0.13	0.00	0.12	0.00	52.00	0.0	0.0	100.0	0.41	0.58	0.61
WQ1	32	2.96	0.25	0.00	2.71	0.00	8.45	0.0	0.0	100.0	0.20	0.47	0.53
WQ3	47	0.44	0.00	0.00	0.44	0.00	0.00	0.0	0.0	100.0	0.15	0.44	0.50
WG1	33	0.54	0.35	0.00	0.19	0.00	64.81	0.0	0.0	100.0	0.49	0.63	0.65
WG2	34	0.65	0.36	0.00	0.29	0.00	55.38	0.0	0.0	100.0	0.43	0.59	0.62
EB1	35	0.87	0.44	0.00	0.43	0.00	50.57	0.0	0.0	100.0	0.40	0.57	0.60
EB2	36	0.67	0.31	0.00	0.36	0.00	46.27	0.0	0.0	100.0	0.38	0.56	0.59
EB3	37	0.97	0.51	0.00	0.46	0.00	52.58	0.0	0.0	100.0	0.41	0.58	0.61
EB4	38	0.87	0.59	0.00	0.28	0.00	67.82	0.0	0.0	100.0	0.51	0.65	0.67
WB1	39	0.83	0.46	0.00	0.37	0.00	55.42	0.0	0.0	100.0	0.43	0.59	0.62
WB2	40	0.68	0.29	0.00	0.39	0.00	42.65	0.0	0.0	100.0	0.36	0.55	0.59
WB3	41	1.33	0.90	0.00	0.43	0.00	67.67	0.0	0.0	100.0	0.51	0.65	0.67
WB4	42	0.31	0.31	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.90	0.96	0.96
WB5	43	0.55	0.23	0.00	0.32	0.00	41.82	0.0	0.0	100.0	0.36	0.55	0.59
WB6	44	0.53	0.53	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.90	0.96	0.96
WB7	45	0.82	0.82	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.90	0.96	0.96
NW1	60	0.78	0.71	0.00	0.07	0.00	91.03	0.0	0.0	100.0	0.76	0.84	0.85
NF1	61	0.22	0.22	0.00	0.00	0.00	98.64	0.0	0.0	100.0	0.87	0.94	0.94
NF2	62	0.29	0.28	0.00	0.01	0.00	96.55	0.0	0.0	100.0	0.84	0.91	0.91
NF3	63	0.36	0.27	0.00	0.09	0.00	75.00	0.0	0.0	100.0	0.58	0.69	0.71
NF4	64	0.40	0.26	0.00	0.14	0.00	65.00	0.0	0.0	100.0	0.49	0.63	0.65
NF5	65	0.25	0.24	0.01	0.00	0.00	99.60	0.0	0.0	100.0	0.89	0.95	0.95
NF6	66	1.11	0.78	0.19	0.14	0.00	85.68	0.0	0.0	100.0	0.69	0.78	0.79
NF7	67	0.54	0.47	0.07	0.00	0.00	97.96	0.0	0.0	100.0	0.86	0.93	0.93
NF8	68	1.02	0.87	0.06	0.09	0.00	90.59	0.0	0.0	100.0	0.75	0.84	0.84
NF9	69	0.32	0.28	0.04	0.00	0.00	98.75	0.0	0.0	100.0	0.88	0.94	0.94
NE1	70	0.80	0.65	0.12	0.03	0.00	94.75	0.0	0.0	100.0	0.81	0.88	0.89
NE2	71	0.61	0.33	0.02	0.26	0.00	57.05	0.0	0.0	100.0	0.44	0.60	0.62
BPE1	80	2.03	1.46	0.00	0.57	0.00	71.91	0.0	0.0	100.0	0.55	0.67	0.69
BPE2	81	6.22	0.70	0.00	4.91	0.61	15.18	0.0	0.0	100.0	0.24	0.49	0.54
5TH1	90	1.12	0.78	0.00	0.34	0.00	69.64	0.0	0.0	100.0	0.53	0.66	0.68
5TH2	91	0.96	0.24	0.21	0.24	0.27	55.94	0.0	0.0	100.0	0.43	0.59	0.62
5TH3	92	0.47	0.17	0.00	0.30	0.00	36.17	0.0	0.0	100.0	0.33	0.54	0.58
5TH4	93	1.49	0.17	0.20	0.99	0.13	26.98	0.0	0.0	100.0	0.29	0.52	0.56
5TH5	94	1.32	0.26	0.10	0.93	0.03	27.42	0.0	0.0	100.0	0.29	0.52	0.56
5TH6	95	0.24	0.16	0.00	0.08	0.00	66.67	0.0	0.0	100.0	0.50	0.64	0.66
5TH7	96	0.10	0.10	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.90	0.96	0.96
OS-1	6	1.12	0.17	0.00	0.95	0.00	15.41	0.0	0.0	100.0	0.24	0.49	0.54
OS-2	50	0.52	0.38	0.00	0.14	0.00	73.08	0.0	0.0	100.0	0.56	0.68	0.70
OS-3	51	0.22	0.21	0.00	0.01	0.00	95.45	0.0	0.0	100.0	0.82	0.89	0.90
OS-4	52	0.52	0.42	0.00	0.10	0.00	80.77	0.0	0.0	100.0	0.63	0.74	0.75
OS-5	53	9.67	3.60	0.55	5.32	0.20	43.17	0.0	0.0	100.0	0.36	0.55	0.59
OS-6	54	13.27	5.13	0.55	7.59	0.00	42.39	0.0	0.0	100.0	0.36	0.55	0.59
OS-7	2	0.61	0.34	0.23	0.04	0.00	89.33	0.0	0.0	100.0	0.74	0.82	0.83
OS-8	4	0.10	0.04	0.00	0.06	0.00	40.00	0.0	0.0	100.0	0.35	0.55	0.58
OS-9	46	0.47	0.47	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.90	0.96	0.96
OS-10	97	0.49	0.35	0.00	0.00	0.14	82.86	0.0	0.0	100.0	0.66	0.76	0.77
Total on-site area		19.70	15.99	0.37	8.63	0.00	82.85	0.00	0.00	100.00			0.77

STANDARD FORM SF-2
PROPOSED TIME OF CONCENTRATION

PROJECT NAME: 6th & Federal Drainage
PROJECT NUMBER: 009-2064

CALCULATED BY: MEG
CHECKED BY: DPK

DATE: 1/7/2011

SUB-BASIN DATA			INITIAL/OVERLAND Ti			TRAVEL TIME Tt				Tc CHECK (URBANIZED BASINS)			FINAL	Remarks
BASIN	AREA	C5	L	S	Ti	L	S	VEL.	Tt	COMP Tc	TOTAL	MIN.Tc	Tc	
ID	(AC)		(FT)	(%)	(MIN)	(FT)	(%)	(FPS)	(MIN)	(MIN)	LENGTH (FT)	(MIN)	(MIN)	
SW1	0.73	0.90	50	1.4	0.5	350	1.50	2.4	2.4	2.9	400		5.0	GUTTER
OS-7	0.61	0.74	20	1.0	0.6	410	2.4	3.1	2.2	2.8	430		5.0	GUTTER
SW2	0.58	0.44	30	8.0	0.7	120	3.0	2.6	0.8					SWALE
						170	0.5	1.4	2.0	3.5	320		5.0	GUTTER
OS-8	0.10	0.35	30	10.0	0.8	60	7.0	4.0	0.3					SWALE
						65	0.5	1.4	0.8	1.8	155		5.0	GUTTER
SW3	1.06	0.44	28	2.1	1.1	385	0.5	1.4	4.5	5.6	413		5.6	GUTTER
OS-1	1.12	0.24	50	11.0	1.1	433	10.7	4.9	1.5					SWALE
						270	2.4	3.1	1.5	4.0	753		5.0	GUTTER
SE1	0.76	0.85	60	2.6	0.6	350	1.3	2.3	2.6	3.1	410		5.0	GUTTER
SE2	0.42	0.87	60	2.0	0.6	300	1.8	2.7	1.9	2.4	360		5.0	GUTTER
SE3	0.41	0.58	70	3.3	1.2	350	4.6	4.3	1.4	2.5	420		5.0	GUTTER
SE4	0.28	0.61	60	5.8	0.8	265	4.9	4.4	1.0	1.8	325		5.0	GUTTER
SE5	0.19	0.90	60	4.5	0.4	205	3.0	3.5	1.0	1.4	265		5.0	GUTTER
SE6	0.51	0.90	50	2.3	0.4	265	1.7	2.6	1.7	2.1	315		5.0	GUTTER
SE7	0.28	0.87	50	2.8	0.5	150	1.9	2.8	0.9	1.4	200		5.0	GUTTER
SE8	0.28	0.90	50	2.0	0.5	160	1.7	2.6	1.0	1.5	210		5.0	GUTTER
SE9	0.17	0.90	50	2.3	0.4	155	2.2	3.0	0.9	1.3	205		5.0	GUTTER
SE10	0.11	0.90	30	1.4	0.4	240	1.2	2.2	1.8	2.2	270		5.0	GUTTER
SR1	0.15	0.42	20	2.5	0.9	160	1.6	2.5	1.1	1.9	180		5.0	GUTTER
SR2	0.20	0.33	35	7.6	0.9	150	3.7	3.8	0.6	1.6	185		5.0	GUTTER
SR3	0.30	0.32	50	25.0	0.8	175	3.3	3.6	0.8	1.6	225		5.0	GUTTER
SR4	0.25	0.41	50	3.8	1.2	160	1.5	2.4	1.1	2.3	210		5.0	GUTTER
NE1	0.80	0.81	60	2.0	0.7	395	2.8	3.3	2.0	2.7	455		5.0	GUTTER
NE2	0.61	0.44	50	0.9	1.9	360	6.2	5.0	1.2	3.1	410		5.0	GUTTER
BPE1	2.03	0.55	35	2.0	1.0	850	3.2	3.6	4.0	5.0	885		5.0	PAVED
BPE2	6.22	0.24	100	2.0	2.7	345	1.3	0.8	7.2		445			GRASS
						560	4.6	3.2	2.9	12.8	1,005	15.6	12.8	SWALE

OLSSON ASSOCIATES

STANDARD FORM SF-2
PROPOSED TIME OF CONCENTRATION

PROJECT NAME: 6th & Federal Drainage
PROJECT NUMBER: 009-2064

CALCULATED BY: MEG
CHECKED BY: DPK

DATE: 1/7/2011

SUB-BASIN DATA			INITIAL/OVERLAND Ti			TRAVEL TIME Tt				Tc CHECK (URBANIZED BASINS)			FINAL	Remarks
BASIN	AREA	C5	L	S	Ti	L	S	VEL.	Tt	COMP Tc	TOTAL	MIN.Tc	Tc	
ID	(AC)		(FT)	(%)	(MIN)	(FT)	(%)	(FPS)	(MIN)	(MIN)	LENGTH (FT)	(MIN)	(MIN)	
5TH1	1.12	0.53	50	1.8	1.3	400	3.1	3.5	1.9	3.2	450		5.0	GUTTER
5TH2	0.96	0.43	50	2.4	1.4	385	2.9	3.4	1.9	3.3	435		5.0	GUTTER
5TH3	0.47	0.33	70	4.6	1.5	245	5.0	4.5	0.9	2.4	315		5.0	GUTTER
5TH4	1.49	0.29	90	2.1	2.4	220	3.2	1.3	2.9		310			GRASS
						295	4.6	4.3	1.1	6.4	605		6.4	GUTTER
5TH5	1.32	0.29	65	4.8	1.5	260	8.2	2.0	2.2		325			GRASS
						50	1.9	2.8	0.3	4.0	375		5.0	GUTTER
5TH6	0.24	0.50	50	4.8	1.0	255	4.4	4.2	1.0	2.0	305		5.0	GUTTER
5TH7	0.10	0.90	50	5.5	0.3	150	4.4	4.2	0.6	0.9	200		5.0	GUTTER
WG1	0.54	0.49	50	4.0	1.1	275	4.2	4.1	1.1	2.2	325		5.0	GUTTER
WG2	0.65	0.43	50	4.0	1.2	270	4.3	4.1	1.1	2.3	320		5.0	GUTTER
WQ1	2.96	0.20	50	2.0	2.0	560	8.9	6.0	1.6	3.6	610		5.0	GUTTER
WQ3	0.44	0.15	10	25.0	0.4	40	25.0	3.5	0.2	0.6	50		5.0	GRASS
EB1	0.87	0.40	50	4.5	1.2	330	3.2	3.6	1.5	2.7	380		5.0	GUTTER
EB2	0.67	0.38	50	2.2	1.6	200	1.0	2.0	1.7	3.2	250		5.0	GUTTER
EB3	0.97	0.41	50	2.3	1.5	335	1.0	2.0	2.8	4.3	385		5.0	GUTTER
EB4	0.87	0.51	50	2.2	1.3	350	1.1	2.1	2.8	4.0	400		5.0	GUTTER
WB1	0.83	0.43	50	4.5	1.1	335	3.0	3.5	1.6	2.8	385		5.0	GUTTER
WB2	0.68	0.36	50	2.0	1.6	200	1.0	2.0	1.7	3.3	250		5.0	GUTTER
WB3	1.33	0.51	50	2.2	1.3	565	1.0	2.0	4.7	6.0	615		6.0	GUTTER
WB4	0.31	0.90	50	1.6	0.5	190	1.3	2.3	1.4	1.9	240		5.0	GUTTER
WB5	0.55	0.36	40	40.0	0.5	660	1.9	2.8	4.0	4.5	700		5.0	GUTTER
WB6	0.53	0.90	40	2.5	0.4	500	0.8	1.8	4.7	5.0	540		5.0	GUTTER
WB7	0.82	0.90	55	2.5	0.4	500	1.1	2.1	4.0	4.4	555		5.0	GUTTER
OS-9	0.47	0.90	50	2.0	0.5	150	1.2	2.2	1.1	1.6	200		5.0	GUTTER
OS-2	0.52	0.56	50	4.0	1.0	365	3.4	3.7	1.6	2.6	415		5.0	GUTTER
OS-3	0.22	0.82	50	3.5	0.5	160	4.0	4.0	0.7	1.2	210		5.0	GUTTER
OS-4	0.52	0.63	50	4.0	0.8	330	4.0	4.0	1.4	2.2	380		5.0	GUTTER
OS-5	9.67	0.36	65	1.0	2.3	2,455	3.5	3.7	10.9	13.3	2,520	24.0	13.3	GUTTER

OLSSON ASSOCIATES

STANDARD FORM SF-2
PROPOSED TIME OF CONCENTRATION

PROJECT NAME: 6th & Federal Drainage
PROJECT NUMBER: 009-2064

CALCULATED BY: MEG
CHECKED BY: DPK

DATE: 1/7/2011

SUB-BASIN DATA			INITIAL/OVERLAND Ti			TRAVEL TIME Tt				Tc CHECK (URBANIZED BASINS)			FINAL	Remarks
BASIN ID	AREA (AC)	C5	L (FT)	S (%)	Ti (MIN)	L (FT)	S (%)	VEL. (FPS)	Tt (MIN)	COMP Tc (MIN)	TOTAL LENGTH (FT)	MIN.Tc (MIN)	Tc (MIN)	
OS-6	13.27	0.36	45	1.0	2.0	2,290	3.0	3.5	11.0	13.0	2,335	23.0	13.0	GUTTER
OS-10	0.49	0.66	45	2.3	0.9	960	3.2	3.6	4.5	5.4	1,005		5.4	PAVED
NW1	0.78	0.76	60	2.0	0.8	375	1.5	2.4	2.6	3.4	435		5.0	GUTTER
NF1	0.22	0.87	100	3.6	0.6	130	2.0	2.8	0.8	1.4	230		5.0	GUTTER
NF2	0.29	0.84	50	2.9	0.5	175	1.4	2.4	1.2	1.7	225		5.0	GUTTER
NF3	0.36	0.58	65	2.1	1.3	160	0.1	0.6	4.2	5.5	225		5.5	GUTTER
NF4	0.40	0.49	55	1.3	1.6	160	0.4	1.3	2.1	3.7	215		5.0	GUTTER
NF5	0.25	0.89	50	3.3	0.4	170	2.5	3.2	0.9	1.3	220		5.0	GUTTER
NF6	1.11	0.69	50	0.4	1.5	260	1.4	2.4	1.8	3.4	310		5.0	PAVED
NF7	0.54	0.86	50	0.8	0.7	210	1.3	2.3	1.5	2.2	260		5.0	PAVED
NF8	1.02	0.75	50	1.1	0.9	275	1.9	2.8	1.7	2.6	325		5.0	PAVED
NF9	0.32	0.88	40	2.5	0.4	195	1.4	2.4	1.4	1.8	235		5.0	GUTTER

NOTES: $Ti=0.395*(1.1-C5)*L^{0.5})/(S^{0.33})$ Tt=L/60V (V From Fig. 7.2, CDOT DDM) Tc Check= 10+L/180

OLSSON ASSOCIATES

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: P=0.5" WATER QUALITY

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. 5.1, Denver Criteria manual, 2006

PROJECT NAME: 6th & Federal Drainage CALCULATED BY: MEG P_1 = 0.5 inches Table 5.1, Denver Criteria manual, 2006 DATE: 1/7/2011

PROJECT NUMBER: 009-2064 CHECKED BY: DPK WATER QUALITY STORM

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Calculated using FlowMaster with Manning's n = 0.015
	1	906L	SW1	0.73	0.90	5.0	0.65	1.70	1.1													
	3	906R	SW2	0.58	0.44	5.0	0.25	1.70	0.4							1.1	1.00	18	27.55	4.63	0.1	Tt from 906L to 906C
SW1, SW2		906C								5.1	0.91	1.69	1.5			0.4	2.13	18	12.22	4.67	0.0	Tt from 906R to 906C
SW1, SW2		105C								5.4	0.91	1.66	1.5			1.5	0.50	18	73.43	3.87	0.3	Tt from 906C to 105C
	5	509L	SW3	1.06	0.44	5.6	0.47	1.64	0.8							1.5	0.50	18	163.29	3.85	0.7	Tt from 105C to 107C
SW1, SW2, SW3		107C								6.4	1.37	1.58	2.2			0.8	1.00	18	191.15	4.19	0.8	Tt from 509L to 107C
	7	106R	SE1	0.76	0.85	5.0	0.65	1.70	1.1							2.2	0.50	18	94.91	4.13	0.4	Tt from 107C to 609C
SE1		106C-1								5.1	0.65	1.69	1.1			1.1	1.00	18	15.31	4.59	0.1	Tt from 106R to 106C-1
SE1		106C-2								5.5	0.65	1.65	1.1			1.1	0.50	18	92.29	3.55	0.4	Tt from 106C-1 to 106C-2
SE1, SW1, SW2, SW3		609C								6.8	2.02	1.55	3.1			1.1	0.50	18	111.63	3.55	0.5	Tt from 106C-2 to 609C
SW1 SW2, SW3, SE1, SE2	8	610R	SE2	0.42	0.87	5.0	0.36	1.70	0.6	7.4	2.39	1.51	3.6			3.1	0.50	24	185.13	4.63	0.7	Tt from 609C to 610R
SW1, SW2 SW3, SE1, SE2, SE3	9	613R	SE3	0.41	0.58	5.0	0.24	1.70	0.4	8.1	2.62	1.47	3.8			3.6	3.14	24	358.03	9.47	0.6	Tt from 610R to 613R
SW1, SW2, SW3 SE1, SE2, SE3, SE4	10	615R	SE4	0.28	0.61	5.0	0.17	1.70	0.3	8.4	2.80	1.44	4.0			3.8	4.45	24	223.94	10.95	0.3	Tt from 613R to 615R
																4.0	5.57	24	29.72	12.03	0.0	Tt from 615R to 616C
	90	205L	5TH1	1.12	0.53	5.0	0.59	1.70	1.0													
	91	205R	5TH2	0.96	0.43	5.0	0.41	1.70	0.7					4.98	1.0				260	4.50	1.0	Tt from 205L to 208L
5TH1, 5TH3	92	208L	5TH3	0.47	0.33	5.0	0.16	1.70	0.3	6.0	0.75	1.61	1.2	4.40	0.7				300	4.20	1.2	Tt from 205R to 208R
5TH2, 5TH4	93	208R	5TH4	1.49	0.29	6.4	0.43	1.58	0.7	6.4	0.85	1.58	1.3			1.2	0.50	18	31.93	3.64	0.1	Tt from 208L to 208C
5TH1, 5TH2 5TH3, 5TH4		208C								6.5	1.60	1.57	2.5			1.3	0.50	18	13.13	3.75	0.1	Tt from 208L to 208C
	97		OS-10	0.49	0.66	5.4	0.32	1.66	0.5							2.5	4.70	18	158.8	5.34	0.5	Supercritical flow Tt from 208C to 210C-1
5TH5, OS-10	94	811R	5TH5	1.32	0.29	5.0	0.39	1.70	0.7	5.8	0.71	1.63	1.2				1.60		70	2.50	0.5	Tt from OS-10 to 811R
5TH5, OS-10		811C								6.0	0.71	1.62	1.1			1.2	0.57	18	28.59	3.80	0.1	Tt from 811L to 811C
	95	211L	5TH6	0.24	0.50	5.0	0.12	1.70	0.2							1.1	0.51	18	81.4	3.64	0.4	Tt from 811C to 210C
	96	211R	5TH7	0.10	0.90	5.0	0.09	1.70	0.2							0.2	0.50	18	28.35	2.29	0.2	Tt from 211L to 211C
5TH6, 5TH7		211C								5.2	0.21	1.68	0.4			0.2	0.50	18	16.94	2.03	0.1	Tt from 211R to 211C
5TH1-7, OS-10		210C-1								7.0	2.52	1.54	3.9			0.4	0.50	18	125.53	2.57	0.8	Tt from 211C to 210C-1
	80		BPE1	2.03	0.55	5.0	1.11	1.70	1.9							3.9	0.50	24	172.1	4.86	0.6	Tt from 210C-1 to 210C-2
5TH1-7, OS-10, BPE1		210C-2								7.6	3.63	1.50	5.4			1.9	10.00	18	35.95	12.31	0.0	Tt from 210L to 210C-2
	81		BPE2	6.22	0.24	10.0	1.48	1.35	2.0							5.4	0.50	36	269.14	5.32	0.8	Tt from 210C-2 to 616C
																2.0	0.50	18	100	4.08	0.4	Approx; Stub-out Tt from DP23 to DP10

OLSSON ASSOCIATES

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: P=0.5" WATER QUALITY

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. 5.1, Denver Criteria manual, 2006

PROJECT NAME: 6th & Federal Drainage CALCULATED BY: MEG P_1 = 0.5 inches Table 5.1, Denver Criteria manual, 2006 DATE: 1/7/2011

PROJECT NUMBER: 009-2064 CHECKED BY: DPK WATER QUALITY STORM

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Calculated using FlowMaster with Manning's n = 0.015
SW1-3, SE1-4 BPE1-2, 5TH1-7, OS-10		616C								10.0	7.90	1.35	10.7			10.7	0.50	36	168.99	6.27	0.4	Tt from 616C to 618C
	11	717R	SE5	0.19	0.90	5.0	0.17	1.70	0.3							0.3	2.30	18	26.36	4.26	0.1	Tt from 717R to 618C
SW1-3, SE1-5 BPE1-2, 5TH1-7, OS-10		618C								10.4	8.07	1.33	10.7			10.7	0.50	36	129.65	6.28	0.3	Tt from 618C to 619C
	18	721L	SR2	0.20	0.33	5.0	0.07	1.70	0.1							0.1	0.50	18	117.44	1.86	1.1	Plus WQ Diversion flows Tt from 721L to 720C
	14	720R	SR1	0.15	0.42	5.0	0.06	1.70	0.1							0.1	4.38	18	31.95	5.53	0.1	Tt from 720R to 720C
SR1, SR2		720C								6.1	0.13	1.61	0.2			0.2	0.50	18	134.26	2.79	0.8	Tt from 720C to 719C
	13	719R	SE7	0.28	0.87	5.0	0.24	1.70	0.4							0.4	5.32	18	33.99	6.29	0.1	Tt from 719R to 719C
	17	621R	SE10	0.11	0.90	5.0	0.10	1.70	0.2							0.2	1.72	18	56.24	3.13	0.3	Tt from 621R to 620R
	16	620R	SE9	0.17	0.90	5.0	0.15	1.70	0.3	5.3	0.25	1.67	0.4			0.4	0.88	18	91.43	3.57	0.4	Tt from 620R to 619R
	15	619R	SE8	0.28	0.90	5.0	0.25	1.70	0.4	5.7	0.50	1.63	0.8			0.8	5.25	18	20.11	7.68	0.0	Tt from 619R to 719C
SE8, SE9, SE10 SR1, SR2		719C								6.9	0.87	1.55	1.3			1.3	0.50	18	58.36	4.51	0.2	Tt from 719C to 619C
	12	718R	SE6	0.51	0.90	5.0	0.46	1.70	0.8							0.8	3.56	18	36.37	6.60	0.1	Tt from 718R to 619C
SW1-3, SE1-10, SR1-2 BPE1-2, 5TH1-7, OS-10		619C								10.8	9.40	1.31	12.3			12.3	0.50	36	228.98	6.45	0.6	Tt from 619C to 1220L
SW1-3, SE1-10, SR1-2 BPE1-2, 5TH1-7, OS-10		OUTFALL 1220L								11.4	9.40	1.28	12.1									
	64	117L	NF4	0.40	0.49	5.0	0.20	1.70	0.3							0.3	1.00	18	10.39	3.29	0.1	Tt from 117L to 117C
NF4		117C								5.1	0.20	1.69	0.3			0.3	0.50	18	167.73	2.57	1.1	Tt from 117C to 115C
	63	115L	NF3	0.36	0.58	5.5	0.21	1.65	0.3							0.3	3.40	18	14.02	5.06	0.0	Tt from 115L to 115C
NF4, NF3		115C								6.1	0.40	1.60	0.6			0.6	0.50	18	167.73	3.08	0.9	Tt from 115C to 113C-1
	62	113L	NF2	0.29	0.84	5.0	0.24	1.70	0.4							0.4	3.23	18	15.09	5.28	0.0	Tt from 113L to 113C-1
NF4, NF3, NF2		113C-1								7.0	0.65	1.53	1.0			1.0	0.50	18	133.31	3.49	0.6	Tt from 113C-1 to 112C-1
	61	112L	NF1	0.22	0.87	5.0	0.19	1.70	0.3							0.3	9.50	18	18.32	7.26	0.0	Tt from 112L to 112C-1
		112C-1								7.7	0.84	1.49	1.3			1.3	0.50	18	133.31	3.70	0.6	Tt from 112C-1 to 111C-1
	60	413R	NW1	0.78	0.76	5.0	0.59	1.70	1.0							1.0	0.50	18	192.3	3.49	0.9	Inlet in SUMP Tt from 413R To 111C-1
		111C-1								8.3	1.43	1.45	2.1			2.1	0.50	24	111.25	4.19	0.4	Tt from 111C-1 To 111C-2
	69	116R-2	NF9	0.32	0.88	5.0	0.28	1.70	0.5							0.5	1.00	18	83.29	3.66	0.4	Tt from 116R-2 to 116C
	68	116R-1	NF8	1.02	0.75	5.0	0.77	1.70	1.3							1.3	1.00	18	17.36	4.82	0.1	Tt from 116R-1 to 116C
NF9, NF8		116C								5.4	1.05	1.66	1.7			1.7	0.50	18	122.21	3.98	0.5	Tt from 116C to 114C
	67	114R	NF7	0.54	0.86	5.0	0.47	1.70	0.8							0.8	2.97	18	16.72	6.19	0.0	Tt from 114R to 114C

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: P=0.5" WATER QUALITY

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. 5.1, Denver Criteria manual, 2006

PROJECT NAME: 6th & Federal Drainage CALCULATED BY: MEG P_1 = 0.5 inches Table 5.1, Denver Criteria manual, 2006 DATE: 1/7/2011

PROJECT NUMBER: 009-2064 CHECKED BY: DPK WATER QUALITY STORM

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Calculated using FlowMaster with Manning's n = 0.015
NF9, NF8, NF7		114C								5.9	1.51	1.62	2.5									
	66	113R	NF6	1.11	0.69	5.0	0.77	1.70	1.3							2.5	0.50	24	122.21	4.37	0.5	Tt from 114C to 113C-2
NF9, NF8, NF7, NF6		113C-2								6.4	2.28	1.58	3.6			1.3	6.35	18	16.2	9.40	0.0	Tt from 113R To 113C-2
	65	112R	NF5	0.25	0.89	5.0	0.22	1.70	0.4							3.6	0.50	24	133.81	4.78	0.5	Tt from 113C-2 to 112C-2
		112C-2								6.8	2.50	1.55	3.9			0.4	7.04	18	11.36	6.75	0.0	Tt from 112R to 112C-2
		111C-2								8.7	3.93	1.42	5.6			3.9	0.97	24	133.81	6.27	0.4	Tt from 112C-2 to 111C-2
	70	313L	NE1	0.80	0.81	5.0	0.65	1.70	1.1	9.4	4.58	1.39	6.4			5.6	0.50	36	203.3	5.35	0.6	Tt from 111C-2 To 313L
	71	316L	NE2	0.61	0.44	5.0	0.27	1.70	0.5	9.8	4.85	1.36	6.6			6.4	3.77	36	334.73	11.49	0.5	Tt from 313L to 316L
		1119C								10.3	4.85	1.34	6.5			6.6	4.37	36	319.85	12.23	0.4	Tt from 316L to 1119C
OUTFALL		1119L		3.93						10.4	4.85	1.33	6.5			6.5	5.72	36	60.12	13.40	0.1	Tt from 1119C to 1119L (Outfall)
	6		OS-1	1.12	0.24	5.0	0.27	1.70	0.5													
	2		OS-7	0.61	0.74	5.0	0.45	1.70	0.8													
	4		OS-8	0.10	0.35	5.0	0.03	1.70	0.1													
	19		SR3	0.30	0.32	5.0	0.10	1.70	0.2													
	20		SR4	0.25	0.41	5.0	0.10	1.70	0.2										150	3.0	0.8	Tt from DP19 to DP24 Gutter. S=2.5%
SR2, SR3	20									5.8	0.20	1.63	0.3									
	32		WQ1	2.96	0.20	5.0	0.60	1.70	1.0													
	47		WQ3	0.44	0.15	5.0	0.07	1.70	0.1													
	34		WG2	0.65	0.43	5.0	0.28	1.70	0.5													
WG1, WG2	33		WG1	0.54	0.49	5.0	0.26	1.70	0.4	5.3	0.54	1.67	0.9			0.5	2.20	18	100	4.90	0.3	Tt from DP34 to DP33
	35		EB1	0.87	0.40	5.0	0.35	1.70	0.6													
	36		EB2	0.67	0.38	5.0	0.25	1.70	0.4										350	2.1	2.8	Tt from DP 35 to 36 Gutter. S=1.2%
EB1, EB2	36									7.8	0.60	1.48	0.9									
	37		EB3	0.97	0.41	5.0	0.40	1.70	0.7										315	2.0	2.6	Tt from DP 36 to 37 Gutter. S=1.0%
EB1, EB2, EB3	37									10.4	1.00	1.33	1.3									
	38		EB4	0.87	0.51	5.0	0.45	1.70	0.8										330	2.1	2.6	Tt from DP 37 to 38 Gutter. S=1.1%
EB1, EB2, EB3, EB4	38									13.0	1.45	1.21	1.8									
	46		OS-9	0.47	0.90	5.0	0.42	1.70	0.7													
	39		WB1	0.83	0.43	5.0	0.36	1.70	0.6										350	2.0	2.9	Tt from DP 39 to 40 Gutter. S=1.0%

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: P=0.5" WATER QUALITY

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. 5.1, Denver Criteria manual, 2006

PROJECT NAME: 6th & Federal Drainage CALCULATED BY: MEG P_1 = 0.5 inches Table 5.1, Denver Criteria manual, 2006 DATE: 1/7/2011

PROJECT NUMBER: 009-2064 CHECKED BY: DPK WATER QUALITY STORM

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Calculated using FlowMaster with Manning's n = 0.015
	40		WB2	0.68	0.36	5.0	0.25	1.70	0.4													
WB1, WB2	40									7.9	0.60	1.47	0.9									
	41		WB3	1.33	0.51	6.0	0.68	1.61	1.1										550	2.0	4.6	Tt from DP 40 to 41 Gutter. S=1.0%
WB1, WB2, WB3	41									12.5	1.28	1.23	1.6									
	42		WB4	0.31	0.90	5.0	0.28	1.70	0.5										150	2.0	1.3	Tt from DP 41 to 42 Gutter. S=1.0%
WB1, WB2, WB3, WB4	42									13.8	1.56	1.18	1.8									
	44		WB6	0.53	0.90	5.0	0.47	1.69	0.8										275	2.0	2.3	Tt from DP 42 to 44 Gutter. S=1.1%
WB1, WB2 WB3, WB4, WB6	44									16.0	2.03	1.10	2.2									
	43		WB5	0.55	0.36	5.0	0.20	1.70	0.3													
	45		WB7	0.82	0.90	5.0	0.73	1.70	1.2													
Drainage Diversion EB1-4, WB1-7, OS-9		721C											6.3									
	50		OS-2	0.52	0.56	5.0	0.29	1.70	0.5													
	51		OS-3	0.22	0.82	5.0	0.18	1.70	0.3													
	52		OS-4	0.52	0.63	5.0	0.33	1.70	0.6													
	53		OS-5	9.67	0.36	10.0	3.52	1.35	4.8													
	54		OS-6	13.27	0.36	10.0	4.77	1.35	6.5													

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 5-YEAR

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. 5.1, Denver Criteria manual, 2006

PROJECT NAME: 6th & Federal Drainage — CALCULATED BY: MEG — P_1 = 1.34 inches — Table 5.1, Denver Criteria manual, 2006 — DATE: 1/7/2011

PROJECT NUMBER: 009-2064 — CHECKED BY: DPK

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Calculated using FlowMaster with Manning's n = 0.015
	1	906L	SW1	0.73	0.90	5.0	0.65	4.55	3.0													
																3.0	1.00	18	27.55	4.63	0.1	Tt from 906L to 906C
	3	906R	SW2	0.58	0.44	5.0	0.25	4.55	1.2													
																1.2	2.13	18	12.22	4.67	0.0	Tt from 906R to 906C
SW1, SW2		906C								5.1	0.91	4.52	4.1									
																4.1	0.50	18	73.43	3.87	0.3	Tt from 906C to 105C
SW1, SW2		105C								5.4	0.91	4.45	4.0									
																4.0	0.50	18	163.29	3.85	0.7	Tt from 105C to 107C
	5	509L	SW3	1.06	0.44	5.6	0.47	4.40	2.1													
																2.1	1.00	18	191.15	4.19	0.8	Tt from 509L to 107C
SW1, SW2, SW3		107C								6.4	1.37	4.24	5.8									
																5.8	0.50	24	168.02	4.22	0.7	Tt from 107C to 609C
	7	106R	SE1	0.76	0.85	5.0	0.65	4.55	2.9													
																2.9	1.00	18	15.42	4.59	0.1	Tt from 106R to 106C-1
SE1		106C-1								5.1	0.65	4.53	2.9									
																2.9	0.50	18	94.36	3.55	0.4	Tt from 106C-1 to 106C-2
SE1		106C-2								5.5	0.65	4.43	2.9									
																2.9	0.50	18	111.63	3.55	0.5	Tt from 106C-2 to 609C
SE1, SW1, SW2, SW3		609C								7.0	2.02	4.11	8.3									
																8.3	0.50	24	111.41	4.62	0.4	Tt from 609C to 610R
SW1 SW2, SW3, SE1, SE2	8	610R	SE2	0.42	0.87	5.0	0.36	4.55	1.7	7.4	2.39	4.04	9.6									
																9.6	3.15	24	358.03	5.38	1.1	Supercritical flow Tt from 610R to 613R
SW1, SW2 SW3, SE1, SE2, SE3	9	613R	SE3	0.41	0.58	5.0	0.24	4.55	1.1	8.6	2.62	3.85	10.1									
																10.1	4.45	24	223.94	5.48	0.7	Supercritical flow Tt from 613R to 615R
SW1, SW2, SW3 SE1, SE2, SE3, SE4	10	615R	SE4	0.28	0.61	5.0	0.17	4.55	0.8	9.2	2.80	3.74	10.5									
																10.5	5.13	24	29.72	5.55	0.1	Supercritical flow Tt from 615R to 616C
	90	205L	5TH1	1.12	0.53	5.0	0.59	4.55	2.7													
														4.98	2.7				260	4.50	1.0	Tt from 205L to 208L
	91	205R	5TH2	0.96	0.43	5.0	0.41	4.55	1.9													
														4.40	1.9				300	4.20	1.2	Tt from 205R to 208R
5TH1, 5TH3	92	208L	5TH3	0.47	0.33	5.0	0.16	4.55	0.7	6.0	0.75	4.33	3.2									
																3.2	0.50	18	31.93	3.64	0.1	Tt from 208L to 208C
5TH2, 5TH4	93	208R	5TH4	1.49	0.29	6.4	0.43	4.23	1.8	6.4	0.85	4.23	3.6									
																3.6	0.50	18	13.13	3.75	0.1	Tt from 208L to 208C
5TH1, 5TH2 5TH3, 5TH4		208C								6.5	1.60	4.22	6.7									
																6.7	4.70	18	158.8	5.34	0.5	Supercritical flow Tt from 208C to 210C-1
	97		OS-10	0.49	0.66	5.4	0.32	4.46	1.4													
														1.60	1.4				70	2.50	0.5	Tt from OS-10 to 811R
5TH5, OS-10	94	811L	5TH5	1.32	0.29	5.0	0.39	4.55	1.8	5.8	0.71	4.36	3.1									
																3.1	0.57	18	28.59	3.80	0.1	Tt from 811L to 811C
5TH5, OS-10		811C								6.0	0.71	4.33	3.1									
																3.1	0.51	18	81.4	3.64	0.4	Tt from 811C to 210C
	95	211L	5TH6	0.24	0.50	5.0	0.12	4.55	0.6													
																0.6	0.50	18	28.35	2.29	0.2	Tt from 211L to 211C
	96	211R	5TH7	0.10	0.90	5.0	0.09	4.55	0.4													
																0.4	0.50	18	16.94	2.03	0.1	Tt from 211R to 211C
5TH6, 5TH7		211C								5.2	0.21	4.50	0.9									
																0.9	0.50	18	125.53	2.57	0.8	Tt from 211C to 210C-1
5TH1-7, OS-10		210C-1								7.0	2.52	4.12	10.4									
																10.4	0.50	24	172.1	4.86	0.6	Tt from 210C-1 to 210C-2
	80	210L	BPE1	2.03	0.55	5.0	1.11	4.55	5.1													
																5.1	10.00	18	35.95	4.80	0.1	Supercritical flow Tt from 210L to 210C-2
5TH1-7, OS-10, BPE1		210C-2								7.6	3.63	4.01	14.5									
																14.5	0.50	36	269.14	5.32	0.8	Tt from 210C-2 to 616C
	81		BPE2	6.22	0.24	10.0	1.48	3.63	5.3													
																5.3	0.50	18	100	4.08	0.4	Approx; Stub-out Tt from DP23 to DP10

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 5-YEAR

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. 5.1, Denver Criteria manual, 2006

PROJECT NAME: 6th & Federal Drainage — CALCULATED BY: MEG — P_1 = 1.34 inches — Table 5.1, Denver Criteria manual, 2006 — DATE: 1/7/2011

PROJECT NUMBER: 009-2064 — CHECKED BY: DPK

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Calculated using FlowMaster with Manning's n = 0.015
SW1-3, SE1-4 BPE1-2, 5TH1-7, OS-10		616C								10.0	7.90	3.63	28.6									
																28.6	0.50	36	168.99	6.27	0.4	Tt from 616C to 618C
	11	717R	SE5	0.19	0.90	5.0	0.17	4.55	0.8													Supercritical flow
																0.8	2.30	18	26.36	2.74	0.2	Tt from 717R to 618C
SW1-3, SE1-5 BPE1-2, 5TH1-7, OS-10		618C								10.4	8.07	3.56	28.7									
																28.7	0.50	36	129.65	6.28	0.3	Tt from 618C to 619C
Drainage Diversion EB1-4, WB1-7, OS-9		721C		8.90									16.8									
																16.8	0.50	36	7.9	5.51	0.0	Tt from721C to 721L
SR2 EB1-4, WB1-7, OS-9	18	721L	SR2	0.20	0.33	5.0	0.07	4.55	0.3	5.0	0.07	4.55	17.1									Includes WQ Diversion flows
																17.1	0.92	36	93.35	5.71	0.3	Tt from 721L to 720C
	14	720R	SR1	0.15	0.42	5.0	0.06	4.55	0.3													Supercritical flow
																0.3	4.38	18	31.95	2.11	0.3	Tt from 720R to 720C
EB1-4, WB1-7, OS-9 SR1, SR2		720C								5.3	0.13	4.48	17.4									
																17.4	0.50	36	134.26	5.57	0.4	Tt from 720C to 719C
	13	719R	SE7	0.28	0.87	5.0	0.24	4.55	1.1													Supercritical flow
																1.1	5.32	18	33.99	2.99	0.2	Tt from 719R to 719C
	17	621R	SE10	0.11	0.90	5.0	0.10	4.55	0.4													Supercritical flow
																0.4	3.30	18	29.35	2.28	0.2	Tt from 621R to 620R
SE9, SE10	16	620R	SE9	0.17	0.90	5.0	0.15	4.55	0.7	5.2	0.25	4.49	1.1									
																1.1	0.70	18	114.73	3.07	0.6	Tt from 620R to 619R
SE8, SE9, SE10	15	619R	SE8	0.28	0.90	5.0	0.25	4.55	1.1	5.8	0.50	4.36	2.2									Supercritical flow
																2.2	5.25	18	20.11	3.65	0.1	Tt from 619R to 719C
SE8, SE9, SE10 SR1, SR2		719C								5.9	0.87	4.34	20.6									
																20.6	0.50	36	58.36	5.81	0.2	Tt from 719C to 619C
	12	718R	SE6	0.51	0.90	5.0	0.46	4.55	2.1													Supercritical flow
																2.1	3.56	18	36.37	3.60	0.2	Tt from 718R to 619C
SW1-3, SE1-10, SR1-2 BPE1-2, 5TH1-7, OS-10		619C								10.8	9.40	3.52	49.9									**Exceeds capacity**
																49.9	0.50	36	228.98	6.61	0.6	Tt from 619C to 1220L
SW1-3, SE1-10, SR1-2 BPE1-2, 5TH1-7, OS-10		OUTFALL 1220L								11.4	9.40	3.44	49.2									
	64	117L	NF4	0.40	0.49	5.0	0.20	4.55	0.9													
																0.9	1.00	18	10.39	3.29	0.1	Tt from 117L to 117C
NF4		117C								5.1	0.20	4.53	0.9									
																0.9	0.50	18	167.73	2.57	1.1	Tt from 117C to 115C
	63	115L	NF3	0.36	0.58	5.5	0.21	4.42	0.9													
																0.9	3.40	18	14.02	5.06	0.0	Tt from 115L to 115C
NF4, NF3		115C								6.1	0.40	4.29	1.7									
																1.7	0.50	18	167.73	3.08	0.9	Tt from 115C to 113C-1
	62	113L	NF2	0.29	0.84	5.0	0.24	4.55	1.1													
																1.1	3.23	18	15.09	5.28	0.0	Tt from 113L to 113C-1
NF4, NF3, NF2		113C-1								7.0	0.65	4.11	2.7									
																2.7	0.50	18	133.31	3.49	0.6	Tt from 113C-1 to 112C-1
	61	112L	NF1	0.22	0.87	5.0	0.19	4.55	0.9													
																0.9	9.50	18	18.32	7.26	0.0	Tt from 112L to 112C-1
		112C-1								7.7	0.84	3.99	3.4									
																3.4	0.50	18	133.31	3.70	0.6	Tt from 112C-1 to 111C-1
	60	413R	NW1	0.78	0.76	5.0	0.59	4.55	2.7													Inlet in SUMP
																2.7	0.50	18	192.3	3.49	0.9	Tt from 413R To 111C-1
		111C-1								8.3	1.43	3.89	5.6									
																5.6	0.50	24	111.25	4.19	0.4	Tt from 111C-1 To 111C-2
	69	116R-2	NF9	0.32	0.88	5.0	0.28	4.55	1.3													
																1.3	1.00	18	83.29	3.66	0.4	Tt from 116R-2 to 116C
	68	116R-1	NF8	1.02	0.75	5.0	0.77	4.55	3.5													
																3.5	1.00	18	17.36	4.82	0.1	Tt from 116R-1 to 116C
NF9, NF8		116C								5.4	1.05	4.46	4.7									
																4.7	0.50	18	122.21	3.98	0.5	Tt from 116C to 114C

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STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 5-YEAR

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. 5.1, Denver Criteria manual, 2006

PROJECT NAME: 6th & Federal Drainage — CALCULATED BY: MEG — P_1 = 1.34 inches — Table 5.1, Denver Criteria manual, 2006 — DATE: 1/7/2011

PROJECT NUMBER: 009-2064 — CHECKED BY: DPK

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Calculated using FlowMaster with Manning's n = 0.015
	67	114R	NF7	0.54	0.86	5.0	0.47	4.55	2.1													
																2.1	2.97	18	16.72	6.19	0.0	Tt from 114R to 114C
NF9, NF8, NF7		114C								5.9	1.51	4.34	6.6									
																6.6	0.50	24	122.21	4.37	0.5	Tt from 114C to 113C-2
	66	113R	NF6	1.11	0.69	5.0	0.77	4.55	3.5													
																3.5	6.35	18	16.2	9.40	0.0	Tt from 113R To 113C-2
NF9, NF8, NF7, NF6		113C-2								6.4	2.28	4.25	9.7									
																9.7	0.50	24	133.81	4.78	0.5	Tt from 113C-2 to 112C-2
	65	112R	NF5	0.25	0.89	5.0	0.22	4.55	1.0													
																1.0	7.04	18	11.36	6.75	0.0	Tt from 112R to 112C-2
		112C-2								6.8	2.50	4.15	10.4									
																10.4	0.97	24	133.81	6.27	0.4	Tt from 112C-2 to 111C-2
		111C-2								8.7	3.93	3.82	15.0									
																15.0	0.50	36	203.3	5.35	0.6	Tt from 111C-2 To 313L
	70	313L	NE1	0.80	0.81	5.0	0.65	4.55	3.0	9.4	4.58	3.72	17.1									
																17.1	3.77	36	334.73	11.49	0.5	Tt from 313L to 316L
	71	316L	NE2	0.61	0.44	5.0	0.27	4.55	1.2	9.8	4.85	3.65	17.7									
																17.7	4.37	36	319.85	12.23	0.4	Tt from 316L to 1119C
		1119C								10.3	4.85	3.59	17.4									
																17.4	5.72	36	60.12	13.40	0.1	Tt from 1119C to 1119L (Outfall)
OUTFALL		1119L		6.70						10.4	4.85	3.58	17.3									
	6		OS-1	1.12	0.24	5.0	0.27	4.55	1.2													
	2		OS-7	0.61	0.74	5.0	0.45	4.55	2.0													
	4		OS-8	0.10	0.35	5.0	0.03	4.55	0.2													
	19		SR3	0.30	0.32	5.0	0.10	4.55	0.4													
																			150	3.0	0.8	Tt from DP19 to DP24 Gutter. S=2.5%
	20		SR4	0.25	0.41	5.0	0.10	4.55	0.5													
SR2, SR3	20									5.8	0.20	4.36	0.9									
	32		WQ1	2.96	0.20	5.0	0.60	4.55	2.7													
	47		WQ3	0.44	0.15	5.0	0.07	4.55	0.3													
	34		WG2	0.65	0.43	5.0	0.28	4.55	1.3													
																1.3	2.20	18	100	4.90	0.3	Tt from DP34 to DP33
WG1, WG2	33		WG1	0.54	0.49	5.0	0.26	4.55	1.2	5.3	0.54	4.47	2.4									
	35		EB1	0.87	0.40	5.0	0.35	4.55	1.6													
																			350	2.1	2.8	Tt from DP 35 to 36 Gutter. S=1.2%
	36		EB2	0.67	0.38	5.0	0.25	4.55	1.2													
EB1, EB2	36									7.8	0.60	3.98	2.4									
																			315	2.0	2.6	Tt from DP 36 to 37 Gutter. S=1.0%
	37		EB3	0.97	0.41	5.0	0.40	4.55	1.8													
EB1, EB2, EB3	37									10.4	1.00	3.57	3.6									
																			330	2.1	2.6	Tt from DP 37 to 38 Gutter. S=1.1%
	38		EB4	0.87	0.51	5.0	0.45	4.55	2.0													
EB1, EB2, EB3, EB4	38									13.0	1.45	3.25	4.7									
	46		OS-9	0.47	0.90	5.0	0.42	4.55	1.9													

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 5-YEAR

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. 5.1, Denver Criteria manual, 2006

PROJECT NAME: 6th & Federal Drainage — CALCULATED BY: MEG — P_1 = 1.34 inches — Table 5.1, Denver Criteria manual, 2006 — DATE: 1/7/2011

PROJECT NUMBER: 009-2064 — CHECKED BY: DPK

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Calculated using FlowMaster with Manning's n = 0.015
	39		WB1	0.83	0.43	5.0	0.36	4.55	1.6													
	40		WB2	0.68	0.36	5.0	0.25	4.55	1.1										350	2.0	2.9	Tt from DP 39 to 40 Gutter. S=1.0%
WB1, WB2	40									7.9	0.60	3.95	2.4									
	41		WB3	1.33	0.51	6.0	0.68	4.33	2.9										550	2.0	4.6	Tt from DP 40 to 41 Gutter. S=1.0%
WB1, WB2, WB3	41									12.5	1.28	3.30	4.2									
	42		WB4	0.31	0.90	5.0	0.28	4.55	1.3										150	2.0	1.3	Tt from DP 41 to 42 Gutter. S=1.0%
WB1, WB2, WB3, WB4	42									13.8	1.56	3.17	4.9									
	44		WB6	0.53	0.90	5.0	0.47	4.54	2.2										275	2.0	2.3	Tt from DP 42 to 44 Gutter. S=1.1%
WB1, WB2 WB3, WB4, WB6	44									16.0	2.03	2.95	6.0									
	43		WB5	0.55	0.36	5.0	0.20	4.55	0.9													
	45		WB7	0.82	0.90	5.0	0.73	4.55	3.3													
Drainage Diversion EB1-4, WB1-7, OS-9		721C											16.8									
	50		OS-2	0.52	0.56	5.0	0.29	4.55	1.3													
	51		OS-3	0.22	0.82	5.0	0.18	4.55	0.8													
	52		OS-4	0.52	0.63	5.0	0.33	4.55	1.5													
	53		OS-5	9.67	0.36	10.0	3.52	3.63	12.7													
	54		OS-6	13.27	0.36	10.0	4.77	3.63	17.3													

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 50-YEAR (FOR SUMP INLETS ONLY)

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. 5.1, Denver Criteria manual, 2006

PROJECT NAME: 6th & Federal Drainage — CALCULATED BY: MEG — P_1 = 2.25 inches — Table 5.1, Denver Criteria manual, 2006 — DATE: 1/7/2011

PROJECT NUMBER: 009-2064 — CHECKED BY: DPK

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Calculated using FlowMaster with Manning's n = 0.015
	1	906L	SW1	0.73	0.96	5.0	0.70	7.63	5.3													
	3	906R	SW2	0.58	0.60	5.0	0.35	7.63	2.6							5.3	1.00	18	27.55	5.36	0.1	Tt from 906L to 906C
SW1, SW2		906C								5.1	1.04	7.60	7.9			2.6	2.13	18	12.22	5.84	0.0	Tt from 906R to 906C
SW1, SW2		105C								5.4	1.04	7.48	7.8			7.9	0.50	18	73.43	4.16	0.3	**Capacity Exceeded** Tt from 906C to 105C
	5	509L	SW3	1.06	0.60	5.6	0.63	7.39	4.7							7.8	0.50	18	163.29	4.16	0.7	**Capacity Exceeded** Tt from 105C to 107C
SW1, SW2, SW3		107C								6.2	1.68	7.17	12.0			4.7	1.00	18	191.15	5.20	0.6	SUMP Tt from 509L to 107C
	7	106R	SE1	0.76	0.92	5.0	0.70	7.63	5.3							12.0	0.50	24	168.02	4.98	0.6	Tt from 107C to 609C
SE1		106C-1								5.0	0.70	7.61	5.3			5.3	1.00	18	15.42	5.36	0.0	SUMP Tt from 106R to 106C-1
SE1		106C-2								5.4	0.70	7.46	5.2			5.3	0.50	18	94.36	4.08	0.4	Tt from 106C-1 to 106C-2
SE1, SW1, SW2, SW3		609C								6.8	2.38	6.98	16.6			5.2	0.50	18	111.63	4.06	0.5	Tt from 106C-2 to 609C
SW1 SW2, SW3, SE1, SE2	8	610R	SE2	0.42	0.93	5.0	0.39	7.63	3.0	7.2	2.77	6.87	19.0			16.6	0.50	24	111.41	5.04	0.4	**Capacity Exceeded** Tt from 609C to 610R
SW1, SW2 SW3, SE1, SE2, SE3	9	613R	SE3	0.41	0.70	5.0	0.29	7.63	2.2	8.0	3.05	6.62	20.2			19.0	3.15	24	358.03	7.19	0.8	Supercritical flow Tt from 610R to 613R
SW1, SW2, SW3 SE1, SE2, SE3, SE4	10	615R	SE4	0.28	0.72	5.0	0.20	7.63	1.5	8.5	3.25	6.47	21.1			20.2	4.45	24	223.94	7.44	0.5	Supercritical flow Tt from 613R to 615R
																21.1	5.57	24	29.72	7.63	0.1	Supercritical flow Tt from 615R to 616C
	90	205L	5TH1	1.12	0.66	5.0	0.74	7.63	5.6													
	91	205R	5TH2	0.96	0.59	5.0	0.57	7.63	4.3					4.98	5.6				260	4.50	1.0	Tt from 205L to 208L
5TH1, 5TH3	92	208L	5TH3	0.47	0.54	5.0	0.25	7.63	1.9	6.0	0.99	7.27	7.2	4.40	4.3				300	4.20	1.2	Tt from 205R to 208R
5TH2, 5TH4	93	208R	5TH4	1.49	0.52	6.4	0.77	7.10	5.5	6.4	1.34	7.10	9.5			7.2	0.50	18	31.93	4.16	0.1	**Capacity Exceeded** Tt from 208L to 208C
5TH1, 5TH2 5TH3, 5TH4		208C								6.5	2.33	7.08	16.5			9.5	0.50	18	13.13	4.16	0.1	**Capacity Exceeded** Tt from 208L to 208C
	97		OS-10	0.49	0.76	5.4	0.37	7.49	2.8							16.5	4.70	18	158.8	9.49	0.3	Supercritical flow Tt from 208C to 210C-1
5TH5, OS-10	94	811L	5TH5	1.32	0.52	5.0	0.69	7.63	5.2	5.8	1.06	7.32	7.7				1.60		70	2.50	0.5	Tt from OS-10 to 811R
5TH5, OS-10		811C								5.9	1.06	7.28	7.7			7.7	0.57	18	28.59	4.45	0.1	**Capacity Exceeded** Tt from 811L to 811C
	95	211L	5TH6	0.24	0.64	5.0	0.15	7.63	1.2							7.7	0.51	18	81.4	4.21	0.3	**Capacity Exceeded** Tt from 811C to 210C
	96	211R	5TH7	0.10	0.96	5.0	0.10	7.63	0.7							1.2	0.50	18	28.35	2.79	0.2	Tt from 211L to 211C
5TH6, 5TH7		211C								5.2	0.25	7.56	1.9			0.7	0.50	18	16.94	2.39	0.1	Tt from 211R to 211C
5TH1-7, OS-10		210C-1								6.8	3.64	6.99	25.4			1.9	0.50	18	125.53	3.18	0.7	Tt from 211C to 210C-1
	80	210L	BPE1	2.03	0.67	5.0	1.37	7.63	10.4							25.4	0.50	24	172.1	5.04	0.6	**Capacity Exceeded** Tt from 210C-1 to 210C-2
5TH1-7, OS-10, BPE1		210C-2								7.3	5.01	6.81	34.1			10.4	10.00	18	35.95	6.66	0.1	Supercritical flow Tt from 210L to 210C-2
	81		BPE2	6.22	0.49	10.0	3.06	6.09	18.6							34.1	0.50	36	269.14	6.49	0.7	Tt from 210C-2 to 616C
																18.6	0.50	18	100	4.16	0.4	Approx; Stub-out Tt from DP81 to DP10

OLSSON ASSOCIATES

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 50-YEAR (FOR SUMP INLETS ONLY)

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. 5.1, Denver Criteria manual, 2006

PROJECT NAME: 6th & Federal Drainage — CALCULATED BY: MEG — P_1 = 2.25 inches — Table 5.1, Denver Criteria manual, 2006 — DATE: 1/7/2011

PROJECT NUMBER: 009-2064 — CHECKED BY: DPK

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Calculated using FlowMaster with Manning's n = 0.015
SW1-3, SE1-4 BPE1-2, 5TH1-7, OS-10		616C								10.0	11.32	6.09	68.9			68.9	0.50	36	168.99	6.61	0.4	**Capacity Exceeded** Tt from 616C to 618C
	11	717R	SE5	0.19	0.96	5.0	0.18	7.63	1.4							1.4	2.30	18	26.36	3.20	0.1	Supercritical flow Tt from 717R to 618C
SW1-3, SE1-5 BPE1-2, 5TH1-7, OS-10		618C								10.4	11.50	5.99	68.9			68.9	0.50	36	129.65	6.61	0.3	**Capacity Exceeded** Tt from 618C to 619C
Drainage Diversion EB1-4, WB1-7, OS-9		721C											35.2			35.2	0.50	36	7.9	6.52	0.0	Tt from721C to 721L
	18	721L	SR2	0.20	0.54	5.0	0.11	7.63	0.8	5.0	0.11	7.63	36.0			36.0	0.50	36	117.44	6.54	0.3	Includes WQ Diversion flows Tt from 721L to 720C
	14	720R	SR1	0.15	0.58	5.0	0.09	7.63	0.7							0.7	4.38	18	31.95	2.65	0.2	Supercritical flow Tt from 720R to 720C
SR1, SR2		720C								5.3	0.19	7.51	36.6			36.6	0.50	36	134.26	6.52	0.3	Tt from 720C to 719C
	13	719R	SE7	0.28	0.93	5.0	0.26	7.63	2.0							2.0	5.32	18	33.99	3.55	0.2	Supercritical flow Tt from 719R to 719C
	17	621R	SE10	0.11	0.96	5.0	0.11	7.63	0.8							0.8	3.30	18	29.35	2.74	0.2	Supercritical flow Tt from 621R to 620R
	16	620R	SE9	0.17	0.96	5.0	0.16	7.63	1.2	5.2	0.27	7.56	2.0			2.0	0.70	18	114.73	3.55	0.5	Supercritical flow Tt from 620R to 619R
	15	619R	SE8	0.28	0.96	5.0	0.27	7.63	2.0	5.7	0.54	7.36	3.9			3.9	5.25	18	20.11	4.37	0.1	SUMP; Supercritical Tt from 619R to 719C
SE8, SE9, SE10 SR1, SR2		719C								5.8	0.99	7.33	42.4			42.4	0.50	36	58.36	6.61	0.1	**Capacity Exceeded** Tt from 719C to 619C
	12	718R	SE6	0.51	0.96	5.0	0.49	7.63	3.7							3.7	3.56	18	36.37	4.30	0.1	Supercritical flow Tt from 718R to 619C
SW1-3, SE1-10, SR1-2 BPE1-2, 5TH1-7, OS-10		619C								10.8	12.98	5.91	111.9			111.9	0.50	36	228.98	6.61	0.6	**Capacity Exceeded** Tt from 619C to 1220L
SW1-3, SE1-10, SR1-2 BPE1-2, 5TH1-7, OS-10		OUTFALL 1220L								11.3	12.98	5.79	110.3									
	64	117L	NF4	0.40	0.63	5.0	0.25	7.63	1.9							1.9	1.00	18	10.39	4.08	0.0	Tt from 117L to 117C
NF4		117C								5.0	0.25	7.61	1.9			1.9	0.50	18	167.73	3.18	0.9	Tt from 117C to 115C
	63	115L	NF3	0.36	0.69	5.5	0.25	7.43	1.9							1.9	3.40	18	14.02	3.50	0.1	Supercritical flow Tt from 115L to 115C
NF4, NF3		115C								5.9	0.50	7.28	3.7			3.7	0.50	18	167.73	3.78	0.7	Tt from 115C to 113C-1
	62	113L	NF2	0.29	0.91	5.0	0.26	7.63	2.0							2.0	3.23	18	15.09	3.55	0.1	Supercritical flow Tt from 113L to 113C-1
NF4, NF3, NF2		113C-1								6.7	0.77	7.03	5.4			5.4	0.50	18	133.31	4.09	0.5	Tt from 113C-1 to 112C-1
	61	112L	NF1	0.22	0.94	5.0	0.21	7.63	1.6							1.6	9.50	18	18.32	3.33	0.1	Supercritical flow Tt from 112L to 112C-1
		112C-1								7.2	0.97	6.85	6.7			6.7	0.50	18	133.31	4.16	0.5	Tt from 112C-1 to 111C-1
	60	413R	NW1	0.78	0.84	5.0	0.66	7.63	5.0							5.0	0.50	18	192.3	4.03	0.8	Inlet in SUMP Tt from 413R To 111C-1
		111C-1								7.7	1.63	6.69	10.9			10.9	0.50	24	111.25	4.90	0.4	Tt from 111C-1 To 111C-2
	69	116R-2	NF9	0.32	0.94	5.0	0.30	7.63	2.3							2.3	1.00	18	83.29	4.30	0.3	Tt from 116R-2 to 116C
	68	116R-1	NF8	1.02	0.84	5.0	0.85	7.63	6.5							6.5	1.00	18	17.36	5.61	0.1	Tt from 116R-1 to 116C
NF9, NF8		116C								5.3	1.15	7.51	8.6			8.6	0.50	18	122.21	4.11	0.5	Tt from 116C to 114C

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 50-YEAR (FOR SUMP INLETS ONLY)

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. 5.1, Denver Criteria manual, 2006

PROJECT NAME: 6th & Federal Drainage — CALCULATED BY: MEG — P_1 = 2.25 inches — Table 5.1, Denver Criteria manual, 2006 — DATE: 1/7/2011

PROJECT NUMBER: 009-2064 — CHECKED BY: DPK

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Calculated using FlowMaster with Manning's n = 0.015
	67	114R	NF7	0.54	0.93	5.0	0.50	7.63	3.8													
																3.8	2.97	18	16.72	4.34	0.1	Supercritical flow Tt from 114R to 114C
NF9, NF8, NF7		114C								5.8	1.65	7.32	12.1									
																12.1	0.50	24	122.21	4.98	0.4	Tt from 114C to 113C-2
	66	113R	NF6	1.11	0.78	5.0	0.87	7.63	6.6													
																6.6	6.35	18	16.2	5.31	0.1	Supercritical flow Tt from 113R To 113C-2
NF9, NF8, NF7, NF6		113C-2								6.2	2.52	7.17	18.1									
																18.1	0.50	24	133.81	5.04	0.4	**Capacity Exceeded** Tt from 113C-2 to 112C-2
	65	112R	NF5	0.25	0.95	5.0	0.24	7.63	1.8													
																1.8	7.04	18	11.36	3.44	0.1	Supercritical flow Tt from 112R to 112C-2
		112C-2								6.7	2.76	7.02	19.4									
																19.4	0.97	24	133.81	7.03	0.3	Tt from 112C-2 to 111C-2
		111C-2								8.1	4.39	6.58	28.9									
																28.9	0.50	36	203.3	6.28	0.5	Tt from 111C-2 To 313L
	70	313L	NE1	0.80	0.88	5.0	0.71	7.63	5.4	8.7	5.09	6.43	32.8									
																32.8	3.77	36	334.73	7.13	0.8	Supercritical flow Tt from 313L to 316L
	71	316L	NE2	0.61	0.60	5.0	0.36	7.63	2.8	9.4	5.46	6.22	34.0									
																34.0	4.37	36	319.85	7.23	0.7	Supercritical flow Tt from 316L to 1119C
		1119C								10.2	5.46	6.05	33.0									
																33.0	5.13	36	60.12	7.15	0.1	Supercritical flow Tt from 1119C to 1119L (Outfall)
OUTFALL		1119L								10.3	5.46	6.01	32.8									
	6		OS-1	1.12	0.49	5.0	0.55	7.63	4.2													
	2		OS-7	0.61	0.82	5.0	0.50	7.63	3.8													
	4		OS-8	0.10	0.55	5.0	0.05	7.63	0.4													
	19		SR3	0.30	0.53	5.0	0.16	7.63	1.2													
														2.50	1.2				150	3.0	0.8	Tt from DP19 to DP24 Gutter. S=2.5%
	20		SR4	0.25	0.58	5.0	0.14	7.63	1.1													
SR2, SR3	20									5.8	0.30	7.31	2.2									
	32		WQ1	2.96	0.47	5.0	1.40	7.63	10.7													
	47		WQ3	0.44	0.44	5.0	0.19	7.63	1.5													
	33		WG1	0.54	0.63	5.0	0.34	7.63	2.6													
																2.6	2.20	18	100	1.47	1.1	Tt from DP33 to DP34
WG1, WG2	34		WG2	0.65	0.59	5.0	0.38	7.63	2.9	6.1	0.72	7.21	5.2									
	35		EB1	0.87	0.57	5.0	0.50	7.63	3.8													
														1.20	3.8				350	2.1	2.8	Tt from DP 35 to 36 Gutter. S=1.2%
	36		EB2	0.67	0.56	5.0	0.38	7.63	2.9													
EB1, EB2	36									7.8	0.88	6.68	5.9									
														1.00	5.9				315	2.0	2.6	Tt from DP 36 to 37 Gutter. S=1.0%
	37		EB3	0.97	0.58	5.0	0.56	7.63	4.3													
EB1, EB2, EB3	37									10.4	1.44	5.99	8.6									
														1.10	8.6				330	2.1	2.6	Tt from DP 37 to 38 Gutter. S=1.1%
	38		EB4	0.87	0.65	5.0	0.56	7.63	4.3													
EB1, EB2, EB3, EB4	38									13.0	2.00	5.45	10.9									
	46		OS-9	0.47	0.96	5.0	0.45	7.63	3.4													

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 50-YEAR (FOR SUMP INLETS ONLY)

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. 5.1, Denver Criteria manual, 2006

PROJECT NAME: 6th & Federal Drainage — CALCULATED BY: MEG — P_1 = 2.25 inches — Table 5.1, Denver Criteria manual, 2006 — DATE: 1/7/2011

PROJECT NUMBER: 009-2064 — CHECKED BY: DPK

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Calculated using FlowMaster with Manning's n = 0.015
	39		WB1	0.83	0.59	5.0	0.49	7.63	3.7													
	40		WB2	0.68	0.55	5.0	0.38	7.63	2.9					1.00	3.7				350	2.0	2.9	Tt from DP 39 to 40 Gutter. S=1.0%
WB1, WB2	40									7.9	0.87	6.64	5.7									
	41		WB3	1.33	0.65	6.0	0.86	7.26	6.2					1.00	5.7				550	2.0	4.6	Tt from DP 40 to 41 Gutter. S=1.0%
WB1, WB2, WB3	41									12.5	1.73	5.55	9.6									
	42		WB4	0.31	0.96	5.0	0.30	7.63	2.3					1.00	9.6				150	2.0	1.3	Tt from DP 41 to 42 Gutter. S=1.0%
WB1, WB2, WB3, WB4	42									13.8	2.02	5.32	10.8									
	44		WB6	0.53	0.96	5.0	0.51	7.62	3.9					1.10	10.8				275	2.0	2.3	Tt from DP 42 to 44 Gutter. S=1.1%
WB1, WB2 WB3, WB4, WB6	44									16.0	2.53	4.95	12.5									
	43		WB5	0.55	0.55	5.0	0.30	7.63	2.3													
	45		WB7	0.82	0.96	5.0	0.78	7.63	6.0													
Drainage Diversion EB1-4, WB1-7, OS-9		721C											35.2									
	50		OS-2	0.52	0.68	5.0	0.35	7.63	2.7													
	51		OS-3	0.22	0.89	5.0	0.20	7.63	1.5													
	52		OS-4	0.52	0.74	5.0	0.38	7.63	2.9													
	53		OS-5	9.67	0.55	10.0	5.36	6.09	32.6													
	54		OS-6	13.27	0.55	10.0	7.33	6.09	44.6													

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 100-YEAR

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. 5.1, Denver Criteria manual, 2006

PROJECT NAME: 6th & Federal Drainage — CALCULATED BY: MEG — P_1 = 2.57 inches — Table 5.1, Denver Criteria manual, 2006 — DATE: 1/7/2011

PROJECT NUMBER: 009-2064 — CHECKED BY: DPK

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Calculated using Figure 7.2 from the CDOT Drainage Design Manual
	1	SW1	0.73	0.96	5.0	0.70	8.72	6.1													
	3	SW2	0.58	0.62	5.0	0.36	8.72	3.1													
	5	SW3	1.06	0.62	5.6	0.66	8.44	5.6													
	6	OS-1	1.12	0.54	5.0	0.61	8.72	5.3					0.50	5.6				400	1.5	4.4	Tt from DP 5 to 6 Gutter. S=0.5%
SW3, OS-1	5								9.4	1.27	7.11	9.0									
	2	OS-7	0.61	0.83	5.0	0.50	8.72	4.4													
	4	OS-8	0.10	0.58	5.0	0.06	8.72	0.5													
	7	SE1	0.76	0.92	5.0	0.70	8.72	6.1					1.40	6.1				385	2.3	2.8	Tt from DP 7 to 8 Gutter. S=1.4%
SE1, SE2	8	SE2	0.42	0.93	5.0	0.39	8.72	3.4	7.8	1.09	7.62	8.3	5.10	8.3				250	4.4	0.9	Tt from DP 8 to 9 Gutter. S=5.1%
SE1, SE2, SE3	9	SE3	0.41	0.71	5.0	0.29	8.72	2.5	8.7	1.38	7.32	10.1	4.70	10.1				250	4.3	1.0	Tt from DP 9 to 10 Gutter. S=4.7%
SE1-SE4	10	SE4	0.28	0.73	5.0	0.21	8.72	1.8	9.7	1.59	7.03	11.2	2.70	11.2				200	3.2	1.0	Tt from DP 10 to 11 Gutter. S=2.7%
SE1-SE5	11	SE5	0.19	0.96	5.0	0.18	8.72	1.6	10.7	1.77	6.76	12.0	2.20	12.0				140	3.0	0.8	Tt from DP 11 to 12 Gutter. S=2.2%
SE1-SE6	12	SE6	0.51	0.96	5.0	0.49	8.72	4.3	11.5	2.26	6.56	14.8	0.50	14.8				65	1.5	0.7	Tt from DP 12 to 13 Gutter. S=0.5%
SE1-SE7	13	SE7	0.28	0.93	5.0	0.26	8.72	2.3	12.2	2.52	6.39	16.1	0.50	16.1				65	1.5	0.7	Tt from DP 13 to 14 Gutter. S=0.5%
SE1-SE10, SR1	14	SR1	0.15	0.61	5.0	0.09	8.72	0.8	13.0	3.15	6.24	19.6	2.70	19.6				520	3.1	2.8	Tt from DP 14 to 18 Gutter. S=2.7%
SE1-SE10,SR1, SR2	18	SR2	0.20	0.57	5.0	0.11	8.72	1.0	15.8	3.26	5.70	18.6	2.50	18.6				150	3.0	0.8	Tt from DP 18 to 19 Gutter. S=2.5%
SE1-SE10,SR1-SR3	19	SR3	0.30	0.57	5.0	0.17	8.72	1.5	16.6	3.43	5.56	19.1	2.50	19.1				150	3.0	0.8	Tt from DP 19 to 24 Gutter. S=2.5%
SE1-SE10,SR1-SR4	20	SR4	0.25	0.61	5.0	0.15	8.72	1.3	17.4	3.58	5.42	19.4									
	17	SE10	0.11	0.96	5.0	0.11	8.72	0.9					1.70	0.9				50	2.6	0.3	Tt from DP 17 to 16 Gutter. S=1.7%
SE9, SE10	16	SE9	0.17	0.96	5.0	0.16	8.72	1.4	5.3	0.27	8.57	2.3	1.50	2.3				200	2.5	1.3	Tt from DP 16 to 15 Gutter. S=1.5%
SE8-SE10	15	SE8	0.28	0.96	5.0	0.27	8.72	2.3	6.7	0.54	8.03	4.3									
	70	NE1	0.80	0.89	5.0	0.71	8.72	6.2					4.30	6.2				335	4.2	1.3	Tt from DP 70 to 71 Gutter. S=4.3%
NE1, NE2	71	NE2	0.61	0.62	5.0	0.38	8.72	3.3	6.3	1.09	8.15	8.9									
NW1	60	NW1	0.78	0.85	5.0	0.66	8.72	5.7													
NF1	61	NF1	0.22	0.94	5.0	0.21	8.72	1.8					0.84	1.8				135	1.8	1.3	Tt from DP 61 to 62 Gutter. S=0.84%
NF1, NF2	62	NF2	0.29	0.91	5.0	0.26	8.72	2.3	6.3	0.47	8.19	3.8	0.15	3.8				167	1.4	2.0	Tt from DP 62 to 63 Gutter. S=0.15%
NF1, NF2, NF3	63	NF3	0.36	0.71	5.5	0.25	8.48	2.2	8.2	0.73	7.48	5.4	0.65	5.4				167	1.6	1.7	Tt from DP 62 to 63 Gutter. S=0.65%
NF1, NF2 NF3, NF4	64	NF4	0.40	0.65	5.0	0.26	8.72	2.3	10.0	0.99	6.96	6.9									
NF5	65	NF5	0.25	0.95	5.0	0.24	8.72	2.1					0.83	2.1				135	1.8	1.3	Tt from DP 65 to 66 Gutter. S=0.83%

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 100-YEAR

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. 5.1, Denver Criteria manual, 2006

PROJECT NAME: 6th & Federal Drainage — CALCULATED BY: MEG — P_1 = 2.57 inches — Table 5.1, Denver Criteria manual, 2006 — DATE: 1/7/2011

PROJECT NUMBER: 009-2064 — CHECKED BY: DPK

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Calculated using Figure 7.2 from the CDOT Drainage Design Manual
NF5, NF6	66	NF6	1.11	0.79	5.0	0.88	8.72	7.7	6.3	1.12	8.19	9.1									
													0.25	9.1				125	1.4	1.5	Tt from DP 66 to 67 Gutter. S=0.25%
NF5, NF6, NF7	67	NF7	0.54	0.93	5.0	0.50	8.72	4.4	7.7	1.62	7.64	12.4									
													0.30	12.4				125	1.4	1.5	Tt from DP 67 to 68 Gutter. S=0.30%
NF5, NF6 NF7, NF8	68	NF8	1.02	0.84	5.0	0.86	8.72	7.5	9.2	2.48	7.17	17.8									
NF9	69	NF9	0.32	0.94	5.0	0.30	8.72	2.6													
	80	BPE1	2.03	0.69	5.0	1.40	8.72	12.2													
BPE1, BPE2	81	BPE2	6.22	0.54	10.0	3.38	6.95	23.5	10.0	4.78	6.95	33.2									
	90	5TH1	1.12	0.68	5.0	0.76	8.72	6.6													
													4.98	6.6				260	4.50	1.0	Tt from DP 90 to 92
	91	5TH2	0.96	0.62	5.0	0.59	8.72	5.2													
													4.40	5.2				300	4.20	1.2	Tt from DP 91 to 93
	92	5TH3	0.47	0.58	5.0	0.27	8.72	2.4	6.0	1.03	8.30	8.5									
	93	5TH4	1.49	0.56	6.4	0.84	8.11	6.8	6.4	1.43	8.11	11.6									
	97	OS-10	0.49	0.77	5.4	0.38	8.55	3.2													
													1.60	3.2				70	2.50	0.5	Tt from DP 97 to 94
	94	5TH5	1.32	0.56	5.0	0.74	8.72	6.5	5.8	1.12	8.36	9.4									
	95	5TH6	0.24	0.66	5.0	0.16	8.72	1.4													
	96	5TH7	0.10	0.96	5.0	0.10	8.72	0.8													
	32	WQ1	2.96	0.53	5.0	1.56	8.72	13.6													
	47	WQ3	0.44	0.50	5.0	0.22	8.72	1.9													
	33	WG1	0.54	0.65	5.0	0.35	8.72	3.1													
	34	WG2	0.65	0.62	5.0	0.40	8.72	3.5													
	35	EB1	0.87	0.60	5.0	0.53	8.72	4.6													
													1.2	4.6				350	2.1	2.8	Tt from DP 35 to 36 Gutter. S=1.2%
EB1, EB2	36	EB2	0.67	0.59	5.0	0.40	8.72	3.5	7.8	0.92	7.63	7.0									
													1.0	7.0				315	2.0	2.6	Tt from DP 36 to 37 Gutter. S=1.0%
EB1, EB2, EB3	37	EB3	0.97	0.61	5.0	0.59	8.72	5.2	10.4	1.51	6.84	10.4									
													1.1	10.4				330	2.1	2.6	Tt from DP 37 to 38 Gutter. S=1.1%
EB1, EB2, EB3, EB4	38	EB4	0.87	0.67	5.0	0.58	8.72	5.1	13.0	2.09	6.22	13.0									
	46	OS-9	0.47	0.96	5.0	0.45	8.72	3.9													
	39	WB1	0.83	0.62	5.0	0.51	8.72	4.5													
																		350	2.0	2.9	Tt from DP 39 to 40 Gutter. S=1.0%
WB1, WB2	40	WB2	0.68	0.59	5.0	0.40	8.72	3.5	7.9	0.91	7.58	6.9									
																		550	2.0	4.6	Tt from DP 40 to 41 Gutter. S=1.0%
WB1, WB2, WB3	41	WB3	1.33	0.67	6.0	0.89	8.30	7.3	12.5	1.80	6.34	11.4									
																		150	2.0	1.3	Tt from DP 41 to 42 Gutter. S=1.0%
WB1, WB2, WB3, WB4	42	WB4	0.31	0.96	5.0	0.30	8.72	2.6	13.8	2.09	6.07	12.7									
																		275	2.0	2.3	Tt from DP 42 to 44 Gutter. S=1.1%
WB1, WB2 WB3, WB4, WB6	44	WB6	0.53	0.96	5.0	0.51	8.70	4.4	16.0	2.60	5.65	14.7									
	43	WB5	0.55	0.59	5.0	0.32	8.72	2.8													

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 100-YEAR

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. 5.1, Denver Criteria manual, 2006

PROJECT NAME: 6th & Federal Drainage — CALCULATED BY: MEG — P_1 = 2.57 inches — Table 5.1, Denver Criteria manual, 2006 — DATE: 1/7/2011

PROJECT NUMBER: 009-2064 — CHECKED BY: DPK

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Calculated using Figure 7.2 from the CDOT Drainage Design Manual
	45	WB7	0.82	0.96	5.0	0.78	8.72	6.8													
	50	OS-2	0.52	0.70	5.0	0.36	8.72	3.2													
	51	OS-3	0.22	0.90	5.0	0.20	8.72	1.7													
	52	OS-4	0.52	0.75	5.0	0.39	8.72	3.4													
	53	OS-5	9.67	0.59	10.0	5.69	6.95	39.6													
	54	OS-6	13.27	0.59	10.0	7.79	6.95	54.1													

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 100-YEAR THEORETICAL
(ROUTED THROUGH STORM SEWER SYSTEM FOR DETENTION BASIN CALCULATIONS)

PROJECT NAME: 6th & Federal Drainage
PROJECT NUMBER: 009-2064

CALCULATED BY: MEG
CHECKED BY: DPK

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. 5.1, Denver Criteria manual, 2006
P_1 = 2.57 inches Table 5.1, Denver Criteria manual, 2006

DATE: 1/7/2011

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Calculated using FlowMaster with Manning's n = 0.015
	1	906L	SW1	0.73	0.96	5.0	0.70	8.72	6.1													
	3	906R	SW2	0.58	0.62	5.0	0.36	8.72	3.1							6.1	1.00	18	27.55	4.63	0.1	Tt from 906L to 906C
SW1, SW2		906C								5.1	1.06	8.67	9.2			3.1	2.13	18	12.22	4.67	0.0	Tt from 906R to 906C
SW1, SW2		105C								5.4	1.06	8.53	9.0			9.2	0.50	18	73.43	3.87	0.3	Tt from 906C to 105C
	5	509L	SW3	1.06	0.62	5.6	0.66	8.44	5.6							9.0	0.50	18	163.29	3.85	0.7	Tt from 105C to 107C
SW1, SW2, SW3		107C								6.4	1.72	8.13	14.0			5.6	1.00	18	191.15	4.19	0.8	Tt from 509L to 107C
	7	106R	SE1	0.76	0.92	5.0	0.70	8.72	6.1							14.0	0.50	24	168.02	4.22	0.7	Tt from 107C to 609C
SE1		106C-1								5.1	0.70	8.69	6.1			6.1	1.00	18	15.42	4.59	0.1	Tt from 106R to 106C-1
SE1		106C-2								5.5	0.70	8.50	5.9			6.1	0.50	18	94.36	3.55	0.4	Tt from 106C-1 to 106C-2
SE1, SW1, SW2, SW3		609C								7.0	2.42	7.88	19.1			5.9	0.50	18	111.63	3.55	0.5	Tt from 106C-2 to 609C
SW1 SW2, SW3, SE1, SE2	8	610R	SE2	0.42	0.93	5.0	0.39	8.72	3.4	7.4	2.81	7.74	21.8			19.1	0.50	24	111.41	4.62	0.4	Tt from 609C to 610R
SW1, SW2 SW3, SE1, SE2, SE3	9	613R	SE3	0.41	0.71	5.0	0.29	8.72	2.5	8.1	3.10	7.53	23.4			21.8	3.15	24	358.03	9.47	0.6	Tt from 610R to 613R
SW1, SW2, SW3 SE1, SE2, SE3, SE4	10	615R	SE4	0.28	0.73	5.0	0.21	8.72	1.8	8.4	3.31	7.42	24.5			23.4	4.45	24	223.94	10.95	0.3	Tt from 613R to 615R
																24.5	5.57	24	29.72	12.03	0.0	Tt from 615R to 616C
	90	205L	5TH1	1.12	0.68	5.0	0.76	8.72	6.6													
	91	205R	5TH2	0.96	0.62	5.0	0.59	8.72	5.2					4.98	6.6				260	4.50	1.0	Tt from 205L to 208L
5TH1, 5TH3	92	208L	5TH3	0.47	0.58	5.0	0.27	8.72	2.4	6.0	1.03	8.30	8.5	4.40	5.2				300	4.20	1.2	Tt from 205R to 208R
5TH2, 5TH4	93	208R	5TH4	1.49	0.56	6.4	0.84	8.11	6.8	6.4	1.43	8.11	11.6			8.5	0.50	18	31.93	3.64	0.1	Tt from 208L to 208C
5TH1, 5TH2 5TH3, 5TH4		208C								6.5	2.46	8.09	19.9			11.6	0.50	18	13.13	3.75	0.1	Tt from 208L to 208C
	97		OS-10	0.49	0.77	5.4	0.38	8.55	3.2							19.9	4.70	18	158.8	10.11	0.3	Tt from 208C to 210C-1
5TH5, OS-10	94	811L	5TH5	1.32	0.56	5.0	0.74	8.72	6.5	5.8	1.12	8.36	9.4				1.60		70	2.50	0.5	Tt from OS-10 to 811R
5TH5, OS-10		811C								6.0	1.12	8.30	9.3			9.4	0.57	18	28.59	3.80	0.1	Tt from 811L to 811C
	95	211L	5TH6	0.24	0.66	5.0	0.16	8.72	1.4							9.3	0.51	18	81.4	3.64	0.4	Tt from 811C to 210C
	96	211R	5TH7	0.10	0.96	5.0	0.10	8.72	0.8							1.4	0.50	18	28.35	2.29	0.2	Tt from 211L to 211C
5TH6, 5TH7		211C								5.2	0.25	8.62	2.2			0.8	0.50	18	16.94	2.03	0.1	Tt from 211R to 211C
5TH1-7, OS-10		210C-1								6.8	3.84	7.99	30.6			2.2	0.50	18	125.53	2.57	0.8	Tt from 211C to 210C-1
	80	210L	BPE1	2.03	0.69	5.0	1.40	8.72	12.2							30.6	0.50	24	172.1	4.86	0.6	Tt from 210C-1 to 210C-2
5TH1-7, OS-10, BPE1		210C-2								7.4	5.24	7.77	40.7			12.2	10.00	18	35.95	12.31	0.0	Tt from 210L to 210C-2
	81		BPE2	6.22	0.54	10.0	3.38	6.95	23.5							40.7	0.50	36	269.14	5.32	0.8	Tt from 210C-2 to 616C
																23.5	0.50	18	100	4.08	0.4	Approx; Stub-out Tt from DP23 to DP10

OLSSON ASSOCIATES

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 100-YEAR THEORETICAL
(ROUTED THROUGH STORM SEWER SYSTEM FOR DETENTION BASIN CALCULATIONS)

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. 5.1, Denver Criteria manual, 2006

PROJECT NAME: 6th & Federal Drainage — CALCULATED BY: MEG

P_1 = 2.57 inches Table 5.1, Denver Criteria manual, 2006 — DATE: 1/7/2011

PROJECT NUMBER: 009-2064 — CHECKED BY: DPK

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Calculated using FlowMaster with Manning's n = 0.015
SW1-3, SE1-4 BPE1-2, 5TH1-7, OS-10		616C								10.0	11.92	6.95	82.9									
	11	717R	SE5	0.19	0.96	5.0	0.18	8.72	1.6							82.9	0.50	36	168.99	6.27	0.4	Tt from 616C to 618C
SW1-3, SE1-5 BPE1-2, 5TH1-7, OS-10		618C								10.4	12.10	6.83	82.7			1.6	2.30	18	26.36	4.26	0.1	Tt from 717R to 618C
Drainage Diversion EB1-4, WB1-7, OS-9		721C											41.3			82.7	0.50	36	129.65	6.28	0.3	Tt from 618C to 619C
	18	721L	SR2	0.20	0.57	5.0	0.11	8.72	1.0	5.0	0.11	8.72	42.3			41.3	0.50	36	6.61	5.51	0.0	Tt from721C to 721L
	14	720R	SR1	0.15	0.61	5.0	0.09	8.72	0.8							42.3	0.92	36	93.35	8.66	0.2	Plus WQ Diversion flows Tt from 721L to 720C
SR1, SR2		720C								5.2	0.21	8.64	43.1			0.8	4.38	18	31.95	5.53	0.1	Tt from 720R to 720C
	13	719R	SE7	0.28	0.93	5.0	0.26	8.72	2.3							43.1	0.50	36	134.26	6.61	0.3	Tt from 720C to 719C
	17	621R	SE10	0.11	0.96	5.0	0.11	8.72	0.9							2.3	5.32	18	33.99	6.29	0.1	Tt from 719R to 719C
	16	620R	SE9	0.17	0.96	5.0	0.16	8.72	1.4	5.1	0.27	8.66	2.3			0.9	3.30	18	29.35	3.93	0.1	Tt from 621R to 620R
	15	619R	SE8	0.28	0.96	5.0	0.27	8.72	2.3	5.7	0.54	8.39	4.5			2.3	0.70	18	114.73	3.07	0.6	Tt from 620R to 619R
SE8, SE9, SE10 SR1, SR2		719C								5.8	1.00	8.37	49.7			4.5	5.25	18	20.11	7.68	0.0	Tt from 619R to 719C
	12	718R	SE6	0.51	0.96	5.0	0.49	8.72	4.3							49.7	0.50	36	58.36	6.61	0.1	Tt from 719C to 619C
SW1-3, SE1-10, SR1-2 BPE1-2, 5TH1-7, OS-10		619C								10.8	13.59	6.74	133.0			4.3	3.56	18	36.37	6.60	0.1	Tt from 718R to 619C
SW1-3, SE1-10, SR1-2 BPE1-2, 5TH1-7, OS-10		OUTFALL 1220L								11.4	13.59	6.60	131.0			133.0	0.50	36	228.98	6.61	0.6	Tt from 619C to 1220L
	64	117L	NF4	0.40	0.65	5.0	0.26	8.72	2.3													
NF4		117C								5.1	0.26	8.69	2.3			2.3	1.00	18	10.39	3.29	0.1	Tt from 117L to 117C
	63	115L	NF3	0.36	0.71	5.5	0.25	8.48	2.2							2.3	0.50	18	167.73	2.57	1.1	Tt from 117C to 115C
NF4, NF3		115C								6.1	0.52	8.23	4.2			2.2	3.40	18	14.02	5.06	0.0	Tt from 115L to 115C
	62	113L	NF2	0.29	0.91	5.0	0.26	8.72	2.3							4.2	0.50	18	167.73	3.08	0.9	Tt from 115C to 113C-1
NF4, NF3, NF2		113C-1								7.0	0.78	7.88	6.1			2.3	3.23	18	15.09	5.28	0.0	Tt from 113L to 113C-1
	61	112L	NF1	0.22	0.94	5.0	0.21	8.72	1.8							6.1	0.50	18	133.31	3.49	0.6	Tt from 113C-1 to 112C-1
		112C-1								7.7	0.99	7.66	7.6			1.8	9.50	18	18.32	7.26	0.0	Tt from 112L to 112C-1
	60	413R	NW1	0.78	0.85	5.0	0.66	8.72	5.7							7.6	0.50	18	133.31	3.70	0.6	Tt from 112C-1 to 111C-1
		111C-1								8.3	1.65	7.46	12.3			5.7	0.50	18	192.3	3.49	0.9	Inlet in SUMP Tt from 413R To 111C-1
	69	116R-2	NF9	0.32	0.94	5.0	0.30	8.72	2.6							12.3	0.50	24	111.25	4.19	0.4	Tt from 111C-1 To 111C-2
	68	116R-1	NF8	1.02	0.84	5.0	0.86	8.72	7.5							2.6	1.00	18	83.29	3.66	0.4	Tt from 116R-2 to 116C
NF9, NF8		116C								5.4	1.16	8.55	9.9			7.5	1.00	18	17.36	4.82	0.1	Tt from 116R-1 to 116C
																9.9	0.50	18	122.21	3.98	0.5	Tt from 116C to 114C

STANDARD FORM SF-3
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(ROUTED THROUGH STORM SEWER SYSTEM FOR DETENTION BASIN CALCULATIONS)

PROJECT NAME: 6th & Federal Drainage
PROJECT NUMBER: 009-2064

CALCULATED BY: MEG
CHECKED BY: DPK

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. 5.1, Denver Criteria manual, 2006
$P_1 =$ 2.57 inches Table 5.1, Denver Criteria manual, 2006

DATE: 1/7/2011

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Calculated using FlowMaster with Manning's n = 0.015
	67	114R	NF7	0.54	0.93	5.0	0.50	8.72	4.4													
																4.4	2.97	18	16.72	6.19	0.0	Tt from 114R to 114C
NF9, NF8, NF7		114C								5.9	1.66	8.33	13.8									
																13.8	0.50	24	122.21	4.37	0.5	Tt from 114C to 113C-2
	66	113R	NF6	1.11	0.79	5.0	0.88	8.72	7.7													
																7.7	6.35	18	16.2	9.40	0.0	Tt from 113R To 113C-2
NF9, NF8, NF7, NF6		113C-2								6.4	2.54	8.14	20.7									
																20.7	0.50	24	133.81	4.78	0.5	Tt from 113C-2 to 112C-2
	65	112R	NF5	0.25	0.95	5.0	0.24	8.72	2.1													
																2.1	7.04	18	11.36	6.75	0.0	Tt from 112R to 112C-2
		112C-2								6.8	2.78	7.97	22.1									
																22.1	0.97	24	133.81	6.27	0.4	Tt from 112C-2 to 111C-2
		111C-2								8.7	4.42	7.32	32.4									
																32.4	0.50	36	203.3	5.35	0.6	Tt from 111C-2 To 313L
	70	313L	NE1	0.80	0.89	5.0	0.71	8.72	6.2	9.4	5.13	7.13	36.6									
																36.6	3.77	36	334.73	11.49	0.5	Tt from 313L to 316L
	71	316L	NE2	0.61	0.62	5.0	0.38	8.72	3.3	9.8	5.51	7.00	38.6									
																38.6	4.37	36	319.85	12.23	0.4	Tt from 316L to 1119C
		1119C								10.3	5.51	6.88	37.9									
																37.9	5.72	36	60.12	13.40	0.1	Tt from 1119C to 1119L (Outfall)
OUTFALL		1119L		6.70						10.4	5.51	6.86	37.8									
	6		OS-1	1.12	0.54	5.0	0.61	8.72	5.3													
	2		OS-7	0.61	0.83	5.0	0.50	8.72	4.4													
	4		OS-8	0.10	0.58	5.0	0.06	8.72	0.5													
	19		SR3	0.30	0.57	5.0	0.17	8.72	1.5													
																			150	3.0	0.8	Tt from DP19 to DP24 Gutter. S=2.5%
	20		SR4	0.25	0.61	5.0	0.15	8.72	1.3													
SR2, SR3	20									5.8	0.32	8.35	2.7									
	32		WQ1	2.96	0.53	5.0	1.56	8.72	13.6													
	47		WQ3	0.44	0.50	5.0	0.22	8.72	1.9													
	34		WG2	0.65	0.62	5.0	0.40	8.72	3.5													
																3.5	2.20	18	100	4.90	0.3	Tt from DP34 to DP33
WG1, WG2	33		WG1	0.54	0.65	5.0	0.35	8.72	3.1	5.3	0.75	8.56	6.5									
	35		EB1	0.87	0.60	5.0	0.53	8.72	4.6													
																			350	2.1	2.8	Tt from DP 35 to 36 Gutter. S=1.2%
	36		EB2	0.67	0.59	5.0	0.40	8.72	3.5													
EB1, EB2	36									7.8	0.92	7.63	7.0									
																			315	2.0	2.6	Tt from DP 36 to 37 Gutter. S=1.0%
	37		EB3	0.97	0.61	5.0	0.59	8.72	5.2													
EB1, EB2, EB3	37									10.4	1.51	6.84	10.4									
																			330	2.1	2.6	Tt from DP 37 to 38 Gutter. S=1.1%
	38		EB4	0.87	0.67	5.0	0.58	8.72	5.1													
EB1, EB2, EB3, EB4	38									13.0	2.09	6.22	13.0									
	46		OS-9	0.47	0.96	5.0	0.45	8.72	3.9													

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 100-YEAR THEORETICAL
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$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. 5.1, Denver Criteria manual, 2006

PROJECT NAME: 6th & Federal Drainage CALCULATED BY: MEG

P_1 = 2.57 inches Table 5.1, Denver Criteria manual, 2006 DATE: 1/7/2011

PROJECT NUMBER: 009-2064 CHECKED BY: DPK

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Calculated using FlowMaster with Manning's n = 0.015
	39		WB1	0.83	0.62	5.0	0.51	8.72	4.5													
	40		WB2	0.68	0.59	5.0	0.40	8.72	3.5										350	2.0	2.9	Tt from DP 39 to 40 Gutter. S=1.0%
WB1, WB2	40									7.9	0.91	7.58	6.9									
	41		WB3	1.33	0.67	6.0	0.89	8.30	7.3										550	2.0	4.6	Tt from DP 40 to 41 Gutter. S=1.0%
WB1, WB2, WB3	41									12.5	1.80	6.34	11.4									
	42		WB4	0.31	0.96	5.0	0.30	8.72	2.6										150	2.0	1.3	Tt from DP 41 to 42 Gutter. S=1.0%
WB1, WB2, WB3, WB4	42									13.8	2.09	6.07	12.7									
	44		WB6	0.53	0.96	5.0	0.51	8.70	4.4										275	2.0	2.3	Tt from DP 42 to 44 Gutter. S=1.1%
WB1, WB2 WB3, WB4, WB6	44									16.0	2.60	5.65	14.7									
	43		WB5	0.55	0.59	5.0	0.32	8.72	2.8													
	45		WB7	0.82	0.96	5.0	0.78	8.72	6.8													
Drainage Diversion EB1-4, WB1-7, OS-9		721C											41.3									
	50		OS-2	0.52	0.70	5.0	0.36	8.72	3.2													
	51		OS-3	0.22	0.90	5.0	0.20	8.72	1.7													
	52		OS-4	0.52	0.75	5.0	0.39	8.72	3.4													
	53		OS-5	9.67	0.59	10.0	5.69	6.95	39.6													
	54		OS-6	13.27	0.59	10.0	7.79	6.95	54.1													

APPENDIX D

Inlet Calculations

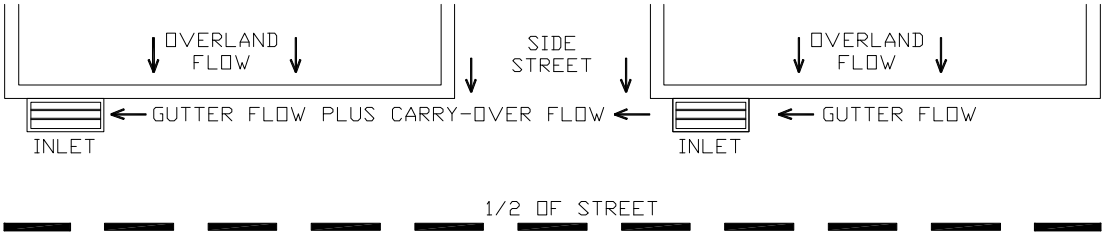
(Printed 2-sided)

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th Ave & Federal Blvd Storm Drainage Design

5th Avenue Storm Sewer - Structure 208L, DP 92

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:

(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):

*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

	Minor Storm	Major Storm	
***Q =**	**3.40**	**8.50**	**cfs**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)	
Site is Urban:	X
Site Is Non-Urban:	

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.00**	**0.00**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

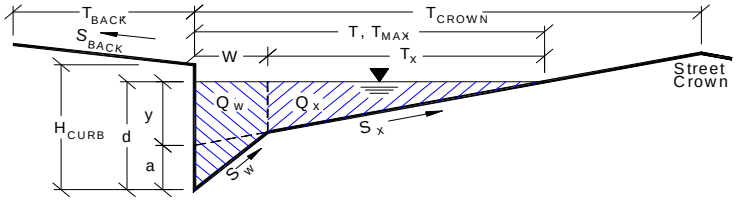
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**3.40**	**8.50**	**cfs**

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

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

Project: **6th Ave & Federal Blvd Storm Drainage Design**

Inlet ID: **5th Avenue Storm Sewer - Structure 208L, DP 92**



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0130	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	40.0	ft
Gutter Depression	a =	1.52	inches
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.0200	ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0470	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	19.0	24.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread

		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0833	0.0833	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	4.56	5.76	inches
Water Depth with a Gutter Depression	d =	6.08	7.28	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	17.0	22.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.313	0.245	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	21.4	42.5	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	9.7	13.8	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Water Spread	**Q_T =**	**31.1**	**56.3**	**cfs**
Flow Velocity Within the Gutter Section	V =	11.5	13.2	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	5.8	8.0	

Maximum Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	20.3	233.3	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	20.3	233.0	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	9.5	35.1	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**29.7**	**268.0**	**cfs**
Flow Velocity Within the Gutter Section	V =	11.4	19.1	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	5.7	19.1	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	0.52	0.42	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**15.5**	**112.9**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	4.95	9.05	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	0.00	inches

		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**15.5**	**56.3**	**cfs**

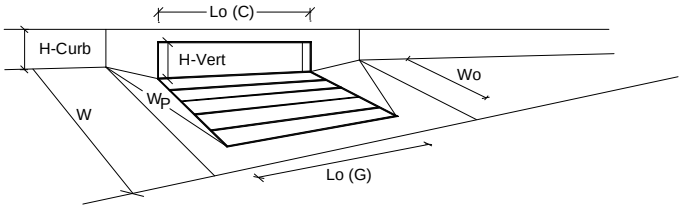
MINOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: 6th Ave & Federal Blvd Storm Drainage Design

Inlet ID: 5th Avenue Storm Sewer - Structure 208L, DP 92



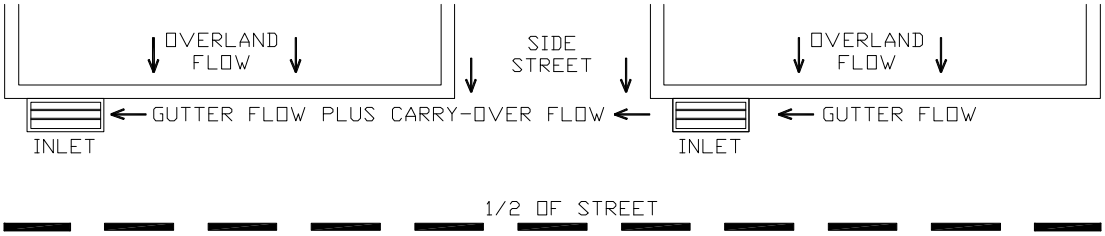
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 14 Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	9.00	9.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	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 < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	**Q_o =**	**3.40**	**8.50**	**cfs**
Water Spread Width	T =	7.1	11.1	ft
Water Depth at Flowline (outside of local depression)	d =	3.2	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 =	0.745	0.529	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.87	4.01	cfs
Discharge within the Gutter Section W	Q_w =	2.53	4.50	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.63	1.35	sq ft
Street Flow Velocity	V_s =	5.38	6.29	fps
Water Depth for Design Condition	d_{LOCAL} =	6.2	7.2	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =			ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =			
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
Interception Capacity	Q_i =			cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =			
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =			
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =			ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
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 or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.1604	0.1196	ft/ft
Required Length L_T to Have 100% Interception	L_T =	14.37	25.18	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	9.00	9.00	ft
Interception Capacity	Q_i =	2.82	4.67	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.10	0.10	
Effective (Unclogged) Length	L_e =	8.10	8.10	ft
Actual Interception Capacity	**Q_a =**	**2.64**	**4.27**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.76**	**4.23**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**2.64**	**4.27**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.76**	**4.23**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**77.5**	**50.3**	**%**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th Ave & Federal Blvd Storm Drainage Design

5th Avenue Storm Sewer - Structure 208R, DP 93

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):

	Minor Storm	Major Storm	
*Q =	3.60	11.60	cfs

*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)

Site is Urban:	X
Site Is Non-Urban:	

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.00**	**0.00**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

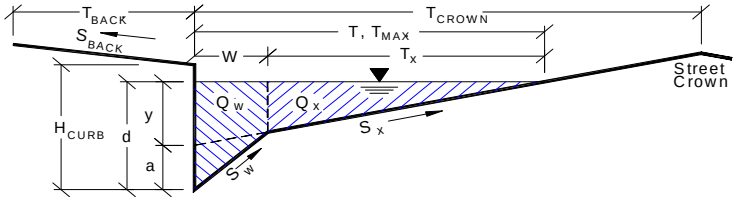
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**3.60**	**11.60**	**cfs**

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

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

Project: **6th Ave & Federal Blvd Storm Drainage Design**

Inlet ID: **5th Avenue Storm Sewer - Structure 208R, DP 93**



Gutter Geometry (Enter data in the blue cells)				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =			ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0130		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	16.0		ft
Gutter Depression	a =	1.52		inches
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.0200		ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0450		ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160		
		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	11.0	16.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0833	0.0833	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	2.64	3.84	inches
Water Depth with a Gutter Depression	d =	4.16	5.36	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	9.0	14.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.532	0.373	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	3.8	12.5	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	4.4	7.4	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Water Spread	**Q_T =**	**8.2**	**19.9**	**cfs**
Flow Velocity Within the Gutter Section	V =	8.3	10.2	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.9	4.5	

Maximum Gutter Capacity Based on Allowable Gutter Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	19.8	228.3	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	19.7	151.7	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	9.3	34.3	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**29.0**	**186.0**	**cfs**
Flow Velocity Within the Gutter Section	V =	11.1	18.7	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	5.6	18.7	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	0.54	0.44	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**15.6**	**81.1**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.00	8.54	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	3.18	inches
		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**8.2**	**19.9**	**cfs**

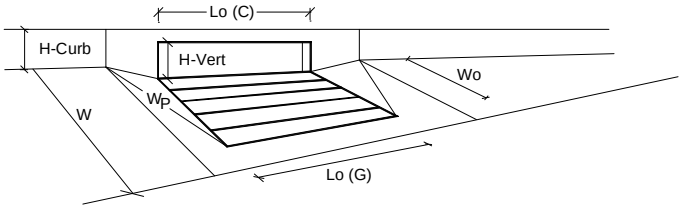
MINOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: 6th Ave & Federal Blvd Storm Drainage Design

Inlet ID: 5th Avenue Storm Sewer - Structure 208R, DP 93



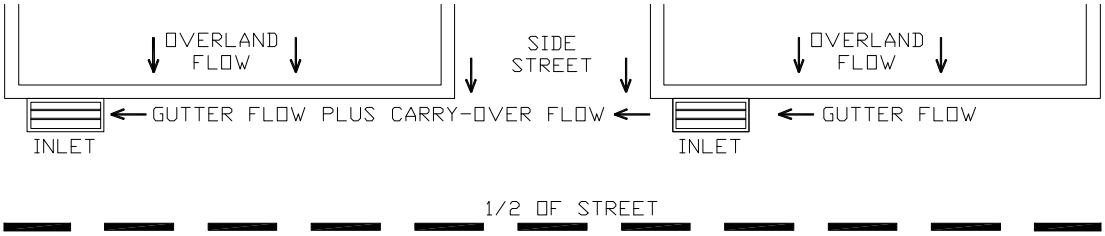
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 14 Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	9.00	9.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	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 < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	**Q_o =**	**3.60**	**11.60**	**cfs**
Water Spread Width	T =	7.4	12.8	ft
Water Depth at Flowline (outside of local depression)	d =	3.3	4.6	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 =	0.725	0.463	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.99	6.24	cfs
Discharge within the Gutter Section W	Q_w =	2.61	5.38	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.68	1.77	sq ft
Street Flow Velocity	V_s =	5.32	6.58	fps
Water Depth for Design Condition	d_{LOCAL} =	6.3	7.6	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =			ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =			
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
Interception Capacity	Q_i =			cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =			
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =			
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =			ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
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 or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.1565	0.1072	ft/ft
Required Length L_T to Have 100% Interception	L_T =	14.74	30.23	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	9.00	9.00	ft
Interception Capacity	Q_i =	2.94	5.46	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.10	0.10	
Effective (Unclogged) Length	L_e =	8.10	8.10	ft
Actual Interception Capacity	**Q_a =**	**2.74**	**4.98**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.86**	**6.62**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**2.74**	**4.98**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.86**	**6.62**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**76.2**	**43.0**	**%**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th Ave & Federal Blvd Storm Drainage Design

5th Avenue Storm Sewer - Structure 811L, DP 94

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):
*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

	Minor Storm	Major Storm	
***Q =**	**3.10**	**6.50**	**cfs**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)	
Site is Urban:	X
Site Is Non-Urban:	

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**1.14**	**8.90**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

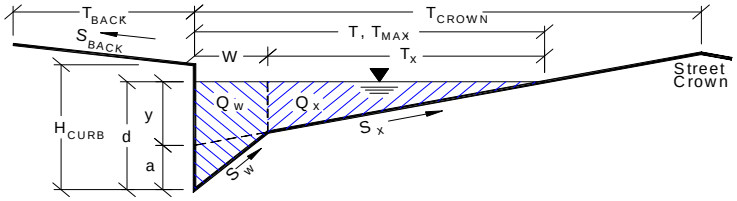
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**4.24**	**15.40**	**cfs**

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

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

Project: **6th Ave & Federal Blvd Storm Drainage Design**

Inlet ID: **5th Avenue Storm Sewer - Structure 811L, DP 94**



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0130	
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 Depression	a =	1.52	inches
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.0200	ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0000	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	34.0	34.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread

		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0833	0.0833	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	8.16	8.16	inches
Water Depth with a Gutter Depression	d =	9.68	9.68	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	32.0	32.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.170	0.170	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_T - 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
Maximum Flow Based On Allowable Water 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 Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	0.0	0.0	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (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	**Q =**	**0.0**	**0.0**	**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	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	SUMP	SUMP	
Max Flow Based on Allow. Gutter 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	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

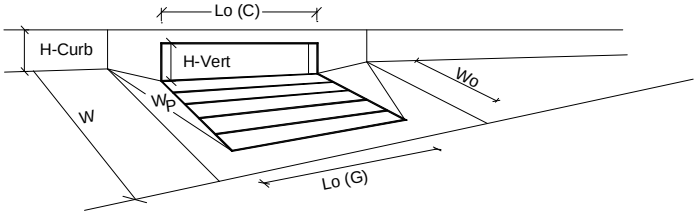
MINOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET IN A SUMP OR SAG LOCATION

Project = **6th Ave & Federal Blvd Storm Drainage Design**

Inlet ID = **5th Avenue Storm Sewer - Structure 811L, DP 94**



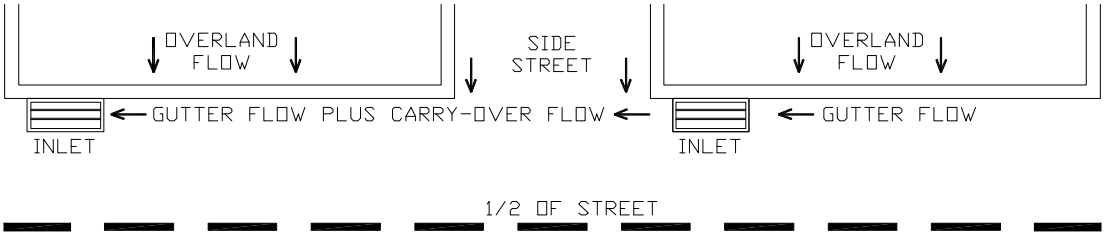
		MINOR	MAJOR	
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 14 Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Grate Information		MINOR	MAJOR	
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
Area Opening 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 3.00)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.67)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	9.00	9.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	5.95	5.95	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.4	63.4	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 2.30-3.00)	C_w (C) =	2.30	2.30	
Curb Opening Orifice Coefficient (typical value 0.67)	C_o (C) =	0.67	0.67	
Resulting Gutter Flow Depth for Grate Inlet Capacity in a Sump		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	N/A	N/A	
Clogging Factor for Multiple Units	Clog =	N/A	N/A	
Grate as a Weir				
Flow Depth at Local Depression without Clogging (0 cfs grate, 4.24 cfs curb)	d_{wi} =	N/A	N/A	inches
This Row Used for Combination Inlets Only	$d_{curb\text{-}un}$ =	N/A	N/A	inches
Flow Depth at Local Depression with Clogging (0 cfs grate, 4.24 cfs curb)	d_{wa} =	N/A	N/A	inches
This Row Used for Combination Inlets Only	$d_{curb\text{-}cl}$ =	N/A	N/A	inches
Grate as an Orifice		MINOR	MAJOR	
Flow Depth at Local Depression without Clogging (0 cfs grate, 4.24 cfs curb)	d_{oi} =	N/A	N/A	inches
Flow Depth at Local Depression with Clogging (0 cfs grate, 4.24 cfs curb)	d_{oa} =	N/A	N/A	inches
Resulting Gutter Flow Depth Outside of Local Depression	**$d_{a\text{-}Grate}$ =**	**N/A**	**N/A**	**inches**
Resulting Gutter Flow Depth for Curb Opening Inlet Capacity in a Sump		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	1.00	1.00	
Clogging Factor for Multiple Units	Clog =	0.10	0.10	
Curb as a Weir, Grate as an Orifice		MINOR	MAJOR	
Flow Depth at Local Depression without Clogging (0 cfs grate, 4.24 cfs curb)	d_{wi} =	3.33	7.87	inches
Flow Depth at Local Depression with Clogging (0 cfs grate, 4.24 cfs curb)	d_{wa} =	3.50	8.27	inches
Curb as an Orifice, Grate as an Orifice		MINOR	MAJOR	
Flow Depth at Local Depression without Clogging (0 cfs grate, 4.24 cfs curb)	d_{oi} =	3.03	7.60	inches
Flow Depth at Local Depression with Clogging (0 cfs grate, 4.24 cfs curb)	d_{oa} =	3.12	8.76	inches
Resulting Gutter Flow Depth Outside of Local Depression	**$d_{a\text{-}Curb}$ =**	**0.50**	**5.76**	**inches**
Resultant Street Conditions		MINOR	MAJOR	
Total Inlet Length	L =	9.0	9.0	feet
Total Inlet Interception Capacity (Design Discharge from ***Q-Peak***)	Q_a =	4.2	15.4	cfs
Resultant Gutter Flow Depth (based on sheet *Q-Allow* geometry)	**d =**	**0.50**	**5.76**	**inches**
Resultant Street Flow Spread (based on sheet *Q-Allow* geometry)	**T =**	**0.5**	**17.7**	**feet**
Resultant Flow Depth at Street Crown	**d_{CROWN} =**	**0.00**	**0.00**	**inches**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th Ave & Federal Blvd Storm Drainage Design

5th Avenue Storm Sewer - Structure 211L, DP 95

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):

	Minor Storm	Major Storm	
*Q =	0.60	1.40	cfs

*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)			Slope (ft/ft)	Length (ft)
Site is Urban:	X	Overland Flow =		
Site Is Non-Urban:		Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.76**	**4.23**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

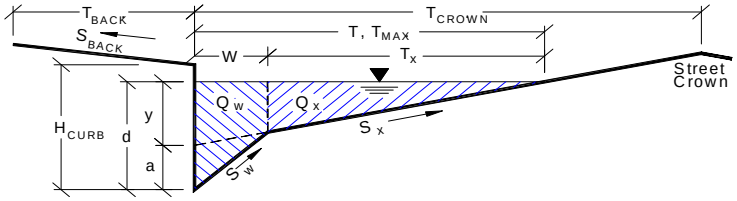
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**1.36**	**5.63**	**cfs**

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

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

Project: **6th Ave & Federal Blvd Storm Drainage Design**

Inlet ID: **5th Avenue Storm Sewer - Structure 211L, DP 95**



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0130	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	20.0	ft
Gutter Depression	a =	1.52	inches
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.0200	ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0460	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	14.0	20.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread

		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0833	0.0833	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	3.36	4.80	inches
Water Depth with a Gutter Depression	d =	4.88	6.32	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	12.0	18.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.425	0.297	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	8.3	24.6	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	6.2	10.4	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Water Spread	**Q_T =**	**14.5**	**35.0**	**cfs**
Flow Velocity Within the Gutter Section	V =	9.5	11.7	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	3.9	6.2	

Maximum Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	20.0	230.8	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	20.0	179.7	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	9.4	34.7	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**29.4**	**214.4**	**cfs**
Flow Velocity Within the Gutter Section	V =	11.2	18.9	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	5.6	18.9	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	0.53	0.43	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**15.6**	**91.9**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	4.98	8.65	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	2.33	inches

		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**14.5**	**35.0**	**cfs**

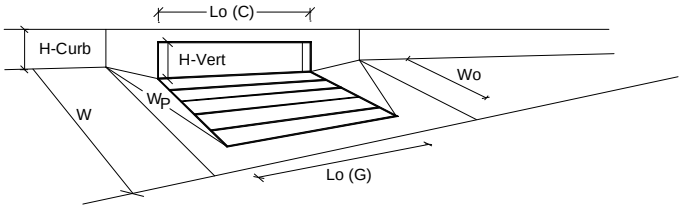
MINOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: 6th Ave & Federal Blvd Storm Drainage Design

Inlet ID: 5th Avenue Storm Sewer - Structure 211L, DP 95



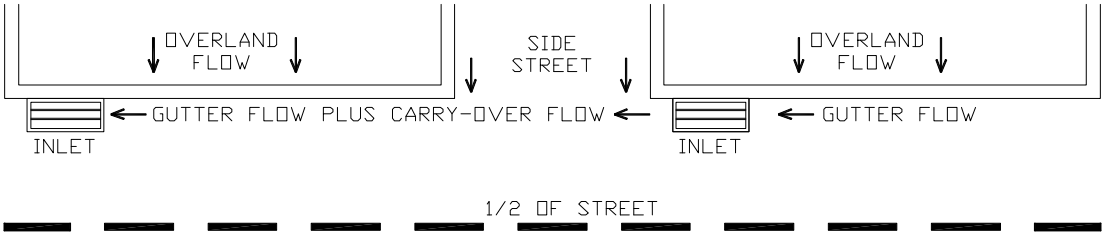
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 14 Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	9.00	9.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	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 < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	**Q_o =**	**1.36**	**5.63**	**cfs**
Water Spread Width	T =	3.9	9.2	ft
Water Depth at Flowline (outside of local depression)	d =	2.5	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 =	0.954	0.619	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.06	2.15	cfs
Discharge within the Gutter Section W	Q_w =	1.30	3.48	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.28	0.97	sq ft
Street Flow Velocity	V_s =	4.87	5.77	fps
Water Depth for Design Condition	d_{LOCAL} =	5.5	6.7	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =			ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =			
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
Interception Capacity	Q_i =			cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =			
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =			
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =			ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
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 or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.1997	0.1365	ft/ft
Required Length L_T to Have 100% Interception	L_T =	8.52	19.44	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	8.51	9.00	ft
Interception Capacity	Q_i =	1.36	3.79	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.10	0.10	
Effective (Unclogged) Length	L_e =	8.10	8.10	ft
Actual Interception Capacity	**Q_a =**	**1.35**	**3.50**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.01**	**2.13**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.35**	**3.50**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.01**	**2.13**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**99.3**	**62.2**	**%**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th Ave & Federal Blvd Storm Drainage Design

5th Avenue Storm Sewer - Structure 211R, DP 96

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):

	Minor Storm	Major Storm	
*Q =	0.40	0.80	cfs

*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)

Site is Urban:	X
Site Is Non-Urban:	

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	0.00	0.00	cfs

Analysis of Flow Time (Time of Concentration) for a Catchment:

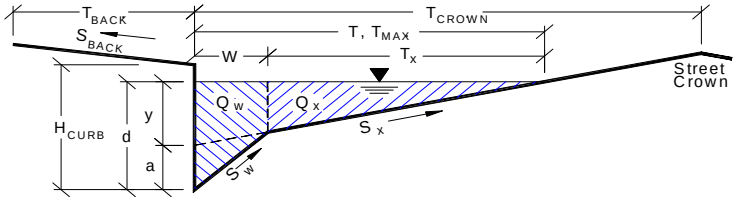
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**0.40**	**0.80**	**cfs**

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

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

Project: **6th Ave & Federal Blvd Storm Drainage Design**

Inlet ID: **5th Avenue Storm Sewer - Structure 211R, DP 96**



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0130	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	20.0	ft
Gutter Depression	a =	1.52	inches
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.0200	ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0460	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	15.0	20.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread

		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0833	0.0833	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	3.60	4.80	inches
Water Depth with a Gutter Depression	d =	5.12	6.32	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	13.0	18.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.397	0.297	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	10.3	24.6	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	6.8	10.4	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Water Spread	**Q_T =**	**17.1**	**35.0**	**cfs**
Flow Velocity Within the Gutter Section	V =	9.9	11.7	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	4.2	6.2	

Maximum Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	20.0	230.8	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	20.0	179.7	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	9.4	34.7	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**29.4**	**214.4**	**cfs**
Flow Velocity Within the Gutter Section	V =	11.2	18.9	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	5.6	18.9	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	0.53	0.43	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**15.6**	**91.9**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	4.98	8.65	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	2.33	inches

		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**15.6**	**35.0**	**cfs**

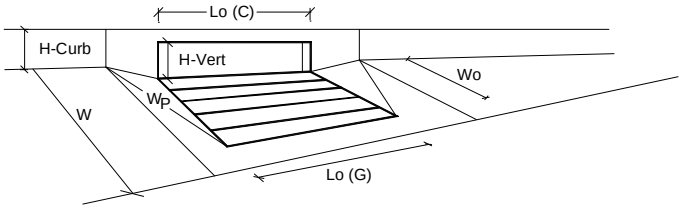
MINOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: 6th Ave & Federal Blvd Storm Drainage Design

Inlet ID: 5th Avenue Storm Sewer - Structure 211R, DP 96



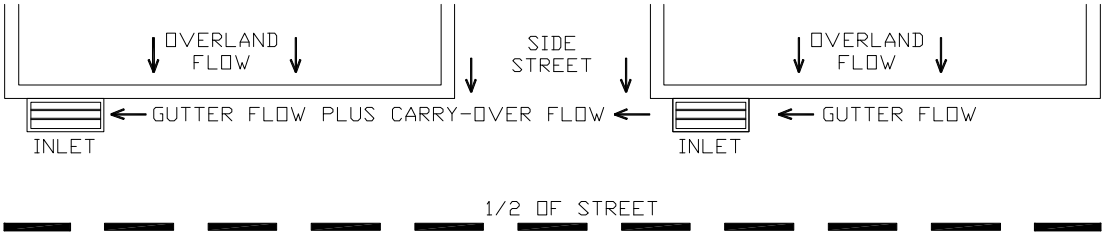
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 14 Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	6.00	6.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	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 < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	**Q_o =**	**0.40**	**0.80**	**cfs**
Water Spread Width	T =	1.6	2.1	ft
Water Depth at Flowline (outside of local depression)	d =	1.6	2.1	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 =	1.000	1.000	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.00	0.00	cfs
Discharge within the Gutter Section W	Q_w =	0.40	0.81	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.11	0.18	sq ft
Street Flow Velocity	V_s =	3.84	4.58	fps
Water Depth for Design Condition	d_{LOCAL} =	4.6	5.1	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =			ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =			
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
Interception Capacity	Q_i =			cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =			
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =			
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =			ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
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 or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.2084	0.2084	ft/ft
Required Length L_T to Have 100% Interception	L_T =	4.97	6.65	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	4.96	6.00	ft
Interception Capacity	Q_i =	0.40	0.79	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.10	0.10	
Effective (Unclogged) Length	L_e =	4.96	5.40	ft
Actual Interception Capacity	**Q_a =**	**0.40**	**0.76**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.00**	**0.04**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.40**	**0.76**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.00**	**0.04**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**100.0**	**95.1**	**%**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th and Federal

North Storm Sewer System - Structure 112L, DP 61

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):
*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

	Minor Storm	Major Storm	
***Q =**	**0.90**	**1.80**	**cfs**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)	
Site is Urban:	X
Site Is Non-Urban:	

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.00**	**0.00**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

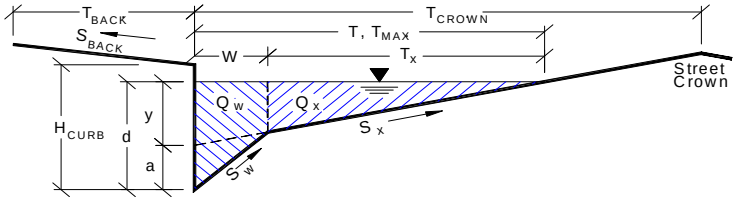
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**0.90**	**1.80**	**cfs**

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

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

Project: **6th and Federal**

Inlet ID: **North Storm Sewer System - Structure 112L, DP 61**



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0150	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	69.0	ft
Gutter Depression	a =	1.52	inches
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.0200	ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0080	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	59.0	69.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread

		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0833	0.0833	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	14.16	16.56	inches
Water Depth with a Gutter Depression	d =	15.68	18.08	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	57.0	67.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.095	0.081	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	222.0	341.6	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	23.4	30.1	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Water Spread	**Q_T =**	**245.4**	**371.7**	**cfs**
Flow Velocity Within the Gutter Section	V =	9.6	10.6	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	12.5	15.9	

Maximum Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	8.4	96.3	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	8.4	96.3	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	3.9	14.5	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**12.3**	**110.7**	**cfs**
Flow Velocity Within the Gutter Section	V =	4.7	7.9	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.3	7.9	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	1.00	1.00	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**12.3**	**110.7**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	12.00	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	0.00	inches

		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**12.3**	**110.7**	**cfs**

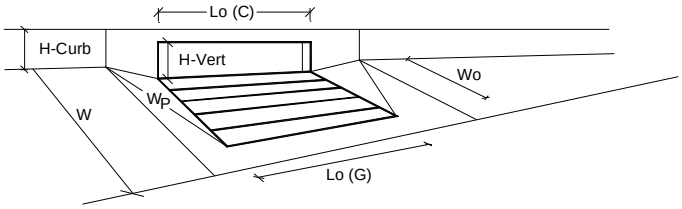
MINOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: 6th and Federal

Inlet ID: North Storm Sewer System - Structure 112L, DP 61



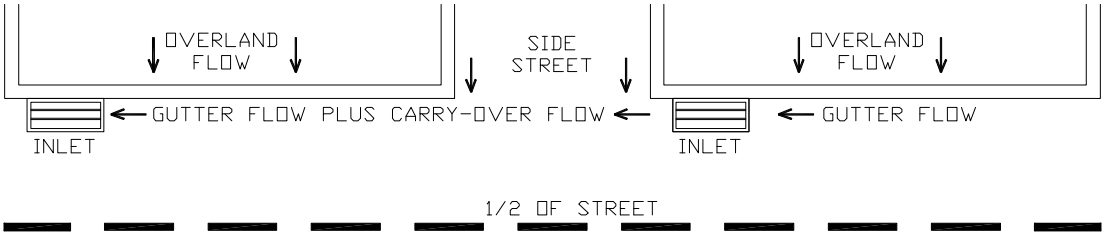
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 14 Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.00	3.00	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	6.00	6.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	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 < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	**Q_o =**	**0.90**	**1.80**	**cfs**
Water Spread Width	T =	5.5	8.1	ft
Water Depth at Flowline (outside of local depression)	d =	2.8	3.5	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 =	0.857	0.682	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.13	0.57	cfs
Discharge within the Gutter Section W	Q_w =	0.77	1.23	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.43	0.78	sq ft
Street Flow Velocity	V_s =	2.11	2.30	fps
Water Depth for Design Condition	d_{LOCAL} =	5.8	6.5	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =			ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =			
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
Interception Capacity	Q_i =			cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =			
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =			
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =			ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
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 or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.1813	0.1485	ft/ft
Required Length L_T to Have 100% Interception	L_T =	4.49	6.77	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	4.48	6.00	ft
Interception Capacity	Q_i =	0.90	1.76	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.10	0.10	
Effective (Unclogged) Length	L_e =	4.48	5.40	ft
Actual Interception Capacity	**Q_a =**	**0.90**	**1.70**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.00**	**0.10**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.90**	**1.70**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.00**	**0.10**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**100.0**	**94.3**	**%**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th and Federal

North Storm Sewer System - Structure 112R, DP 65

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):
*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

	Minor Storm	Major Storm	
***Q =**	**1.00**	**2.10**	**cfs**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)			Slope (ft/ft)	Length (ft)
Site is Urban:	X	Overland Flow =		
Site Is Non-Urban:		Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.00**	**0.00**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

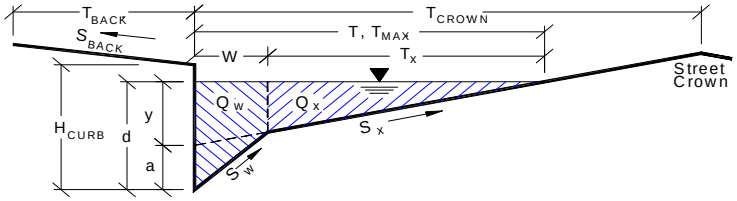
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**1.00**	**2.10**	**cfs**

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

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

Project: **6th and Federal**

Inlet ID: **North Storm Sewer System - Structure 112R, DP 65**



Gutter Geometry (Enter data in the blue cells)				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =			ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0150		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	59.0		ft
Gutter Depression	a =	1.52		inches
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.0200		ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0150		ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160		
		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	26.0	59.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0833	0.0833	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	6.24	14.16	inches
Water Depth with a Gutter Depression	d =	7.76	15.68	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	24.0	57.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.226	0.095	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	30.3	304.0	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	8.8	32.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Water Spread	**Q_T =**	**39.1**	**336.0**	**cfs**
Flow Velocity Within the Gutter Section	V =	7.8	13.1	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	5.1	17.1	

Maximum Gutter Capacity Based on Allowable Gutter Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	11.4	131.8	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	11.4	131.8	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	5.4	19.8	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**16.8**	**151.6**	**cfs**
Flow Velocity Within the Gutter Section	V =	6.4	10.8	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	3.2	10.8	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	1.00	1.00	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**16.8**	**151.6**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	12.00	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	0.00	inches
		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**16.8**	**151.6**	**cfs**

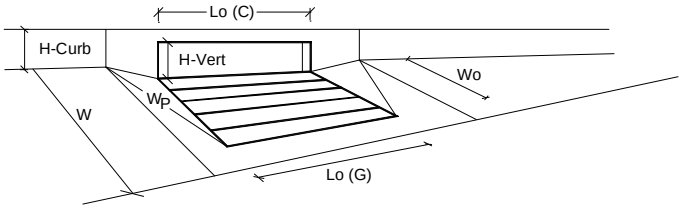
MINOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: 6th and Federal

Inlet ID: North Storm Sewer System - Structure 112R, DP 65



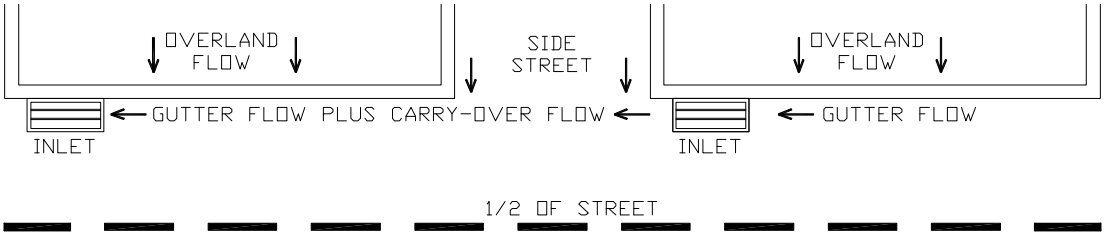
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 14 Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	6.00	6.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	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 < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	**Q_o =**	**1.00**	**2.10**	**cfs**
Water Spread Width	T =	4.8	7.5	ft
Water Depth at Flowline (outside of local depression)	d =	2.7	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 =	0.905	0.722	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.09	0.58	cfs
Discharge within the Gutter Section W	Q_w =	0.91	1.52	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.35	0.68	sq ft
Street Flow Velocity	V_s =	2.83	3.08	fps
Water Depth for Design Condition	d_{LOCAL} =	5.7	6.3	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =			ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =			
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
Interception Capacity	Q_i =			cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =			
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =			
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =			ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
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 or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.1905	0.1561	ft/ft
Required Length L_T to Have 100% Interception	L_T =	5.50	8.47	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	5.49	6.00	ft
Interception Capacity	Q_i =	1.00	1.87	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.10	0.10	
Effective (Unclogged) Length	L_e =	5.40	5.40	ft
Actual Interception Capacity	**Q_a =**	**1.00**	**1.76**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.00**	**0.34**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.00**	**1.76**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.00**	**0.34**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**99.9**	**83.9**	**%**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th and Federal

North Storm Sewer System - Structure 113L, DP 62

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):
*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

	Minor Storm	Major Storm	
***Q =**	**1.10**	**2.30**	**cfs**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)	
Site is Urban:	X
Site Is Non-Urban:	

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.00**	**0.10**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

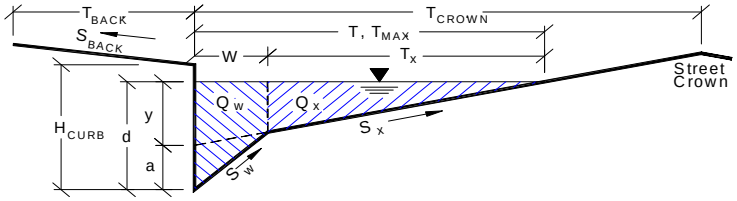
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**1.10**	**2.40**	**cfs**

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

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

Project: **6th and Federal**

Inlet ID: **North Storm Sewer System - Structure 113L, DP 62**



Gutter Geometry (Enter data in the blue cells)			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0150	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	65.0	ft
Gutter Depression	a =	1.52	inches
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.0200	ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0030	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	52.0	65.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0833	0.0833	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	12.48	15.60	inches
Water Depth with a Gutter Depression	d =	14.00	17.12	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	50.0	63.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.109	0.086	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	95.9	177.5	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	11.7	16.7	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Water Spread	**Q_T =**	**107.5**	**194.3**	**cfs**
Flow Velocity Within the Gutter Section	V =	5.4	6.2	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	6.3	8.9	

Maximum Gutter Capacity Based on Allowable Gutter Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	5.1	58.9	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	5.1	58.9	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	2.4	8.9	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**7.5**	**67.8**	**cfs**
Flow Velocity Within the Gutter Section	V =	2.9	4.8	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	1.4	4.8	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	1.00	1.00	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**7.5**	**67.8**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	12.00	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	0.00	inches

		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**7.5**	**67.8**	**cfs**

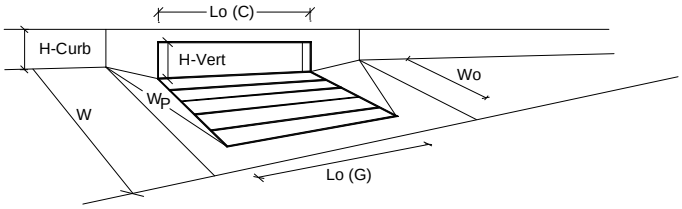
MINOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: 6th and Federal

Inlet ID: North Storm Sewer System - Structure 113L, DP 62



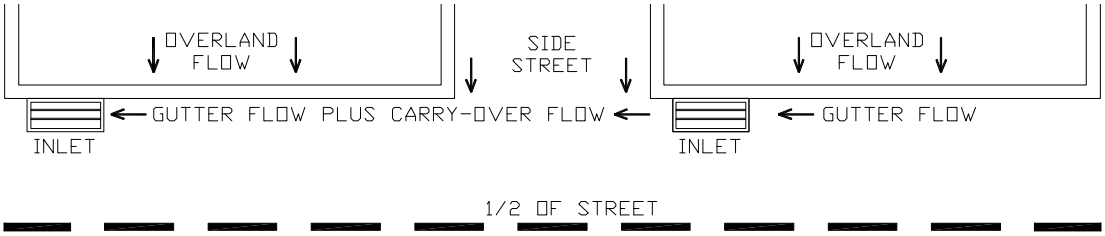
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 14 Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.00	3.00	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	6.00	6.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	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 < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	**Q_o =**	**1.10**	**2.40**	**cfs**
Water Spread Width	T =	8.1	11.6	ft
Water Depth at Flowline (outside of local depression)	d =	3.5	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 =	0.683	0.506	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.35	1.19	cfs
Discharge within the Gutter Section W	Q_w =	0.75	1.22	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.78	1.48	sq ft
Street Flow Velocity	V_s =	1.41	1.62	fps
Water Depth for Design Condition	d_{LOCAL} =	6.5	7.3	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =			ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =			
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
Interception Capacity	Q_i =			cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =			
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =			
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =			ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
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 or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.1486	0.1154	ft/ft
Required Length L_T to Have 100% Interception	L_T =	4.10	6.63	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	4.09	6.00	ft
Interception Capacity	Q_i =	1.10	2.37	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.10	0.10	
Effective (Unclogged) Length	L_e =	4.09	5.40	ft
Actual Interception Capacity	**Q_a =**	**1.10**	**2.28**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.00**	**0.12**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.10**	**2.28**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.00**	**0.12**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**100.0**	**95.1**	**%**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th and Federal

North Storm Sewer System - Structure 113R, DP 66

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):
*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

	Minor Storm	Major Storm	
***Q =**	**3.50**	**7.70**	**cfs**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)	
Site is Urban:	X
Site Is Non-Urban:	

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.00**	**0.34**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

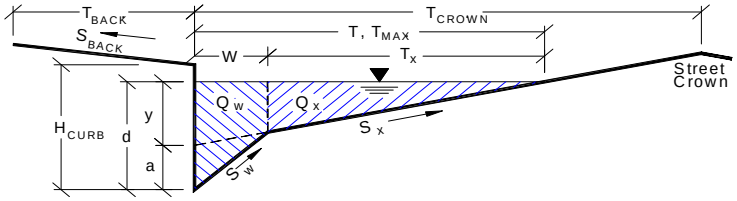
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**3.50**	**8.04**	**cfs**

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

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

Project: **6th and Federal**

Inlet ID: **North Storm Sewer System - Structure 113R, DP 66**



Gutter Geometry (Enter data in the blue cells)				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =			ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0150		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	56.0		ft
Gutter Depression	a =	1.52		inches
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.0200		ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0030		ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160		
		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	26.0	56.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0833	0.0833	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	6.24	13.44	inches
Water Depth with a Gutter Depression	d =	7.76	14.96	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	24.0	54.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.226	0.101	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	13.5	117.7	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	3.9	13.2	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Water Spread	**Q_T =**	**17.5**	**130.9**	**cfs**
Flow Velocity Within the Gutter Section	V =	3.5	5.7	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.3	7.1	

Maximum Gutter Capacity Based on Allowable Gutter Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	5.1	58.9	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	5.1	58.9	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	2.4	8.9	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**7.5**	**67.8**	**cfs**
Flow Velocity Within the Gutter Section	V =	2.9	4.8	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	1.4	4.8	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	1.00	1.00	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**7.5**	**67.8**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	12.00	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	0.00	inches
		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**7.5**	**67.8**	**cfs**

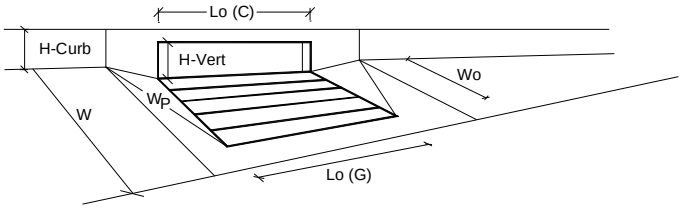
MINOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: 6th and Federal

Inlet ID: North Storm Sewer System - Structure 113R, DP 66



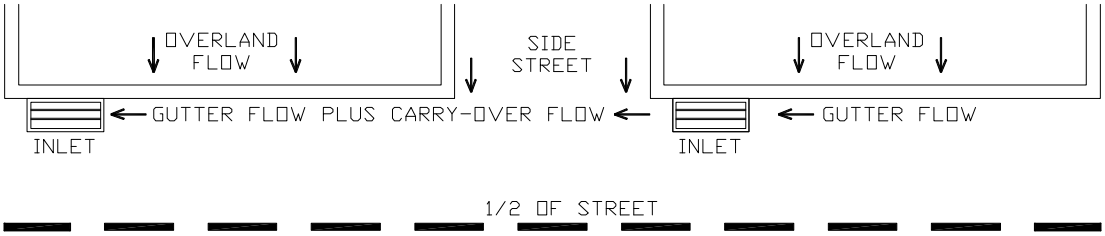
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 14 Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	6.00	6.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	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 < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	**Q_o =**	**3.50**	**8.04**	**cfs**
Water Spread Width	T =	13.7	19.2	ft
Water Depth at Flowline (outside of local depression)	d =	4.8	6.1	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 =	0.435	0.310	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	1.98	5.55	cfs
Discharge within the Gutter Section W	Q_w =	1.52	2.49	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	2.00	3.81	sq ft
Street Flow Velocity	V_s =	1.76	2.11	fps
Water Depth for Design Condition	d_{LOCAL} =	7.8	9.1	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =			ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =			
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
Interception Capacity	Q_i =			cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =			
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =			
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =			ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
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 or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.1019	0.0784	ft/ft
Required Length L_T to Have 100% Interception	L_T =	8.36	13.89	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	6.00	6.00	ft
Interception Capacity	Q_i =	3.14	5.14	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.10	0.10	
Effective (Unclogged) Length	L_e =	5.40	5.40	ft
Actual Interception Capacity	**Q_a =**	**2.96**	**4.73**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.54**	**3.31**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**2.96**	**4.73**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.54**	**3.31**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**84.5**	**58.8**	**%**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th and Federal

North Storm Sewer System - Structure 114R, DP 67

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):

	Minor Storm	Major Storm	
*Q =	2.10	4.40	cfs

*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)

Site is Urban:	X
Site Is Non-Urban:	

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.54**	**3.31**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

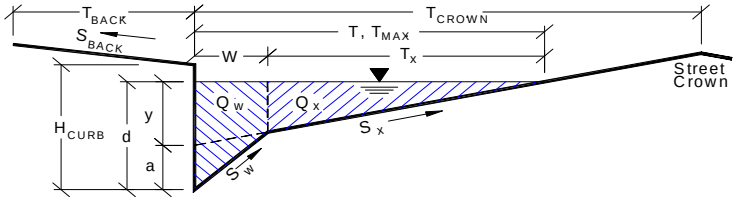
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**2.64**	**7.71**	**cfs**

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

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

Project: **6th and Federal**

Inlet ID: **North Storm Sewer System - Structure 114R, DP 67**



Gutter Geometry (Enter data in the blue cells)				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =			ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0150		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	54.0		ft
Gutter Depression	a =	1.52		inches
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.0200		ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0025		ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160		
		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	38.0	54.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0833	0.0833	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	9.12	12.96	inches
Water Depth with a Gutter Depression	d =	10.64	14.48	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	36.0	52.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.151	0.105	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	36.4	97.1	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	6.5	11.3	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Water Spread	**Q_T =**	**42.9**	**108.5**	**cfs**
Flow Velocity Within the Gutter Section	V =	4.0	5.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	3.6	6.1	

Maximum Gutter Capacity Based on Allowable Gutter Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	4.7	53.8	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	4.7	53.8	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	2.2	8.1	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**6.9**	**61.9**	**cfs**
Flow Velocity Within the Gutter Section	V =	2.6	4.4	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	1.3	4.4	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	1.00	1.00	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**6.9**	**61.9**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	12.00	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	0.00	inches
		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**6.9**	**61.9**	**cfs**

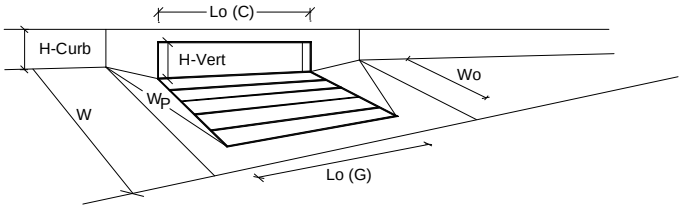
MINOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: 6th and Federal

Inlet ID: North Storm Sewer System - Structure 114R, DP 67



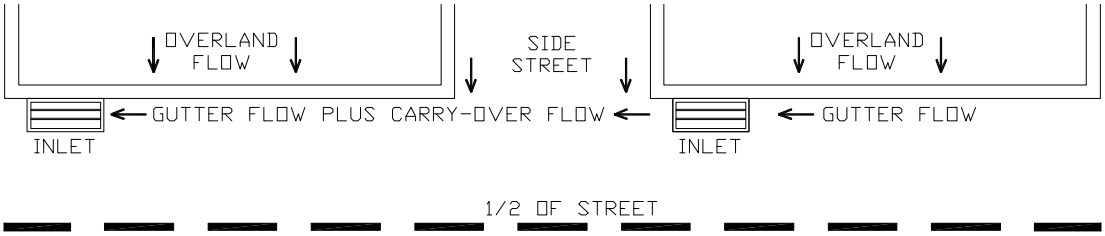
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 14 Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	6.00	6.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	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 < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	**Q_o =**	**2.64**	**7.71**	**cfs**
Water Spread Width	T =	12.6	19.6	ft
Water Depth at Flowline (outside of local depression)	d =	4.6	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 =	0.470	0.304	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	1.40	5.37	cfs
Discharge within the Gutter Section W	Q_w =	1.24	2.34	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	1.72	3.95	sq ft
Street Flow Velocity	V_s =	1.54	1.95	fps
Water Depth for Design Condition	d_{LOCAL} =	7.5	9.2	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =			ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =			
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
Interception Capacity	Q_i =			cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =			
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =			
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =			ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
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 or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.1085	0.0772	ft/ft
Required Length L_T to Have 100% Interception	L_T =	6.78	13.03	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	6.00	6.00	ft
Interception Capacity	Q_i =	2.59	5.17	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.10	0.10	
Effective (Unclogged) Length	L_e =	5.40	5.40	ft
Actual Interception Capacity	**Q_a =**	**2.49**	**4.77**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.15**	**2.94**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**2.49**	**4.77**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.15**	**2.94**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**94.3**	**61.8**	**%**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th and Federal

North Storm Sewer System - Structure 115L, DP 63

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):
*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

	Minor Storm	Major Storm	
***Q =**	**0.90**	**2.20**	**cfs**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =	0.00	Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)			Slope (ft/ft)	Length (ft)
Site is Urban:	X	Overland Flow =		
Site Is Non-Urban:		Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.00**	**0.13**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

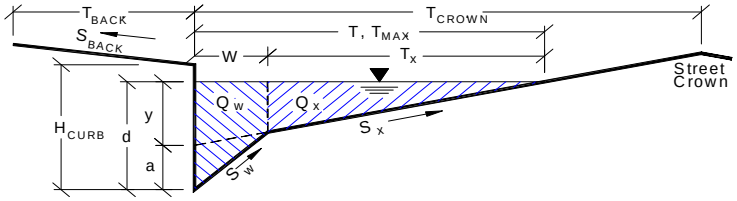
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**0.90**	**2.33**	**cfs**

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

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

Project: **6th and Federal**

Inlet ID: **North Storm Sewer System - Structure 115L, DP 63**



Gutter Geometry (Enter data in the blue cells)				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =			ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0150		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	53.0		ft
Gutter Depression	a =	1.52		inches
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.0200		ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0010		ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160		
		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	33.0	53.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0833	0.0833	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	7.92	12.72	inches
Water Depth with a Gutter Depression	d =	9.44	14.24	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	31.0	51.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.175	0.107	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	15.5	58.3	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	3.3	7.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Water Spread	**Q_T =**	**18.8**	**65.3**	**cfs**
Flow Velocity Within the Gutter Section	V =	2.3	3.2	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	1.8	3.7	

Maximum Gutter Capacity Based on Allowable Gutter Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	3.0	34.0	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	3.0	34.0	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	1.4	5.1	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**4.3**	**39.1**	**cfs**
Flow Velocity Within the Gutter Section	V =	1.7	2.8	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.8	2.8	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	1.00	1.00	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**4.3**	**39.2**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	12.00	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	0.00	inches
		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**4.3**	**39.2**	**cfs**

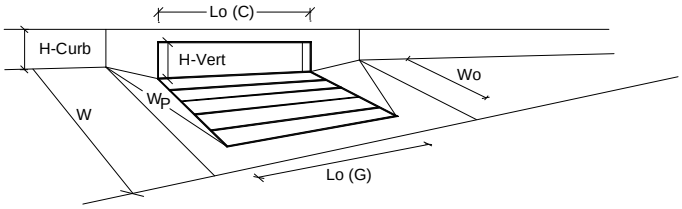
MINOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: 6th and Federal

Inlet ID: North Storm Sewer System - Structure 115L, DP 63



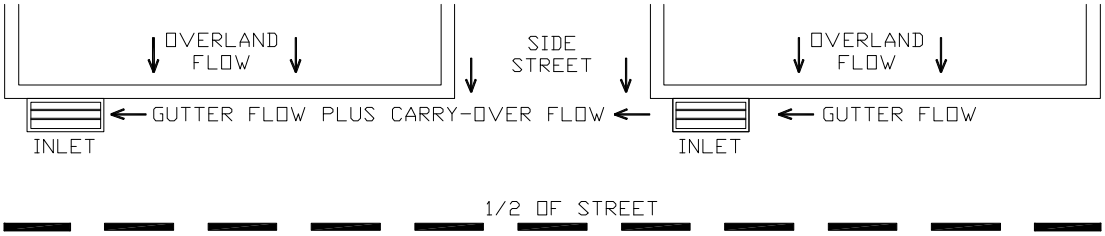
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 14 Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.00	3.00	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	6.00	6.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	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 < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	**Q_o =**	**0.90**	**2.33**	**cfs**
Water Spread Width	T =	9.6	14.5	ft
Water Depth at Flowline (outside of local depression)	d =	3.8	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 =	0.600	0.411	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.36	1.37	cfs
Discharge within the Gutter Section W	Q_w =	0.54	0.96	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	1.04	2.23	sq ft
Street Flow Velocity	V_s =	0.86	1.04	fps
Water Depth for Design Condition	d_{LOCAL} =	6.8	8.0	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =			ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =			
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
Interception Capacity	Q_i =			cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =			
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =			
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =			ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
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 or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.1329	0.0974	ft/ft
Required Length L_T to Have 100% Interception	L_T =	2.90	5.21	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	2.89	5.20	ft
Interception Capacity	Q_i =	0.90	2.33	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.10	0.10	
Effective (Unclogged) Length	L_e =	2.89	5.20	ft
Actual Interception Capacity	**Q_a =**	**0.90**	**2.33**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.00**	**0.00**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.90**	**2.33**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.00**	**0.00**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**100.0**	**100.0**	**%**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th and Federal

North Storm Sewer System - Structure 116R-1, DP 68

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):
*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

	Minor Storm	Major Storm	
***Q =**	**3.50**	**7.50**	**cfs**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)	
Site is Urban:	X
Site Is Non-Urban:	

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.15**	**2.94**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

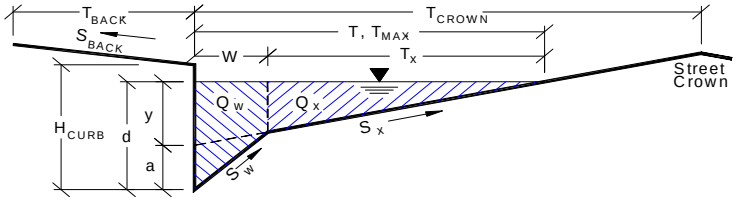
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**3.65**	**10.44**	**cfs**

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

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

Project: **6th and Federal**

Inlet ID: **North Storm Sewer System - Structure 116R-1, DP 68**



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0150	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	52.0	ft
Gutter Depression	a =	1.52	inches
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.0200	ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0000	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	42.0	52.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread

		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0833	0.0833	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	10.08	12.48	inches
Water Depth with a Gutter Depression	d =	11.60	14.00	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	40.0	50.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.136	0.109	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_T - 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
Maximum Flow Based On Allowable Water 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 Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	0.0	0.0	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (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	**Q =**	**0.0**	**0.0**	**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	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	SUMP	SUMP	
Max Flow Based on Allow. Gutter 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	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

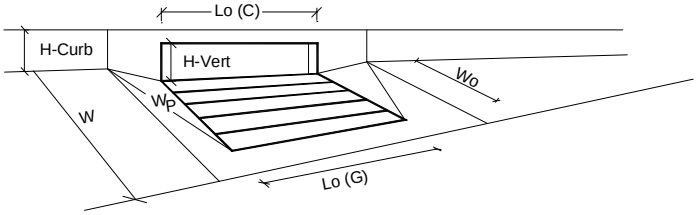
MINOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET IN A SUMP OR SAG LOCATION

Project = **6th and Federal**

Inlet ID = **North Storm Sewer System - Structure 116R-1, DP 68**



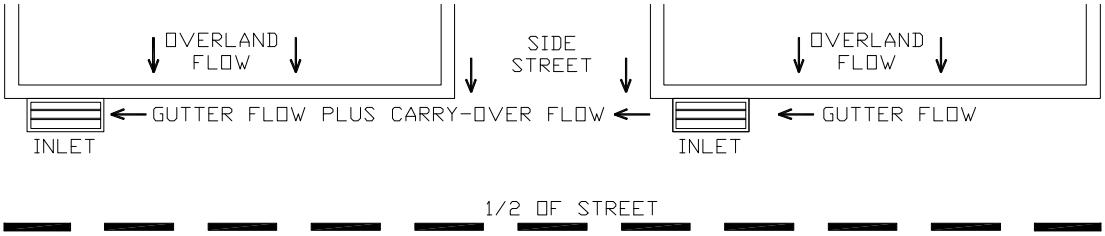
		MINOR	MAJOR	
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 14 Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Grate Information		MINOR	MAJOR	
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
Area Opening 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 3.00)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.67)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	9.00	9.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	5.95	5.95	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.4	63.4	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 2.30-3.00)	C_w (C) =	2.30	2.30	
Curb Opening Orifice Coefficient (typical value 0.67)	C_o (C) =	0.67	0.67	
Resulting Gutter Flow Depth for Grate Inlet Capacity in a Sump		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	N/A	N/A	
Clogging Factor for Multiple Units	Clog =	N/A	N/A	
Grate as a Weir				
Flow Depth at Local Depression without Clogging (0 cfs grate, 3.65 cfs curb)	d_{wi} =	N/A	N/A	inches
This Row Used for Combination Inlets Only	$d_{curb\text{-}un}$ =	N/A	N/A	inches
Flow Depth at Local Depression with Clogging (0 cfs grate, 3.65 cfs curb)	d_{wa} =	N/A	N/A	inches
This Row Used for Combination Inlets Only	$d_{curb\text{-}cl}$ =	N/A	N/A	inches
Grate as an Orifice		MINOR	MAJOR	
Flow Depth at Local Depression without Clogging (0 cfs grate, 3.65 cfs curb)	d_{oi} =	N/A	N/A	inches
Flow Depth at Local Depression with Clogging (0 cfs grate, 3.65 cfs curb)	d_{oa} =	N/A	N/A	inches
Resulting Gutter Flow Depth Outside of Local Depression	**$d_{a\text{-}Grate}$ =**	**N/A**	**N/A**	**inches**
Resulting Gutter Flow Depth for Curb Opening Inlet Capacity in a Sump		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	1.00	1.00	
Clogging Factor for Multiple Units	Clog =	0.10	0.10	
Curb as a Weir, Grate as an Orifice		MINOR	MAJOR	
Flow Depth at Local Depression without Clogging (0 cfs grate, 3.65 cfs curb)	d_{wi} =	3.02	6.08	inches
Flow Depth at Local Depression with Clogging (0 cfs grate, 3.65 cfs curb)	d_{wa} =	3.17	6.39	inches
Curb as an Orifice, Grate as an Orifice		MINOR	MAJOR	
Flow Depth at Local Depression without Clogging (0 cfs grate, 3.65 cfs curb)	d_{oi} =	2.94	4.93	inches
Flow Depth at Local Depression with Clogging (0 cfs grate, 3.65 cfs curb)	d_{oa} =	3.00	5.47	inches
Resulting Gutter Flow Depth Outside of Local Depression	**$d_{a\text{-}Curb}$ =**	**0.17**	**3.39**	**inches**
Resultant Street Conditions		MINOR	MAJOR	
Total Inlet Length	L =	9.0	9.0	feet
Total Inlet Interception Capacity (Design Discharge from ***Q-Peak***)	Q_a =	3.7	10.4	cfs
Resultant Gutter Flow Depth (based on sheet *Q-Allow* geometry)	**d =**	**0.17**	**3.39**	**inches**
Resultant Street Flow Spread (based on sheet *Q-Allow* geometry)	**T =**	**0.2**	**7.8**	**feet**
Resultant Flow Depth at Street Crown	**d_{CROWN} =**	**0.00**	**0.00**	**inches**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th and Federal

North Storm Sewer System - Structure 116R-2, DP 69

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):
*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

	Minor Storm	Major Storm	
***Q =**	**1.30**	**2.60**	**cfs**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)	
Site is Urban:	X
Site Is Non-Urban:	

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.00**	**0.00**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

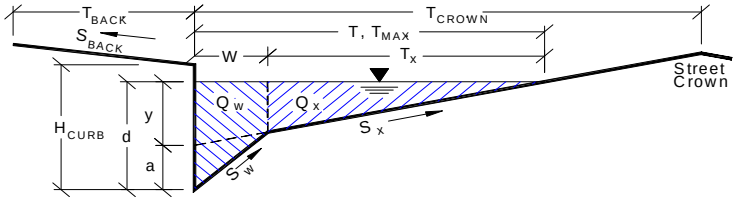
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**1.30**	**2.60**	**cfs**

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

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

Project: **6th and Federal**

Inlet ID: **North Storm Sewer System - Structure 116R-2, DP 69**



Gutter Geometry (Enter data in the blue cells)				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =			ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0150		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	24.0		ft
Gutter Depression	a =	1.52		inches
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.0200		ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0000		ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160		
		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	14.0	24.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0833	0.0833	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	3.36	5.76	inches
Water Depth with a Gutter Depression	d =	4.88	7.28	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	12.0	22.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.425	0.245	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_T - 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
Maximum Flow Based On Allowable Water 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 Gutter Capacity Based on Allowable Gutter Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	0.0	0.0	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (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	**Q =**	**0.0**	**0.0**	**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	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	SUMP	SUMP	
Max Flow Based on Allow. Gutter 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	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

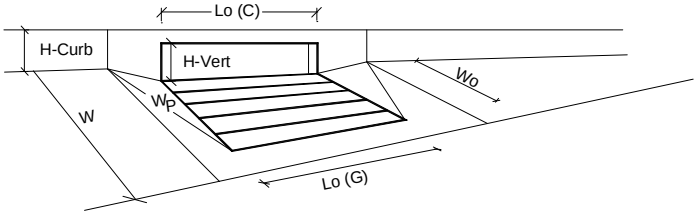
MINOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET IN A SUMP OR SAG LOCATION

Project = **6th and Federal**

Inlet ID = **North Storm Sewer System - Structure 116R-2, DP 69**



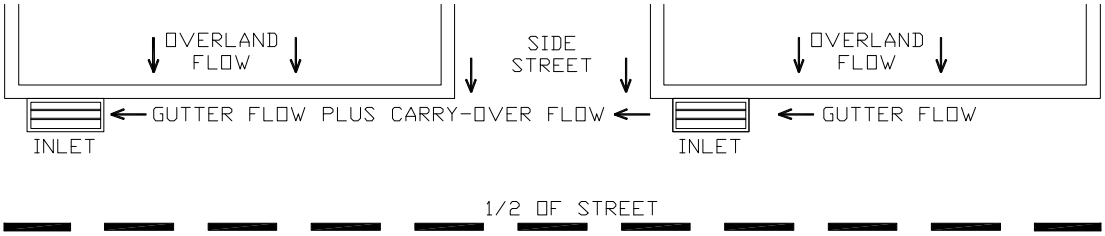
		MINOR	MAJOR	
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 14 Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Grate Information		MINOR	MAJOR	
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
Area Opening 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 3.00)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.67)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	6.00	6.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	5.95	5.95	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.4	63.4	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 2.30-3.00)	C_w (C) =	2.30	2.30	
Curb Opening Orifice Coefficient (typical value 0.67)	C_o (C) =	0.67	0.67	
Resulting Gutter Flow Depth for Grate Inlet Capacity in a Sump		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	N/A	N/A	
Clogging Factor for Multiple Units	Clog =	N/A	N/A	
Grate as a Weir				
Flow Depth at Local Depression without Clogging (0 cfs grate, 1.3 cfs curb)	d_{wi} =	N/A	N/A	inches
This Row Used for Combination Inlets Only	$d_{curb\text{-}un}$ =	N/A	N/A	inches
Flow Depth at Local Depression with Clogging (0 cfs grate, 1.3 cfs curb)	d_{wa} =	N/A	N/A	inches
This Row Used for Combination Inlets Only	$d_{curb\text{-}cl}$ =	N/A	N/A	inches
Grate as an Orifice		MINOR	MAJOR	
Flow Depth at Local Depression without Clogging (0 cfs grate, 1.3 cfs curb)	d_{oi} =	N/A	N/A	inches
Flow Depth at Local Depression with Clogging (0 cfs grate, 1.3 cfs curb)	d_{oa} =	N/A	N/A	inches
Resulting Gutter Flow Depth Outside of Local Depression	**$d_{a\text{-}Grate}$ =**	**N/A**	**N/A**	**inches**
Resulting Gutter Flow Depth for Curb Opening Inlet Capacity in a Sump		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	1.00	1.00	
Clogging Factor for Multiple Units	Clog =	0.10	0.10	
Curb as a Weir, Grate as an Orifice		MINOR	MAJOR	
Flow Depth at Local Depression without Clogging (0 cfs grate, 1.3 cfs curb)	d_{wi} =	1.82	2.88	inches
Flow Depth at Local Depression with Clogging (0 cfs grate, 1.3 cfs curb)	d_{wa} =	1.90	3.01	inches
Curb as an Orifice, Grate as an Orifice		MINOR	MAJOR	
Flow Depth at Local Depression without Clogging (0 cfs grate, 1.3 cfs curb)	d_{oi} =	2.74	2.98	inches
Flow Depth at Local Depression with Clogging (0 cfs grate, 1.3 cfs curb)	d_{oa} =	2.76	3.05	inches
Resulting Gutter Flow Depth Outside of Local Depression	**$d_{a\text{-}Curb}$ =**	**0.00**	**0.05**	**inches**
Resultant Street Conditions		MINOR	MAJOR	
Total Inlet Length	L =	6.0	6.0	feet
Total Inlet Interception Capacity (Design Discharge from ***Q-Peak***)	Q_a =	1.3	2.6	cfs
Resultant Gutter Flow Depth (based on sheet *Q-Allow* geometry)	**d =**	**0.00**	**0.05**	**inches**
Resultant Street Flow Spread (based on sheet *Q-Allow* geometry)	**T =**	**0.0**	**0.1**	**feet**
Resultant Flow Depth at Street Crown	**d_{CROWN} =**	**0.00**	**0.00**	**inches**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th and Federal

North Storm Sewer System - Structure 117L, DP 64

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):
*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

	Minor Storm	Major Storm	
***Q =**	**0.90**	**2.30**	**cfs**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =	0.00	Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)			Slope (ft/ft)	Length (ft)
Site is Urban:	X	Overland Flow =		
Site Is Non-Urban:		Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.00**	**0.01**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

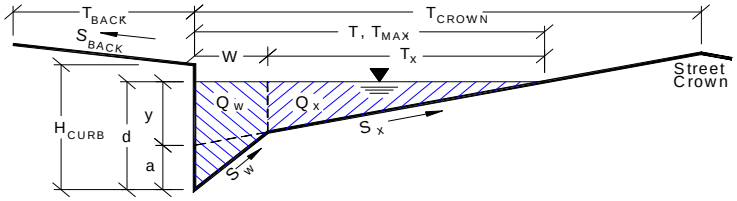
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**0.90**	**2.31**	**cfs**

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

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

Project: **6th and Federal**

Inlet ID: **North Storm Sewer System - Structure 117L, DP 64**



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0150	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	42.0	ft
Gutter Depression	a =	1.52	inches
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.0200	ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0175	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	32.0	42.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread

		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0833	0.0833	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	7.68	10.08	inches
Water Depth with a Gutter Depression	d =	9.20	11.60	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	30.0	40.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.181	0.136	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	59.3	127.7	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	13.1	20.1	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Water Spread	**Q_T =**	**72.4**	**147.8**	**cfs**
Flow Velocity Within the Gutter Section	V =	9.6	11.4	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	7.4	11.0	

Maximum Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	12.4	142.4	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	12.4	142.3	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	5.8	21.4	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**18.1**	**163.7**	**cfs**
Flow Velocity Within the Gutter Section	V =	6.9	11.7	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	3.5	11.7	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	1.00	0.93	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**18.2**	**152.0**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	11.71	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	0.11	inches

		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**18.2**	**147.8**	**cfs**

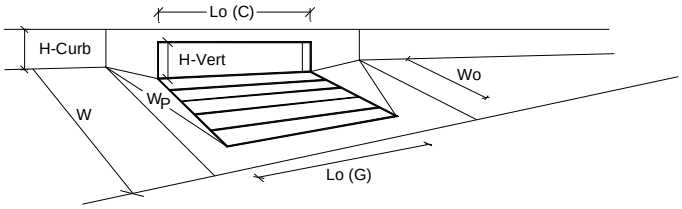
MINOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: 6th and Federal

Inlet ID: North Storm Sewer System - Structure 117L, DP 64



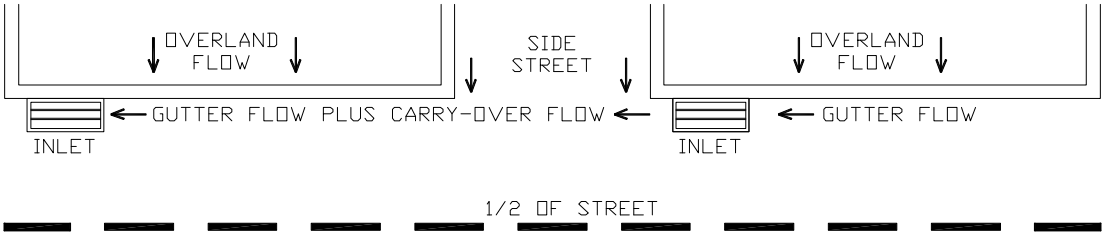
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 14 Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.00	3.00	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	6.00	6.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	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 < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	**Q_o =**	**0.90**	**2.31**	**cfs**
Water Spread Width	T =	4.2	7.5	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 =	0.942	0.718	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.05	0.65	cfs
Discharge within the Gutter Section W	Q_w =	0.85	1.66	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.30	0.69	sq ft
Street Flow Velocity	V_s =	3.02	3.33	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 =			ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =			
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
Interception Capacity	Q_i =			cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =			
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =			
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =			ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
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 or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.1974	0.1553	ft/ft
Required Length L_T to Have 100% Interception	L_T =	5.40	9.26	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	5.39	6.00	ft
Interception Capacity	Q_i =	0.90	1.96	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.10	0.10	
Effective (Unclogged) Length	L_e =	5.39	5.40	ft
Actual Interception Capacity	**Q_a =**	**0.90**	**1.83**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.00**	**0.48**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.90**	**1.83**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.00**	**0.47**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**100.0**	**79.5**	**%**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th and Federal

North Federal Storm Sewer System (NW1)

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):

	Minor Storm	Major Storm	
*Q =	5.00	5.70	cfs

*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)

Site is Urban:	X
Site Is Non-Urban:	

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.00**	**0.00**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

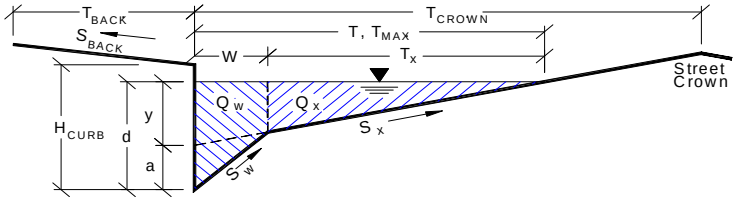
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**5.00**	**5.70**	**cfs**

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

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

Project: **6th and Federal**

Inlet ID: **North Federal Storm Sewer System (NW1)**



Gutter Geometry (Enter data in the blue cells)				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	4.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.0200		ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0150		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	37.0		ft
Gutter Depression	a =	1.52		inches
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.0200		ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0000		ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160		
		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	5.0	28.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0833	0.0833	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	1.20	6.72	inches
Water Depth with a Gutter Depression	d =	2.72	8.24	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	3.0	26.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.890	0.209	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_T - 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
Maximum Flow Based On Allowable Water 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 Gutter Capacity Based on Allowable Gutter Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	0.0	0.0	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (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	**Q =**	**0.0**	**0.0**	**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	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	SUMP	SUMP	
Max Flow Based on Allow. Gutter 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	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

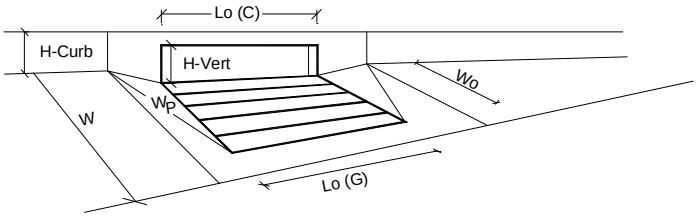
MINOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET IN A SUMP OR SAG LOCATION

Project = **6th and Federal**

Inlet ID = **North Federal Storm Sewer System (NW1)**



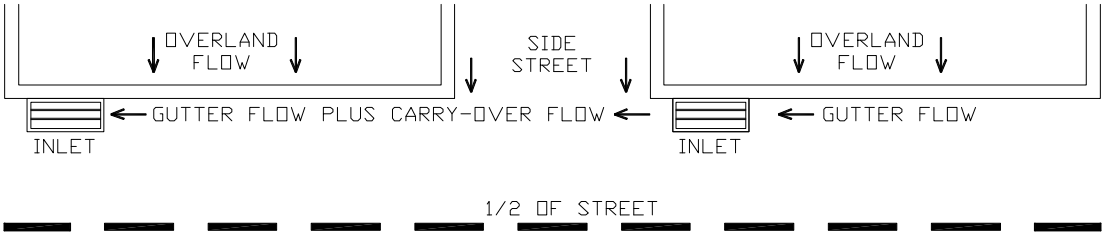
		MINOR	MAJOR	
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Grate Information		MINOR	MAJOR	
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening 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 3.00)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.67)	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} =	5.95	5.95	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.4	63.4	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 2.30-3.00)	C_w (C) =	2.30	2.30	
Curb Opening Orifice Coefficient (typical value 0.67)	C_o (C) =	0.67	0.67	
Resulting Gutter Flow Depth for Grate Inlet Capacity in a Sump		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	N/A	N/A	
Clogging Factor for Multiple Units	Clog =	N/A	N/A	
Grate as a Weir				
Flow Depth at Local Depression without Clogging (0 cfs grate, 5 cfs curb)	d_{wi} =	N/A	N/A	inches
This Row Used for Combination Inlets Only	$d_{curb\text{-}un}$ =	N/A	N/A	inches
Flow Depth at Local Depression with Clogging (0 cfs grate, 5 cfs curb)	d_{wa} =	N/A	N/A	inches
This Row Used for Combination Inlets Only	$d_{curb\text{-}cl}$ =	N/A	N/A	inches
Grate as an Orifice		MINOR	MAJOR	
Flow Depth at Local Depression without Clogging (0 cfs grate, 5 cfs curb)	d_{oi} =	N/A	N/A	inches
Flow Depth at Local Depression with Clogging (0 cfs grate, 5 cfs curb)	d_{oa} =	N/A	N/A	inches
Resulting Gutter Flow Depth Outside of Local Depression	**$d_{a\text{-}Grate}$ =**	**N/A**	**N/A**	**inches**
Resulting Gutter Flow Depth for Curb Opening Inlet Capacity in a Sump		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	1.00	1.00	
Clogging Factor for Multiple Units	Clog =	0.10	0.10	
Curb as a Weir, Grate as an Orifice		MINOR	MAJOR	
Flow Depth at Local Depression without Clogging (0 cfs grate, 5 cfs curb)	d_{wi} =	4.80	5.24	inches
Flow Depth at Local Depression with Clogging (0 cfs grate, 5 cfs curb)	d_{wa} =	4.99	5.45	inches
Curb as an Orifice, Grate as an Orifice		MINOR	MAJOR	
Flow Depth at Local Depression without Clogging (0 cfs grate, 5 cfs curb)	d_{oi} =	4.35	4.85	inches
Flow Depth at Local Depression with Clogging (0 cfs grate, 5 cfs curb)	d_{oa} =	4.74	5.37	inches
Resulting Gutter Flow Depth Outside of Local Depression	**$d_{a\text{-}Curb}$ =**	**1.99**	**2.45**	**inches**
Resultant Street Conditions		MINOR	MAJOR	
Total Inlet Length	L =	5.0	5.0	feet
Total Inlet Interception Capacity (Design Discharge from ***Q-Peak***)	Q_a =	5.0	5.7	cfs
Resultant Gutter Flow Depth (based on sheet *Q-Allow* geometry)	**d =**	**1.99**	**2.45**	**inches**
Resultant Street Flow Spread (based on sheet *Q-Allow* geometry)	**T =**	**2.0**	**3.9**	**feet**
Resultant Flow Depth at Street Crown	**d_{CROWN} =**	**0.00**	**0.00**	**inches**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th Ave & Federal Blvd Storm Drainage Design

Northeast Ramp - DP70, Structure 313L

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):

	Minor Storm	Major Storm	
*Q =	3.00	6.20	cfs

*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)

Site is Urban:	X
Site Is Non-Urban:	

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.00**	**0.00**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

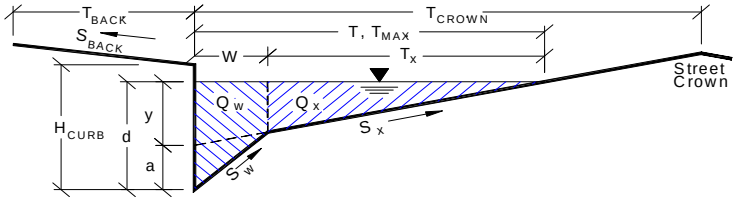
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**3.00**	**6.20**	**cfs**

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

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

Project: **6th Ave & Federal Blvd Storm Drainage Design**

Inlet ID: **Northeast Ramp - DP70, Structure 313L**



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0130	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	60.0	ft
Gutter Depression	a =	1.52	inches
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.0210	ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0440	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	6.0	60.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread

		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0843	0.0843	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	1.51	15.12	inches
Water Depth with a Gutter Depression	d =	3.03	16.64	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	4.0	58.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.816	0.093	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.5	591.5	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	2.1	60.9	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Water Spread	**Q_T =**	**2.6**	**652.4**	**cfs**
Flow Velocity Within the Gutter Section	V =	6.2	23.4	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	1.6	32.4	

Maximum Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	17.8	41.6	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	15.8	39.6	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.332	0.137	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	18.4	213.6	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	18.4	213.6	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	9.1	33.9	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**27.5**	**247.5**	**cfs**
Flow Velocity Within the Gutter Section	V =	11.0	18.5	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	5.5	18.5	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	0.55	0.44	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**15.1**	**109.9**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.03	9.21	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	0.00	inches

		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**2.6**	**109.9**	**cfs**

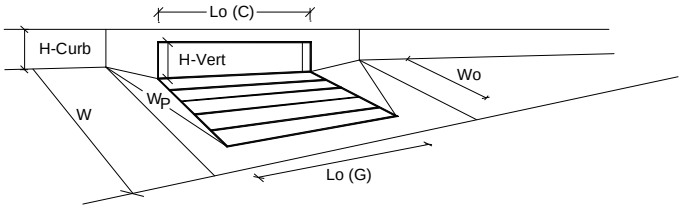
WARNING: MINOR STORM max. allowable capacity is less than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: 6th Ave & Federal Blvd Storm Drainage Design

Inlet ID: Northeast Ramp - DP70, Structure 313L



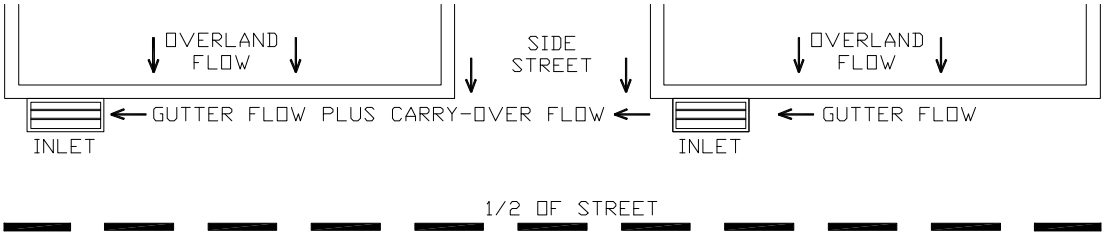
	Design Information (Input)		MINOR	MAJOR	
	Type of Inlet	Type =	CDOT Type R Curb Opening		
	Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	inches
	Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
	Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	10.00	10.00	ft
	Width of a Unit Grate (cannot be greater than W from Q-Allow)	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	
Warning	**Street Hydraulics: WARNING: Q > ALLOWABLE Q FOR MINOR STORM'**		MINOR	MAJOR	
	Design Discharge for Half of Street (from Sheet *Q-Peak*)	**Q_o =**	**3.00**	**6.20**	**cfs**
	Water Spread Width	T =	6.6	9.5	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 =	0.778	0.601	
	Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.67	2.48	cfs
	Discharge within the Gutter Section W	Q_w =	2.34	3.73	cfs
	Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
	Street Flow Area	A_s =	0.58	1.06	sq ft
	Street Flow Velocity	V_s =	5.20	5.84	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 =			ft
	Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =			
	Under No-Clogging Condition		MINOR	MAJOR	
	Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
	Interception Rate of Frontal Flow	R_f =			
	Interception Rate of Side Flow	R_x =			
	Interception Capacity	Q_i =			cfs
	Under Clogging Condition		MINOR	MAJOR	
	Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =			
	Clogging Factor for Multiple-unit Grate Inlet	GrateClog =			
	Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =			ft
	Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
	Interception Rate of Frontal Flow	R_f =			
	Interception Rate of Side Flow	R_x =			
	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 or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
	Equivalent Slope S_e (based on grate carry-over)	S_e =	0.1675	0.1342	ft/ft
	Required Length L_T to Have 100% Interception	L_T =	13.02	20.18	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 =	2.78	4.39	cfs
	Under Clogging Condition		MINOR	MAJOR	
	Clogging Coefficient	CurbCoef =	1.00	1.00	
	Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.10	0.10	
	Effective (Unclogged) Length	L_e =	9.00	9.00	ft
	Actual Interception Capacity	**Q_a =**	**2.64**	**4.06**	**cfs**
	Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.36**	**2.14**	**cfs**
	Summary		MINOR	MAJOR	
	Total Inlet Interception Capacity	**Q =**	**2.64**	**4.06**	**cfs**
	Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.36**	**2.14**	**cfs**
	Capture Percentage = Q_a/Q_o =	**C% =**	**87.9**	**65.5**	**%**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th Ave & Federal Blvd Storm Drainage Design

Northeast Ramp - DP71, Structure 316L

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):

	Minor Storm	Major Storm	
*Q =	1.20	3.30	cfs

*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)

Site is Urban:	X
Site Is Non-Urban:	

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.36**	**2.14**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

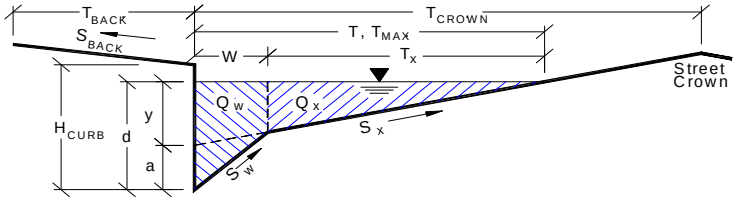
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**1.56**	**5.44**	**cfs**

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

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

Project: **6th Ave & Federal Blvd Storm Drainage Design**

Inlet ID: **Northeast Ramp - DP71, Structure 316L**



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0130	
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 Depression	a =	1.52	inches
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.0210	ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0430	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	6.0	28.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread

		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0843	0.0843	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	1.51	7.06	inches
Water Depth with a Gutter Depression	d =	3.03	8.58	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	4.0	26.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.816	0.207	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.5	68.8	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	2.1	18.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Water Spread	**Q_T =**	**2.5**	**86.8**	**cfs**
Flow Velocity Within the Gutter Section	V =	6.2	14.3	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	1.6	10.2	

Maximum Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	17.8	41.6	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	15.8	39.6	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.332	0.137	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	18.2	211.2	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	18.2	199.0	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	9.0	33.5	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**27.2**	**232.5**	**cfs**
Flow Velocity Within the Gutter Section	V =	10.9	18.3	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	5.4	18.3	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	0.56	0.45	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**15.2**	**105.1**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.05	9.12	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	0.54	inches

		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**2.5**	**86.8**	**cfs**

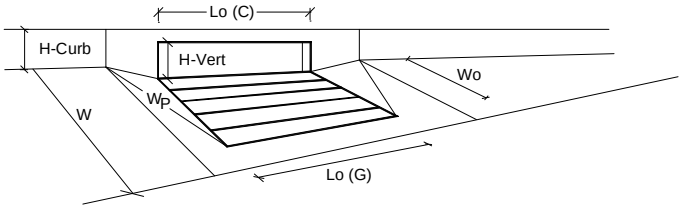
MINOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: 6th Ave & Federal Blvd Storm Drainage Design

Inlet ID: Northeast Ramp - DP71, Structure 316L



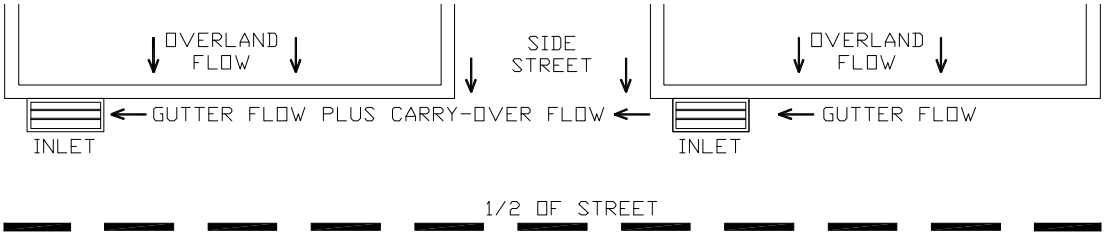
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	10.00	10.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	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 < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	**Q_o =**	**1.56**	**5.44**	**cfs**
Water Spread Width	T =	4.4	8.9	ft
Water Depth at Flowline (outside of local depression)	d =	2.6	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 =	0.928	0.628	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.11	2.03	cfs
Discharge within the Gutter Section W	Q_w =	1.45	3.42	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.32	0.96	sq ft
Street Flow Velocity	V_s =	4.81	5.65	fps
Water Depth for Design Condition	d_{LOCAL} =	5.6	6.8	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =			ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =			
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
Interception Capacity	Q_i =			cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =			
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =			
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =			ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
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 or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.1959	0.1393	ft/ft
Required Length L_T to Have 100% Interception	L_T =	8.95	18.55	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	8.94	10.00	ft
Interception Capacity	Q_i =	1.56	4.09	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.10	0.10	
Effective (Unclogged) Length	L_e =	8.94	9.00	ft
Actual Interception Capacity	**Q_a =**	**1.56**	**3.79**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.00**	**1.65**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.56**	**3.79**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.00**	**1.65**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**99.9**	**69.7**	**%**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th Ave & Federal Blvd Storm Drainage Design

South Federal - DP8 - Structure 610R

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):
*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

	Minor Storm	Major Storm	
***Q =**	**1.70**	**3.40**	**cfs**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)	
Site is Urban:	X
Site Is Non-Urban:	

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.00**	**0.00**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

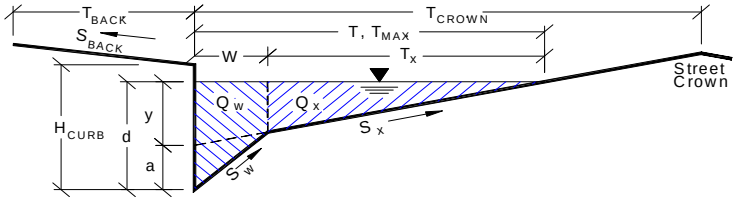
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**1.70**	**3.40**	**cfs**

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

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

Project: **6th Ave & Federal Blvd Storm Drainage Design**

Inlet ID: **South Federal - DP8 - Structure 610R**



Gutter Geometry (Enter data in the blue cells)				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =			ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0130		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	40.0		ft
Gutter Depression	a =	1.52		inches
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.0210		ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0250		ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160		
		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	6.0	40.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0843	0.0843	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	1.51	10.08	inches
Water Depth with a Gutter Depression	d =	3.03	11.60	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	4.0	38.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.816	0.143	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.4	144.4	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	1.6	24.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Water Spread	**Q_T =**	**1.9**	**168.4**	**cfs**
Flow Velocity Within the Gutter Section	V =	4.7	13.6	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	1.2	13.1	

Maximum Gutter Capacity Based on Allowable Gutter Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	17.8	41.6	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	15.8	39.6	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.332	0.137	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	13.9	161.0	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	13.9	161.0	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	6.9	25.5	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**20.7**	**186.5**	**cfs**
Flow Velocity Within the Gutter Section	V =	8.3	13.9	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	4.1	13.9	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	0.86	0.70	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**17.9**	**130.2**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.74	10.66	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	0.00	inches
		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**1.9**	**130.2**	**cfs**

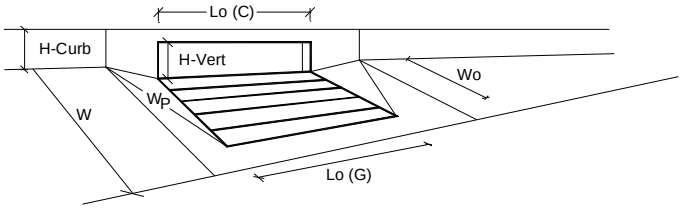
MINOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: 6th Ave & Federal Blvd Storm Drainage Design

Inlet ID: South Federal - DP8 - Structure 610R



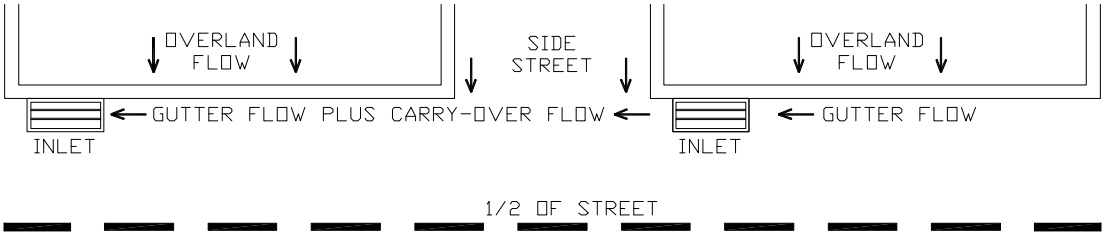
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	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 < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	**Q_o =**	**1.70**	**3.40**	**cfs**
Water Spread Width	T =	5.6	8.1	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 =	0.849	0.676	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.26	1.10	cfs
Discharge within the Gutter Section W	Q_w =	1.45	2.30	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.45	0.82	sq ft
Street Flow Velocity	V_s =	3.79	4.17	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 =			ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =			
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
Interception Capacity	Q_i =			cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =			
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =			
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =			ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
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 or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.1809	0.1483	ft/ft
Required Length L_T to Have 100% Interception	L_T =	8.27	12.46	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 =	1.38	2.05	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	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 =**	**1.29**	**1.88**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.41**	**1.52**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.29**	**1.88**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.41**	**1.52**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**75.7**	**55.4**	**%**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th Ave & Federal Blvd Storm Drainage Design

South Federal - DP9 - Structure 613R

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):

	Minor Storm	Major Storm	
*Q =	1.10	2.50	cfs

*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)			Slope (ft/ft)	Length (ft)
Site is Urban:	X	Overland Flow =		
Site Is Non-Urban:		Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.41**	**1.52**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

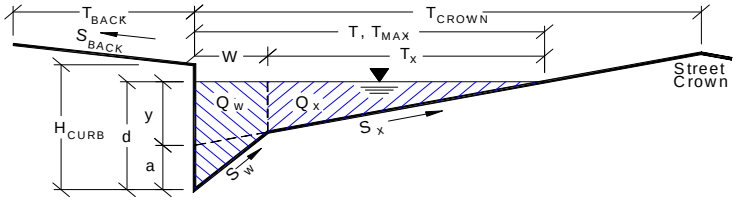
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**1.51**	**4.02**	**cfs**

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

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

Project: **6th Ave & Federal Blvd Storm Drainage Design**

Inlet ID: **South Federal - DP9 - Structure 613R**



Gutter Geometry (Enter data in the blue cells)				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =			ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0130		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	40.0		ft
Gutter Depression	a =	1.52		inches
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.0200		ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0540		ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160		
		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	6.0	40.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0833	0.0833	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	1.44	9.60	inches
Water Depth with a Gutter Depression	d =	2.96	11.12	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	4.0	38.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.821	0.143	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.5	195.6	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	2.2	32.7	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Water Spread	**Q_T =**	**2.7**	**228.3**	**cfs**
Flow Velocity Within the Gutter Section	V =	6.8	19.4	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	1.7	18.0	

Maximum Gutter Capacity Based on Allowable Gutter Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	21.7	250.1	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	21.7	249.7	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	10.2	37.6	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**31.9**	**287.3**	**cfs**
Flow Velocity Within the Gutter Section	V =	12.2	20.5	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	6.1	20.5	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	0.46	0.38	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**14.8**	**108.3**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	4.80	8.74	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	0.00	inches
		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**2.7**	**108.3**	**cfs**

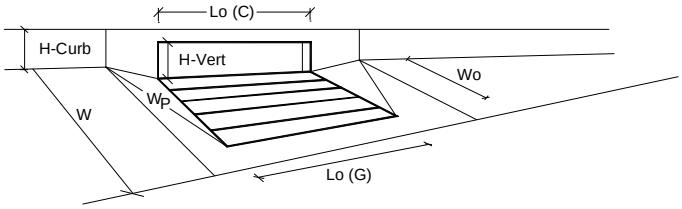
MINOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: 6th Ave & Federal Blvd Storm Drainage Design

Inlet ID: South Federal - DP9 - Structure 613R



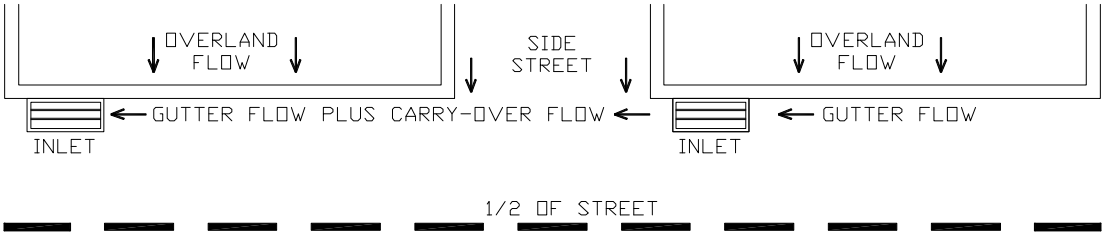
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	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 < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	**Q_o =**	**1.51**	**4.02**	**cfs**
Water Spread Width	T =	4.0	7.5	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 =	0.950	0.720	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.08	1.12	cfs
Discharge within the Gutter Section W	Q_w =	1.44	2.90	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.29	0.69	sq ft
Street Flow Velocity	V_s =	5.29	5.85	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 =			ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =			
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
Interception Capacity	Q_i =			cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =			
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =			
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =			ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
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 or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.1989	0.1557	ft/ft
Required Length L_T to Have 100% Interception	L_T =	9.36	16.36	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 =	1.13	1.93	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	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 =**	**1.05**	**1.77**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.46**	**2.25**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.05**	**1.77**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.47**	**2.25**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**69.1**	**44.0**	**%**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th Ave & Federal Blvd Storm Drainage Design

South Federal - DP10 - Structure 615R

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):

	Minor Storm	Major Storm	
*Q =	0.80	1.80	cfs

*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)

Site is Urban:	X
Site Is Non-Urban:	

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.47**	**2.25**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

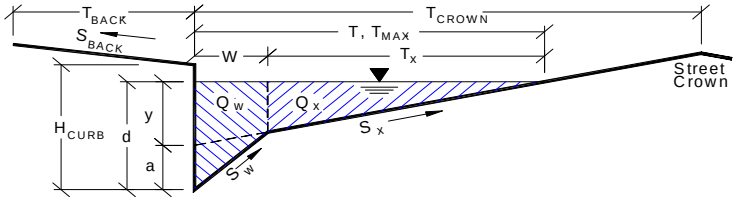
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**1.27**	**4.05**	**cfs**

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

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

Project: **6th Ave & Federal Blvd Storm Drainage Design**

Inlet ID: **South Federal - DP10 - Structure 615R**



Gutter Geometry (Enter data in the blue cells)				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =			ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0130		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	40.0		ft
Gutter Depression	a =	1.52		inches
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.0200		ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0380		ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160		
		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	6.0	40.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0833	0.0833	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	1.44	9.60	inches
Water Depth with a Gutter Depression	d =	2.96	11.12	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	4.0	38.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.821	0.143	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.4	164.1	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	1.9	27.4	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Water Spread	**Q_T =**	**2.3**	**191.5**	**cfs**
Flow Velocity Within the Gutter Section	V =	5.7	16.3	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	1.4	15.1	

Maximum Gutter Capacity Based on Allowable Gutter Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	18.2	209.8	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	18.2	209.5	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	8.5	31.5	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**26.7**	**241.0**	**cfs**
Flow Velocity Within the Gutter Section	V =	10.2	17.2	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	5.1	17.2	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	0.62	0.50	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**16.5**	**120.3**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.20	9.56	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	0.00	inches
		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**2.3**	**120.3**	**cfs**

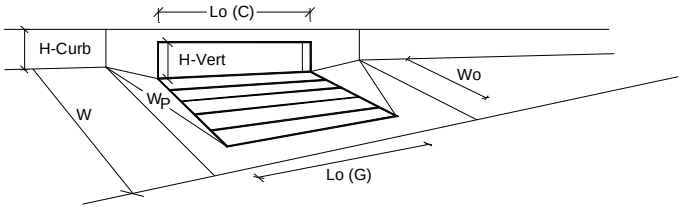
MINOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: 6th Ave & Federal Blvd Storm Drainage Design

Inlet ID: South Federal - DP10 - Structure 615R



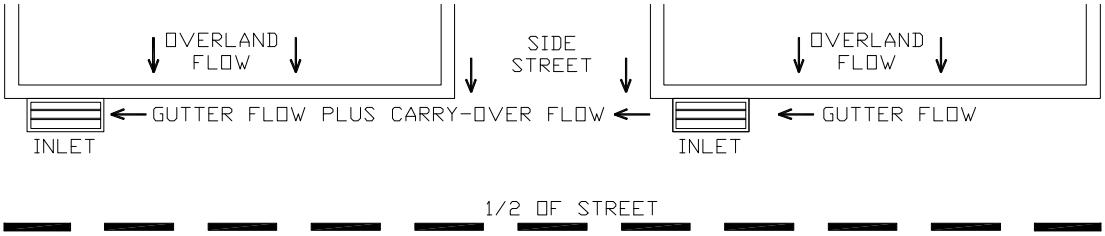
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	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 < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	**Q_o =**	**1.27**	**4.05**	**cfs**
Water Spread Width	T =	4.0	8.2	ft
Water Depth at Flowline (outside of local depression)	d =	2.5	3.5	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 =	0.950	0.674	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.06	1.32	cfs
Discharge within the Gutter Section W	Q_w =	1.21	2.74	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.29	0.80	sq ft
Street Flow Velocity	V_s =	4.43	5.05	fps
Water Depth for Design Condition	d_{LOCAL} =	5.5	6.5	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =			ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =			
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
Interception Capacity	Q_i =			cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =			
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =			
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =			ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
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 or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.1989	0.1470	ft/ft
Required Length L_T to Have 100% Interception	L_T =	7.84	15.29	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 =	1.07	2.06	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	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 =**	**1.00**	**1.89**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.27**	**2.16**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.00**	**1.89**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.27**	**2.16**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**78.7**	**46.6**	**%**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th Ave & Federal Blvd Storm Drainage Design

US6 - DP15 - Structure 619R

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):

	Minor Storm	Major Storm	
*Q =	2.00	2.30	cfs

*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)

Site is Urban:	X
Site Is Non-Urban:	

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.00**	**0.25**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

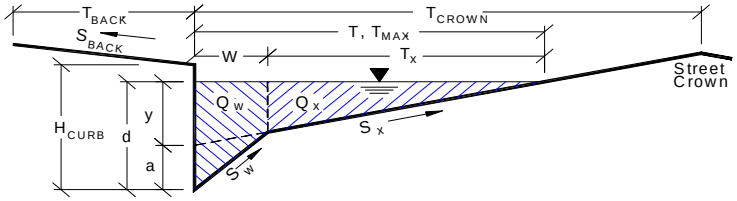
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**2.00**	**2.55**	**cfs**

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

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

Project: **6th Ave & Federal Blvd Storm Drainage Design**

Inlet ID: **US6 - DP15 - Structure 619R**



Gutter Geometry (Enter data in the blue cells)				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =			ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0130		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	75.0		ft
Gutter Depression	a =	1.52		inches
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.0250		ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0000		ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160		
		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	4.0	6.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0883	0.0883	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	1.20	1.80	inches
Water Depth with a Gutter Depression	d =	2.72	3.32	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	2.0	4.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.940	0.799	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_T - 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
Maximum Flow Based On Allowable Water 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 Gutter Capacity Based on Allowable Gutter Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	14.9	34.9	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	12.9	32.9	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.383	0.161	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	0.0	0.0	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (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	**Q =**	**0.0**	**0.0**	**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	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	SUMP	SUMP	
Max Flow Based on Allow. Gutter 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	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

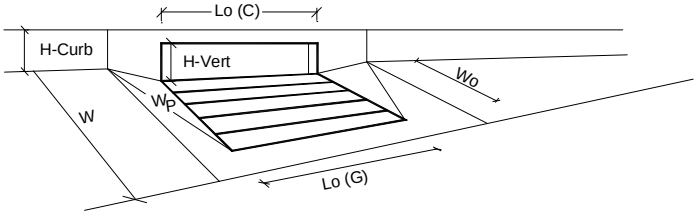
MINOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET IN A SUMP OR SAG LOCATION

Project = **6th Ave & Federal Blvd Storm Drainage Design**

Inlet ID = **US6 - DP15 - Structure 619R**



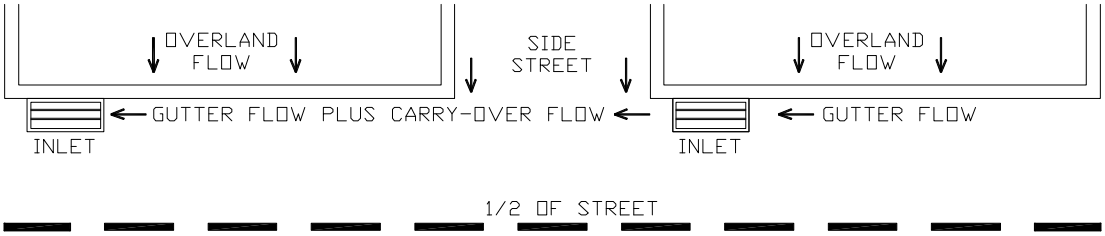
		MINOR	MAJOR	
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Grate Information		MINOR	MAJOR	
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening 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 3.00)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.67)	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} =	5.95	5.95	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.4	63.4	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 2.30-3.00)	C_w (C) =	2.30	2.30	
Curb Opening Orifice Coefficient (typical value 0.67)	C_o (C) =	0.67	0.67	
Resulting Gutter Flow Depth for Grate Inlet Capacity in a Sump		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	N/A	N/A	
Clogging Factor for Multiple Units	Clog =	N/A	N/A	
Grate as a Weir				
Flow Depth at Local Depression without Clogging (0 cfs grate, 2 cfs curb)	d_{wi} =	N/A	N/A	inches
This Row Used for Combination Inlets Only	$d_{curb\text{-}un}$ =	N/A	N/A	inches
Flow Depth at Local Depression with Clogging (0 cfs grate, 2 cfs curb)	d_{wa} =	N/A	N/A	inches
This Row Used for Combination Inlets Only	$d_{curb\text{-}cl}$ =	N/A	N/A	inches
Grate as an Orifice		MINOR	MAJOR	
Flow Depth at Local Depression without Clogging (0 cfs grate, 2 cfs curb)	d_{oi} =	N/A	N/A	inches
Flow Depth at Local Depression with Clogging (0 cfs grate, 2 cfs curb)	d_{oa} =	N/A	N/A	inches
Resulting Gutter Flow Depth Outside of Local Depression	**$d_{a\text{-}Grate}$ =**	**N/A**	**N/A**	**inches**
Resulting Gutter Flow Depth for Curb Opening Inlet Capacity in a Sump		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	1.00	1.00	
Clogging Factor for Multiple Units	Clog =	0.10	0.10	
Curb as a Weir, Grate as an Orifice		MINOR	MAJOR	
Flow Depth at Local Depression without Clogging (0 cfs grate, 2 cfs curb)	d_{wi} =	2.25	2.65	inches
Flow Depth at Local Depression with Clogging (0 cfs grate, 2 cfs curb)	d_{wa} =	2.34	2.76	inches
Curb as an Orifice, Grate as an Orifice		MINOR	MAJOR	
Flow Depth at Local Depression without Clogging (0 cfs grate, 2 cfs curb)	d_{oi} =	2.83	2.94	inches
Flow Depth at Local Depression with Clogging (0 cfs grate, 2 cfs curb)	d_{oa} =	2.87	3.01	inches
Resulting Gutter Flow Depth Outside of Local Depression	**$d_{a\text{-}Curb}$ =**	**0.00**	**0.01**	**inches**
Resultant Street Conditions		MINOR	MAJOR	
Total Inlet Length	L =	5.0	5.0	feet
Total Inlet Interception Capacity (Design Discharge from ***Q-Peak***)	Q_a =	1.6	2.1	cfs
Resultant Gutter Flow Depth (based on sheet *Q-Allow* geometry)	**d =**	**0.00**	**0.01**	**inches**
Resultant Street Flow Spread (based on sheet *Q-Allow* geometry)	**T =**	**0.0**	**0.0**	**feet**
Resultant Flow Depth at Street Crown	**d_{CROWN} =**	**0.00**	**0.00**	**inches**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th Ave & Federal Blvd Storm Drainage Design

US6 - DP16 - Structure 620R

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):

	Minor Storm	Major Storm	
*Q =	0.70	1.40	cfs

*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)

Site is Urban:	X
Site Is Non-Urban:	

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.00**	**0.10**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

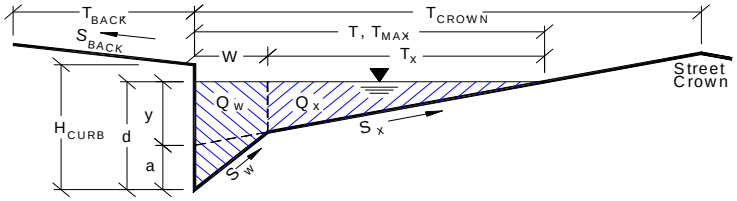
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**0.70**	**1.50**	**cfs**

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

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

Project: **6th Ave & Federal Blvd Storm Drainage Design**

Inlet ID: **US6 - DP16 - Structure 620R**



Gutter Geometry (Enter data in the blue cells)				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =			ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0130		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	75.0		ft
Gutter Depression	a =	1.52		inches
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.0200		ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0170		ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160		
		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	4.0	6.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0833	0.0833	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	0.96	1.44	inches
Water Depth with a Gutter Depression	d =	2.48	2.96	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	2.0	4.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.950	0.821	
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_T - Q_X)	Q_W =	0.8	1.2	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Water Spread	**Q_T =**	**0.9**	**1.5**	**cfs**
Flow Velocity Within the Gutter Section	V =	3.3	3.8	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.7	0.9	

Maximum Gutter Capacity Based on Allowable Gutter Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	12.2	140.3	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	12.2	140.3	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	5.7	21.1	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**17.9**	**161.4**	**cfs**
Flow Velocity Within the Gutter Section	V =	6.8	11.5	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	3.4	11.5	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	1.00	0.95	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**17.9**	**153.3**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	11.80	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	0.00	inches
		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**0.9**	**1.5**	**cfs**

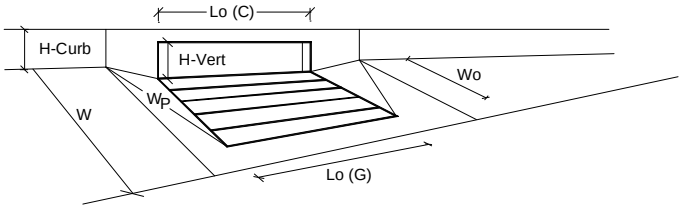
MINOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: 6th Ave & Federal Blvd Storm Drainage Design

Inlet ID: US6 - DP16 - Structure 620R



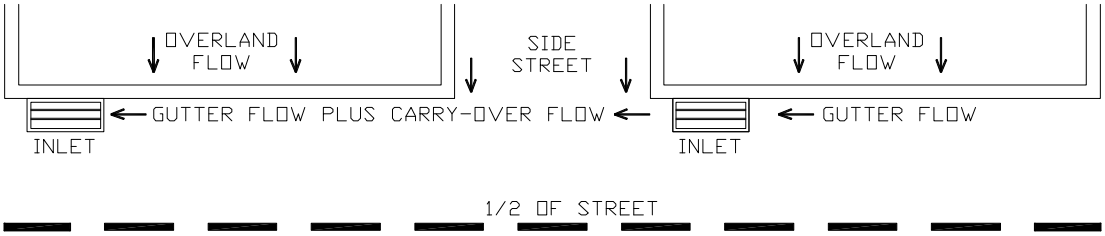
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	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 < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	**Q_o =**	**0.70**	**1.50**	**cfs**
Water Spread Width	T =	3.4	6.0	ft
Water Depth at Flowline (outside of local depression)	d =	2.3	3.0	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 =	0.978	0.823	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.02	0.27	cfs
Discharge within the Gutter Section W	Q_w =	0.69	1.24	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.24	0.48	sq ft
Street Flow Velocity	V_s =	2.93	3.11	fps
Water Depth for Design Condition	d_{LOCAL} =	5.3	6.0	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =			ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =			
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
Interception Capacity	Q_i =			cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =			
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =			
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =			ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
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 or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.2042	0.1751	ft/ft
Required Length L_T to Have 100% Interception	L_T =	4.72	7.13	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	4.71	5.00	ft
Interception Capacity	Q_i =	0.70	1.33	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	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 =**	**0.70**	**1.25**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.00**	**0.25**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.70**	**1.25**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.00**	**0.25**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**99.6**	**83.3**	**%**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th Ave & Federal Blvd Storm Drainage Design

US6 - DP17 - Structure 621R

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):
*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

	Minor Storm	Major Storm	
***Q =**	**0.40**	**0.90**	**cfs**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)	
Site is Urban:	X
Site Is Non-Urban:	

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.00**	**0.00**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

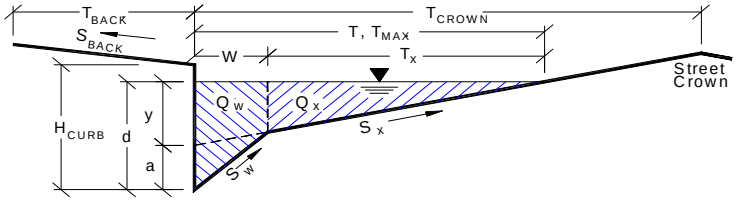
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**0.40**	**0.90**	**cfs**

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

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

Project: **6th Ave & Federal Blvd Storm Drainage Design**

Inlet ID: **US6 - DP17 - Structure 621R**



Gutter Geometry (Enter data in the blue cells)				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =			ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0130		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	75.0		ft
Gutter Depression	a =	1.52		inches
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.0082		ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0240		ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160		
		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	4.0	6.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0715	0.0715	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	0.39	0.59	inches
Water Depth with a Gutter Depression	d =	1.91	2.11	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	2.0	4.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.980	0.909	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.0	0.1	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	0.6	0.7	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Water Spread	**Q_T =**	**0.6**	**0.8**	**cfs**
Flow Velocity Within the Gutter Section	V =	3.2	3.5	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.5	0.6	

Maximum Gutter Capacity Based on Allowable Gutter Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	45.5	106.5	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	43.5	104.5	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.143	0.055	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	42.4	438.1	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	42.4	420.2	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	7.1	25.6	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**49.5**	**445.8**	**cfs**
Flow Velocity Within the Gutter Section	V =	8.3	13.8	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	4.1	13.8	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	0.89	0.72	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**44.0**	**321.4**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.80	10.69	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	1.79	inches
		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**0.6**	**0.8**	**cfs**

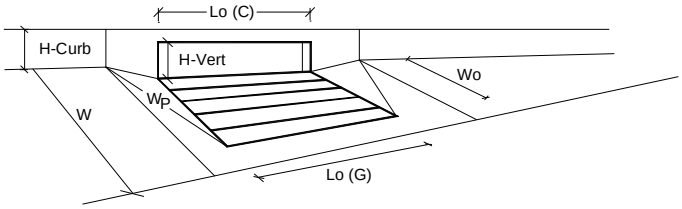
MINOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

WARNING: MAJOR STORM max. allowable capacity is less than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: 6th Ave & Federal Blvd Storm Drainage Design

Inlet ID: US6 - DP17 - Structure 621R



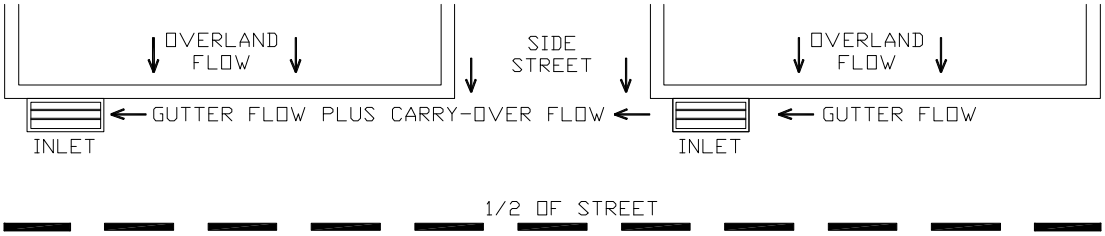
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	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	
Warning **Street Hydraulics: WARNING: Q > ALLOWABLE Q FOR MAJOR STORM**		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	**Q_o =**	**0.40**	**0.90**	**cfs**
Water Spread Width	T =	2.0	6.7	ft
Water Depth at Flowline (outside of local depression)	d =	1.7	2.2	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 =	1.000	0.876	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.00	0.11	cfs
Discharge within the Gutter Section W	Q_w =	0.40	0.79	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.14	0.31	sq ft
Street Flow Velocity	V_s =	2.90	2.90	fps
Water Depth for Design Condition	d_{LOCAL} =	4.7	5.2	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =			ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =			
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
Interception Capacity	Q_i =			cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =			
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =			
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =			ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
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 or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.1965	0.1731	ft/ft
Required Length L_T to Have 100% Interception	L_T =	4.23	6.42	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	4.22	5.00	ft
Interception Capacity	Q_i =	0.40	0.84	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.10	0.10	
Effective (Unclogged) Length	L_e =	4.22	4.50	ft
Actual Interception Capacity	**Q_a =**	**0.40**	**0.80**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.00**	**0.10**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.40**	**0.80**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.00**	**0.10**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**100.0**	**88.6**	**%**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th Ave & Federal Blvd Storm Drainage Design

Slip Ramp - DP11 - Structure 717R

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):

	Minor Storm	Major Storm	
*Q =	0.80	1.60	cfs

*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)

Site is Urban:	X
Site Is Non-Urban:	

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.27**	**2.16**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

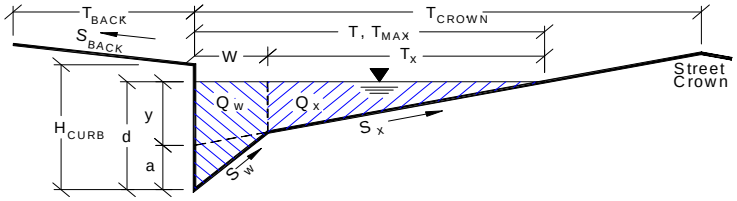
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**1.07**	**3.76**	**cfs**

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

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

Project: **6th Ave & Federal Blvd Storm Drainage Design**

Inlet ID: **Slip Ramp - DP11 - Structure 717R**



Gutter Geometry (Enter data in the blue cells)				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =			ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0130		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	30.0		ft
Gutter Depression	a =	0.00		inches
Gutter Width	W =	8.00		ft
Street Transverse Slope	S_X =	0.0200		ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0220		ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160		
		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	12.0	30.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0200	0.0200	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	2.88	7.20	inches
Water Depth with a Gutter Depression	d =	2.88	7.20	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	4.0	22.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.947	0.563	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.3	29.1	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	5.5	37.4	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Water Spread	**Q_T =**	**5.8**	**66.5**	**cfs**
Flow Velocity Within the Gutter Section	V =	68.3	143.9	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	16.4	86.3	

Maximum Gutter Capacity Based on Allowable Gutter Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	25.0	50.0	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	17.0	42.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.642	0.372	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	14.6	163.1	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	14.6	140.5	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	26.3	96.5	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**40.9**	**237.0**	**cfs**
Flow Velocity Within the Gutter Section	V =	125.1	209.8	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	62.5	209.8	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	0.95	0.77	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**39.0**	**183.2**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.90	10.75	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	3.55	inches
		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**5.8**	**66.5**	**cfs**

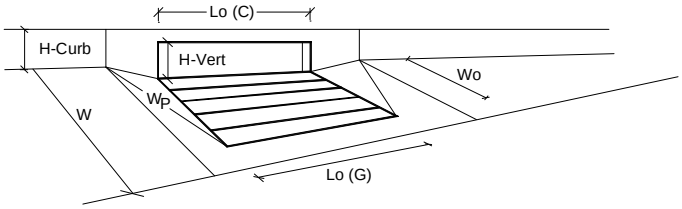
MINOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: 6th Ave & Federal Blvd Storm Drainage Design

Inlet ID: Slip Ramp - DP11 - Structure 717R



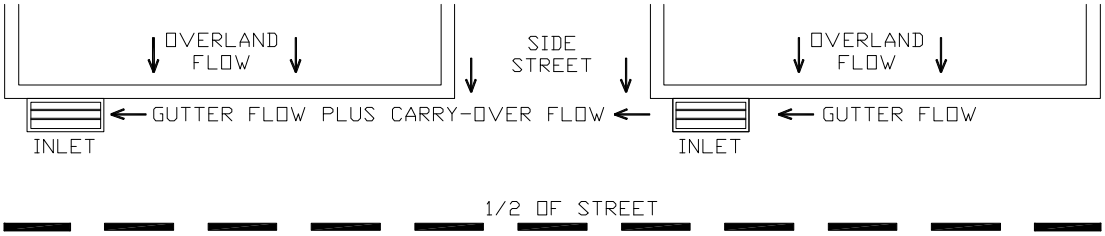
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Directional Cast Vane Grate		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	1.0	1.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	2.50	2.50	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	W_o =	3.00	3.00	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	N/A	N/A	
Street Hydraulics: OK - Q < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	Q_o =	**1.07**	**3.76**	**cfs**
Water Spread Width	T =	6.4	10.2	ft
Water Depth at Flowline (outside of local depression)	d =	1.5	2.5	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 =	1.000	0.983	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.00	0.06	cfs
Discharge within the Gutter Section W	Q_w =	1.07	3.71	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.41	1.05	sq ft
Street Flow Velocity	V_s =	2.62	3.60	fps
Water Depth for Design Condition	d_{LOCAL} =	2.5	3.5	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	2.50	2.50	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	0.694	0.537	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =	6.58	6.58	fps
Interception Rate of Frontal Flow	R_f =	1.00	1.00	
Interception Rate of Side Flow	R_x =	0.16	0.10	
Interception Capacity	Q_i =	0.80	2.20	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =	1.00	1.00	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	0.50	0.50	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	1.25	1.25	ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =	4.61	4.61	fps
Interception Rate of Frontal Flow	R_f =	1.00	1.00	
Interception Rate of Side Flow	R_x =	0.04	0.02	
Actual Interception Capacity	Q_a =	**0.76**	**2.06**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	Q_b =	**0.31**	**1.70**	**cfs**
Curb or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =			ft/ft
Required Length L_T to Have 100% Interception	L_T =			ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =			ft
Interception Capacity	Q_i =			cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =			
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =			
Effective (Unclogged) Length	L_e =			ft
Actual Interception Capacity	Q_a =	**N/A**	**N/A**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	Q_b =	**N/A**	**N/A**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	**0.76**	**2.06**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	**0.31**	**1.70**	**cfs**
Capture Percentage = Q_a/Q_o =	C% =	**70.6**	**54.9**	**%**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th Ave & Federal Blvd Storm Drainage Design

Slip Ramp - DP12 - Structure 718R

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):
*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

	Minor Storm	Major Storm	
***Q =**	**2.10**	**4.30**	**cfs**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)	
Site is Urban:	X
Site Is Non-Urban:	

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.31**	**1.70**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

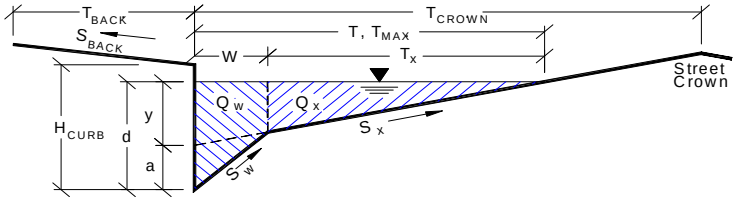
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**2.41**	**6.00**	**cfs**

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

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

Project: **6th Ave & Federal Blvd Storm Drainage Design**

Inlet ID: **Slip Ramp - DP12 - Structure 718R**



Gutter Geometry (Enter data in the blue cells)				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =			ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0130		
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 Depression	a =	0.00		inches
Gutter Width	W =	8.00		ft
Street Transverse Slope	S_X =	0.0190		ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0120		ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160		
		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	12.0	31.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0190	0.0190	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	2.74	7.07	inches
Water Depth with a Gutter Depression	d =	2.74	7.07	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	4.0	23.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.947	0.549	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.2	22.2	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	3.7	27.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Water Spread	**Q_T =**	**3.9**	**49.2**	**cfs**
Flow Velocity Within the Gutter Section	V =	48.8	105.3	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	11.1	62.0	

Maximum Gutter Capacity Based on Allowable Gutter Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	26.3	52.6	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	18.3	44.6	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.620	0.356	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	12.1	130.0	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	12.1	111.2	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	19.7	71.8	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**31.8**	**182.9**	**cfs**
Flow Velocity Within the Gutter Section	V =	92.9	155.4	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	46.4	155.4	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	1.00	1.00	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**31.8**	**183.0**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	12.00	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	4.94	inches
		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**3.9**	**49.2**	**cfs**

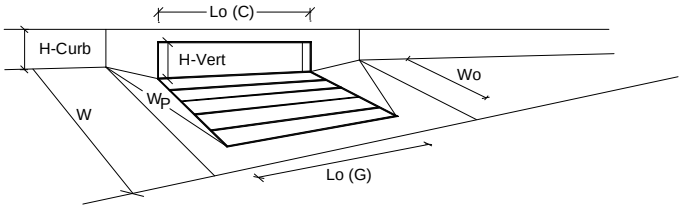
MINOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: 6th Ave & Federal Blvd Storm Drainage Design

Inlet ID: Slip Ramp - DP12 - Structure 718R



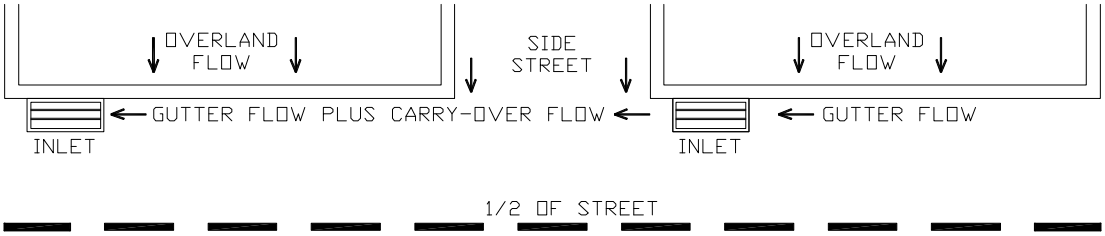
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Directional Cast Vane Grate		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	1.0	1.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	2	2	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	2.50	2.50	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	W_o =	3.00	3.00	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	N/A	N/A	
Street Hydraulics: OK - Q < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	Q_o =	**2.42**	**6.00**	**cfs**
Water Spread Width	T =	10.0	14.1	ft
Water Depth at Flowline (outside of local depression)	d =	2.3	3.2	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 =	0.986	0.893	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.03	0.64	cfs
Discharge within the Gutter Section W	Q_w =	2.39	5.37	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.95	1.89	sq ft
Street Flow Velocity	V_s =	2.54	3.19	fps
Water Depth for Design Condition	d_{LOCAL} =	3.3	4.2	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	5.00	5.00	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	0.544	0.440	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =	10.55	10.55	fps
Interception Rate of Frontal Flow	R_f =	1.00	1.00	
Interception Rate of Side Flow	R_x =	0.49	0.39	
Interception Capacity	Q_i =	1.86	3.95	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =	1.50	1.50	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	0.38	0.38	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	3.13	3.13	ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =	7.24	7.24	fps
Interception Rate of Frontal Flow	R_f =	1.00	1.00	
Interception Rate of Side Flow	R_x =	0.25	0.18	
Actual Interception Capacity	Q_a =	**1.59**	**3.24**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	Q_b =	**0.83**	**2.76**	**cfs**
Curb or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =			ft/ft
Required Length L_T to Have 100% Interception	L_T =			ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =			ft
Interception Capacity	Q_i =			cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =			
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =			
Effective (Unclogged) Length	L_e =			ft
Actual Interception Capacity	Q_a =	**N/A**	**N/A**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	Q_b =	**N/A**	**N/A**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	**1.59**	**3.24**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	**0.83**	**2.76**	**cfs**
Capture Percentage = Q_a/Q_o =	C% =	**65.7**	**54.1**	**%**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th Ave & Federal Blvd Storm Drainage Design

Slip Ramp - DP13 - Structure 719R

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):
*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

	Minor Storm	Major Storm	
***Q =**	**1.10**	**2.30**	**cfs**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)	
Site is Urban:	X
Site Is Non-Urban:	

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.83**	**2.76**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

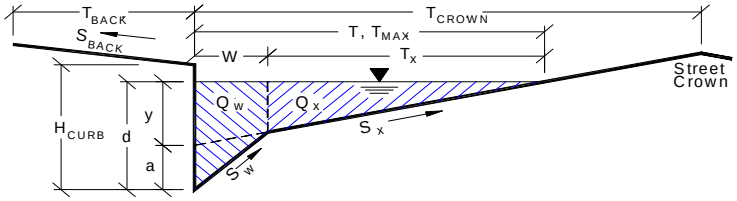
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**1.93**	**5.06**	**cfs**

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

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

Project: **6th Ave & Federal Blvd Storm Drainage Design**

Inlet ID: **Slip Ramp - DP13 - Structure 719R**



Gutter Geometry (Enter data in the blue cells)				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =			ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0130		
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 Depression	a =	0.00		inches
Gutter Width	W =	8.00		ft
Street Transverse Slope	S_X =	0.0240		ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0100		ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160		
		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	12.0	31.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0240	0.0240	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	3.46	8.93	inches
Water Depth with a Gutter Depression	d =	3.46	8.93	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	4.0	23.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.947	0.549	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.3	29.9	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	5.0	36.4	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Water Spread	**Q_T =**	**5.3**	**66.3**	**cfs**
Flow Velocity Within the Gutter Section	V =	52.0	112.3	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	15.0	83.5	

Maximum Gutter Capacity Based on Allowable Gutter Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	20.8	41.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	12.8	33.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.725	0.434	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	6.3	82.6	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	6.3	78.7	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	16.7	63.2	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**23.0**	**142.0**	**cfs**
Flow Velocity Within the Gutter Section	V =	82.5	139.9	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	41.2	139.9	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	1.00	1.00	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**23.0**	**142.0**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	12.00	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	3.08	inches
		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**5.3**	**66.3**	**cfs**

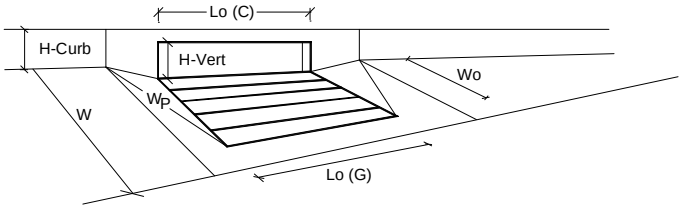
MINOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: 6th Ave & Federal Blvd Storm Drainage Design

Inlet ID: Slip Ramp - DP13 - Structure 719R



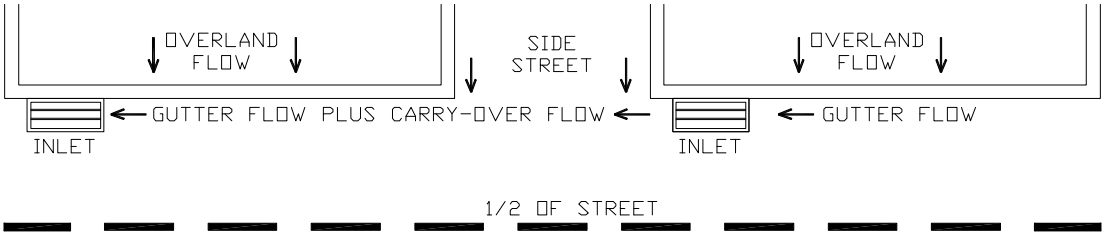
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Directional Cast Vane Grate		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	1.0	1.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	2.50	2.50	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	W_o =	3.00	3.00	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	N/A	N/A	
Street Hydraulics: OK - Q < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	Q_o =	**1.93**	**5.06**	**cfs**
Water Spread Width	T =	8.2	11.8	ft
Water Depth at Flowline (outside of local depression)	d =	2.4	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	0.951	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.00	0.25	cfs
Discharge within the Gutter Section W	Q_w =	1.93	4.82	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.81	1.68	sq ft
Street Flow Velocity	V_s =	2.37	3.02	fps
Water Depth for Design Condition	d_{LOCAL} =	3.4	4.4	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	2.50	2.50	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	0.600	0.490	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =	6.58	6.58	fps
Interception Rate of Frontal Flow	R_f =	1.00	1.00	
Interception Rate of Side Flow	R_x =	0.22	0.15	
Interception Capacity	Q_i =	1.33	2.88	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =	1.00	1.00	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	0.50	0.50	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	1.25	1.25	ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =	4.61	4.61	fps
Interception Rate of Frontal Flow	R_f =	1.00	1.00	
Interception Rate of Side Flow	R_x =	0.05	0.04	
Actual Interception Capacity	Q_a =	**1.20**	**2.58**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	Q_b =	**0.73**	**2.48**	**cfs**
Curb or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =			ft/ft
Required Length L_T to Have 100% Interception	L_T =			ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =			ft
Interception Capacity	Q_i =			cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =			
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =			
Effective (Unclogged) Length	L_e =			ft
Actual Interception Capacity	Q_a =	**N/A**	**N/A**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	Q_b =	**N/A**	**N/A**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	**1.20**	**2.58**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	**0.73**	**2.48**	**cfs**
Capture Percentage = Q_a/Q_o =	C% =	**62.2**	**50.9**	**%**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th Ave & Federal Blvd Storm Drainage Design

Slip Ramp - DP14 - Structure 720R

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):

	Minor Storm	Major Storm	
*Q =	0.30	0.80	cfs

*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)

Site is Urban:	X
Site Is Non-Urban:	

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.73**	**2.48**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

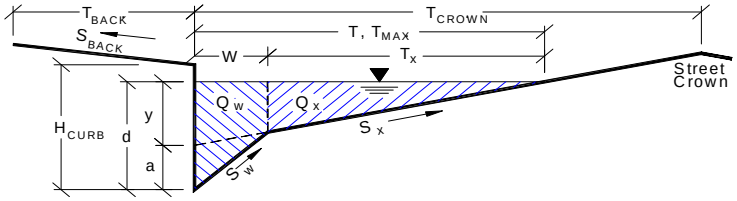
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**1.03**	**3.28**	**cfs**

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

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

Project: **6th Ave & Federal Blvd Storm Drainage Design**

Inlet ID: **Slip Ramp - DP14 - Structure 720R**



Gutter Geometry (Enter data in the blue cells)				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =			ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0130		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	30.0		ft
Gutter Depression	a =	0.00		inches
Gutter Width	W =	8.00		ft
Street Transverse Slope	S_X =	0.0135		ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0270		ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160		
		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	12.0	30.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0135	0.0135	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	1.94	4.86	inches
Water Depth with a Gutter Depression	d =	1.94	4.86	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	4.0	22.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.947	0.563	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.2	16.7	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	3.1	21.5	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Water Spread	**Q_T =**	**3.3**	**38.2**	**cfs**
Flow Velocity Within the Gutter Section	V =	58.2	122.6	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	9.4	49.7	

Maximum Gutter Capacity Based on Allowable Gutter Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	37.0	74.1	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	29.0	66.1	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.477	0.263	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	35.1	314.1	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	34.3	207.4	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	32.0	111.9	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**66.3**	**319.3**	**cfs**
Flow Velocity Within the Gutter Section	V =	143.6	236.6	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	71.8	236.6	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	0.81	0.66	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**53.7**	**209.5**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.53	9.83	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.67	4.97	inches
		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**3.3**	**38.2**	**cfs**

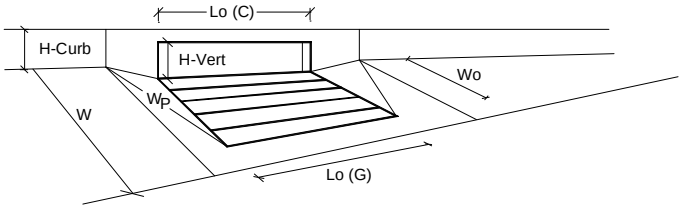
MINOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: 6th Ave & Federal Blvd Storm Drainage Design

Inlet ID: Slip Ramp - DP14 - Structure 720R



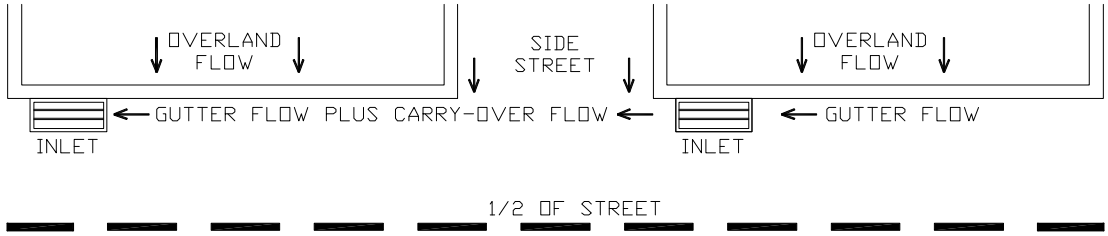
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Directional Cast Vane Grate		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	1.0	1.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	2.50	2.50	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	W_o =	3.00	3.00	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	N/A	N/A	
Street Hydraulics: OK - Q < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	Q_o =	**1.03**	**3.28**	**cfs**
Water Spread Width	T =	7.8	12.0	ft
Water Depth at Flowline (outside of local depression)	d =	1.3	1.9	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 =	1.000	0.948	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.00	0.17	cfs
Discharge within the Gutter Section W	Q_w =	1.03	3.11	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.41	0.96	sq ft
Street Flow Velocity	V_s =	2.55	3.41	fps
Water Depth for Design Condition	d_{LOCAL} =	2.3	2.9	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	2.50	2.50	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	0.618	0.498	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =	6.58	6.58	fps
Interception Rate of Frontal Flow	R_f =	1.00	1.00	
Interception Rate of Side Flow	R_x =	0.12	0.08	
Interception Capacity	Q_i =	0.69	1.76	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =	1.00	1.00	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	0.50	0.50	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	1.25	1.25	ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =	4.61	4.61	fps
Interception Rate of Frontal Flow	R_f =	1.00	1.00	
Interception Rate of Side Flow	R_x =	0.03	0.02	
Actual Interception Capacity	Q_a =	**0.65**	**1.66**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	Q_b =	**0.38**	**1.62**	**cfs**
Curb or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =			ft/ft
Required Length L_T to Have 100% Interception	L_T =			ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =			ft
Interception Capacity	Q_i =			cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =			
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =			
Effective (Unclogged) Length	L_e =			ft
Actual Interception Capacity	Q_a =	**N/A**	**N/A**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	Q_b =	**N/A**	**N/A**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	**0.65**	**1.66**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	**0.38**	**1.62**	**cfs**
Capture Percentage = Q_a/Q_o =	C% =	**63.0**	**50.7**	**%**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th Ave & Federal Blvd Storm Drainage Design

Slip Ramp - DP18 - Structure 721L

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):
*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

	Minor Storm	Major Storm	
***Q =**	**0.30**	**1.20**	**cfs**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)	
Site is Urban:	X
Site Is Non-Urban:	

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.38**	**1.62**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

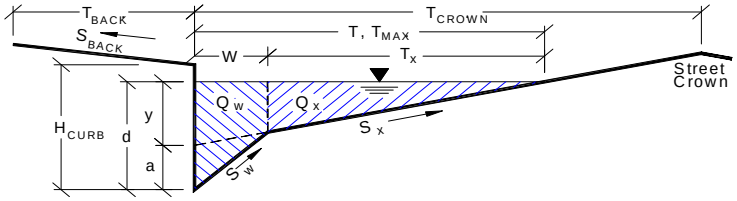
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**0.68**	**2.82**	**cfs**

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

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

Project: **6th Ave & Federal Blvd Storm Drainage Design**

Inlet ID: **Slip Ramp - DP18 - Structure 721L**



Gutter Geometry (Enter data in the blue cells)			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0130	
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 Depression	a =	1.52	inches
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.0340	ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0400	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	6.0	28.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0973	0.0973	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	2.45	11.42	inches
Water Depth with a Gutter Depression	d =	3.97	12.94	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	4.0	26.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.772	0.197	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	1.0	148.2	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	3.4	36.2	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Water Spread	**Q_T =**	**4.4**	**184.4**	**cfs**
Flow Velocity Within the Gutter Section	V =	7.3	18.5	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.4	19.9	

Maximum Gutter Capacity Based on Allowable Gutter Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	11.0	25.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	9.0	23.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.488	0.214	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	8.7	115.6	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	8.7	115.6	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	8.3	31.5	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**17.0**	**147.1**	**cfs**
Flow Velocity Within the Gutter Section	V =	10.3	17.5	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	5.1	17.5	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	0.59	0.48	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**10.0**	**70.5**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.11	9.42	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	0.00	inches

		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**4.4**	**70.5**	**cfs**

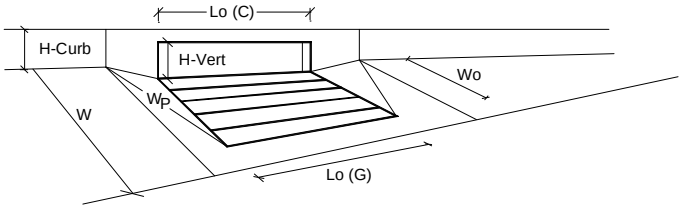
MINOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: 6th Ave & Federal Blvd Storm Drainage Design

Inlet ID: Slip Ramp - DP18 - Structure 721L



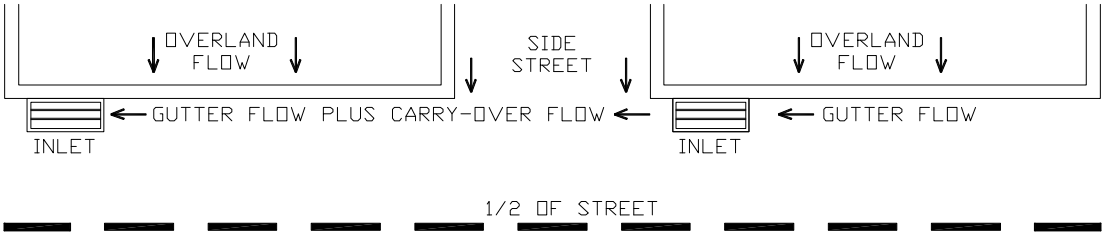
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	10.00	10.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	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 < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	**Q_o =**	**0.68**	**2.82**	**cfs**
Water Spread Width	T =	1.8	4.7	ft
Water Depth at Flowline (outside of local depression)	d =	2.1	3.5	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 =	1.000	0.871	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.00	0.36	cfs
Discharge within the Gutter Section W	Q_w =	0.68	2.46	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.16	0.51	sq ft
Street Flow Velocity	V_s =	4.32	5.57	fps
Water Depth for Design Condition	d_{LOCAL} =	5.1	6.5	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =			ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =			
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
Interception Capacity	Q_i =			cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =			
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =			
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =			ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
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 or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.2224	0.1981	ft/ft
Required Length L_T to Have 100% Interception	L_T =	5.72	11.15	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	5.71	10.00	ft
Interception Capacity	Q_i =	0.68	2.77	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.10	0.10	
Effective (Unclogged) Length	L_e =	5.71	9.00	ft
Actual Interception Capacity	**Q_a =**	**0.68**	**2.67**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.00**	**0.15**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.68**	**2.67**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.00**	**0.14**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**100.0**	**94.9**	**%**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th Ave & Federal Blvd Storm Drainage Design

Slip Ramp - DP24 - Structure 724R

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):

	Minor Storm	Major Storm	
*Q =	0.80	2.60	cfs

*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)

Site is Urban:	X
Site Is Non-Urban:	

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.00**	**0.00**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

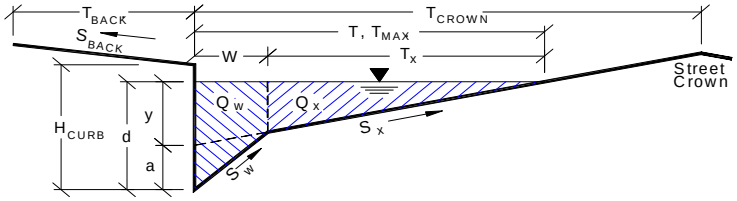
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**0.80**	**2.60**	**cfs**

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

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

Project: **6th Ave & Federal Blvd Storm Drainage Design**

Inlet ID: **Slip Ramp - DP24 - Structure 724R**



Gutter Geometry (Enter data in the blue cells)				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =			ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0130		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	26.0		ft
Gutter Depression	a =	1.52		inches
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.0200		ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0450		ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160		
		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	26.0	26.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0833	0.0833	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	6.24	6.24	inches
Water Depth with a Gutter Depression	d =	7.76	7.76	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	24.0	24.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.226	0.226	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	52.4	52.4	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	15.3	15.3	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Water Spread	**Q_T =**	**67.7**	**67.7**	**cfs**
Flow Velocity Within the Gutter Section	V =	13.6	13.6	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	8.8	8.8	

Maximum Gutter Capacity Based on Allowable Gutter Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	19.8	228.3	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	19.8	205.1	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	9.3	34.3	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**29.1**	**239.4**	**cfs**
Flow Velocity Within the Gutter Section	V =	11.1	18.7	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	5.6	18.7	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	0.54	0.44	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**15.7**	**104.4**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.01	8.92	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	1.16	inches
		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**15.7**	**67.7**	**cfs**

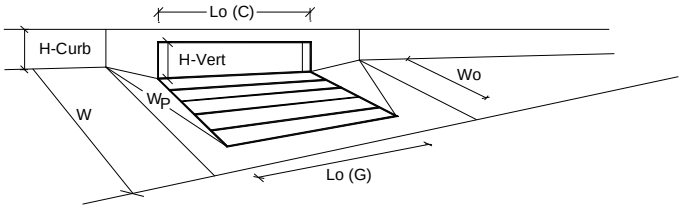
MINOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: 6th Ave & Federal Blvd Storm Drainage Design

Inlet ID: Slip Ramp - DP24 - Structure 724R



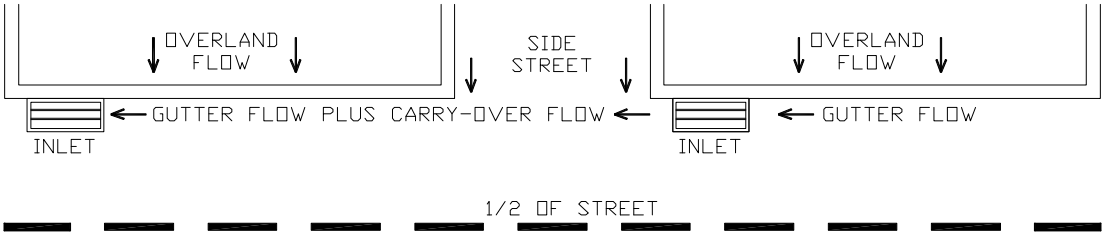
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	2.0	2.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	3.00	3.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	W_o =	1.73	1.73	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	
Street Hydraulics: OK - Q < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	**Q_o =**	**0.80**	**2.60**	**cfs**
Water Spread Width	T =	2.1	6.2	ft
Water Depth at Flowline (outside of local depression)	d =	2.1	3.0	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 =	1.000	0.808	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.00	0.50	cfs
Discharge within the Gutter Section W	Q_w =	0.80	2.10	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.18	0.51	sq ft
Street Flow Velocity	V_s =	4.53	5.10	fps
Water Depth for Design Condition	d_{LOCAL} =	4.1	5.0	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	3.00	3.00	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	0.978	0.762	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =	7.11	7.11	fps
Interception Rate of Frontal Flow	R_f =	1.00	1.00	
Interception Rate of Side Flow	R_x =	0.10	0.08	
Interception Capacity	Q_i =	0.78	2.03	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =	1.00	1.00	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	0.50	0.50	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	1.50	1.50	ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =	5.13	5.13	fps
Interception Rate of Frontal Flow	R_f =	1.00	1.00	
Interception Rate of Side Flow	R_x =	0.02	0.02	
Actual Interception Capacity	**Q_a =**	**0.78**	**1.99**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**0.02**	**0.61**	**cfs**
Curb or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.1667	0.1385	ft/ft
Required Length L_T to Have 100% Interception	L_T =	1.49	7.52	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	1.48	3.00	ft
Interception Capacity	Q_i =	0.01	0.18	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.10	0.10	
Effective (Unclogged) Length	L_e =	1.48	2.70	ft
Actual Interception Capacity	**Q_a =**	**0.01**	**0.17**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.01**	**0.44**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.79**	**2.16**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.01**	**0.44**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**99.0**	**83.1**	**%**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th Ave & Federal Blvd Storm Drainage Design

South Federal - DP7 - Structure 106R

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):

	Minor Storm	Major Storm	
*Q =	2.90	6.10	cfs

*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)

Site is Urban:	X
Site Is Non-Urban:	

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.00**	**0.00**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

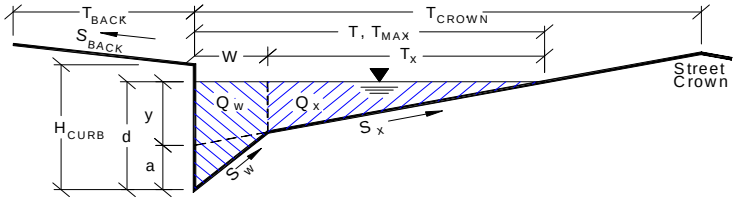
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**2.90**	**6.10**	**cfs**

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

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

Project: **6th Ave & Federal Blvd Storm Drainage Design**

Inlet ID: **South Federal - DP7 - Structure 106R**



Gutter Geometry (Enter data in the blue cells)				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =			ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0130		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	56.0		ft
Gutter Depression	a =	1.52		inches
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.0200		ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0000		ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160		
		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	5.0	56.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0833	0.0833	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	1.20	13.44	inches
Water Depth with a Gutter Depression	d =	2.72	14.96	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	3.0	54.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.890	0.101	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_T - 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
Maximum Flow Based On Allowable Water 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 Gutter Capacity Based on Allowable Gutter Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	0.0	0.0	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (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	**Q =**	**0.0**	**0.0**	**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	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	SUMP	SUMP	
Max Flow Based on Allow. Gutter 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	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

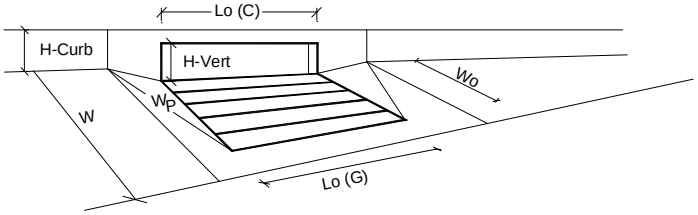
MINOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET IN A SUMP OR SAG LOCATION

Project = **6th Ave & Federal Blvd Storm Drainage Design**

Inlet ID = **South Federal - DP7 - Structure 106R**



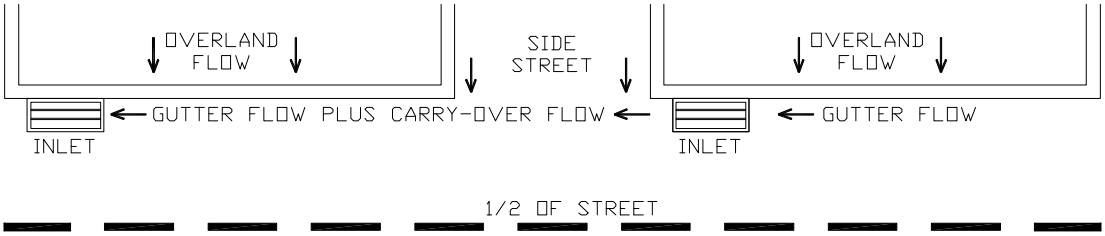
		MINOR	MAJOR	
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 14 Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Grate Information		MINOR	MAJOR	
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
Area Opening 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 3.00)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.67)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	6.00	6.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	5.95	5.95	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.4	63.4	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 2.30-3.00)	C_w (C) =	2.30	2.30	
Curb Opening Orifice Coefficient (typical value 0.67)	C_o (C) =	0.67	0.67	
Resulting Gutter Flow Depth for Grate Inlet Capacity in a Sump		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	N/A	N/A	
Clogging Factor for Multiple Units	Clog =	N/A	N/A	
Grate as a Weir				
Flow Depth at Local Depression without Clogging (0 cfs grate, 2.9 cfs curb)	d_{wi} =	N/A	N/A	inches
This Row Used for Combination Inlets Only	$d_{curb\text{-}un}$ =	N/A	N/A	inches
Flow Depth at Local Depression with Clogging (0 cfs grate, 2.9 cfs curb)	d_{wa} =	N/A	N/A	inches
This Row Used for Combination Inlets Only	$d_{curb\text{-}cl}$ =	N/A	N/A	inches
Grate as an Orifice		MINOR	MAJOR	
Flow Depth at Local Depression without Clogging (0 cfs grate, 2.9 cfs curb)	d_{oi} =	N/A	N/A	inches
Flow Depth at Local Depression with Clogging (0 cfs grate, 2.9 cfs curb)	d_{oa} =	N/A	N/A	inches
Resulting Gutter Flow Depth Outside of Local Depression	**$d_{a\text{-}Grate}$ =**	**N/A**	**N/A**	**inches**
Resulting Gutter Flow Depth for Curb Opening Inlet Capacity in a Sump		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	1.00	1.00	
Clogging Factor for Multiple Units	Clog =	0.10	0.10	
Curb as a Weir, Grate as an Orifice		MINOR	MAJOR	
Flow Depth at Local Depression without Clogging (0 cfs grate, 2.9 cfs curb)	d_{wi} =	3.10	5.09	inches
Flow Depth at Local Depression with Clogging (0 cfs grate, 2.9 cfs curb)	d_{wa} =	3.24	5.31	inches
Curb as an Orifice, Grate as an Orifice		MINOR	MAJOR	
Flow Depth at Local Depression without Clogging (0 cfs grate, 2.9 cfs curb)	d_{oi} =	3.05	4.41	inches
Flow Depth at Local Depression with Clogging (0 cfs grate, 2.9 cfs curb)	d_{oa} =	3.15	4.81	inches
Resulting Gutter Flow Depth Outside of Local Depression	**$d_{a\text{-}Curb}$ =**	**0.24**	**2.31**	**inches**
Resultant Street Conditions		MINOR	MAJOR	
Total Inlet Length	L =	6.0	6.0	feet
Total Inlet Interception Capacity (Design Discharge from ***Q-Peak***)	Q_a =	2.9	6.1	cfs
Resultant Gutter Flow Depth (based on sheet *Q-Allow* geometry)	**d =**	**0.24**	**2.31**	**inches**
Resultant Street Flow Spread (based on sheet *Q-Allow* geometry)	**T =**	**0.2**	**3.3**	**feet**
Resultant Flow Depth at Street Crown	**d_{CROWN} =**	**0.00**	**0.00**	**inches**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th Ave & Federal Blvd Storm Drainage Design

South Federal - DP5 - Structure 509L

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):

	Minor Storm	Major Storm	
*Q =	4.70	5.60	cfs

*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)			Slope (ft/ft)	Length (ft)
Site is Urban:	X	Overland Flow =		
Site Is Non-Urban:		Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.14**	**2.24**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

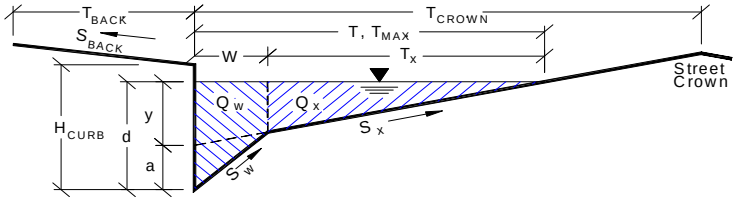
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**4.84**	**7.84**	**cfs**

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

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

Project: **6th Ave & Federal Blvd Storm Drainage Design**

Inlet ID: **South Federal - DP5 - Structure 509L**



Gutter Geometry (Enter data in the blue cells)				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =			ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0130		
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 Depression	a =	1.52		inches
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.0200		ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0000		ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160		
		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	5.0	28.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0833	0.0833	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	1.20	6.72	inches
Water Depth with a Gutter Depression	d =	2.72	8.24	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	3.0	26.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.890	0.209	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_T - 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
Maximum Flow Based On Allowable Water 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 Gutter Capacity Based on Allowable Gutter Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	0.0	0.0	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (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	**Q =**	**0.0**	**0.0**	**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	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	SUMP	SUMP	
Max Flow Based on Allow. Gutter 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	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

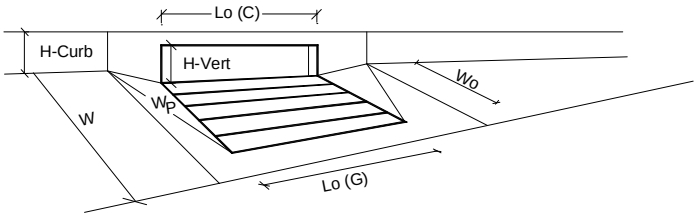
MINOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET IN A SUMP OR SAG LOCATION

Project = **6th Ave & Federal Blvd Storm Drainage Design**

Inlet ID = **South Federal - DP5 - Structure 509L**



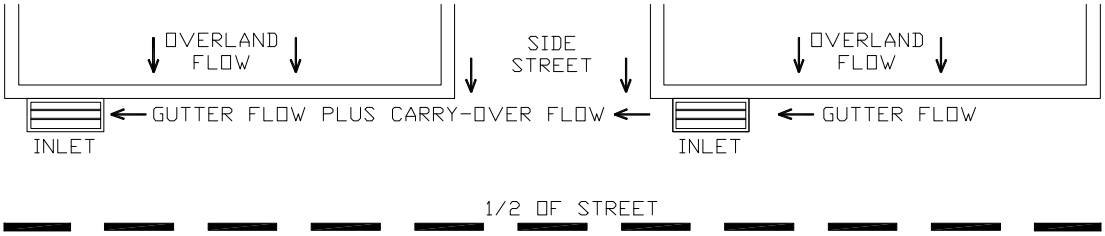
		MINOR	MAJOR	
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Grate Information		MINOR	MAJOR	
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening 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 3.00)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.67)	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} =	5.95	5.95	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.4	63.4	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 2.30-3.00)	C_w (C) =	2.30	2.30	
Curb Opening Orifice Coefficient (typical value 0.67)	C_o (C) =	0.67	0.67	
Resulting Gutter Flow Depth for Grate Inlet Capacity in a Sump		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	N/A	N/A	
Clogging Factor for Multiple Units	Clog =	N/A	N/A	
Grate as a Weir				
Flow Depth at Local Depression without Clogging (0 cfs grate, 4.84 cfs curb)	d_{wi} =	N/A	N/A	inches
This Row Used for Combination Inlets Only	$d_{curb\text{-}un}$ =	N/A	N/A	inches
Flow Depth at Local Depression with Clogging (0 cfs grate, 4.84 cfs curb)	d_{wa} =	N/A	N/A	inches
This Row Used for Combination Inlets Only	$d_{curb\text{-}cl}$ =	N/A	N/A	inches
Grate as an Orifice		MINOR	MAJOR	
Flow Depth at Local Depression without Clogging (0 cfs grate, 4.84 cfs curb)	d_{oi} =	N/A	N/A	inches
Flow Depth at Local Depression with Clogging (0 cfs grate, 4.84 cfs curb)	d_{oa} =	N/A	N/A	inches
Resulting Gutter Flow Depth Outside of Local Depression	**$d_{a\text{-}Grate}$ =**	**N/A**	**N/A**	**inches**
Resulting Gutter Flow Depth for Curb Opening Inlet Capacity in a Sump		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	1.00	1.00	
Clogging Factor for Multiple Units	Clog =	0.10	0.10	
Curb as a Weir, Grate as an Orifice		MINOR	MAJOR	
Flow Depth at Local Depression without Clogging (0 cfs grate, 4.84 cfs curb)	d_{wi} =	3.46	4.77	inches
Flow Depth at Local Depression with Clogging (0 cfs grate, 4.84 cfs curb)	d_{wa} =	3.64	5.02	inches
Curb as an Orifice, Grate as an Orifice		MINOR	MAJOR	
Flow Depth at Local Depression without Clogging (0 cfs grate, 4.84 cfs curb)	d_{oi} =	3.06	3.70	inches
Flow Depth at Local Depression with Clogging (0 cfs grate, 4.84 cfs curb)	d_{oa} =	3.15	3.94	inches
Resulting Gutter Flow Depth Outside of Local Depression	**$d_{a\text{-}Curb}$ =**	**0.64**	**2.02**	**inches**
Resultant Street Conditions		MINOR	MAJOR	
Total Inlet Length	L =	10.0	10.0	feet
Total Inlet Interception Capacity (Design Discharge from ***Q-Peak***)	Q_a =	4.8	7.8	cfs
Resultant Gutter Flow Depth (based on sheet *Q-Allow* geometry)	**d =**	**0.64**	**2.02**	**inches**
Resultant Street Flow Spread (based on sheet *Q-Allow* geometry)	**T =**	**0.6**	**2.1**	**feet**
Resultant Flow Depth at Street Crown	**d_{CROWN} =**	**0.00**	**0.00**	**inches**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th Ave & Federal Blvd Storm Drainage Design

South Federal - DP1 - Structure 906L

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):

	Minor Storm	Major Storm	
*Q =	3.00	6.10	cfs

*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)

Site is Urban:	X
Site Is Non-Urban:	

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.79**	**0.79**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

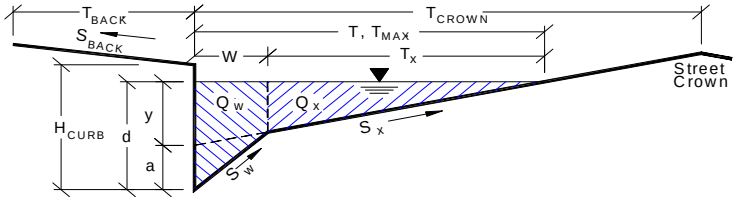
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**3.79**	**6.89**	**cfs**

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

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

Project: **6th Ave & Federal Blvd Storm Drainage Design**

Inlet ID: **South Federal - DP1 - Structure 906L**



Gutter Geometry (Enter data in the blue cells)			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0130	
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 Depression	a =	1.52	inches
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.0200	ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0100	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	18.0	18.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0833	0.0833	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	4.32	4.32	inches
Water Depth with a Gutter Depression	d =	5.84	5.84	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	16.0	16.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.331	0.331	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	8.4	8.4	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	4.1	4.1	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Water Spread	**Q_T =**	**12.5**	**12.5**	**cfs**
Flow Velocity Within the Gutter Section	V =	5.1	5.1	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.5	2.5	

Maximum Gutter Capacity Based on Allowable Gutter Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	9.3	107.6	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	9.3	78.1	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	4.4	16.2	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**13.7**	**94.2**	**cfs**
Flow Velocity Within the Gutter Section	V =	5.2	8.8	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.6	8.8	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	1.00	1.00	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**13.7**	**94.2**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	12.00	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.16	6.16	inches

		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**12.5**	**12.5**	**cfs**

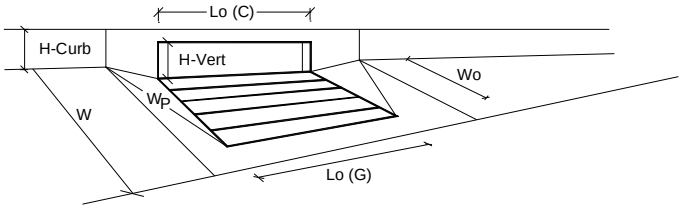
MINOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: 6th Ave & Federal Blvd Storm Drainage Design

Inlet ID: South Federal - DP1 - Structure 906L



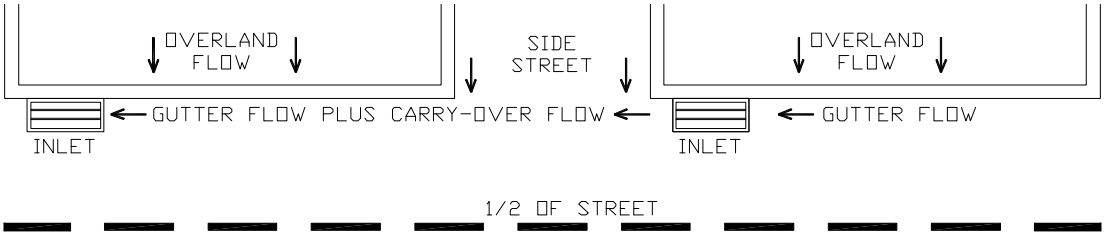
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	2.0	2.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	3	3	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	3.00	3.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	W_o =	1.73	1.73	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	
Street Hydraulics: OK - Q < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	Q_o =	**3.79**	**6.89**	**cfs**
Water Spread Width	T =	10.9	14.1	ft
Water Depth at Flowline (outside of local depression)	d =	4.1	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 =	0.536	0.422	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	1.76	3.99	cfs
Discharge within the Gutter Section W	Q_w =	2.03	2.91	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	1.32	2.12	sq ft
Street Flow Velocity	V_s =	2.88	3.26	fps
Water Depth for Design Condition	d_{LOCAL} =	6.1	6.9	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	9.00	9.00	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	0.494	0.385	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =	47.19	47.19	fps
Interception Rate of Frontal Flow	R_f =	1.00	1.00	
Interception Rate of Side Flow	R_x =	0.76	0.71	
Interception Capacity	Q_i =	3.32	5.68	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =	1.75	1.75	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	0.29	0.29	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	6.37	6.37	ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =	16.84	16.84	fps
Interception Rate of Frontal Flow	R_f =	1.00	1.00	
Interception Rate of Side Flow	R_x =	0.58	0.53	
Actual Interception Capacity	Q_a =	**2.99**	**4.90**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	Q_b =	**0.80**	**1.99**	**cfs**
Curb or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.0987	0.0819	ft/ft
Required Length L_T to Have 100% Interception	L_T =	6.57	10.80	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	6.56	9.00	ft
Interception Capacity	Q_i =	0.40	0.96	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	1.31	1.31	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.04	0.04	
Effective (Unclogged) Length	L_e =	6.56	8.61	ft
Actual Interception Capacity	Q_a =	**0.40**	**0.94**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	Q_b =	**0.40**	**1.05**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	**3.39**	**5.84**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	**0.40**	**1.05**	**cfs**
Capture Percentage = Q_a/Q_o =	C% =	**89.5**	**84.7**	**%**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th Ave & Federal Blvd Storm Drainage Design

South Federal - DP1 - Structure 906L (A)

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):

	Minor Storm	Major Storm	
*Q =	0.00	0.00	cfs

*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)

Site is Urban:	X
Site Is Non-Urban:	

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.40**	**1.05**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

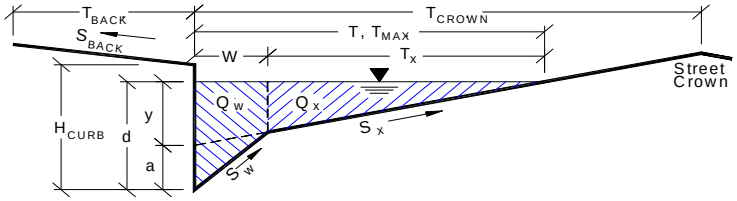
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**0.40**	**1.05**	**cfs**

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

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

Project: **6th Ave & Federal Blvd Storm Drainage Design**

Inlet ID: **South Federal - DP1 - Structure 906L (A)**



Gutter Geometry (Enter data in the blue cells)			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0130	
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 Depression	a =	1.52	inches
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.0200	ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0100	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	18.0	18.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0833	0.0833	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	4.32	4.32	inches
Water Depth with a Gutter Depression	d =	5.84	5.84	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	16.0	16.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.331	0.331	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	8.4	8.4	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	4.1	4.1	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Water Spread	**Q_T =**	**12.5**	**12.5**	**cfs**
Flow Velocity Within the Gutter Section	V =	5.1	5.1	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.5	2.5	

Maximum Gutter Capacity Based on Allowable Gutter Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	9.3	107.6	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	9.3	78.1	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	4.4	16.2	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**13.7**	**94.2**	**cfs**
Flow Velocity Within the Gutter Section	V =	5.2	8.8	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.6	8.8	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	1.00	1.00	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**13.7**	**94.2**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	12.00	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.16	6.16	inches

		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**12.5**	**12.5**	**cfs**

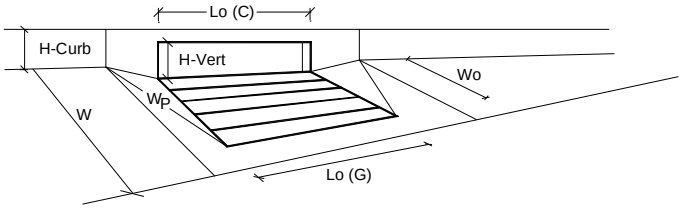
MINOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: 6th Ave & Federal Blvd Storm Drainage Design

Inlet ID: South Federal - DP1 - Structure 906L (A)



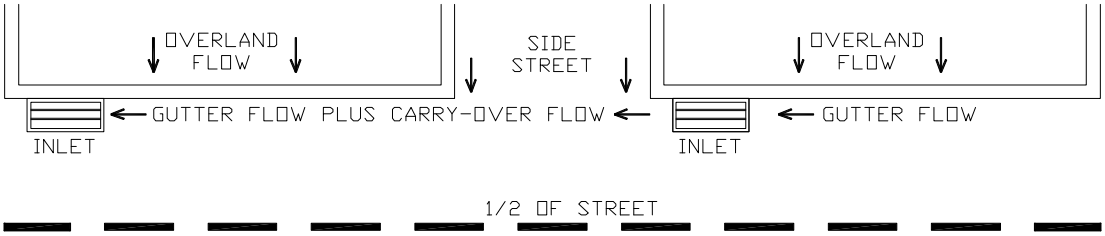
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	2.0	2.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	3.00	3.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	W_o =	1.73	1.73	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	
Street Hydraulics: OK - Q < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	**Q_o =**	**0.40**	**1.05**	**cfs**
Water Spread Width	T =	2.1	5.7	ft
Water Depth at Flowline (outside of local depression)	d =	2.1	2.9	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 =	1.000	0.846	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.00	0.16	cfs
Discharge within the Gutter Section W	Q_w =	0.40	0.89	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.19	0.45	sq ft
Street Flow Velocity	V_s =	2.17	2.37	fps
Water Depth for Design Condition	d_{LOCAL} =	4.1	4.9	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	3.00	3.00	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	0.976	0.800	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =	7.11	7.11	fps
Interception Rate of Frontal Flow	R_f =	1.00	1.00	
Interception Rate of Side Flow	R_x =	0.29	0.26	
Interception Capacity	Q_i =	0.39	0.89	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =	1.00	1.00	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	0.50	0.50	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	1.50	1.50	ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =	5.13	5.13	fps
Interception Rate of Frontal Flow	R_f =	1.00	1.00	
Interception Rate of Side Flow	R_x =	0.08	0.07	
Actual Interception Capacity	**Q_a =**	**0.39**	**0.85**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**0.01**	**0.20**	**cfs**
Curb or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.1667	0.1440	ft/ft
Required Length L_T to Have 100% Interception	L_T =	0.73	2.91	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	0.72	2.90	ft
Interception Capacity	Q_i =	0.00	0.10	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.10	0.10	
Effective (Unclogged) Length	L_e =	0.72	2.70	ft
Actual Interception Capacity	**Q_a =**	**0.00**	**0.10**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.00**	**0.10**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.40**	**0.95**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.00**	**0.10**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**99.1**	**90.2**	**%**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th Ave & Federal Blvd Storm Drainage Design

South Federal - DP3 - Structure 906R

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):

	Minor Storm	Major Storm	
*Q =	1.20	3.10	cfs

*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)

Site is Urban:	X
Site Is Non-Urban:	

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.00**	**0.00**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

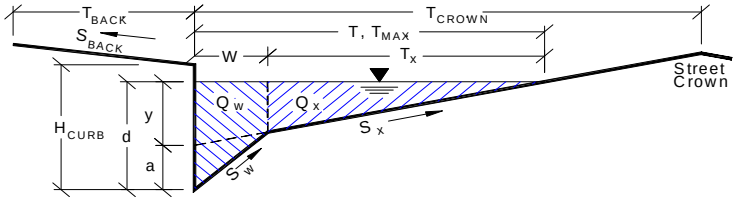
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**1.20**	**3.10**	**cfs**

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

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

Project: **6th Ave & Federal Blvd Storm Drainage Design**

Inlet ID: **South Federal - DP3 - Structure 906R**



Gutter Geometry (Enter data in the blue cells)				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =			ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0130		
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 Depression	a =	1.52		inches
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.0200		ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0100		ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160		
		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	18.0	18.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0833	0.0833	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	4.32	4.32	inches
Water Depth with a Gutter Depression	d =	5.84	5.84	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	16.0	16.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.331	0.331	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	8.4	8.4	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	4.1	4.1	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Water Spread	**Q_T =**	**12.5**	**12.5**	**cfs**
Flow Velocity Within the Gutter Section	V =	5.1	5.1	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.5	2.5	

Maximum Gutter Capacity Based on Allowable Gutter Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	9.3	107.6	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	9.3	78.1	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	4.4	16.2	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**13.7**	**94.2**	**cfs**
Flow Velocity Within the Gutter Section	V =	5.2	8.8	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.6	8.8	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	1.00	1.00	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**13.7**	**94.2**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	12.00	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.16	6.16	inches
		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**12.5**	**12.5**	**cfs**

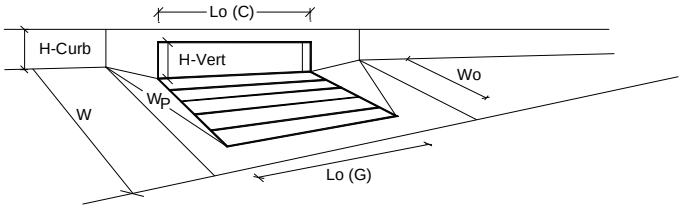
MINOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: 6th Ave & Federal Blvd Storm Drainage Design

Inlet ID: South Federal - DP3 - Structure 906R



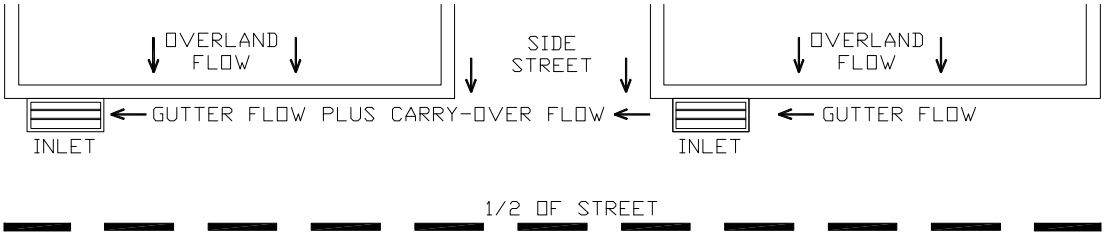
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 14 Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	6.00	6.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	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 < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	Q_o =	**1.20**	**3.10**	**cfs**
Water Spread Width	T =	6.1	10.0	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 =	0.813	0.580	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.22	1.30	cfs
Discharge within the Gutter Section W	Q_w =	0.98	1.80	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.50	1.12	sq ft
Street Flow Velocity	V_s =	2.40	2.77	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 =			ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =			
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
Interception Capacity	Q_i =			cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =			
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =			
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =			ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
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 or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.1731	0.1293	ft/ft
Required Length L_T to Have 100% Interception	L_T =	5.57	9.89	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	5.56	6.00	ft
Interception Capacity	Q_i =	1.20	2.52	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.10	0.10	
Effective (Unclogged) Length	L_e =	5.40	5.40	ft
Actual Interception Capacity	Q_a =	**1.20**	**2.35**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	Q_b =	**0.00**	**0.75**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	**1.20**	**2.35**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	**0.00**	**0.75**	**cfs**
Capture Percentage = Q_a/Q_o =	C% =	**99.8**	**75.9**	**%**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th Ave & Federal Blvd Storm Drainage Design

South Federal - DP6 (Existing)

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):

	Minor Storm	Major Storm	
*Q =	1.20	5.30	cfs

*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)

Site is Urban:	X
Site Is Non-Urban:	

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.00**	**0.00**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

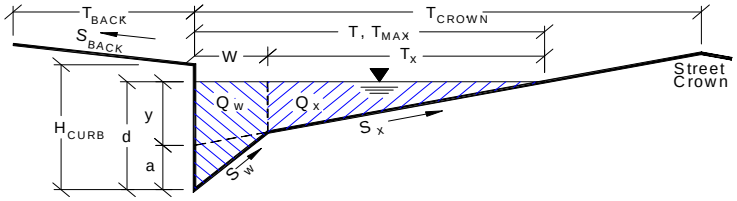
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**1.20**	**5.30**	**cfs**

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

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

Project: **6th Ave & Federal Blvd Storm Drainage Design**

Inlet ID: **South Federal - DP6 (Existing)**



Gutter Geometry (Enter data in the blue cells)				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =			ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0130		
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 Depression	a =	1.52		inches
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.0250		ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0054		ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160		
		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	6.0	28.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0883	0.0883	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	1.80	8.40	inches
Water Depth with a Gutter Depression	d =	3.32	9.92	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	4.0	26.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.799	0.203	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.2	32.6	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	0.9	8.3	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Water Spread	**Q_T =**	**1.1**	**40.9**	**cfs**
Flow Velocity Within the Gutter Section	V =	2.3	5.6	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.6	4.6	

Maximum Gutter Capacity Based on Allowable Gutter Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	14.9	34.9	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	12.9	32.9	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.383	0.161	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	5.1	61.3	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	5.1	60.3	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	3.2	11.8	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**8.2**	**72.1**	**cfs**
Flow Velocity Within the Gutter Section	V =	3.8	6.5	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	1.9	6.5	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d ≥ 6") Storm	R =	1.00	1.00	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**8.2**	**72.1**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	12.01	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	2.09	inches
		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**1.1**	**40.9**	**cfs**

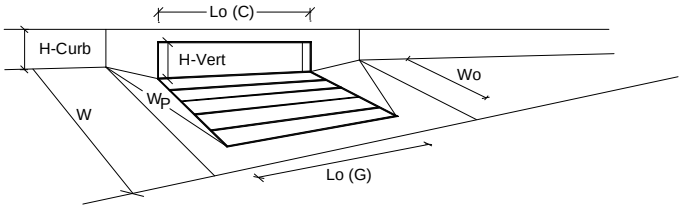
WARNING: MINOR STORM max. allowable capacity is less than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: 6th Ave & Federal Blvd Storm Drainage Design

Inlet ID: South Federal - DP6 (Existing)



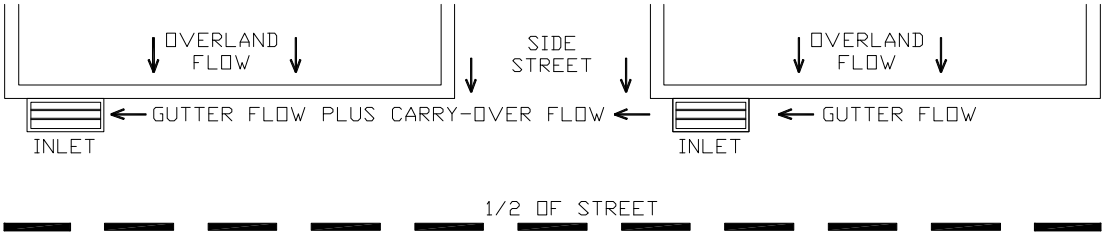
	Design Information (Input)		MINOR	MAJOR	
	Type of Inlet	Type =	Denver No. 16 Combination		
	Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	2.0	2.0	inches
	Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
	Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	3.00	3.00	ft
	Width of a Unit Grate (cannot be greater than W from Q-Allow)	W_o =	1.73	1.73	ft
	Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	0.50	0.50	
	Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	
Warning	**Street Hydraulics: WARNING: Q > ALLOWABLE Q FOR MINOR STORM'**		MINOR	MAJOR	
	Design Discharge for Half of Street (from Sheet *Q-Peak*)	**Q_o =**	**1.20**	**5.30**	**cfs**
	Water Spread Width	T =	6.3	12.5	ft
	Water Depth at Flowline (outside of local depression)	d =	3.4	5.3	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 =	0.779	0.455	
	Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.27	2.89	cfs
	Discharge within the Gutter Section W	Q_w =	0.94	2.42	cfs
	Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
	Street Flow Area	A_s =	0.62	2.07	sq ft
	Street Flow Velocity	V_s =	1.94	2.56	fps
	Water Depth for Design Condition	d_{LOCAL} =	5.4	7.3	inches
	Grate Analysis (Calculated)		MINOR	MAJOR	
	Total Length of Inlet Grate Opening	L =	3.00	3.00	ft
	Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	0.730	0.415	
	Under No-Clogging Condition		MINOR	MAJOR	
	Minimum Velocity Where Grate Spash-Over Begins	V_o =	7.11	7.11	fps
	Interception Rate of Frontal Flow	R_f =	1.00	1.00	
	Interception Rate of Side Flow	R_x =	0.39	0.28	
	Interception Capacity	Q_i =	1.00	3.06	cfs
	Under Clogging Condition		MINOR	MAJOR	
	Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =	1.00	1.00	
	Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	0.50	0.50	
	Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	1.50	1.50	ft
	Minimum Velocity Where Grate Spash-Over Begins	V_o =	5.13	5.13	fps
	Interception Rate of Frontal Flow	R_f =	1.00	1.00	
	Interception Rate of Side Flow	R_x =	0.11	0.07	
	Actual Interception Capacity	**Q_a =**	**0.91**	**2.42**	**cfs**
	Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**0.29**	**2.88**	**cfs**
	Curb or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
	Equivalent Slope S_e (based on grate carry-over)	S_e =	0.1393	0.0918	ft/ft
	Required Length L_T to Have 100% Interception	L_T =	2.89	9.78	ft
	Under No-Clogging Condition		MINOR	MAJOR	
	Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	2.88	3.00	ft
	Interception Capacity	Q_i =	0.14	0.69	cfs
	Under Clogging Condition		MINOR	MAJOR	
	Clogging Coefficient	CurbCoef =	1.00	1.00	
	Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.10	0.10	
	Effective (Unclogged) Length	L_e =	2.70	2.70	ft
	Actual Interception Capacity	**Q_a =**	**0.14**	**0.63**	**cfs**
	Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.14**	**2.24**	**cfs**
	Summary		MINOR	MAJOR	
	Total Inlet Interception Capacity	**Q =**	**1.06**	**3.06**	**cfs**
	Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.14**	**2.24**	**cfs**
	Capture Percentage = Q_a/Q_o =	**C% =**	**88.0**	**57.7**	**%**

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

6th and Federal

Wilson DP 20 w/ additonal flow from north of Short Place

Design Flow = Gutter Flow + Carry-over Flow



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):
*** If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)**

	Minor Storm	Major Storm	
***Q =**	**2.50**	**3.00**	**cfs**

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site: (Check One Box Only)	
Site is Urban:	X
Site Is Non-Urban:	

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.00**	**0.00**	**cfs**

Analysis of Flow Time (Time of Concentration) for a Catchment:

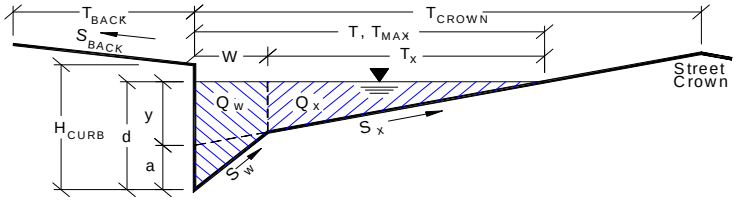
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	N/A	N/A	
Calculated 5-yr. Runoff Coefficient, C5 =	N/A	N/A	
Overland Flow Velocity, V_O =	N/A	N/A	fps
Gutter Flow Velocity, V_G =	N/A	N/A	fps
Overland Flow Time, t_O =	N/A	N/A	minutes
Gutter Flow Time, t_G =	N/A	N/A	minutes
Calculated Time of Concentration, T_c =	N/A	N/A	minutes
Time of Concentration by Regional Formula, T_c =	N/A	N/A	minutes
Recommended T_c =	N/A	N/A	minutes
Time of Concentration Selected by User, T_c =	**N/A**	**N/A**	**minutes**
Design Rainfall Intensity, I =	N/A	N/A	inch/hr
Calculated Local Peak Flow, Q_p =	N/A	N/A	cfs
Total Design Peak Flow, Q =	**2.50**	**3.00**	**cfs**

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

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

Project: **6th and Federal**

Inlet ID: **Wilson DP 20 w/ additonal flow from north of Short Place**



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0150	
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 Depression	a =	1.52	inches
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.0200	ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0072	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0160	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	18.7	34.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	12.00	inches
Allow Flow Depth at Street Crown (leave blank for no)				X = yes

Maximum Gutter Capacity Based On Allowable Water Spread		Minor Storm	Major Storm	
Gutter Cross Slope (Eq. ST-8)	S_W =	0.0833	0.0833	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	4.49	8.16	inches
Water Depth with a Gutter Depression	d =	6.01	9.68	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	16.7	32.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.318	0.170	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	8.0	45.2	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	3.7	9.3	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Water Spread	**Q_T =**	**11.7**	**54.4**	**cfs**
Flow Velocity Within the Gutter Section	V =	4.5	6.4	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.2	5.2	

Maximum Gutter Capacity Based on Allowable Gutter Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	7.9	91.3	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	7.9	89.5	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	3.7	13.7	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**11.6**	**103.2**	**cfs**
Flow Velocity Within the Gutter Section	V =	4.5	7.5	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.2	7.5	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	1.00	1.00	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**11.6**	**103.2**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	12.00	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	2.32	inches

		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**11.6**	**54.4**	**cfs**

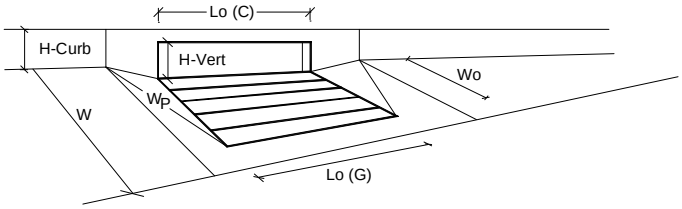
MINOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

MAJOR STORM max. allowable capacity OK - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: 6th and Federal

Inlet ID: Wilson DP 20 w/ additonal flow from north of Short Place

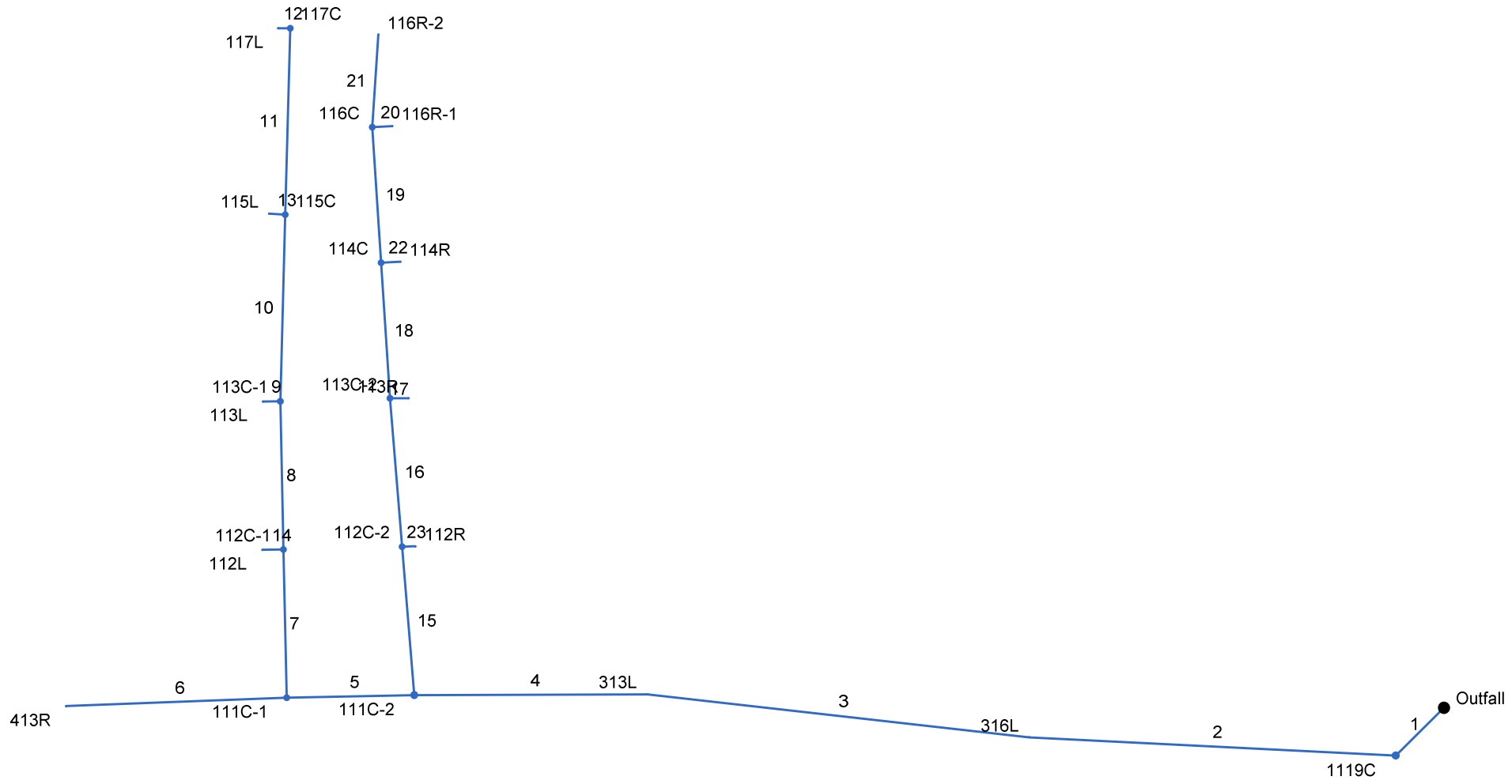


Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 14 Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	6.00	6.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	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 < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	**Q_o =**	**2.50**	**3.00**	**cfs**
Water Spread Width	T =	9.7	10.6	ft
Water Depth at Flowline (outside of local depression)	d =	3.9	4.1	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 =	0.591	0.551	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	1.02	1.35	cfs
Discharge within the Gutter Section W	Q_w =	1.48	1.66	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	1.07	1.25	sq ft
Street Flow Velocity	V_s =	2.33	2.41	fps
Water Depth for Design Condition	d_{LOCAL} =	6.9	7.1	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =			ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =			
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
Interception Capacity	Q_i =			cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =			
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =			
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =			ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =			fps
Interception Rate of Frontal Flow	R_f =			
Interception Rate of Side Flow	R_x =			
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 or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.1314	0.1237	ft/ft
Required Length L_T to Have 100% Interception	L_T =	8.11	9.07	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	6.00	6.00	ft
Interception Capacity	Q_i =	2.28	2.57	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.10	0.10	
Effective (Unclogged) Length	L_e =	5.40	5.40	ft
Actual Interception Capacity	**Q_a =**	**2.15**	**2.41**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.35**	**0.59**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**2.15**	**2.41**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.35**	**0.59**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**86.1**	**80.4**	**%**

APPENDIX E

Storm Sewer Analysis

US6 & Fed North Storm Sewer



Project File: Federal North System 5YR 112210.stm	Number of lines: 23	Date: 1/3/2011

Storm Sewers v8.00

Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data								Line ID
	Dnstr line No.	Line length (ft)	Defl angle (deg)	Junc type	Known Q (cfs)	Drng area (ac)	Runoff coeff (C)	Inlet time (min)	Invert El Dn (ft)	Line slope (%)	Invert El Up (ft)	Line size (in)	Line shape	N value (n)	J-loss coeff (K)	Inlet/ Rim El (ft)	
1	End	60.123	134.424	MH	17.40	0.00	0.00	0.0	5203.94	5.72	5207.38	36	Cir	0.012	0.79	5223.46	Pipe - NE Ramp (1)
2	1	319.854	48.508	Genr	17.70	0.00	0.00	0.0	5214.98	4.36	5228.94	36	Cir	0.012	0.50	5234.90	Pipe - NE Ramp (2)
3	2	334.732	3.698	Genr	17.10	0.00	0.00	0.0	5229.14	3.77	5241.76	36	Cir	0.012	0.50	5250.93	Pipe - NE Ramp (3)
4	3	203.299	-6.797	MH	15.00	0.00	0.00	0.0	5241.77	0.50	5242.78	36	Cir	0.012	1.00	5257.37	Pipe - NE Ramp (4)
5	4	111.252	-1.042	MH	5.60	0.00	0.00	0.0	5243.78	0.50	5244.34	24	Cir	0.012	1.00	5257.38	Pipe - Under Feder
6	5	192.296	-1.074	Genr	2.70	0.00	0.00	0.0	5249.05	0.50	5250.02	18	Cir	0.012	1.00	5255.38	Pipe - NW Ramp
7	5	133.310	90.013	MH	3.40	0.00	0.00	0.0	5244.84	0.50	5245.50	18	Cir	0.012	1.00	5254.52	Pipe - NW Federal
8	7	133.310	0.000	MH	2.70	0.00	0.00	0.0	5245.70	0.49	5246.36	18	Cir	0.012	1.00	5253.33	Pipe - NW Federal
9	8	15.095	-89.991	Genr	1.10	0.00	0.00	0.0	5247.25	3.18	5247.73	18	Cir	0.012	1.00	5253.49	Pipe - NW Federal
10	8	167.732	2.669	MH	1.70	0.00	0.00	0.0	5246.55	0.49	5247.38	18	Cir	0.012	1.00	5253.07	Pipe - NW Federal
11	10	167.732	0.000	MH	0.90	0.00	0.00	0.0	5247.58	0.50	5248.42	18	Cir	0.012	1.00	5251.92	Pipe - NW Federal
12	11	10.392	-91.987	Genr	0.90	0.00	0.00	0.0	5248.62	0.96	5248.72	18	Cir	0.012	1.00	5252.12	Pipe - NW Federal
13	10	14.016	-87.628	Genr	0.90	0.00	0.00	0.0	5247.58	3.42	5248.06	18	Cir	0.012	1.00	5253.26	Pipe - NW Federal
14	7	18.321	-90.000	Genr	0.90	0.00	0.00	0.0	5247.13	9.50	5248.87	18	Cir	0.012	1.00	5254.62	Pipe - NW Federal
15	4	133.810	85.611	MH	10.40	0.00	0.00	0.0	5243.78	0.97	5245.08	24	Cir	0.012	1.00	5254.56	Pipe - NE Federal
16	15	133.810	0.000	MH	9.70	0.00	0.00	0.0	5245.28	0.50	5245.95	24	Cir	0.012	1.00	5253.54	Pipe - NE Federal
17	16	16.198	94.557	Genr	3.50	0.00	0.00	0.0	5246.65	6.30	5247.67	18	Cir	0.012	1.00	5253.69	Pipe - NE Federal
18	16	122.213	0.939	MH	6.60	0.00	0.00	0.0	5246.15	0.50	5246.76	24	Cir	0.012	1.00	5253.23	Pipe - NE Federal
19	18	122.213	0.000	MH	4.70	0.00	0.00	0.0	5247.26	0.50	5247.87	18	Cir	0.012	1.00	5252.89	Pipe - NE Federal
20	19	17.361	91.121	Genr	3.50	0.00	0.00	0.0	5248.07	0.98	5248.24	18	Cir	0.012	1.00	5252.99	Pipe - NE Federal
21	19	83.288	7.257	Genr	1.30	0.00	0.00	0.0	5248.07	1.01	5248.91	18	Cir	0.012	1.00	5252.40	Pipe - NE Federal
22	18	16.719	90.236	Genr	2.10	0.00	0.00	0.0	5247.46	2.99	5247.96	18	Cir	0.012	1.00	5253.37	Pipe - NE Federal
23	15	11.355	92.730	Genr	1.00	0.00	0.00	0.0	5248.25	7.04	5249.05	18	Cir	0.012	1.00	5254.80	PPipe - NE Federal

US6 & Fed North Storm Sewer | Number of lines: 23 | Date: 11-22-2010

Structure Report

Struct No.	Structure ID	Junction Type	Rim Elev. (ft)	Structure			Line Out			Line In		
				Shape	Length (ft)	Width (ft)	Size (in)	Shape	Invert (ft)	Size (in)	Shape	Invert (ft)
1	1119C	Manhole	5223.46	Cir	5.00	5.00	36	Cir	5207.38	36	Cir	5214.98
2	316L	Generic	5234.90	Rect	0.38	0.83	36	Cir	5228.94	36	Cir	5229.14
3	313L	Generic	5250.93	Rect	0.38	0.42	36	Cir	5241.76	36	Cir	5241.77
4	111C-2	Manhole	5257.37	Cir	5.00	5.00	36	Cir	5242.78	24 24	Cir Cir	5243.78 5243.78
5	111C-1	Manhole	5257.38	Cir	4.00	4.00	24	Cir	5244.34	18 18	Cir Cir	5249.05 5244.84
6	413R	Generic	5255.38	Rect	0.38	0.50	18	Cir	5250.02			
7	112C-1	Manhole	5254.52	Cir	4.00	4.00	18	Cir	5245.50	18 18	Cir Cir	5245.70 5247.13
8	113C-1	Manhole	5253.33	Cir	4.00	4.00	18	Cir	5246.36	18 18	Cir Cir	5247.25 5246.55
9	113L	Generic	5253.49	Rect	0.38	0.50	18	Cir	5247.73			
10	115C	Manhole	5253.07	Cir	4.00	4.00	18	Cir	5247.38	18 18	Cir Cir	5247.58 5247.58
11	117C	Manhole	5251.92	Cir	4.00	4.00	18	Cir	5248.42	18	Cir	5248.62
12	117L	Generic	5252.12	Rect	0.38	0.50	18	Cir	5248.72			
13	115L	Generic	5253.26	Rect	0.38	0.50	18	Cir	5248.06			
14	112L	Generic	5254.62	Rect	0.38	0.50	18	Cir	5248.87			
15	112C-2	Manhole	5254.56	Cir	4.00	4.00	24	Cir	5245.08	24 18	Cir Cir	5245.28 5248.25
16	113C-2	Manhole	5253.54	Cir	4.00	4.00	24	Cir	5245.95	18 24	Cir Cir	5246.65 5246.15
17	113R	Generic	5253.69	Rect	0.38	0.50	18	Cir	5247.67			
18	114C	Manhole	5253.23	Cir	4.00	4.00	24	Cir	5246.76	18 18	Cir Cir	5247.26 5247.46
19	116C	Manhole	5252.89	Cir	4.00	4.00	18	Cir	5247.87	18 18	Cir Cir	5248.07 5248.07

US6 & Fed North Storm Sewer | Number of Structures: 23 | Run Date: 11-22-2010

Structure Report

Struct No.	Structure ID	Junction Type	Rim Elev. (ft)	Structure			Line Out			Line In		
				Shape	Length (ft)	Width (ft)	Size (in)	Shape	Invert (ft)	Size (in)	Shape	Invert (ft)
20	116R-1	Generic	5252.99	Rect	0.38	0.50	18	Cir	5248.24			
21	116R-2	Generic	5252.40	Rect	0.38	0.50	18	Cir	5248.91			
22	114R	Generic	5253.37	Rect	0.38	0.50	18	Cir	5247.96			
23	112R	Generic	5254.80	Rect	0.38	0.50	18	Cir	5249.05			

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line slope (%)	HGL down (ft)	HGL up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns line No.	Junction Type
1	Pipe - NE Ramp (1)	17.40	36	Cir	60.123	5203.94	5207.38	5.721	5205.27	5208.71	0.41	5208.71	End	Manhole
2	Pipe - NE Ramp (2)	17.70	36	Cir	319.854	5214.98	5228.94	4.364	5215.67	5230.28	n/a	5230.28	1	Generic
3	Pipe - NE Ramp (3)	17.10	36	Cir	334.732	5229.14	5241.76	3.770	5230.71	5243.08	n/a	5243.08 j	2	Generic
4	Pipe - NE Ramp (4)	15.00	36	Cir	203.299	5241.77	5242.78	0.497	5243.52	5244.01	n/a	5244.01 j	3	Manhole
5	Pipe - Under Federal	5.60	24	Cir	111.252	5243.78	5244.34	0.503	5244.56	5245.18	0.31	5245.18	4	Manhole
6	Pipe - NW Ramp	2.70	18	Cir	192.296	5249.05	5250.02	0.505	5249.65	5250.65	n/a	5250.65	5	Generic
7	Pipe - NW Federal (1)	3.40	18	Cir	133.310	5244.84	5245.50	0.495	5245.52	5246.21	0.27	5246.48	5	Manhole
8	Pipe - NW Federal (2)	2.70	18	Cir	133.310	5245.70	5246.36	0.495	5246.71	5246.99	n/a	5246.99 j	7	Manhole
9	Pipe - NW Federal (113L)	1.10	18	Cir	15.095	5247.25	5247.73	3.180	5247.49	5248.26	0.06	5248.32	8	Generic
10	Pipe - NW Federal (3)	1.70	18	Cir	167.732	5246.55	5247.38	0.495	5247.20	5247.88	n/a	5247.88 j	8	Manhole
11	Pipe - NW Federal (4)	0.90	18	Cir	167.732	5247.58	5248.42	0.501	5248.05	5248.78	n/a	5248.78 j	10	Manhole
12	Pipe - NW Federal (117L)	0.90	18	Cir	10.392	5248.62	5248.72	0.963	5248.91	5249.09	0.11	5249.20	11	Generic
13	Pipe - NW Federal (115L)	0.90	18	Cir	14.016	5247.58	5248.06	3.424	5248.05	5248.42	n/a	5248.42 j	10	Generic
14	Pipe - NW Federal (112L)	0.90	18	Cir	18.321	5247.13	5248.87	9.498	5247.30	5249.24	0.11	5249.35	7	Generic
15	Pipe - NE Federal (1)	10.40	24	Cir	133.810	5243.78	5245.08	0.972	5244.70	5246.22	n/a	5246.22	4	Manhole
16	Pipe - NE Federal (2)	9.70	24	Cir	133.810	5245.28	5245.95	0.501	5246.56	5247.05	n/a	5247.05 j	15	Manhole
17	Pipe - NE Federal (113R)	3.50	18	Cir	16.198	5246.65	5247.67	6.297	5247.46	5248.38	n/a	5248.38 j	16	Generic
18	Pipe - NE Federal (3)	6.60	24	Cir	122.213	5246.15	5246.76	0.499	5247.45	5247.67	n/a	5247.67 j	16	Manhole
19	Pipe - NE Federal (4)	4.70	18	Cir	122.213	5247.26	5247.87	0.499	5248.08	5248.70	0.34	5249.04	18	Manhole
20	Pipe - NE Federal (116R-1)	3.50	18	Cir	17.361	5248.07	5248.24	0.982	5249.26	5249.24	0.12	5249.36	19	Generic
21	Pipe - NE Federal (116R-2)	1.30	18	Cir	83.288	5248.07	5248.91	1.009	5249.37	5249.39	0.11	5249.50	19	Generic
22	Pipe - NE Federal (114R)	2.10	18	Cir	16.719	5247.46	5247.96	2.991	5248.00	5248.51	0.20	5248.51	18	Generic
23	PPipe - NE Federal (112R)	1.00	18	Cir	11.355	5248.25	5249.05	7.043	5248.44	5249.78	0.02	5249.80	15	Generic

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NOTES: Return period = 5 Yrs. ; j - Line contains hyd. jump.

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q byp (cfs)	Junc type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp line No
							Ht (in)	L (ft)	area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	1119C	17.40*	91.30	0.00	108.70	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
2	316L	17.70*	74.80	1.20	91.30	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	1
3	313L	17.10*	60.70	3.00	74.80	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	2
4	111C-2	15.00*	45.70	0.00	60.70	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	3
5	111C-1	5.60*	8.70	0.00	14.30	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	4
6	413R	2.70*	0.00	2.70	0.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	5
7	112C-1	3.40*	5.30	0.00	8.70	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	5
8	113C-1	2.70*	2.60	0.00	5.30	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	7
9	113L	1.10*	0.00	1.10	0.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	8
10	115C	1.70*	0.90	0.00	2.60	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	8
11	117C	0.90*	0.00	0.00	0.90	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	10
12	117L	0.90*	0.00	0.90	0.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	11
13	115L	0.90*	0.00	0.90	0.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	10
14	112L	0.90*	0.00	0.90	0.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	7
15	112C-2	10.40*	21.00	0.00	31.40	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	4
16	113C-2	9.70*	11.30	0.00	21.00	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	15
17	113R	3.50*	0.00	3.50	0.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	16
18	114C	6.60*	4.70	0.00	11.30	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	16
19	116C	4.70*	0.00	0.00	4.70	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	18
20	116R-1	3.50*	0.00	3.50	0.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	19
21	116R-2	1.30*	0.00	1.30	0.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	19
22	114R	2.10*	0.00	2.10	0.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	18
23	112R	1.00*	0.00	1.00	0.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	15

US6 & Fed North Storm Sewer | Number of lines: 23 | Run Date: 11-22-2010

NOTES: Inlet N-Values = 0.016 ; Intensity = 79.26 / (Inlet time + 14.60) ^ 0.84; Return period = 5 Yrs. ; * Indicates Known Q added. All curb inlets are Horiz throat.

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
	(in)	(cfs)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	(ft)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)	(K)	(ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1	36	17.40	5203.94	5205.27	1.33	3.02	5.75	0.51	5205.78	0.353	60.123	5207.38	5208.71	1.33**	3.02	5.75	0.51	5209.22	0.353	0.353	n/a	0.79	0.41
2	36	17.70	5214.98	5215.67	0.69*	1.24	14.30	3.18	5218.85	4.362	319.854	5228.94	5230.28	1.34**	3.06	5.79	0.52	5230.80	0.354	2.358	n/a	0.50	n/a
3	36	17.10	5229.14	5230.71	1.57	3.75	4.56	0.32	5231.04	0.192	334.732	5241.76	5243.08 j	1.32**	2.99	5.72	0.51	5243.59	0.352	0.272	n/a	0.50	n/a
4	36	15.00	5241.77	5243.52	1.75	4.27	3.51	0.19	5243.71	0.105	203.299	5242.78	5244.01 j	1.23**	2.74	5.47	0.47	5244.48	0.342	0.224	n/a	1.00	n/a
5	24	5.60	5243.78	5244.56	0.78*	1.14	4.93	0.38	5244.94	0.503	111.252	5244.34	5245.18	0.84**	1.25	4.49	0.31	5245.49	0.388	0.446	n/a	1.00	0.31
6	18	2.70	5249.05	5249.65	0.60*	0.66	4.11	0.26	5249.91	0.503	192.296	5250.02	5250.65	0.63**	0.70	3.86	0.23	5250.88	0.422	0.463	n/a	1.00	n/a
7	18	3.40	5244.84	5245.52	0.68*	0.78	4.34	0.29	5245.82	0.495	133.310	5245.50	5246.21	0.71**	0.82	4.15	0.27	5246.48	0.437	0.466	0.621	1.00	0.27
8	18	2.70	5245.70	5246.71	1.01	1.26	2.14	0.07	5246.78	0.090	133.310	5246.36	5246.99 j	0.63**	0.70	3.86	0.23	5247.22	0.422	0.256	n/a	1.00	n/a
9	18	1.10	5247.25	5247.49	0.24*	0.18	6.13	0.58	5248.07	3.179	15.095	5247.73	5248.26	0.53	0.56	1.96	0.06	5248.32	0.129	1.654	0.250	1.00	0.06
10	18	1.70	5246.55	5247.20	0.65	0.74	2.30	0.08	5247.29	0.144	167.732	5247.38	5247.88 j	0.50**	0.51	3.32	0.17	5248.05	0.396	0.270	n/a	1.00	n/a
11	18	0.90	5247.58	5248.05	0.46	0.47	1.93	0.06	5248.10	0.144	167.732	5248.42	5248.78 j	0.36**	0.33	2.74	0.12	5248.90	0.383	0.264	n/a	1.00	0.12
12	18	0.90	5248.62	5248.91	0.29*	0.24	3.79	0.22	5249.13	0.963	10.392	5248.72	5249.09	0.37**	0.34	2.67	0.11	5249.20	0.358	0.660	0.069	1.00	0.11
13	18	0.90	5247.58	5248.05	0.46	0.47	1.93	0.06	5248.10	0.144	14.016	5248.06	5248.42 j	0.36**	0.33	2.74	0.12	5248.54	0.383	0.264	n/a	1.00	0.12
14	18	0.90	5247.13	5247.30	0.17*	0.11	8.47	1.12	5248.41	9.507	18.321	5248.87	5249.24	0.37**	0.33	2.70	0.11	5249.35	0.370	4.939	0.905	1.00	0.11
15	24	10.40	5243.78	5244.70	0.92*	1.41	7.40	0.85	5245.55	0.970	133.810	5245.08	5246.22	1.14**	1.85	5.61	0.49	5246.71	0.465	0.718	n/a	1.00	n/a
16	24	9.70	5245.28	5246.56	1.28	2.13	4.55	0.32	5246.89	0.284	133.810	5245.95	5247.05 j	1.10**	1.78	5.46	0.46	5247.52	0.453	0.369	n/a	1.00	n/a
17	18	3.50	5246.65	5247.46	0.81	0.97	3.62	0.20	5247.66	0.298	16.198	5247.67	5248.38 j	0.71**	0.83	4.22	0.28	5248.66	0.448	0.373	n/a	1.00	n/a
18	24	6.60	5246.15	5247.45	1.30	2.16	3.06	0.15	5247.59	0.127	122.213	5246.76	5247.67 j	0.91**	1.39	4.75	0.35	5248.02	0.402	0.265	n/a	1.00	n/a
19	18	4.70	5247.26	5248.08	0.82*	0.99	4.72	0.35	5248.43	0.499	122.213	5247.87	5248.70	0.83**	1.01	4.68	0.34	5249.04	0.486	0.492	0.602	1.00	0.34
20	18	3.50	5248.07	5249.26	1.19	1.50	2.34	0.08	5249.34	0.101	17.361	5248.24	5249.24	1.00	1.25	2.79	0.12	5249.36	0.153	0.127	0.022	1.00	0.12
21	18	1.30	5248.07	5249.37	1.30	1.63	0.80	0.01	5249.38	0.012	83.288	5248.91	5249.39	0.48	0.48	2.69	0.11	5249.50	0.273	0.142	0.119	1.00	0.11
22	18	2.10	5247.46	5248.00	0.54	0.57	3.69	0.21	5248.21	0.451	16.719	5247.96	5248.51	0.55**	0.59	3.55	0.20	5248.71	0.405	0.428	n/a	1.00	0.20

US6 & Fed North Storm Sewer | Number of lines: 23 | Run Date: 11-22-2010

Notes: * Normal depth assumed.; ** Critical depth.; j-Line contains hyd. jump. ; c = cir e = ellip b = box

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
	(in)	(cfs)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	(ft)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)	(K)	(ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
23	18	1.00	5248.25	5248.44	0.19*	0.13	7.87	0.96	5249.40	7.049	11.355	5249.05	5249.78	0.73	0.86	1.17	0.02	5249.80	0.034	3.541	0.402	1.00	0.02

US6 & Fed North Storm Sewer | Number of lines: 23 | Run Date: 11-22-2010

Notes: * Normal depth assumed.; ** Critical depth.; j-Line contains hyd. jump. ; c = cir e = ellip b = box

Hydraflow HGL Computation Procedure

General Procedure: Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

Col. 21 The average of the downstream and upstream friction slopes.

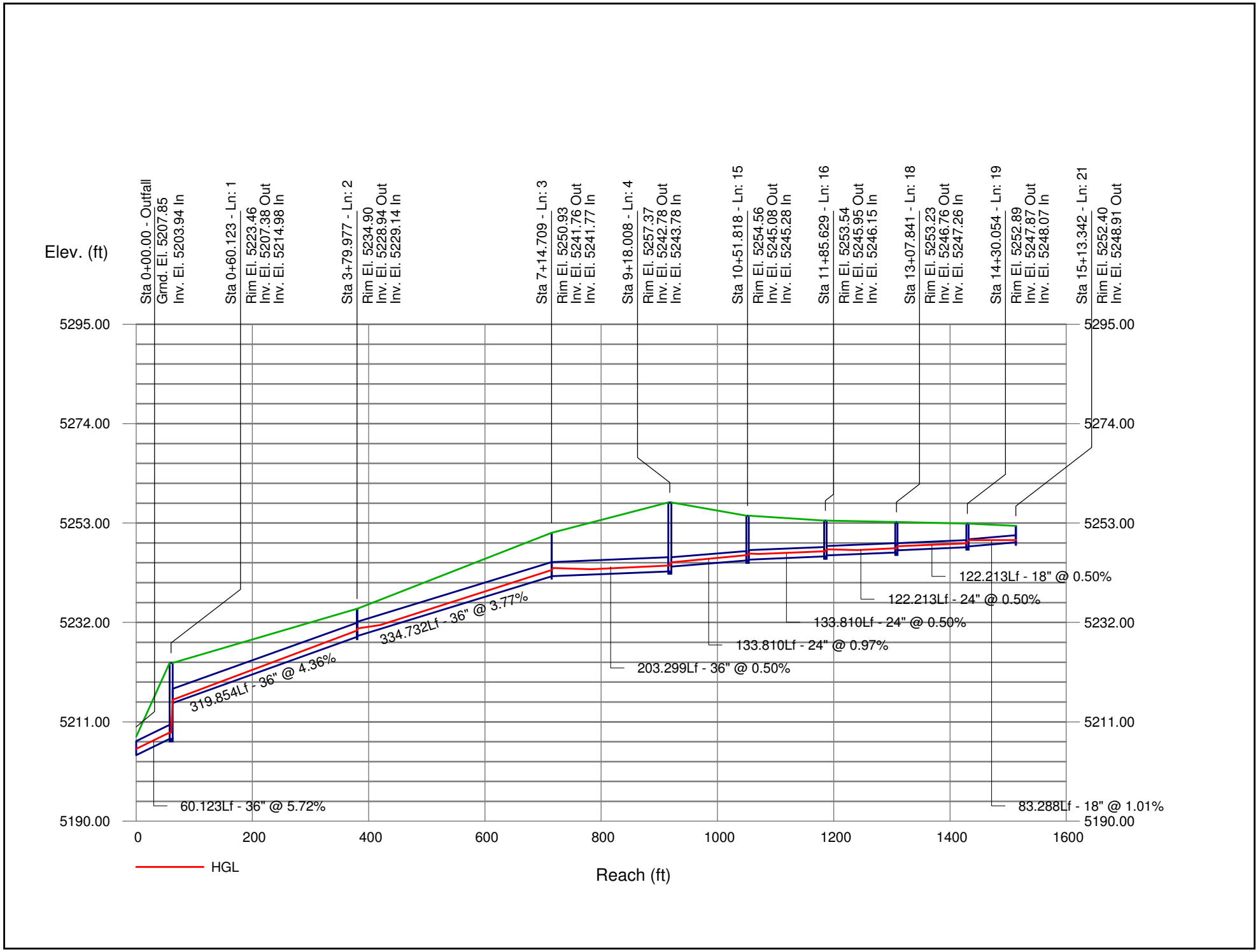
Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

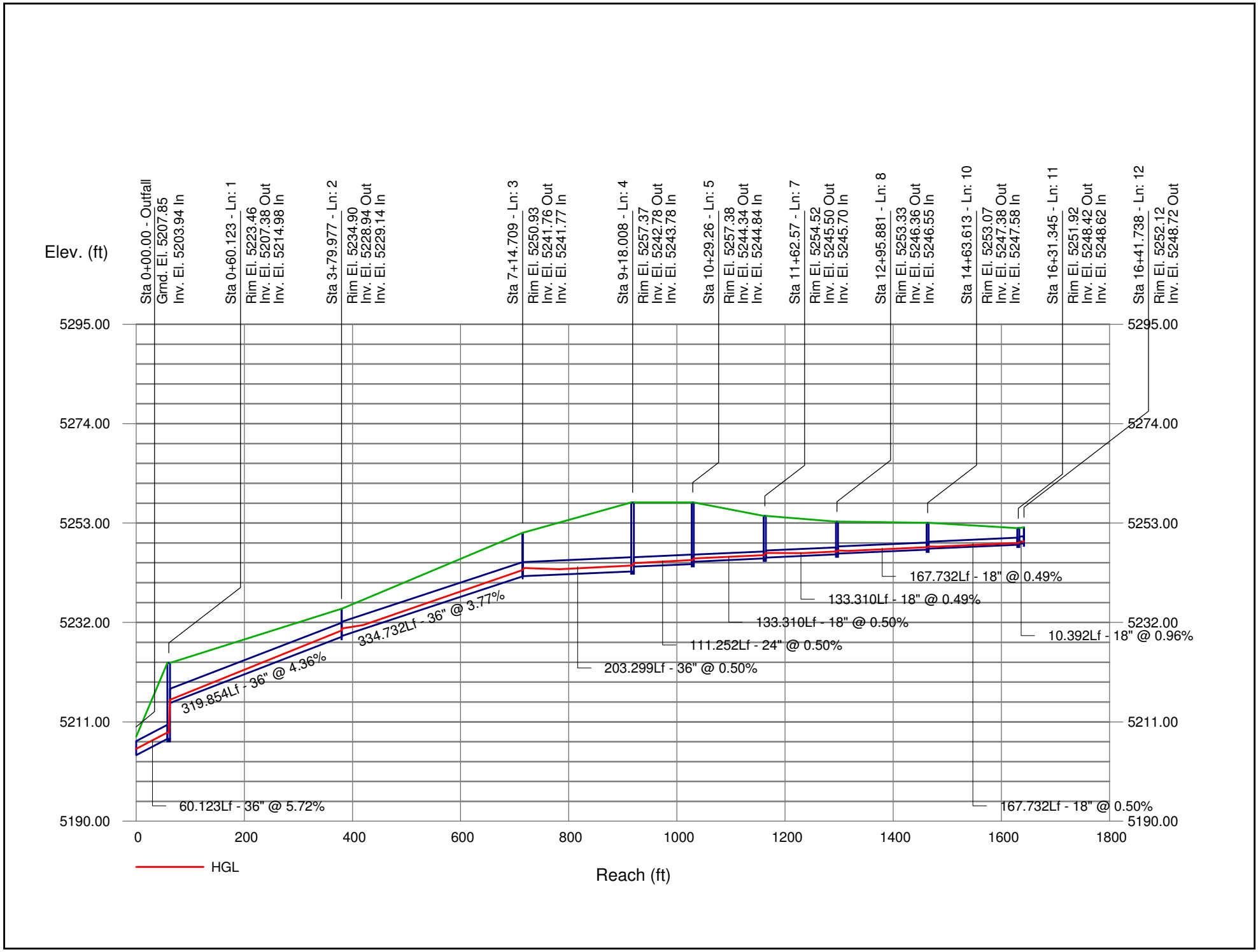
Storm Sewer Profile

Proj. file: Federal North System 112210.stm



Storm Sewer Profile

Proj. file: Federal North System 112210.stm



Storm Sewer Profile

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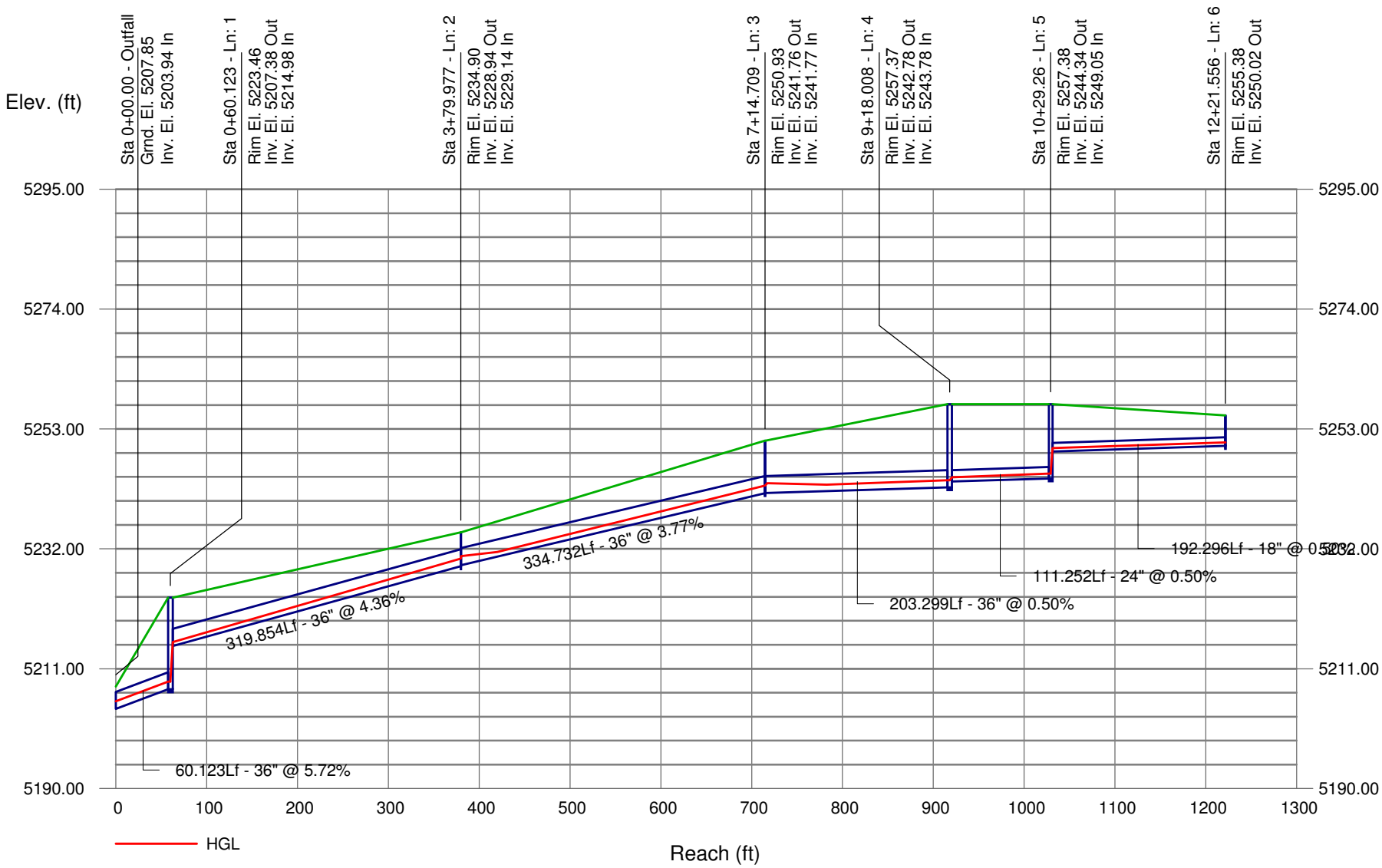
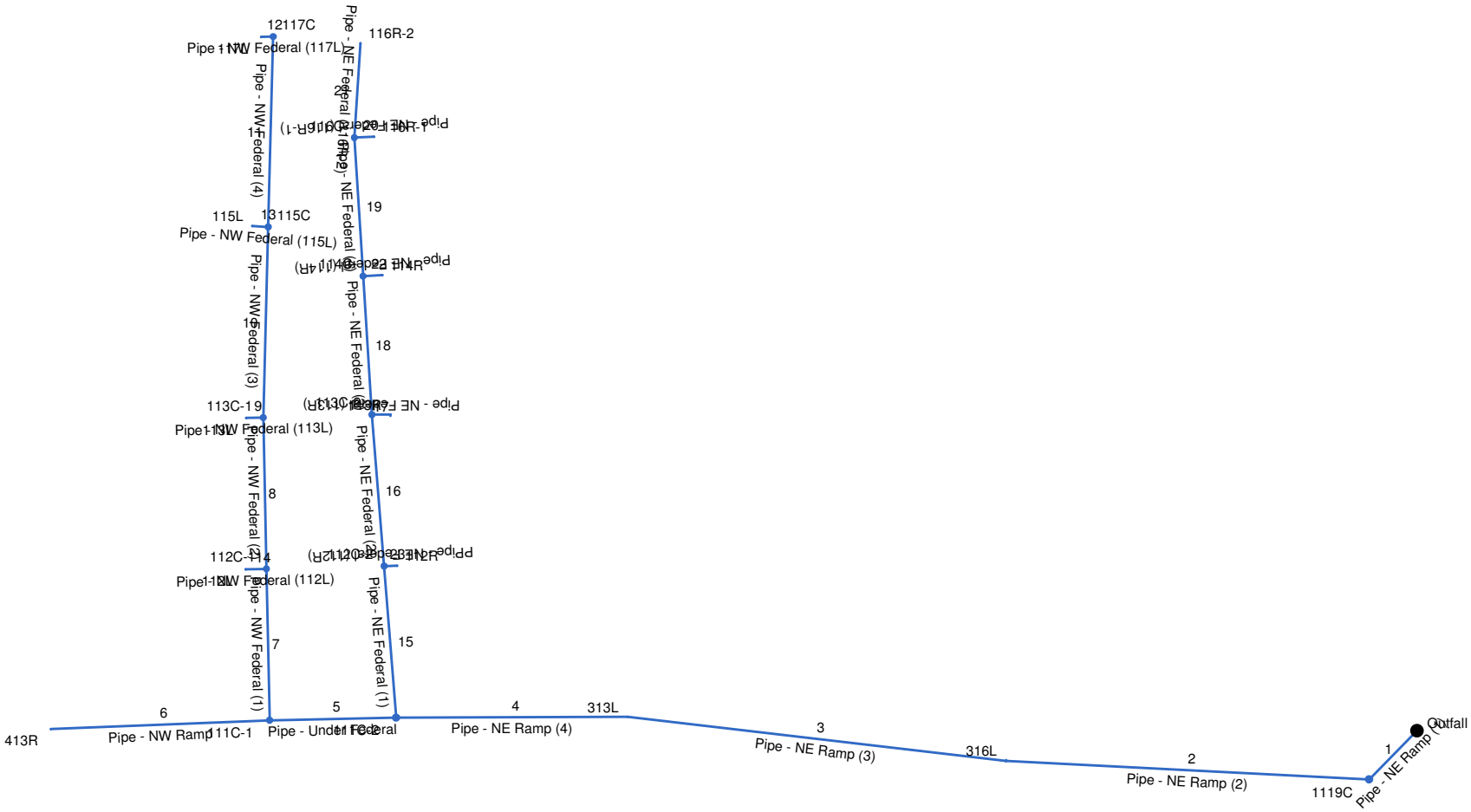


US6 & Fed North Storm Sewer



Project File: Federal North System 5YR 112210.stm	Number of lines: 23	Date: 11-22-2010

Hydraflow Storm Sewers Extension v6.052

Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data								Line ID
	Dnstr line No.	Line length (ft)	Defl angle (deg)	Junc type	Known Q (cfs)	Drng area (ac)	Runoff coeff (C)	Inlet time (min)	Invert El Dn (ft)	Line slope (%)	Invert El Up (ft)	Line size (in)	Line shape	N value (n)	J-loss coeff (K)	Inlet/ Rim El (ft)	
1	End	60.123	134.424	MH	32.90	0.00	0.00	0.0	5203.94	5.72	5207.38	36	Cir	0.012	0.79	5223.46	Pipe - NE Ramp (1)
2	1	319.854	48.508	Genr	33.40	0.00	0.00	0.0	5214.98	4.36	5228.94	36	Cir	0.012	0.50	5234.90	Pipe - NE Ramp (2)
3	2	334.732	3.698	Genr	31.80	0.00	0.00	0.0	5229.14	3.77	5241.76	36	Cir	0.012	0.50	5250.93	Pipe - NE Ramp (3)
4	3	203.299	-6.797	MH	28.10	0.00	0.00	0.0	5241.77	0.50	5242.78	36	Cir	0.012	1.00	5257.37	Pipe - NE Ramp (4)
5	4	111.252	-1.042	MH	10.60	0.00	0.00	0.0	5243.78	0.50	5244.34	24	Cir	0.012	1.00	5257.38	Pipe - Under Feder
6	5	192.296	-1.074	Genr	5.00	0.00	0.00	0.0	5249.05	0.50	5250.02	18	Cir	0.012	1.00	5255.38	Pipe - NW Ramp
7	5	133.310	90.013	MH	6.50	0.00	0.00	0.0	5244.84	0.50	5245.50	18	Cir	0.012	1.00	5254.52	Pipe - NW Federal
8	7	133.310	0.000	MH	5.30	0.00	0.00	0.0	5245.70	0.49	5246.36	18	Cir	0.012	1.00	5253.33	Pipe - NW Federal
9	8	15.095	-89.991	Genr	2.00	0.00	0.00	0.0	5247.25	3.18	5247.73	18	Cir	0.012	1.00	5253.49	Pipe - NW Federal
10	8	167.732	2.669	MH	3.60	0.00	0.00	0.0	5246.55	0.49	5247.38	18	Cir	0.012	1.00	5253.07	Pipe - NW Federal
11	10	167.732	0.000	MH	1.90	0.00	0.00	0.0	5247.58	0.50	5248.42	18	Cir	0.012	1.00	5251.92	Pipe - NW Federal
12	11	10.392	-91.987	Genr	1.90	0.00	0.00	0.0	5248.62	0.96	5248.72	18	Cir	0.012	1.00	5252.12	Pipe - NW Federal
13	10	14.016	-87.628	Genr	1.90	0.00	0.00	0.0	5247.58	3.42	5248.06	18	Cir	0.012	1.00	5253.26	Pipe - NW Federal
14	7	18.321	-90.000	Genr	1.60	0.00	0.00	0.0	5247.13	9.50	5248.87	18	Cir	0.012	1.00	5254.62	Pipe - NW Federal
15	4	133.810	85.611	MH	19.20	0.00	0.00	0.0	5243.78	0.97	5245.08	24	Cir	0.012	1.00	5254.56	Pipe - NE Federal
16	15	133.810	0.000	MH	18.00	0.00	0.00	0.0	5245.28	0.50	5245.95	24	Cir	0.012	1.00	5253.54	Pipe - NE Federal
17	16	16.198	94.557	Genr	6.60	0.00	0.00	0.0	5246.65	6.30	5247.67	18	Cir	0.012	1.00	5253.69	Pipe - NE Federal
18	16	122.213	0.939	MH	12.10	0.00	0.00	0.0	5246.15	0.50	5246.76	24	Cir	0.012	1.00	5253.23	Pipe - NE Federal
19	18	122.213	0.000	MH	8.60	0.00	0.00	0.0	5247.26	0.50	5247.87	18	Cir	0.012	1.00	5252.89	Pipe - NE Federal
20	19	17.361	91.121	Genr	6.50	0.00	0.00	0.0	5248.07	0.98	5248.24	18	Cir	0.012	1.00	5252.99	Pipe - NE Federal
21	19	83.288	7.257	Genr	2.30	0.00	0.00	0.0	5248.07	1.01	5248.91	18	Cir	0.012	1.00	5252.40	Pipe - NE Federal
22	18	16.719	90.236	Genr	3.80	0.00	0.00	0.0	5247.46	2.99	5247.96	18	Cir	0.012	1.00	5253.37	Pipe - NE Federal
23	15	11.355	92.730	Genr	1.80	0.00	0.00	0.0	5248.25	7.04	5249.05	18	Cir	0.012	1.00	5254.80	PPipe - NE Federal

US6 & Fed North Storm Sewer | Number of lines: 23 | Date: 11-22-2010

Structure Report

Struct No.	Structure ID	Junction Type	Rim Elev. (ft)	Structure			Line Out			Line In		
				Shape	Length (ft)	Width (ft)	Size (in)	Shape	Invert (ft)	Size (in)	Shape	Invert (ft)
1	1119C	Manhole	5223.46	Cir	5.00	5.00	36	Cir	5207.38	36	Cir	5214.98
2	316L	Generic	5234.90	Rect	0.38	0.83	36	Cir	5228.94	36	Cir	5229.14
3	313L	Generic	5250.93	Rect	0.38	0.42	36	Cir	5241.76	36	Cir	5241.77
4	111C-2	Manhole	5257.37	Cir	5.00	5.00	36	Cir	5242.78	24 24	Cir Cir	5243.78 5243.78
5	111C-1	Manhole	5257.38	Cir	4.00	4.00	24	Cir	5244.34	18 18	Cir Cir	5249.05 5244.84
6	413R	Generic	5255.38	Rect	0.38	0.50	18	Cir	5250.02			
7	112C-1	Manhole	5254.52	Cir	4.00	4.00	18	Cir	5245.50	18 18	Cir Cir	5245.70 5247.13
8	113C-1	Manhole	5253.33	Cir	4.00	4.00	18	Cir	5246.36	18 18	Cir Cir	5247.25 5246.55
9	113L	Generic	5253.49	Rect	0.38	0.50	18	Cir	5247.73			
10	115C	Manhole	5253.07	Cir	4.00	4.00	18	Cir	5247.38	18 18	Cir Cir	5247.58 5247.58
11	117C	Manhole	5251.92	Cir	4.00	4.00	18	Cir	5248.42	18	Cir	5248.62
12	117L	Generic	5252.12	Rect	0.38	0.50	18	Cir	5248.72			
13	115L	Generic	5253.26	Rect	0.38	0.50	18	Cir	5248.06			
14	112L	Generic	5254.62	Rect	0.38	0.50	18	Cir	5248.87			
15	112C-2	Manhole	5254.56	Cir	4.00	4.00	24	Cir	5245.08	24 18	Cir Cir	5245.28 5248.25
16	113C-2	Manhole	5253.54	Cir	4.00	4.00	24	Cir	5245.95	18 24	Cir Cir	5246.65 5246.15
17	113R	Generic	5253.69	Rect	0.38	0.50	18	Cir	5247.67			
18	114C	Manhole	5253.23	Cir	4.00	4.00	24	Cir	5246.76	18 18	Cir Cir	5247.26 5247.46
19	116C	Manhole	5252.89	Cir	4.00	4.00	18	Cir	5247.87	18 18	Cir Cir	5248.07 5248.07

US6 & Fed North Storm Sewer | Number of Structures: 23 | Run Date: 11-22-2010

Structure Report

Struct No.	Structure ID	Junction Type	Rim Elev. (ft)	Structure			Line Out			Line In		
				Shape	Length (ft)	Width (ft)	Size (in)	Shape	Invert (ft)	Size (in)	Shape	Invert (ft)
20	116R-1	Generic	5252.99	Rect	0.38	0.50	18	Cir	5248.24			
21	116R-2	Generic	5252.40	Rect	0.38	0.50	18	Cir	5248.91			
22	114R	Generic	5253.37	Rect	0.38	0.50	18	Cir	5247.96			
23	112R	Generic	5254.80	Rect	0.38	0.50	18	Cir	5249.05			

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line slope (%)	HGL down (ft)	HGL up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns line No.	Junction Type
1	Pipe - NE Ramp (1)	32.90	36	Cir	60.123	5203.94	5207.38	5.721	5205.77	5209.21	n/a	5209.21	End	Manhole
2	Pipe - NE Ramp (2)	33.40	36	Cir	319.854	5214.98	5228.94	4.364	5215.94	5230.78	0.42	5230.78	1	Generic
3	Pipe - NE Ramp (3)	31.80	36	Cir	334.732	5229.14	5241.76	3.770	5231.31	5243.56	n/a	5243.56 j	2	Generic
4	Pipe - NE Ramp (4)	28.10	36	Cir	203.299	5241.77	5242.78	0.497	5244.12	5244.47	n/a	5244.47 j	3	Manhole
5	Pipe - Under Federal	10.60	24	Cir	111.252	5243.78	5244.34	0.503	5245.02	5245.49	0.50	5245.49	4	Manhole
6	Pipe - NW Ramp	5.00	18	Cir	192.296	5249.05	5250.02	0.505	5249.90	5250.88	0.36	5251.23	5	Generic
7	Pipe - NW Federal (1)	6.50	18	Cir	133.310	5244.84	5245.50	0.495	5245.87	5246.53	0.40	5246.92	5	Manhole
8	Pipe - NW Federal (2)	5.30	18	Cir	133.310	5245.70	5246.36	0.495	5247.18	5247.41	0.25	5247.66	7	Manhole
9	Pipe - NW Federal (113L)	2.00	18	Cir	15.095	5247.25	5247.73	3.180	5247.89	5248.27	n/a	5248.27 j	8	Generic
10	Pipe - NW Federal (3)	3.60	18	Cir	167.732	5246.55	5247.38	0.495	5247.85	5248.11	0.28	5248.39	8	Manhole
11	Pipe - NW Federal (4)	1.90	18	Cir	167.732	5247.58	5248.42	0.501	5248.65	5248.95	n/a	5248.95 j	10	Manhole
12	Pipe - NW Federal (117L)	1.90	18	Cir	10.392	5248.62	5248.72	0.963	5249.11	5249.25	n/a	5249.25	11	Generic
13	Pipe - NW Federal (115L)	1.90	18	Cir	14.016	5247.58	5248.06	3.424	5248.65	5248.59	n/a	5248.59 j	10	Generic
14	Pipe - NW Federal (112L)	1.60	18	Cir	18.321	5247.13	5248.87	9.498	5247.35	5249.76	0.03	5249.80	7	Generic
15	Pipe - NE Federal (1)	19.20	24	Cir	133.810	5243.78	5245.08	0.972	5245.13	5246.63	n/a	5246.63	4	Manhole
16	Pipe - NE Federal (2)	18.00	24	Cir	133.810	5245.28	5245.95	0.501	5247.00	5247.67	0.61	5248.28	15	Manhole
17	Pipe - NE Federal (113R)	6.60	18	Cir	16.198	5246.65	5247.67	6.297	5248.67	5248.65	n/a	5248.65	16	Generic
18	Pipe - NE Federal (3)	12.10	24	Cir	122.213	5246.15	5246.76	0.499	5248.66*	5248.96*	0.23	5249.19	16	Manhole
19	Pipe - NE Federal (4)	8.60	18	Cir	122.213	5247.26	5247.87	0.499	5249.19*	5249.89*	0.37	5250.26	18	Manhole
20	Pipe - NE Federal (116R-1)	6.50	18	Cir	17.361	5248.07	5248.24	0.982	5250.41*	5250.47*	0.21	5250.68	19	Generic
21	Pipe - NE Federal (116R-2)	2.30	18	Cir	83.288	5248.07	5248.91	1.009	5250.60*	5250.63*	0.03	5250.66	19	Generic
22	Pipe - NE Federal (114R)	3.80	18	Cir	16.719	5247.46	5247.96	2.991	5249.35	5249.36	0.08	5249.44	18	Generic
23	PPipe - NE Federal (112R)	1.80	18	Cir	11.355	5248.25	5249.05	7.043	5248.50	5250.24	0.02	5250.27	15	Generic

US6 & Fed North Storm Sewer | Number of lines: 23 | Run Date: 11-22-2010

NOTES: Return period = 50 Yrs. ; *Surcharged (HGL above crown). ; j - Line contains hyd. jump.

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q byp (cfs)	Junc type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp line No
							Ht (in)	L (ft)	area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	1119C	32.90*	190.40	0.00	223.30	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
2	316L	33.40*	158.20	1.20	190.40	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	1
3	313L	31.80*	129.40	3.00	158.20	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	2
4	111C-2	28.10*	101.30	0.00	129.40	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	3
5	111C-1	10.60*	23.20	0.00	33.80	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	4
6	413R	5.00*	0.00	2.70	2.30	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	5
7	112C-1	6.50*	14.40	0.00	20.90	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	5
8	113C-1	5.30*	8.40	0.00	13.70	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	7
9	113L	2.00*	0.00	1.10	0.90	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	8
10	115C	3.60*	3.90	0.00	7.50	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	8
11	117C	1.90*	1.00	0.00	2.90	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	10
12	117L	1.90*	0.00	0.90	1.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	11
13	115L	1.90*	0.00	0.90	1.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	10
14	112L	1.60*	0.00	0.90	0.70	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	7
15	112C-2	19.20*	48.30	0.00	67.50	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	4
16	113C-2	18.00*	29.50	0.00	47.50	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	15
17	113R	6.60*	0.00	3.50	3.10	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	16
18	114C	12.10*	14.30	0.00	26.40	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	16
19	116C	8.60*	4.00	0.00	12.60	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	18
20	116R-1	6.50*	0.00	3.50	3.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	19
21	116R-2	2.30*	0.00	1.30	1.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	19
22	114R	3.80*	0.00	2.10	1.70	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	18
23	112R	1.80*	0.00	1.00	0.80	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	15

US6 & Fed North Storm Sewer | Number of lines: 23 | Run Date: 11-22-2010

NOTES: Inlet N-Values = 0.016 ; Intensity = 114.82 / (Inlet time + 17.20) ^ 0.82; Return period = 50 Yrs. ; * Indicates Known Q added. All curb inlets are Horiz throat.

Hydraulic Grade Line Computations

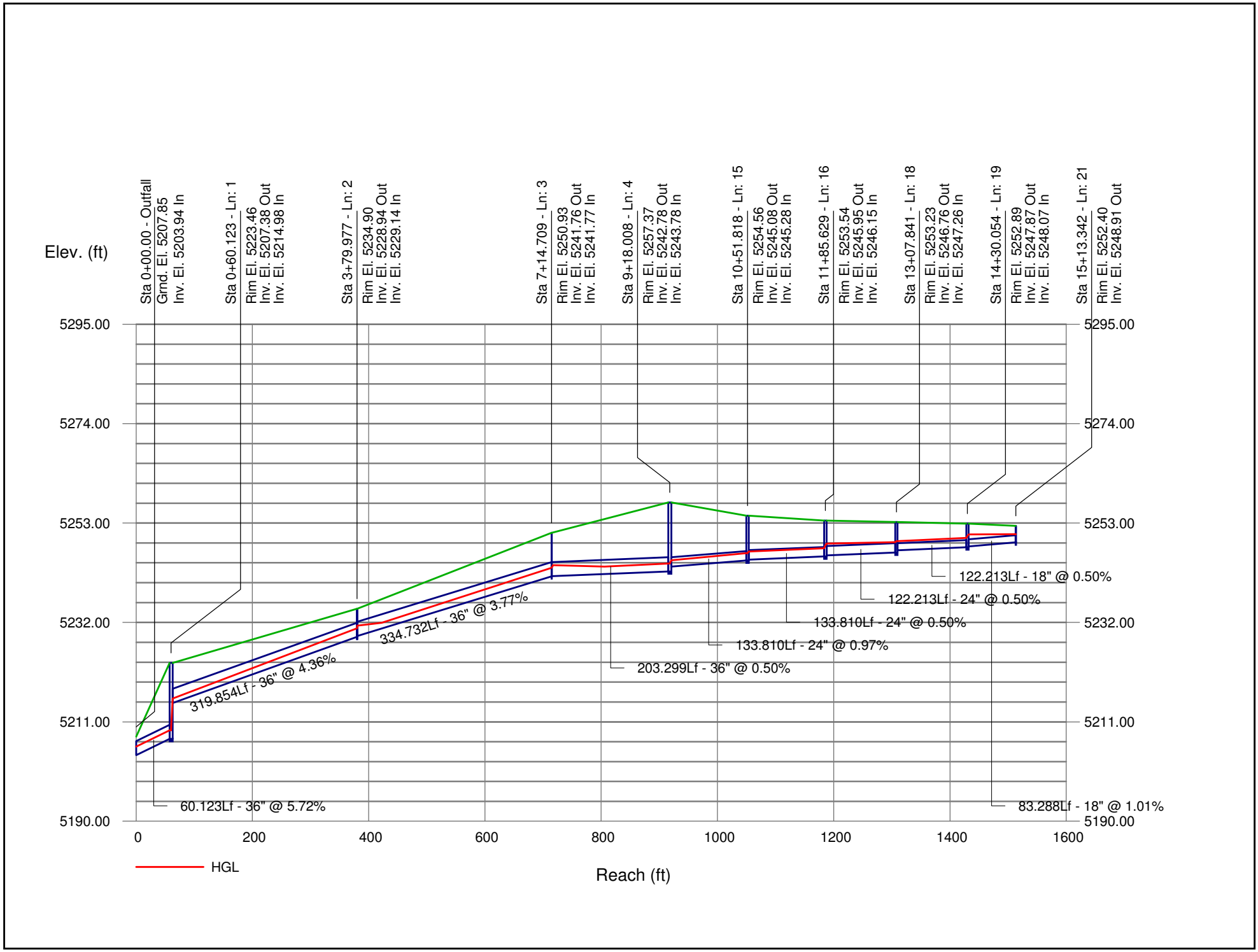
Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
	(in)	(cfs)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	(ft)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)	(K)	(ft)
1	36	32.90	5203.94	5205.77	1.83	4.51	7.29	0.83	5206.60	0.438	60.123	5207.38	5209.21	1.83**	4.51	7.29	0.83	5210.04	0.438	0.438	n/a	0.79	n/a
2	36	33.40	5214.98	5215.94	0.96*	1.95	17.14	4.57	5220.51	4.356	319.854	5228.94	5230.78	1.84**	4.55	7.34	0.84	5231.62	0.441	2.399	n/a	0.50	0.42
3	36	31.80	5229.14	5231.31	2.16	5.46	5.82	0.53	5231.83	0.256	334.732	5241.76	5243.56 j	1.80**	4.42	7.19	0.80	5244.36	0.431	0.343	n/a	0.50	n/a
4	36	28.10	5241.77	5244.12	2.35	5.93	4.74	0.35	5244.47	0.166	203.299	5242.78	5244.47 j	1.69**	4.10	6.85	0.73	5245.20	0.408	0.287	n/a	1.00	n/a
5	24	10.60	5243.78	5245.02	1.24	2.05	5.17	0.42	5245.44	0.374	111.252	5244.34	5245.49	1.15**	1.88	5.65	0.50	5245.99	0.469	0.422	n/a	1.00	0.50
6	18	5.00	5249.05	5249.90	0.85*	1.04	4.81	0.36	5250.26	0.504	192.296	5250.02	5250.88	0.86**	1.04	4.79	0.36	5251.23	0.498	0.501	0.964	1.00	0.36
7	18	6.50	5244.84	5245.87	1.03*	1.29	5.04	0.40	5246.26	0.495	133.310	5245.50	5246.53	1.03	1.29	5.05	0.40	5246.92	0.495	0.495	0.660	1.00	0.40
8	18	5.30	5245.70	5247.18	1.48	1.76	3.01	0.14	5247.32	0.197	133.310	5246.36	5247.41	1.05	1.32	4.02	0.25	5247.66	0.312	0.254	0.339	1.00	0.25
9	18	2.00	5247.25	5247.89	0.64	0.72	2.78	0.12	5248.01	0.215	15.095	5247.73	5248.27 j	0.54**	0.57	3.49	0.19	5248.46	0.403	0.309	n/a	1.00	n/a
10	18	3.60	5246.55	5247.85	1.30	1.62	2.22	0.08	5247.92	0.092	167.732	5247.38	5248.11	0.73**	0.85	4.23	0.28	5248.39	0.444	0.268	0.449	1.00	0.28
11	18	1.90	5247.58	5248.65	1.07	1.34	1.41	0.03	5248.68	0.038	167.732	5248.42	5248.95 j	0.53**	0.55	3.44	0.18	5249.13	0.400	0.219	n/a	1.00	n/a
12	18	1.90	5248.62	5249.11	0.49	0.50	3.78	0.22	5249.33	0.519	10.392	5248.72	5249.25	0.53**	0.55	3.44	0.18	5249.43	0.400	0.460	n/a	1.00	n/a
13	18	1.90	5247.58	5248.65	1.07	1.34	1.41	0.03	5248.68	0.038	14.016	5248.06	5248.59 j	0.53**	0.55	3.44	0.18	5248.77	0.400	0.219	n/a	1.00	n/a
14	18	1.60	5247.13	5247.35	0.22*	0.16	10.06	1.57	5248.92	9.499	18.321	5248.87	5249.76	0.89	1.10	1.46	0.03	5249.80	0.045	4.772	0.874	1.00	0.03
15	24	19.20	5243.78	5245.13	1.35*	2.25	8.53	1.13	5246.26	0.971	133.810	5245.08	5246.63	1.55**	2.62	7.34	0.84	5247.47	0.684	0.828	n/a	1.00	n/a
16	24	18.00	5245.28	5247.00	1.72*	2.87	6.27	0.61	5247.61	0.501	133.810	5245.95	5247.67	1.71	2.87	6.28	0.61	5248.28	0.502	0.501	0.671	1.00	0.61
17	18	6.60	5246.65	5248.67	1.50	1.77	3.74	0.22	5248.89	0.337	16.198	5247.67	5248.65	0.98**	1.22	5.39	0.45	5249.10	0.579	0.458	n/a	1.00	n/a
18	24	12.10	5246.15	5248.66	2.00	3.14	3.85	0.23	5248.89	0.244	122.213	5246.76	5248.96	2.00	3.14	3.85	0.23	5249.19	0.244	0.244	0.298	1.00	0.23
19	18	8.60	5247.26	5249.19	1.50	1.77	4.87	0.37	5249.56	0.572	122.213	5247.87	5249.89	1.50	1.77	4.87	0.37	5250.26	0.572	0.572	0.699	1.00	0.37
20	18	6.50	5248.07	5250.41	1.50	1.77	3.68	0.21	5250.62	0.327	17.361	5248.24	5250.47	1.50	1.77	3.68	0.21	5250.68	0.326	0.327	0.057	1.00	0.21
21	18	2.30	5248.07	5250.60	1.50	1.77	1.30	0.03	5250.62	0.041	83.288	5248.91	5250.63	1.50	1.77	1.30	0.03	5250.66	0.041	0.041	0.034	1.00	0.03
22	18	3.80	5247.46	5249.35	1.50	1.77	2.15	0.07	5249.42	0.112	16.719	5247.96	5249.36	1.40	1.72	2.21	0.08	5249.44	0.096	0.104	0.017	1.00	0.08
23	18	1.80	5248.25	5248.50	0.25*	0.19	9.38	1.37	5249.87	7.039	11.355	5249.05	5250.24	1.19	1.51	1.19	0.02	5250.27	0.026	3.533	0.401	1.00	0.02

US6 & Fed North Storm Sewer | Number of lines: 23 | Run Date: 11-22-2010

Notes: * Normal depth assumed.; ** Critical depth.; j-Line contains hyd. jump. ; c = cir e = ellip b = box

Storm Sewer Profile

Proj. file: Federal North System 50YR 112210.stm



Storm Sewer Profile

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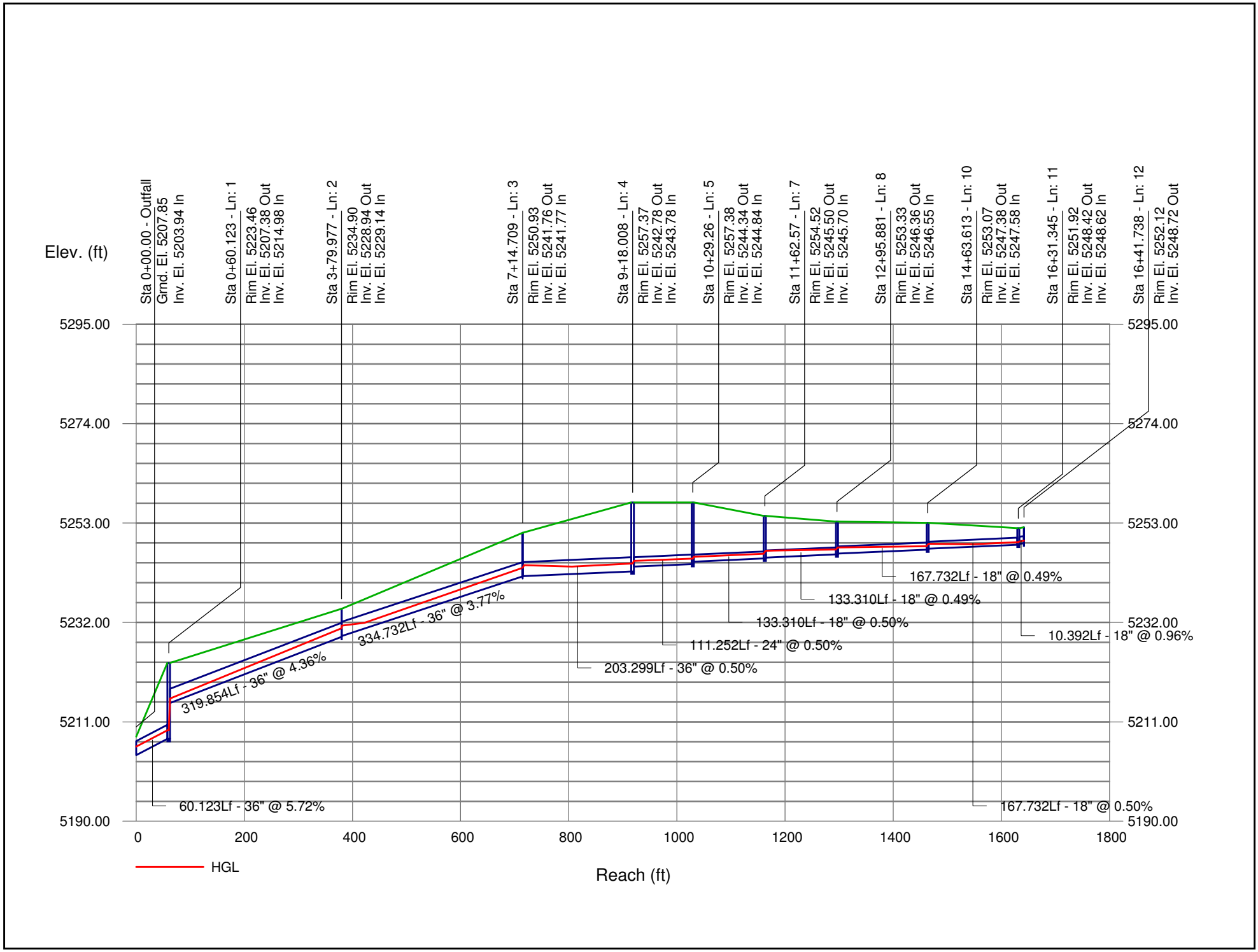

Storm Sewer Profile

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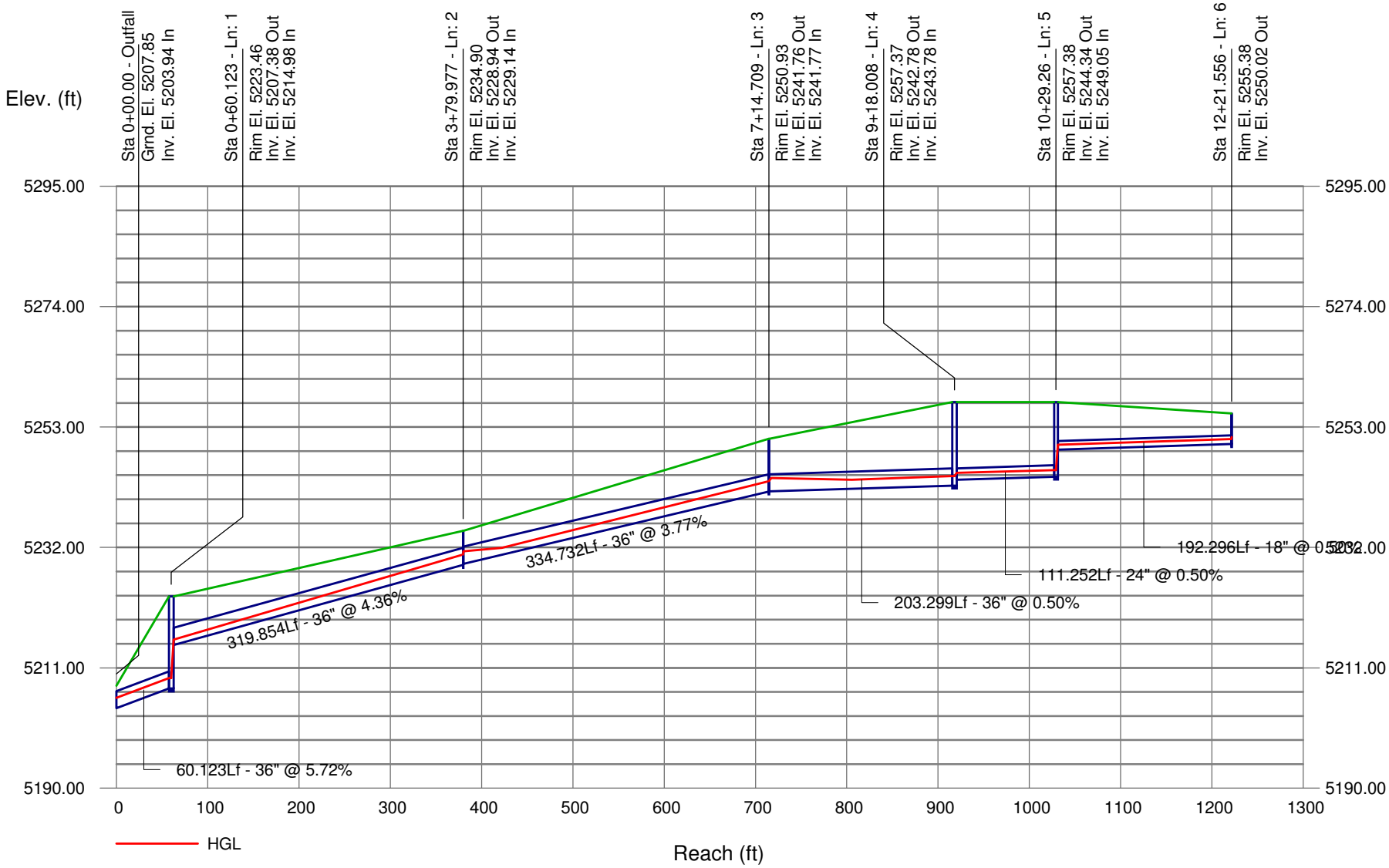
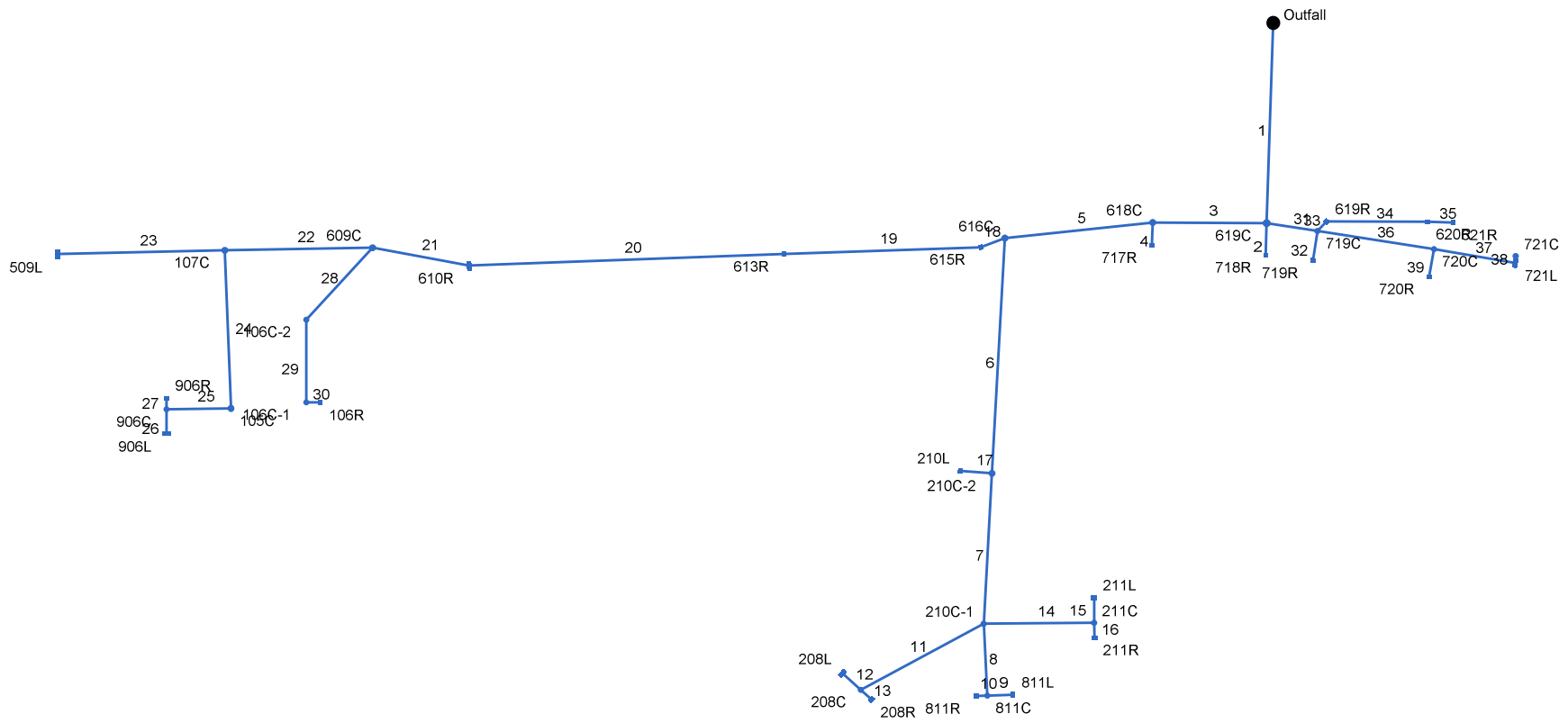


US6 & Fed Blvd: South Storm



Project File: Federal South System 5 YR 122010.stm	Number of lines: 39	Date: 12/21/2010

Storm Sewers v8.00

Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data								Line ID
	Dnstr Line No.	Line Length (ft)	Defl angle (deg)	Junc Type	Known Q (cfs)	Drng Area (ac)	Runoff Coeff (C)	Inlet Time (min)	Invert El Dn (ft)	Line Slope (%)	Invert El Up (ft)	Line Size (in)	Line Shape	N Value (n)	J-Loss Coeff (K)	Inlet/ Rim El (ft)	
1	End	228.998	91.877	MH	49.90	0.00	0.00	0.0	5204.00	0.50	5205.15	36	Cir	0.013	1.00	5221.64	Pipe - Under 6th
2	1	36.394	-0.007	Genr	2.10	0.00	0.00	0.0	5215.85	3.57	5217.15	18	Cir	0.013	1.00	5220.94	Pipe - SE Ramp (71
3	1	129.627	88.455	MH	28.70	0.00	0.00	0.0	5214.35	0.50	5215.00	36	Cir	0.013	1.00	5223.53	Pipe - SE Ramp (6)
4	3	26.327	-88.427	Genr	0.80	0.00	0.00	0.0	5218.40	2.32	5219.01	18	Cir	0.013	1.00	5223.04	Pipe - SE Ramp (71
5	3	169.010	-6.403	MH	28.60	0.00	0.00	0.0	5215.20	0.50	5216.05	36	Cir	0.013	0.99	5227.80	Pipe - SE Ramp (5)
6	5	269.151	-80.801	MH	14.50	0.00	0.00	0.0	5216.26	0.50	5217.60	36	Cir	0.013	1.00	5232.62	Pipe - BP ROW (1)
7	6	172.131	-0.006	MH	10.40	0.00	0.00	0.0	5218.60	0.51	5219.47	24	Cir	0.013	1.00	5230.84	Pipe - BP ROW (2)
8	7	82.166	-6.000	MH	3.10	0.00	0.00	0.0	5223.40	0.50	5223.81	18	Cir	0.013	1.00	5229.67	Pipe - Decatur (1)
9	8	28.510	-88.630	Genr	3.10	0.00	0.00	0.0	5224.01	0.60	5224.18	18	Cir	0.013	1.00	5229.57	Pipe - Decatur (3)
10	8	12.754	91.474	Genr	0.01	0.00	0.00	0.0	5224.01	1.02	5224.14	18	Cir	0.013	1.00	5230.21	Pipe - Decatur (2)
11	7	158.786	58.487	MH	6.70	0.00	0.00	0.0	5225.38	4.62	5232.72	18	Cir	0.013	1.00	5238.39	Pipe - 5th (2)
12	11	28.677	70.387	Genr	3.20	0.00	0.00	0.0	5232.92	0.98	5233.20	18	Cir	0.013	1.00	5238.41	Pipe - 5th - 208L
13	11	16.413	-109.233	Genr	3.60	0.00	0.00	0.0	5232.92	2.13	5233.27	18	Cir	0.013	1.00	5238.51	Pipe - 5th - 208R
14	7	125.505	-93.607	MH	0.90	0.00	0.00	0.0	5219.97	0.50	5220.60	18	Cir	0.013	1.00	5224.93	Pipe - 5th - 211C
15	14	28.375	-89.389	Genr	0.60	0.00	0.00	0.0	5220.80	1.02	5221.09	18	Cir	0.013	1.00	5225.00	Pipe - 5th - 211L
16	14	16.947	88.583	Genr	0.40	0.00	0.00	0.0	5220.80	1.01	5220.97	18	Cir	0.013	1.00	5225.05	Pipe - 5th - 211R
17	6	35.928	91.462	Genr	5.10	0.00	0.00	0.0	5223.49	9.99	5227.08	18	Cir	0.013	1.00	5232.00	Pipe - 5th - 210L
18	5	29.729	-14.612	Genr	10.50	0.00	0.00	0.0	5220.64	5.58	5222.30	24	Cir	0.013	0.56	5228.54	Pipe - SE Ramp (4)
19	18	223.942	18.732	Genr	10.10	0.00	0.00	0.0	5222.49	4.45	5232.46	24	Cir	0.013	0.50	5238.92	Pipe - SE Ramp (3)
20	19	357.993	-0.160	Genr	9.60	0.00	0.00	0.0	5232.66	3.15	5243.92	24	Cir	0.013	0.50	5255.19	Pipe - SE Ramp (2)
21	20	111.452	12.677	MH	8.30	0.00	0.00	0.0	5244.12	0.50	5244.68	24	Cir	0.013	0.87	5258.15	Pipe - SE Ramp (1)
22	21	168.027	-11.589	MH	5.80	0.00	0.00	0.0	5244.88	0.51	5245.73	24	Cir	0.013	1.00	5259.56	Pipe - S Fed (2)
23	22	190.236	-0.276	Genr	2.10	0.00	0.00	0.0	5250.71	1.00	5252.62	18	Cir	0.013	1.00	5257.41	Pipe - SW Ramp

US6 & Fed Blvd: South Storm | Number of lines: 39 | Date: 12/21/2010

Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data								Line ID
	Dnstr Line No.	Line Length (ft)	Defl angle (deg)	Junc Type	Known Q (cfs)	Drng Area (ac)	Runoff Coeff (C)	Inlet Time (min)	Invert El Dn (ft)	Line Slope (%)	Invert El Up (ft)	Line Size (in)	Line Shape	N Value (n)	J-Loss Coeff (K)	Inlet/ Rim El (ft)	
24	22	180.823	-91.196	MH	4.00	0.00	0.00	0.0	5250.01	0.45	5250.83	18	Cir	0.013	1.00	5257.86	Pipe - S Fed (3)
25	24	73.444	91.438	MH	4.10	0.00	0.00	0.0	5251.03	0.50	5251.40	18	Cir	0.013	1.00	5256.83	Pipe - W 5th (1)
26	25	27.563	-89.090	Genr	3.00	0.00	0.00	0.0	5251.60	0.98	5251.87	18	Cir	0.013	1.00	5258.36	Pipe - W 5th (906L
27	25	12.188	90.780	Genr	1.20	0.00	0.00	0.0	5251.60	2.13	5251.86	18	Cir	0.013	1.00	5256.67	Pipe - W 5th (906R
28	21	111.614	-58.131	MH	2.90	0.00	0.00	0.0	5250.62	0.49	5251.17	18	Cir	0.013	0.72	5258.32	Pipe - S Fed (4)
29	28	94.375	-42.360	MH	2.90	0.00	0.00	0.0	5251.37	0.50	5251.84	18	Cir	0.013	1.00	5257.73	Pipe - S Fed (1)
30	29	15.438	-89.612	Genr	2.90	0.00	0.00	0.0	5252.04	0.97	5252.19	18	Cir	0.013	1.00	5257.89	Pipe - S Fed (106R
31	1	58.385	-83.009	MH	20.70	0.00	0.00	0.0	5205.35	0.50	5205.64	36	Cir	0.013	1.00	5219.84	Pipe - Slip Ramp (
32	31	34.023	89.903	Genr	1.10	0.00	0.00	0.0	5214.97	5.32	5216.78	18	Cir	0.013	1.00	5220.37	Pipe - SE Ramp (71
33	31	15.081	-56.051	Genr	2.20	0.00	0.00	0.0	5214.97	7.03	5216.03	18	Cir	0.013	1.16	5221.28	Pipe - SE Ramp (61
34	33	114.751	47.433	Genr	1.10	0.00	0.00	0.0	5216.22	0.70	5217.02	18	Cir	0.013	0.50	5222.28	Pipe - SE Ramp (62
35	34	29.324	1.338	Genr	0.40	0.00	0.00	0.0	5217.23	3.31	5218.20	18	Cir	0.013	1.00	5223.17	Pipe - SE Ramp (62
36	31	134.238	0.025	MH	17.50	0.00	0.00	0.0	5205.84	0.50	5206.51	36	Cir	0.013	1.00	5219.48	Pipe - Slip Ramp (
37	36	93.390	0.778	Genr	17.20	0.00	0.00	0.0	5206.71	0.60	5207.27	36	Cir	0.013	1.50	5215.56	Pipe - SE Ramp (72
38	37	7.911	-94.230	MH	16.80	0.00	0.00	0.0	5207.46	0.51	5207.50	36	Cir	0.013	1.00	5217.26	Pipe - Slip Ramp D
39	36	31.977	91.012	Genr	0.30	0.00	0.00	0.0	5213.43	4.38	5214.83	18	Cir	0.013	1.00	5218.49	Pipe - SE Ramp (72

US6 & Fed Blvd: South Storm | Number of lines: 39 | Date: 12/21/2010

Structure Report

Struct No.	Structure ID	Junction Type	Rim Elev (ft)	Structure			Line Out			Line In		
				Shape	Length (ft)	Width (ft)	Size (in)	Shape	Invert (ft)	Size (in)	Shape	Invert (ft)
1	619C	Manhole	5221.64	Cir	6.00	6.00	36	Cir	5205.15	18 36 36	Cir Cir Cir	5215.85 5214.35 5205.35
2	718R	Generic	5220.94	Rect	4.50	5.00	18	Cir	5217.15			
3	618C	Manhole	5223.53	Cir	5.00	5.00	36	Cir	5215.00	18 36	Cir Cir	5218.40 5215.20
4	717R	Generic	5223.04	Rect	4.50	5.00	18	Cir	5219.01			
5	616C	Manhole	5227.80	Cir	5.00	5.00	36	Cir	5216.05	36 24	Cir Cir	5216.26 5220.64
6	210C-2	Manhole	5232.62	Cir	5.00	5.00	36	Cir	5217.60	24 18	Cir Cir	5218.60 5223.49
7	210C-1	Manhole	5230.84	Cir	4.50	4.50	24	Cir	5219.47	18 18 18	Cir Cir Cir	5223.40 5225.38 5219.97
8	811C	Manhole	5229.67	Cir	4.00	4.00	18	Cir	5223.81	18 18	Cir Cir	5224.01 5224.01
9	811L	Generic	5229.57	Rect	4.50	6.00	18	Cir	5224.18			
10	811R	Generic	5230.21	Rect	6.00	4.50	18	Cir	5224.14			
11	208C	Manhole	5238.39	Cir	4.00	4.00	18	Cir	5232.72	18 18	Cir Cir	5232.92 5232.92
12	208L	Generic	5238.41	Rect	4.50	9.00	18	Cir	5233.20			
13	208R	Generic	5238.51	Rect	4.50	6.00	18	Cir	5233.27			
14	211C	Manhole	5224.93	Cir	4.00	4.00	18	Cir	5220.60	18 18	Cir Cir	5220.80 5220.80
15	211L	Generic	5225.00	Rect	4.50	6.00	18	Cir	5221.09			
16	211R	Generic	5225.05	Rect	4.50	6.00	18	Cir	5220.97			
17	210L	Generic	5232.00	Rect	4.50	6.00	18	Cir	5227.08			
18	615R	Generic	5228.54	Rect	4.50	5.00	24	Cir	5222.30	24	Cir	5222.49

Structure Report

Struct No.	Structure ID	Junction Type	Rim Elev (ft)	Structure			Line Out			Line In		
				Shape	Length (ft)	Width (ft)	Size (in)	Shape	Invert (ft)	Size (in)	Shape	Invert (ft)
19	613R	Generic	5238.92	Rect	4.50	5.00	24	Cir	5232.46	24	Cir	5232.66
20	610R	Generic	5255.19	Rect	4.50	10.00	24	Cir	5243.92	24	Cir	5244.12
21	609C	Manhole	5258.15	Cir	5.00	5.00	24	Cir	5244.68	24 18	Cir Cir	5244.88 5250.62
22	107C	Manhole	5259.56	Cir	5.00	5.00	24	Cir	5245.73	18 18	Cir Cir	5250.71 5250.01
23	509L	Generic	5257.41	Rect	5.00	10.00	18	Cir	5252.62			
24	105C	Manhole	5257.86	Cir	5.00	5.00	18	Cir	5250.83	18	Cir	5251.03
25	906C	Manhole	5256.83	Cir	4.00	4.00	18	Cir	5251.40	18 18	Cir Cir	5251.60 5251.60
26	906L	Generic	5258.36	Rect	4.50	9.00	18	Cir	5251.87			
27	906R	Generic	5256.67	Rect	4.50	6.00	18	Cir	5251.86			
28	106C-2	Manhole	5258.32	Cir	4.00	4.00	18	Cir	5251.17	18	Cir	5251.37
29	106C-1	Manhole	5257.73	Cir	4.00	4.00	18	Cir	5251.84	18	Cir	5252.04
30	106R	Generic	5257.89	Rect	4.50	6.00	18	Cir	5252.19			
31	719C	Manhole	5219.84	Cir	4.00	4.00	36	Cir	5205.64	18 18 36	Cir Cir Cir	5214.97 5214.97 5205.84
32	719R	Generic	5220.37	Rect	4.50	5.00	18	Cir	5216.78			
33	619R	Generic	5221.28	Rect	4.50	5.00	18	Cir	5216.03	18	Cir	5216.22
34	620R	Generic	5222.28	Rect	4.50	5.00	18	Cir	5217.02	18	Cir	5217.23
35	621R	Generic	5223.17	Rect	4.50	5.00	18	Cir	5218.20			
36	720C	Manhole	5219.48	Cir	4.00	4.00	36	Cir	5206.51	36 18	Cir Cir	5206.71 5213.43
37	721L	Generic	5215.56	Rect	4.50	10.00	36	Cir	5207.27	36	Cir	5207.46
38	721C	Manhole	5217.26	Cir	4.00	4.00	36	Cir	5207.50			

Structure Report

Struct No.	Structure ID	Junction Type	Rim Elev (ft)	Structure			Line Out			Line In		
				Shape	Length (ft)	Width (ft)	Size (in)	Shape	Invert (ft)	Size (in)	Shape	Invert (ft)
39	720R	Generic	5218.49	Rect	4.50	5.00	18	Cir	5214.83			

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	Pipe - Under 6th	49.90	36	Cir	228.998	5204.00	5205.15	0.502	5206.65	5207.80	0.89	5208.69	End	Manhole
2	Pipe - SE Ramp (718R)	2.10	18	Cir	36.394	5215.85	5217.15	3.571	5216.18	5217.70	0.20	5217.70	1	Generic
3	Pipe - SE Ramp (6)	28.70	36	Cir	129.627	5214.35	5215.00	0.501	5216.04	5216.72	0.73	5217.45	1	Manhole
4	Pipe - SE Ramp (717R)	0.80	18	Cir	26.327	5218.40	5219.01	2.316	5218.63	5219.35	n/a	5219.35	3	Generic
5	Pipe - SE Ramp (5)	28.60	36	Cir	169.010	5215.20	5216.05	0.503	5217.45	5217.75	n/a	5217.75 j	3	Manhole
6	Pipe - BP ROW (1)	14.50	36	Cir	269.151	5216.26	5217.60	0.498	5217.75	5218.81	n/a	5218.81 j	5	Manhole
7	Pipe - BP ROW (2)	10.40	24	Cir	172.131	5218.60	5219.47	0.505	5219.77	5220.64	0.46	5221.10	6	Manhole
8	Pipe - Decatur (1)	3.10	18	Cir	82.166	5223.40	5223.81	0.499	5224.08	5224.49	0.25	5224.74	7	Manhole
9	Pipe - Decatur (3)	3.10	18	Cir	28.510	5224.01	5224.18	0.598	5224.74	5224.86	0.25	5225.11	8	Generic
10	Pipe - Decatur (2)	0.01	18	Cir	12.754	5224.01	5224.14	1.022	5224.74	5224.74	0.00	5224.74	8	Generic
11	Pipe - 5th (2)	6.70	18	Cir	158.786	5225.38	5232.72	4.623	5225.94	5233.71	n/a	5233.71	7	Manhole
12	Pipe - 5th - 208L	3.20	18	Cir	28.677	5232.92	5233.20	0.977	5233.71	5233.88	n/a	5233.88 j	11	Generic
13	Pipe - 5th - 208R	3.60	18	Cir	16.413	5232.92	5233.27	2.133	5233.71	5233.99	n/a	5233.99 j	11	Generic
14	Pipe - 5th - 211C	0.90	18	Cir	125.505	5219.97	5220.60	0.502	5221.10	5221.14	0.04	5221.18	7	Manhole
15	Pipe - 5th - 211L	0.60	18	Cir	28.375	5220.80	5221.09	1.022	5221.18	5221.39	n/a	5221.39 j	14	Generic
16	Pipe - 5th - 211R	0.40	18	Cir	16.947	5220.80	5220.97	1.006	5221.18	5221.21	n/a	5221.29 j	14	Generic
17	Pipe - 5th - 210L	5.10	18	Cir	35.928	5223.49	5227.08	9.992	5223.89	5228.46	0.14	5228.60	6	Generic
18	Pipe - SE Ramp (4)	10.50	24	Cir	29.729	5220.64	5222.30	5.583	5221.24*	5224.64*	0.10	5224.74	5	Generic
19	Pipe - SE Ramp (3)	10.10	24	Cir	223.942	5222.49	5232.46	4.452	5224.74	5233.59	n/a	5233.59 j	18	Generic
20	Pipe - SE Ramp (2)	9.60	24	Cir	357.993	5232.66	5243.92	3.145	5233.59	5245.02	n/a	5245.02	19	Generic
21	Pipe - SE Ramp (1)	8.30	24	Cir	111.452	5244.12	5244.68	0.503	5245.14	5245.71	0.35	5246.06	20	Manhole
22	Pipe - S Fed (2)	5.80	24	Cir	168.027	5244.88	5245.73	0.506	5246.06	5246.58	n/a	5246.58 j	21	Manhole
23	Pipe - SW Ramp	2.10	18	Cir	190.236	5250.71	5252.62	1.004	5251.17	5253.17	0.20	5253.17	22	Generic
24	Pipe - S Fed (3)	4.00	18	Cir	180.823	5250.01	5250.83	0.454	5250.82	5251.64	0.26	5251.90	22	Manhole

US6 & Fed Blvd: South Storm | Number of lines: 39 | Run Date: 12/21/2010

NOTES: Return period = 5 Yrs. ; *Surcharged (HGL above crown). ; j - Line contains hyd. jump.

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
25	Pipe - W 5th (1)	4.10	18	Cir	73.444	5251.03	5251.40	0.504	5251.90	5252.18	0.31	5252.48	24	Manhole
26	Pipe - W 5th (906L)	3.00	18	Cir	27.563	5251.60	5251.87	0.980	5252.48	5252.53	n/a	5252.53 j	25	Generic
27	Pipe - W 5th (906R)	1.20	18	Cir	12.188	5251.60	5251.86	2.131	5252.48	5252.46	0.05	5252.51	25	Generic
28	Pipe - S Fed (4)	2.90	18	Cir	111.614	5250.62	5251.17	0.493	5251.27	5251.82	0.17	5252.00	21	Manhole
29	Pipe - S Fed (1)	2.90	18	Cir	94.375	5251.37	5251.84	0.498	5252.02	5252.49	0.24	5252.73	28	Manhole
30	Pipe - S Fed (106R)	2.90	18	Cir	15.438	5252.04	5252.19	0.971	5252.73	5252.84	n/a	5252.84 j	29	Generic
31	Pipe - Slip Ramp (2)	20.70	36	Cir	58.385	5205.35	5205.64	0.497	5208.69*	5208.74*	0.13	5208.88	1	Manhole
32	Pipe - SE Ramp (719R)	1.10	18	Cir	34.023	5214.97	5216.78	5.319	5215.19	5217.18	0.13	5217.18	31	Generic
33	Pipe - SE Ramp (619R)	2.20	18	Cir	15.081	5214.97	5216.03	7.026	5215.26	5217.13	0.05	5217.17	31	Generic
34	Pipe - SE Ramp (620R)	1.10	18	Cir	114.751	5216.22	5217.02	0.697	5217.17	5217.42	n/a	5217.42 j	33	Generic
35	Pipe - SE Ramp (621R)	0.40	18	Cir	29.324	5217.23	5218.20	3.309	5217.42	5218.44	n/a	5218.44	34	Generic
36	Pipe - Slip Ramp (1)	17.50	36	Cir	134.238	5205.84	5206.51	0.499	5208.88	5208.93	0.13	5209.06	31	Manhole
37	Pipe - SE Ramp (721L)	17.20	36	Cir	93.390	5206.71	5207.27	0.600	5209.06	5209.06	0.36	5209.41	36	Generic
38	Pipe - Slip Ramp Diversion	16.80	36	Cir	7.911	5207.46	5207.50	0.506	5209.41	5209.42	0.19	5209.61	37	Manhole
39	Pipe - SE Ramp (720R)	0.30	18	Cir	31.977	5213.43	5214.83	4.378	5213.55	5215.04	n/a	5215.04	36	Generic

US6 & Fed Blvd: South Storm | Number of lines: 39 | Run Date: 12/21/2010

NOTES: Return period = 5 Yrs. ; *Surcharged (HGL above crown). ; j - Line contains hyd. jump.

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q Byp (cfs)	Junc Type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp Line No
							Ht (in)	L (ft)	Area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	619C	49.90*	131.10	0.00	181.00	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
2	718R	2.10*	0.00	2.10	0.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	1
3	618C	28.70*	64.20	0.00	92.90	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	1
4	717R	0.80*	0.00	0.80	0.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	3
5	616C	28.60*	35.60	0.00	64.20	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	3
6	210C-2	14.50*	21.10	0.00	35.60	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	5
7	210C-1	10.40*	10.70	0.00	21.10	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	6
8	811C	3.10*	0.00	0.00	3.10	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	7
9	811L	3.10*	0.00	3.10	0.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	8
10	811R	0.01*	0.00	0.01	0.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	8
11	208C	6.70*	0.00	0.00	6.70	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	7
12	208L	3.20*	0.00	3.20	0.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	11
13	208R	3.60*	0.00	3.60	0.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	11
14	211C	0.90*	0.00	0.00	0.90	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	7
15	211L	0.60*	0.00	0.60	0.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	14
16	211R	0.40*	0.00	0.40	0.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	14
17	210L	5.10*	0.00	5.10	0.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	6
18	615R	10.50*	0.00	10.50	0.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	5
19	613R	10.10*	0.00	10.10	0.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	18
20	610R	9.60*	28.00	37.60	0.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	19
21	609C	8.30*	19.70	0.00	28.00	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	20
22	107C	5.80*	8.10	0.00	13.90	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	21
23	509L	2.10*	0.00	2.10	0.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	22

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NOTES: Inlet N-Values = 0.016; Intensity = 79.26 / (Inlet time + 14.60) ^ 0.84; Return period = 5 Yrs. ; * Indicates Known Q added. All curb inlets are Horiz throat.

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q Byp (cfs)	Junc Type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp Line No
							Ht (in)	L (ft)	Area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
24	105C	4.00*	4.10	0.00	8.10	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	22
25	906C	4.10*	0.00	0.00	4.10	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	24
26	906L	3.00*	0.00	3.00	0.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	25
27	906R	1.20*	0.00	1.20	0.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	25
28	106C-2	2.90*	2.90	0.00	5.80	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	21
29	106C-1	2.90*	0.00	0.00	2.90	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	28
30	106R	2.90*	0.00	2.90	0.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	29
31	719C	20.70*	17.50	0.00	38.20	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	1
32	719R	1.10*	0.00	1.10	0.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	31
33	619R	2.20*	0.00	2.20	0.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	31
34	620R	1.10*	0.00	1.10	0.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	33
35	621R	0.40*	0.00	0.40	0.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	34
36	720C	17.50*	0.00	0.00	17.50	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	31
37	721L	17.20*	16.80	34.00	0.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	36
38	721C	16.80*	0.00	0.00	16.80	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	37
39	720R	0.30*	0.00	0.30	0.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	36

US6 & Fed Blvd: South Storm | Number of lines: 39 | Run Date: 12/21/2010

NOTES: Inlet N-Values = 0.016; Intensity = 79.26 / (Inlet time + 14.60) ^ 0.84; Return period = 5 Yrs. ; * Indicates Known Q added. All curb inlets are Horiz throat.

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
	(in)	(cfs)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	(ft)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)	(K)	(ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1	36	49.90	5204.00	5206.65	2.65	6.60	7.56	0.89	5207.54	0.502	228.998	5205.15	5207.80	2.65	6.60	7.56	0.89	5208.69	0.502	0.502	1.150	1.00	0.89
2	18	2.10	5215.85	5216.18	0.33*	0.29	7.30	0.83	5217.01	3.570	36.394	5217.15	5217.70	0.55**	0.59	3.55	0.20	5217.90	0.476	2.023	n/a	1.00	0.20
3	36	28.70	5214.35	5216.04	1.69*	4.10	7.00	0.76	5216.80	0.501	129.627	5215.00	5216.72	1.71**	4.18	6.87	0.73	5217.45	0.477	0.489	0.634	1.00	0.73
4	18	0.80	5218.40	5218.63	0.23*	0.17	4.71	0.34	5218.97	2.306	26.327	5219.01	5219.35	0.34**	0.30	2.64	0.11	5219.46	0.450	1.378	n/a	1.00	n/a
5	36	28.60	5215.20	5217.45	2.25	5.68	5.03	0.39	5217.84	0.221	169.010	5216.05	5217.75 j	1.70**	4.15	6.90	0.74	5218.49	0.483	0.352	n/a	0.99	n/a
6	36	14.50	5216.26	5217.75	1.49	3.52	4.12	0.26	5218.02	0.191	269.151	5217.60	5218.81 j	1.21**	2.68	5.41	0.45	5219.27	0.399	0.295	n/a	1.00	0.45
7	24	10.40	5218.60	5219.77	1.17*	1.91	5.44	0.46	5220.23	0.505	172.131	5219.47	5220.64	1.17	1.91	5.44	0.46	5221.10	0.504	0.505	0.869	1.00	0.46
8	18	3.10	5223.40	5224.08	0.68*	0.77	4.01	0.25	5224.33	0.499	82.166	5223.81	5224.49	0.68**	0.77	4.01	0.25	5224.74	0.500	0.500	0.411	1.00	0.25
9	18	3.10	5224.01	5224.74	0.73	0.85	3.65	0.21	5224.94	0.389	28.510	5224.18	5224.86	0.68**	0.77	4.01	0.25	5225.11	0.500	0.444	0.127	1.00	0.25
10	18	0.01	5224.01	5224.74	0.73	0.85	0.01	0.00	5224.74	0.000	12.754	5224.14	5224.74	0.60	0.66	0.02	0.00	5224.74	0.000	0.000	0.000	1.00	0.00
11	18	6.70	5225.38	5225.94	0.56*	0.60	11.13	1.93	5227.87	4.623	158.786	5232.72	5233.71	0.99**	1.23	5.43	0.46	5234.17	0.685	2.654	n/a	1.00	n/a
12	18	3.20	5232.92	5233.71	0.79	0.94	3.40	0.18	5233.89	0.315	28.677	5233.20	5233.88 j	0.68**	0.78	4.09	0.26	5234.14	0.514	0.414	n/a	1.00	n/a
13	18	3.60	5232.92	5233.71	0.79	0.94	3.83	0.23	5233.94	0.398	16.413	5233.27	5233.99 j	0.72**	0.84	4.26	0.28	5234.28	0.530	0.464	n/a	1.00	n/a
14	18	0.90	5219.97	5221.10	1.13	1.43	0.63	0.01	5221.11	0.009	125.505	5220.60	5221.14	0.54	0.57	1.59	0.04	5221.18	0.098	0.053	0.067	1.00	0.04
15	18	0.60	5220.80	5221.18	0.38	0.35	1.73	0.05	5221.22	0.172	28.375	5221.09	5221.39 j	0.30**	0.25	2.44	0.09	5221.48	0.452	0.312	n/a	1.00	0.09
16	18	0.40	5220.80	5221.18	0.38	0.35	1.15	0.02	5221.20	0.077	16.947	5220.97	5221.21 j	0.24**	0.19	2.14	0.07	5221.29	0.439	0.258	0.044	1.00	0.07
17	18	5.10	5223.49	5223.89	0.40*	0.37	13.60	2.88	5226.76	9.992	35.928	5227.08	5228.46	1.38	1.70	3.01	0.14	5228.60	0.205	5.099	1.832	1.00	0.14
18	24	10.50	5220.64	5221.24	0.60*	0.79	13.21	2.71	5223.96	5.583	29.729	5222.30	5224.64	2.00	3.14	3.34	0.17	5224.82	0.216	2.899	0.862	0.56	0.10
19	24	10.10	5222.49	5224.74	2.00	3.14	3.22	0.16	5224.90	0.199	223.942	5232.46	5233.59 j	1.13**	1.82	5.55	0.48	5234.06	0.540	0.370	n/a	0.50	n/a
20	24	9.60	5232.66	5233.59	0.93	1.42	6.75	0.71	5234.29	0.942	357.993	5243.92	5245.02	1.10**	1.77	5.44	0.46	5245.48	0.529	0.736	n/a	0.50	n/a
21	24	8.30	5244.12	5245.14	1.02*	1.61	5.15	0.41	5245.55	0.502	111.452	5244.68	5245.71	1.03**	1.62	5.12	0.41	5246.11	0.495	0.499	0.556	0.87	0.35

US6 & Fed Blvd: South Storm | Number of lines: 39 | Run Date: 12/21/2010

Notes: * Normal depth assumed.; ** Critical depth.; j-Line contains hyd. jump. ; c = cir e = ellip b = box

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
	(in)	(cfs)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	(ft)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)	(K)	(ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
22	24	5.80	5244.88	5246.06	1.18	1.93	3.01	0.14	5246.20	0.153	168.027	5245.73	5246.58 j	0.85**	1.28	4.54	0.32	5246.90	0.459	0.306	n/a	1.00	0.32
23	18	2.10	5250.71	5251.17	0.45*	0.45	4.64	0.34	5251.50	1.003	190.236	5252.62	5253.17	0.55**	0.59	3.55	0.20	5253.37	0.476	0.739	n/a	1.00	0.20
24	18	4.00	5250.01	5250.82	0.81*	0.97	4.12	0.26	5251.08	0.453	180.823	5250.83	5251.64	0.81	0.97	4.12	0.26	5251.90	0.452	0.453	0.819	1.00	0.26
25	18	4.10	5251.03	5251.90	0.87	1.07	3.85	0.23	5252.13	0.372	73.444	5251.40	5252.18	0.78**	0.92	4.44	0.31	5252.48	0.542	0.457	0.336	1.00	0.31
26	18	3.00	5251.60	5252.48	0.88	1.08	2.77	0.12	5252.60	0.192	27.563	5251.87	5252.53 j	0.66**	0.75	4.00	0.25	5252.78	0.506	0.349	n/a	1.00	0.25
27	18	1.20	5251.60	5252.48	0.88	1.08	1.11	0.02	5252.50	0.031	12.188	5251.86	5252.46	0.60	0.66	1.82	0.05	5252.51	0.116	0.073	0.009	1.00	0.05
28	18	2.90	5250.62	5251.27	0.65*	0.74	3.92	0.24	5251.51	0.492	111.614	5251.17	5251.82	0.65**	0.74	3.92	0.24	5252.06	0.493	0.493	0.550	0.72	0.17
29	18	2.90	5251.37	5252.02	0.65*	0.74	3.93	0.24	5252.26	0.496	94.375	5251.84	5252.49	0.65**	0.74	3.92	0.24	5252.73	0.493	0.494	0.467	1.00	0.24
30	18	2.90	5252.04	5252.73	0.69	0.80	3.63	0.21	5252.94	0.401	15.438	5252.19	5252.84 j	0.65**	0.73	3.95	0.24	5253.08	0.503	0.452	n/a	1.00	n/a
31	36	20.70	5205.35	5208.69	3.00	7.07	2.93	0.13	5208.82	0.096	58.385	5205.64	5208.74	3.00	7.07	2.93	0.13	5208.88	0.096	0.096	0.056	1.00	0.13
32	18	1.10	5214.97	5215.19	0.22*	0.16	6.94	0.75	5215.94	5.318	34.023	5216.78	5217.18	0.40**	0.38	2.90	0.13	5217.31	0.452	2.885	n/a	1.00	0.13
33	18	2.20	5214.97	5215.26	0.29*	0.23	9.40	1.37	5216.63	7.036	15.081	5216.03	5217.13	1.09	1.38	1.59	0.04	5217.16	0.056	3.546	0.535	1.16	0.05
34	18	1.10	5216.22	5217.17	0.95	1.18	0.93	0.01	5217.18	0.021	114.751	5217.02	5217.42 j	0.40**	0.38	2.90	0.13	5217.55	0.452	0.236	n/a	0.50	0.07
35	18	0.40	5217.23	5217.42	0.19	0.13	3.07	0.15	5217.57	1.227	29.324	5218.20	5218.44	0.24**	0.18	2.17	0.07	5218.52	0.460	0.844	n/a	1.00	n/a
36	36	17.50	5205.84	5208.88	3.00	7.07	2.48	0.10	5208.97	0.069	134.238	5206.51	5208.93	2.42	6.12	2.86	0.13	5209.06	0.071	0.070	0.094	1.00	0.13
37	36	17.20	5206.71	5209.06	2.35	5.94	2.89	0.13	5209.19	0.073	93.390	5207.27	5209.06	1.78	4.38	3.92	0.24	5209.29	0.151	0.112	0.105	1.50	0.36
38	36	16.80	5207.46	5209.41	1.95	4.87	3.45	0.18	5209.60	0.110	7.911	5207.50	5209.42	1.92	4.76	3.53	0.19	5209.61	0.117	0.114	0.009	1.00	0.19
39	18	0.30	5213.43	5213.55	0.12*	0.07	4.37	0.30	5213.85	4.320	31.977	5214.83	5215.04	0.21**	0.15	2.01	0.06	5215.10	0.468	2.394	n/a	1.00	n/a

US6 & Fed Blvd: South Storm | Number of lines: 39 | Run Date: 12/21/2010

Notes: * Normal depth assumed.; ** Critical depth.; j-Line contains hyd. jump. ; c = cir e = ellip b = box

Hydraflow HGL Computation Procedure

General Procedure:

Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

Col. 21 The average of the downstream and upstream friction slopes.

Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

Storm Sewer Profile

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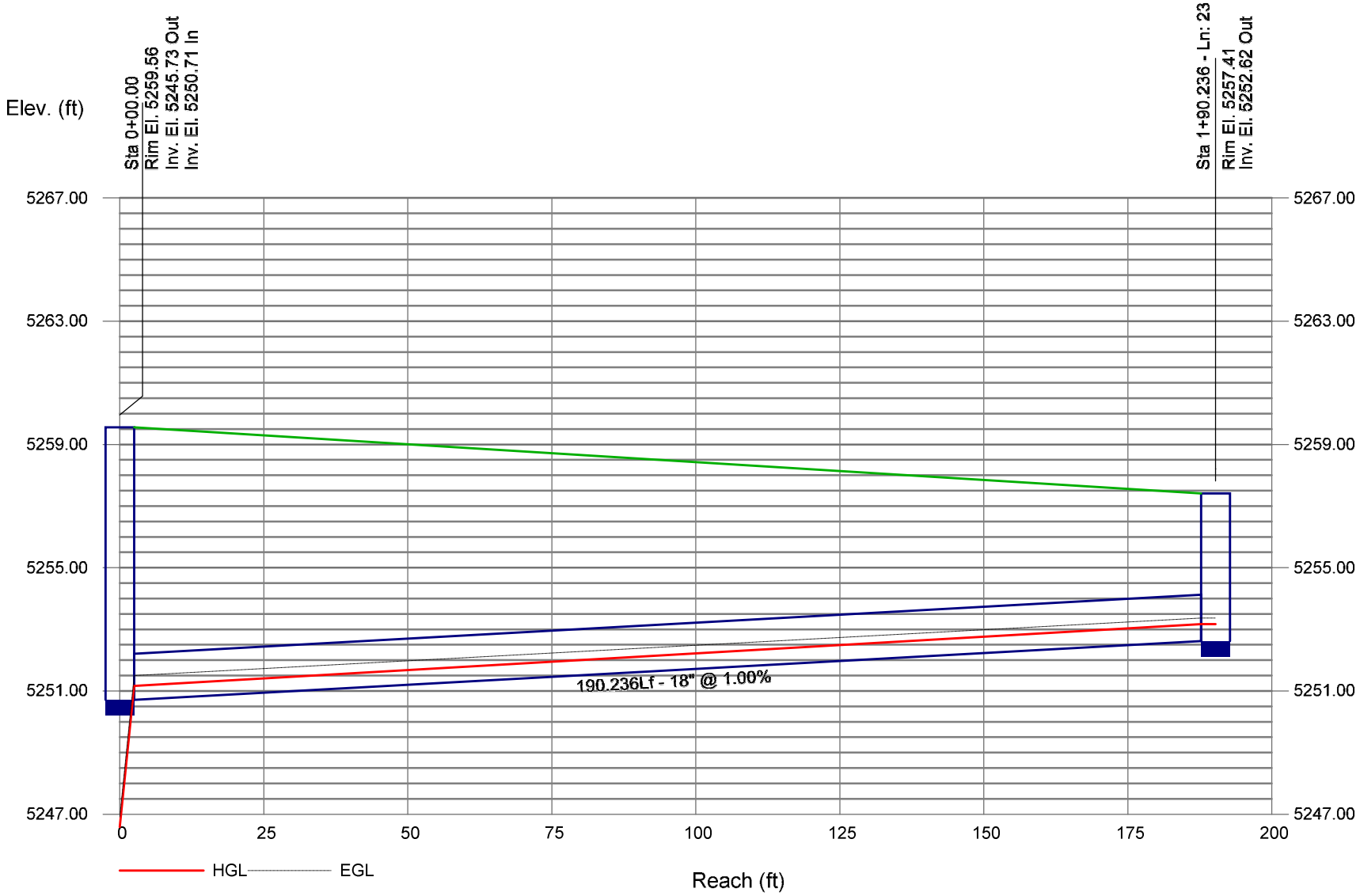

Storm Sewer Profile

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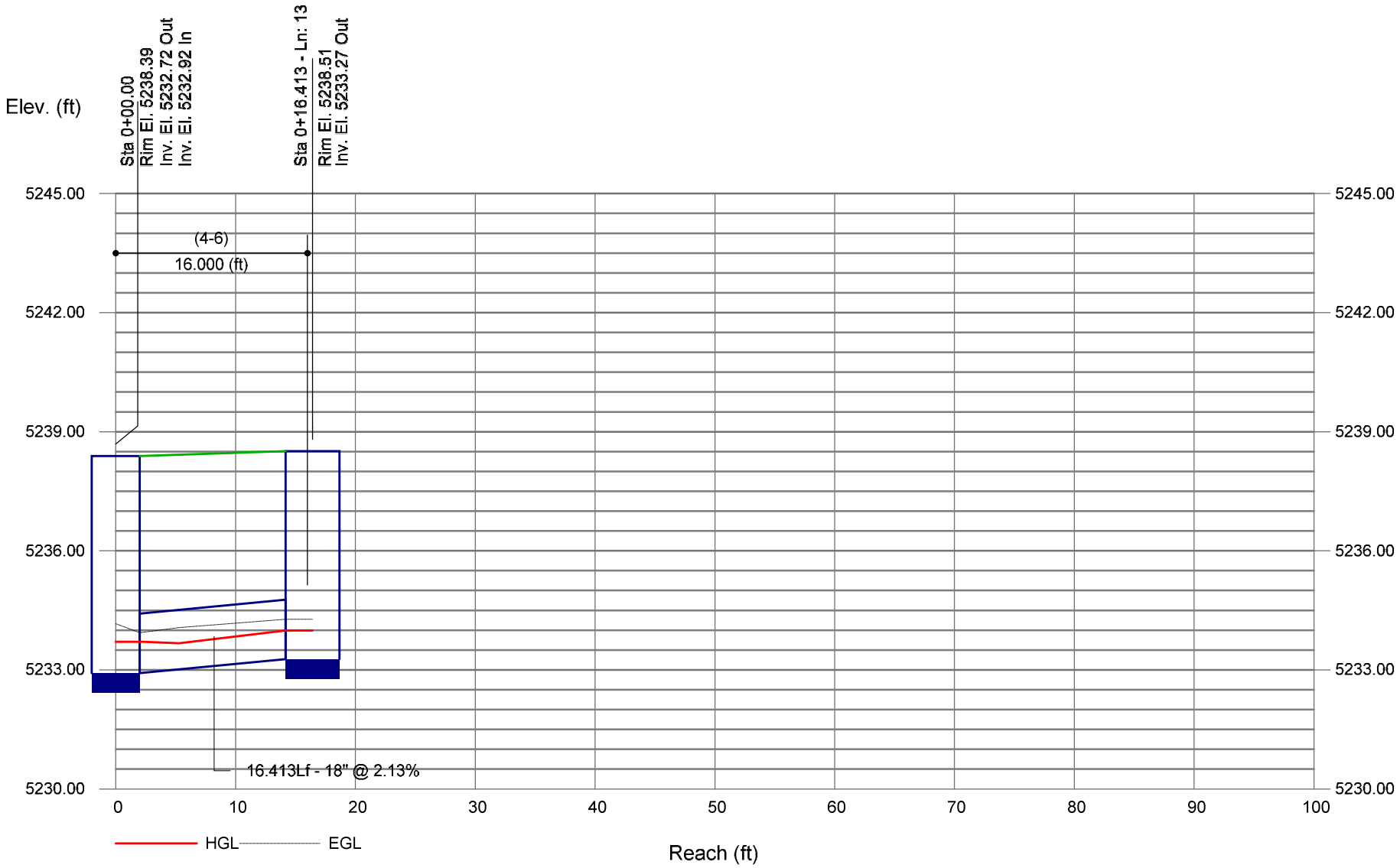

Storm Sewer Profile

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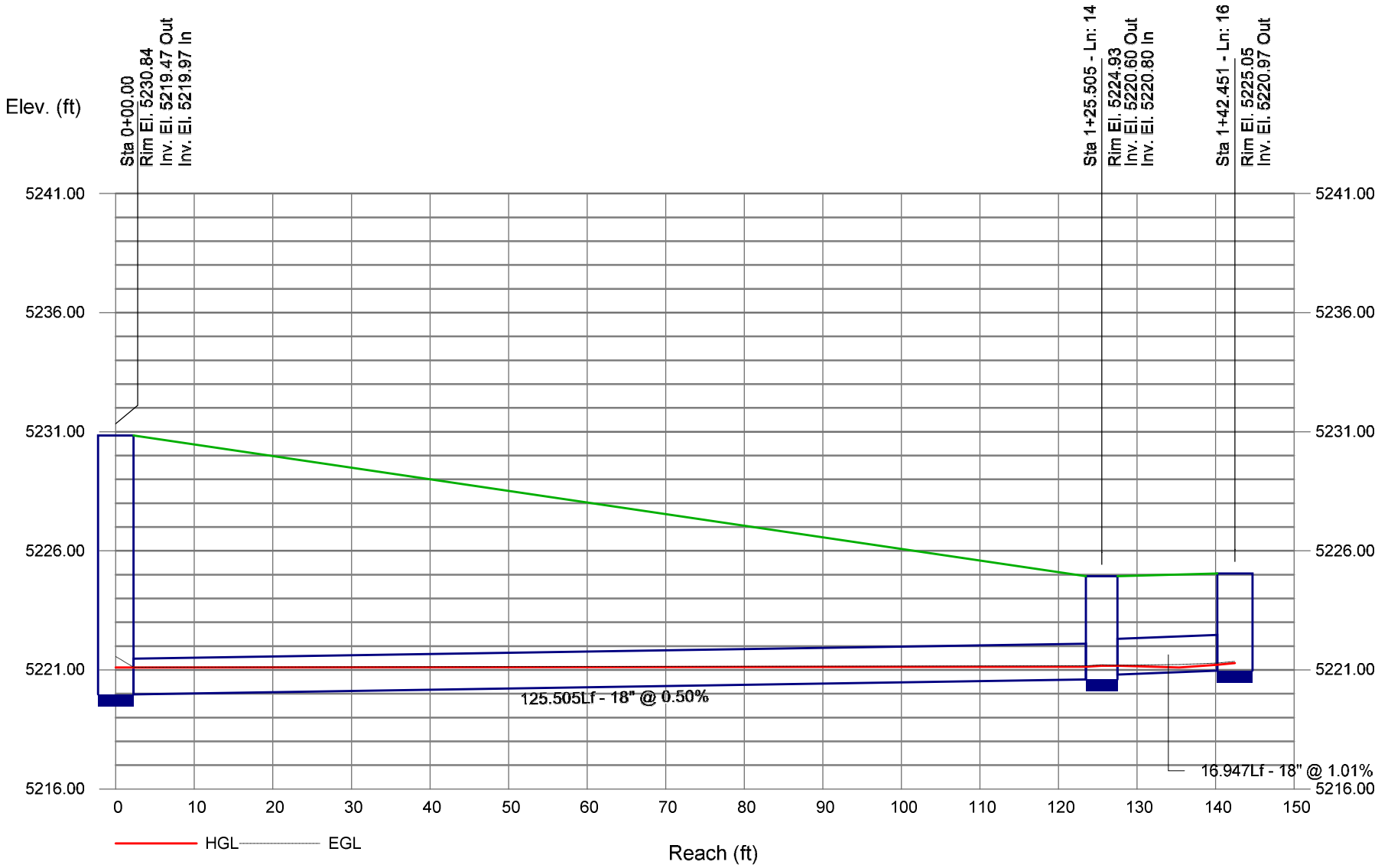

Storm Sewer Profile

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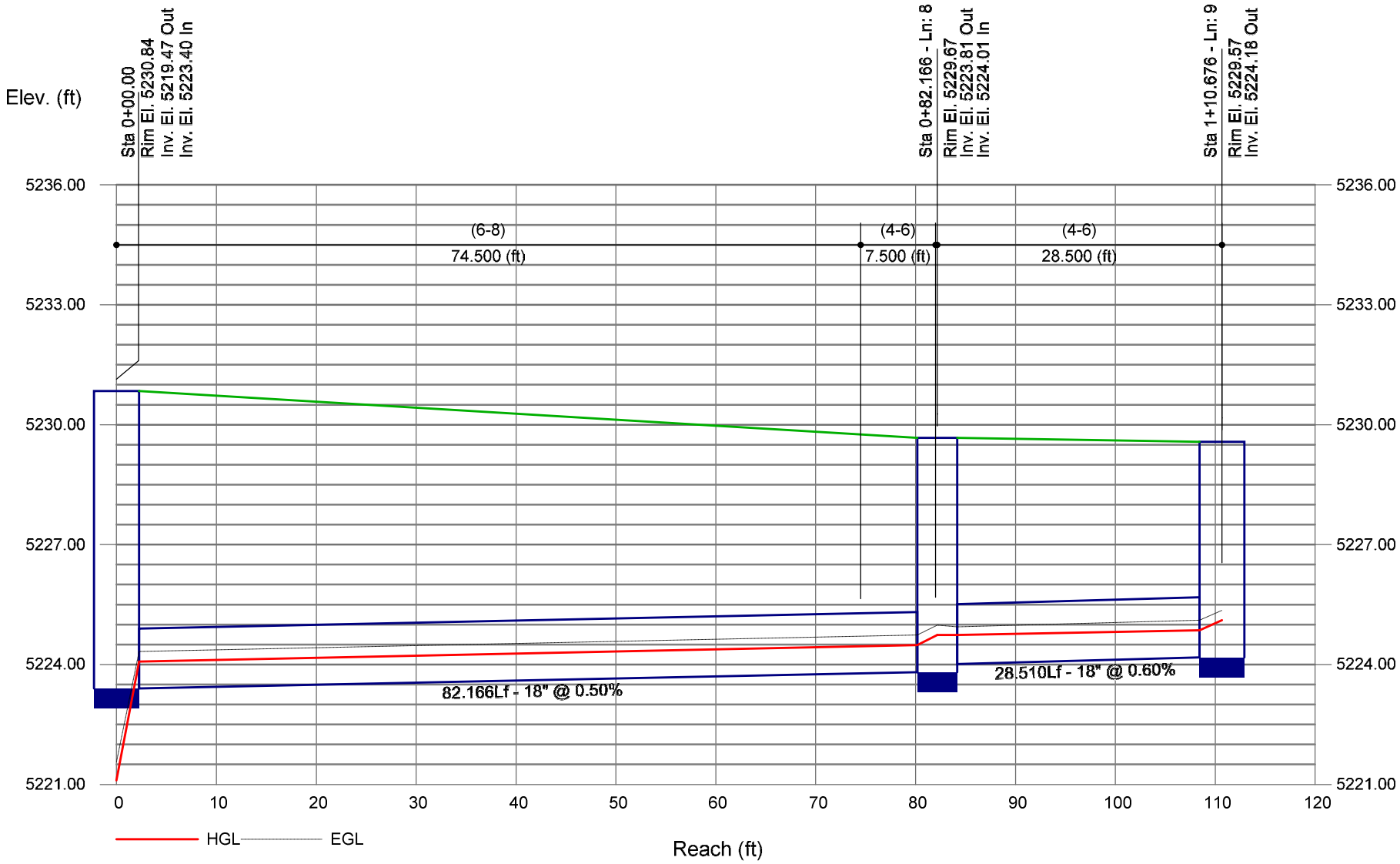

Storm Sewer Profile

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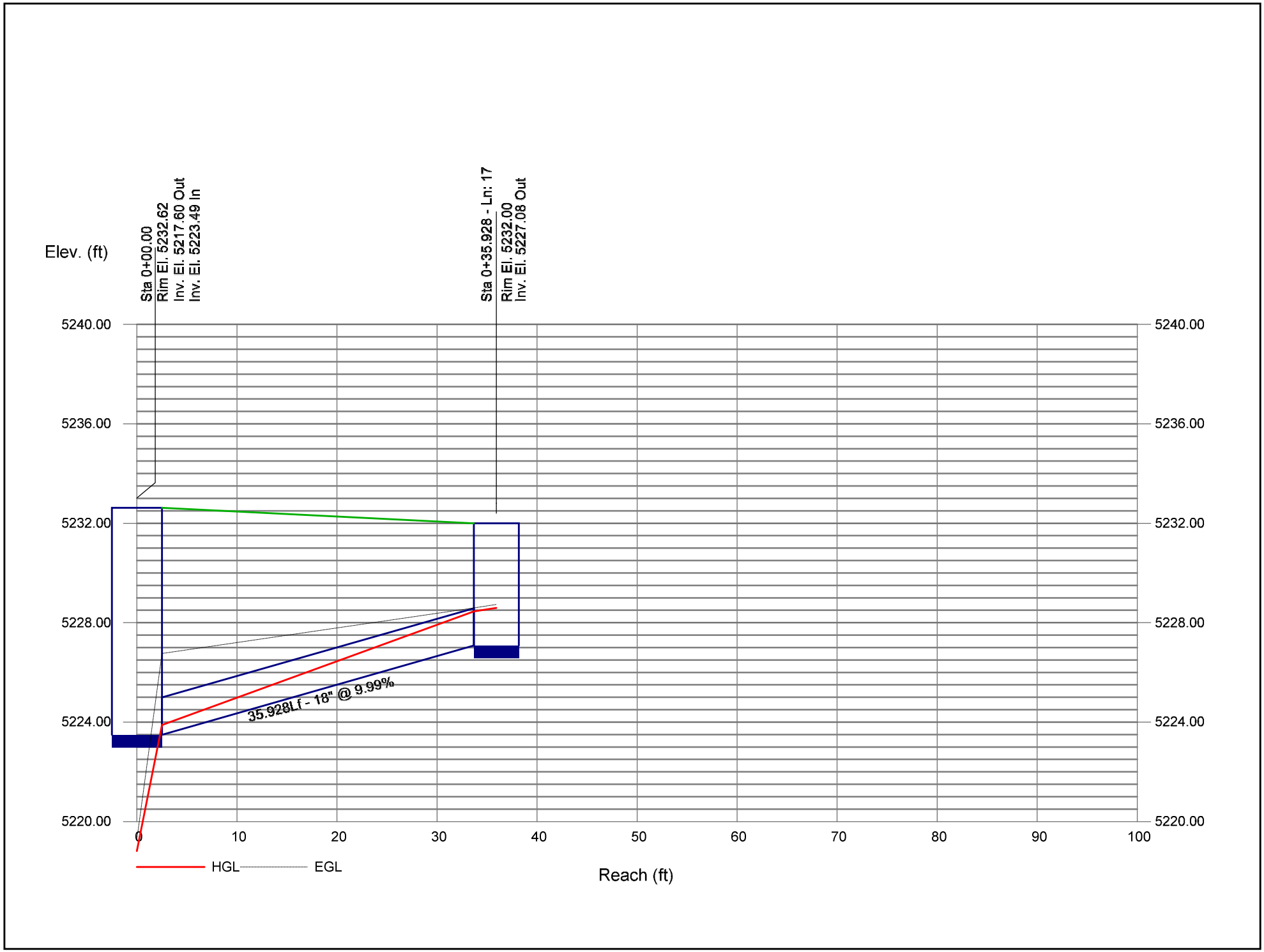

Storm Sewer Profile

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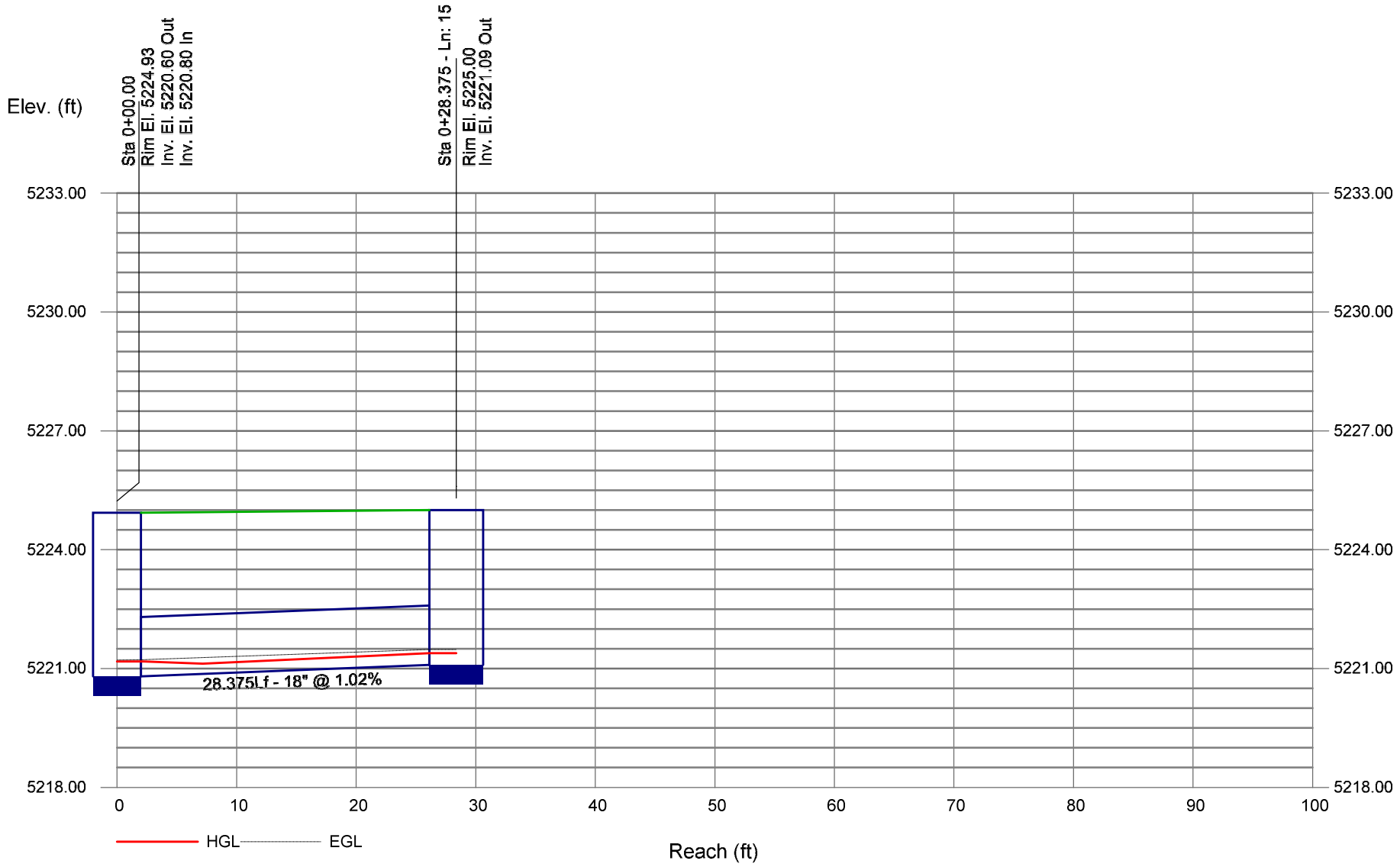

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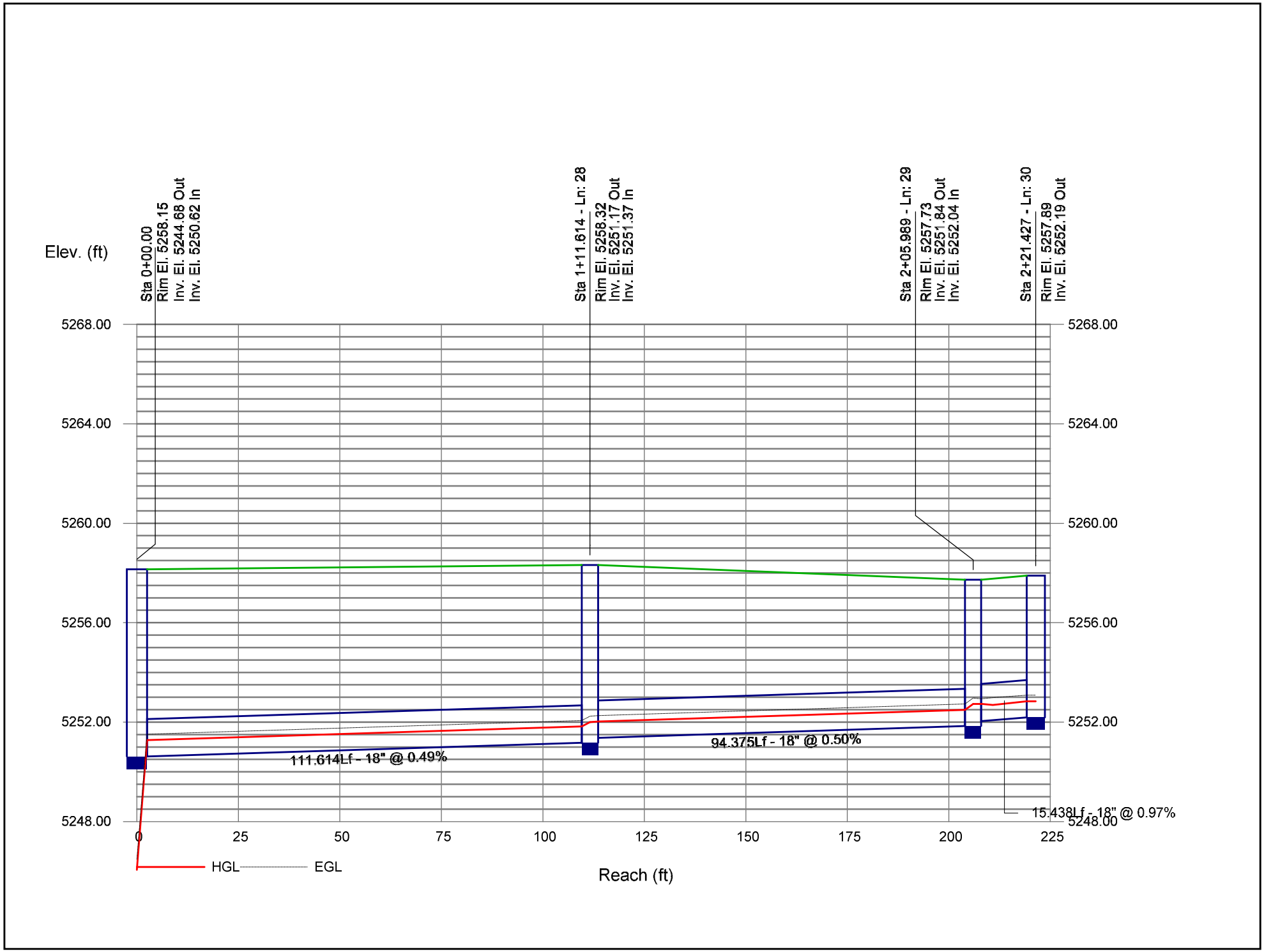

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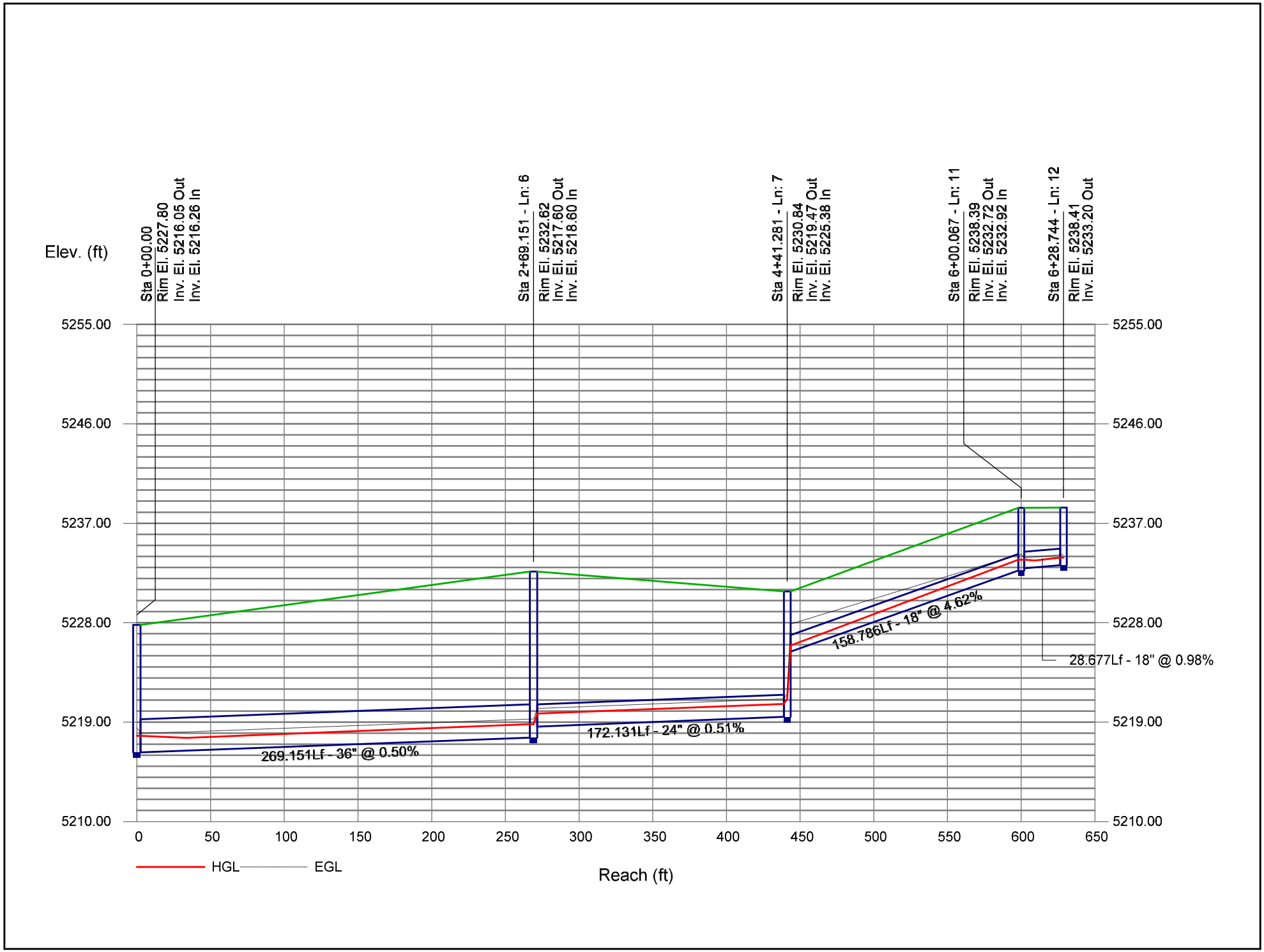

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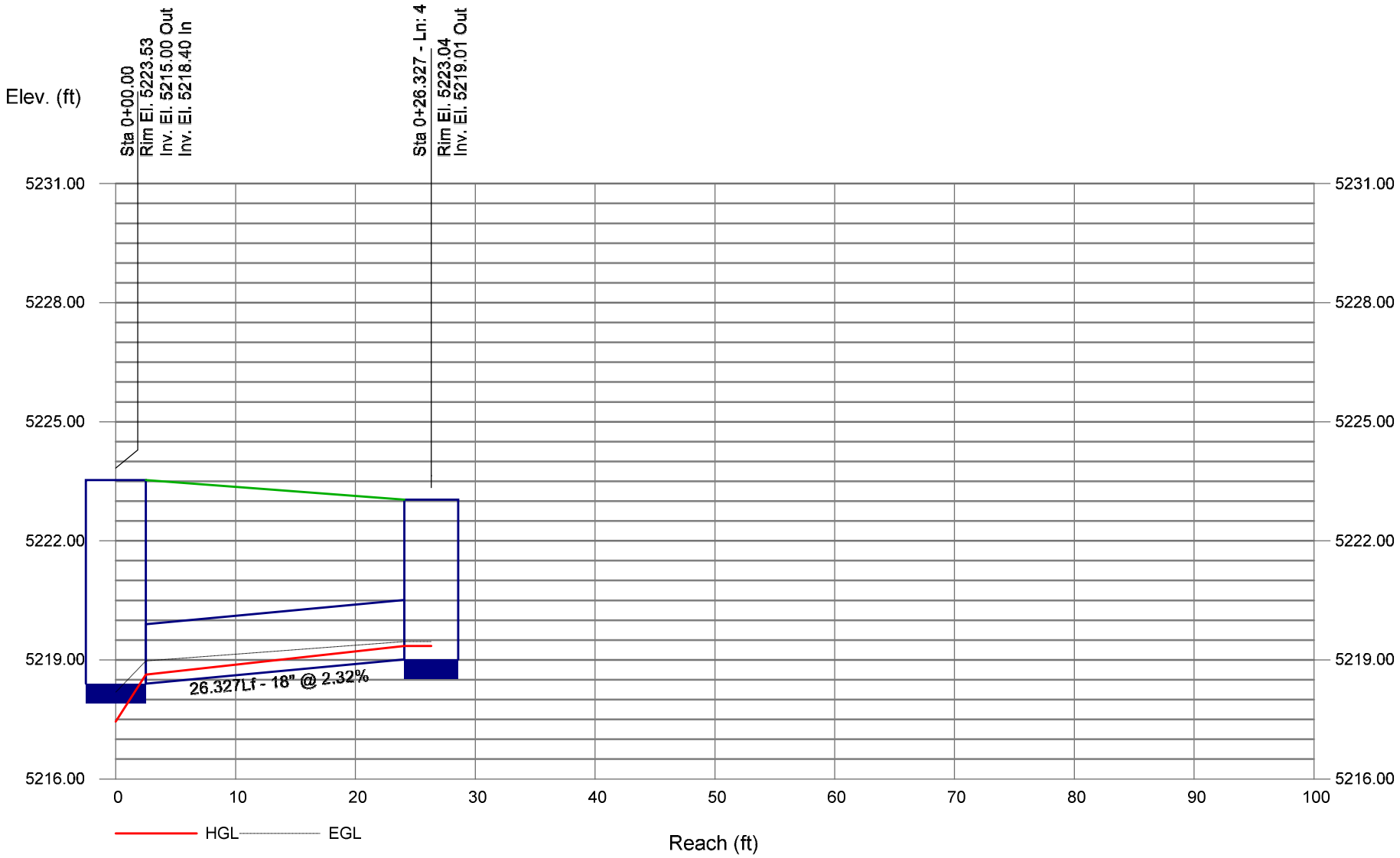

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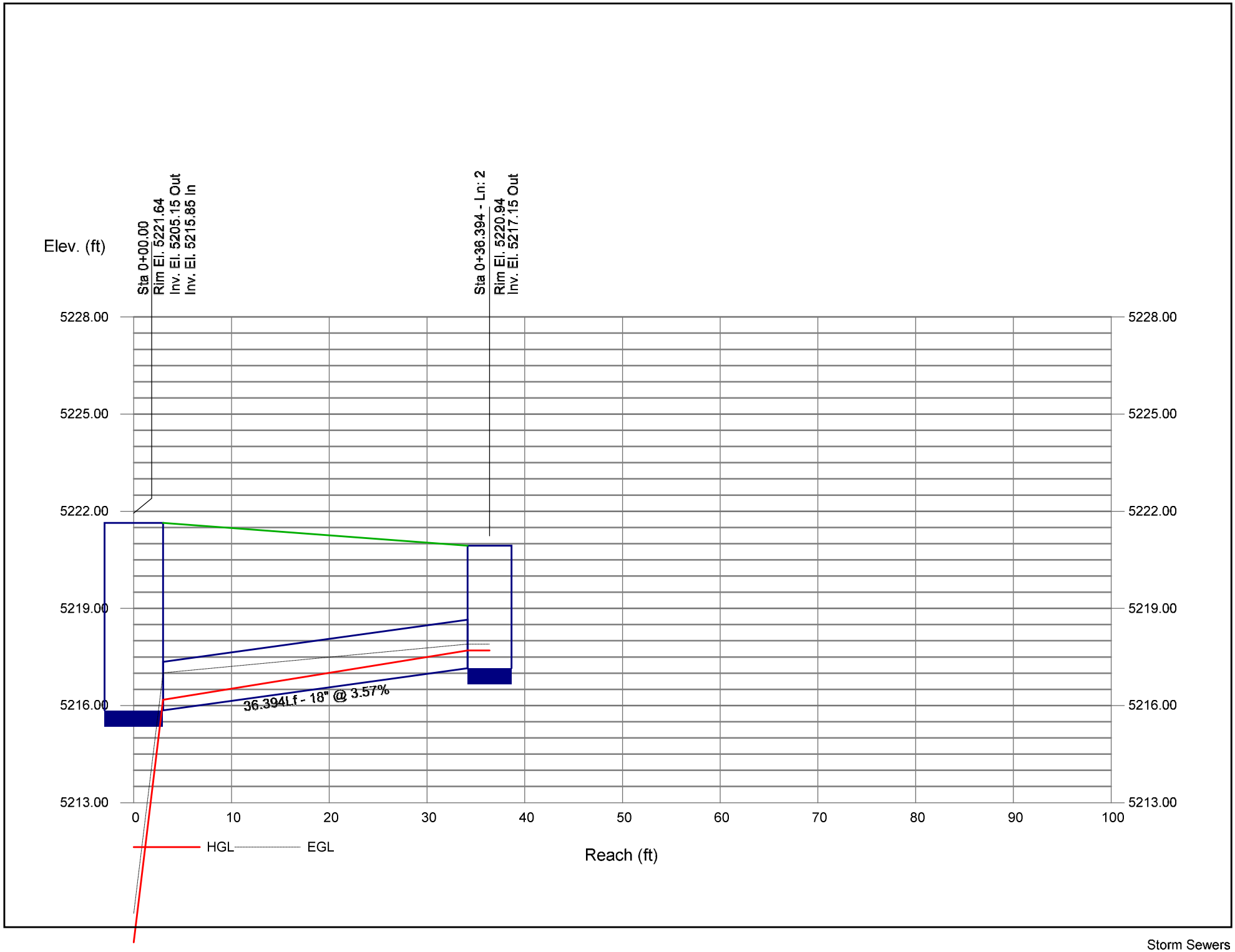

Storm Sewer Profile

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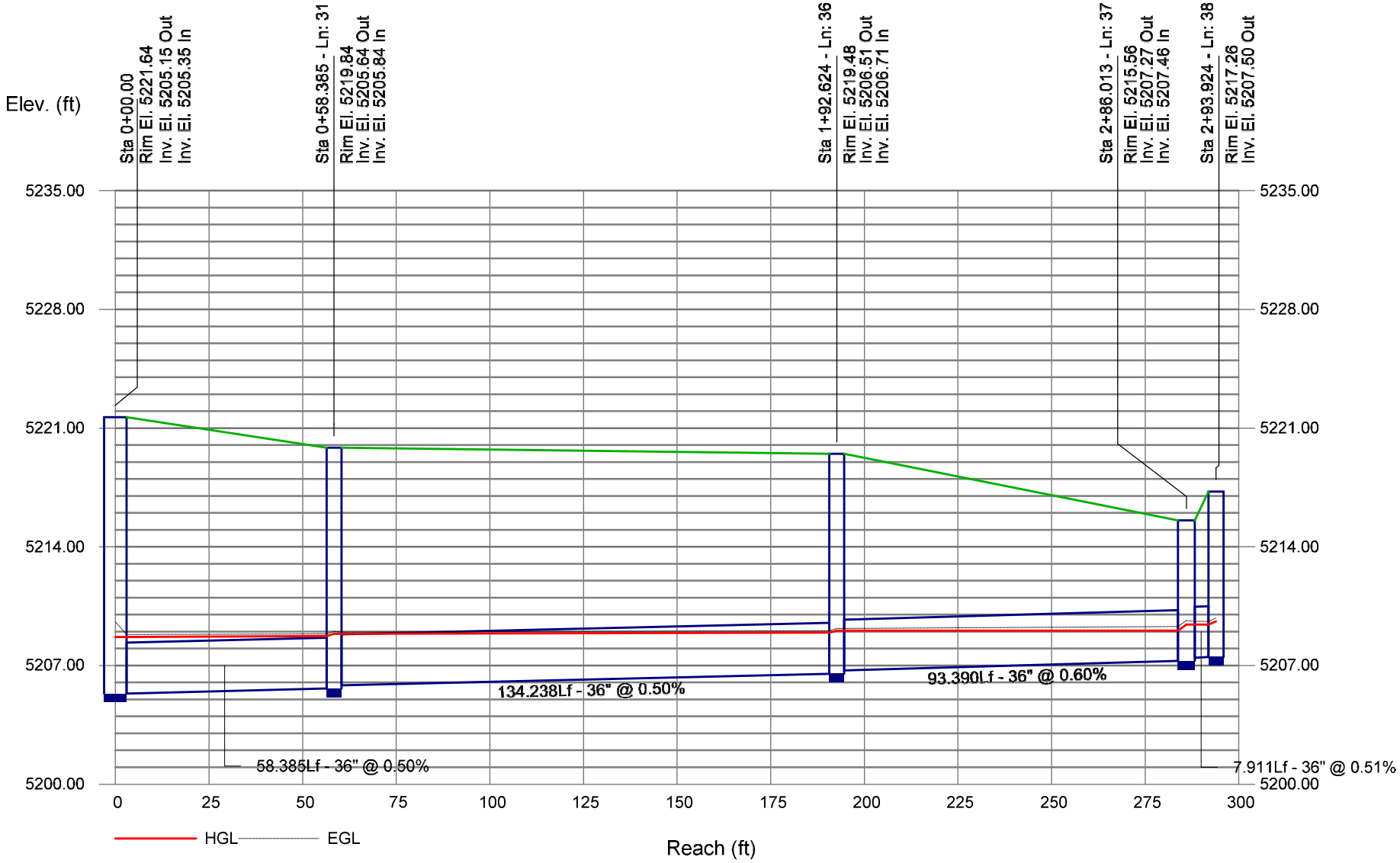

Storm Sewer Profile

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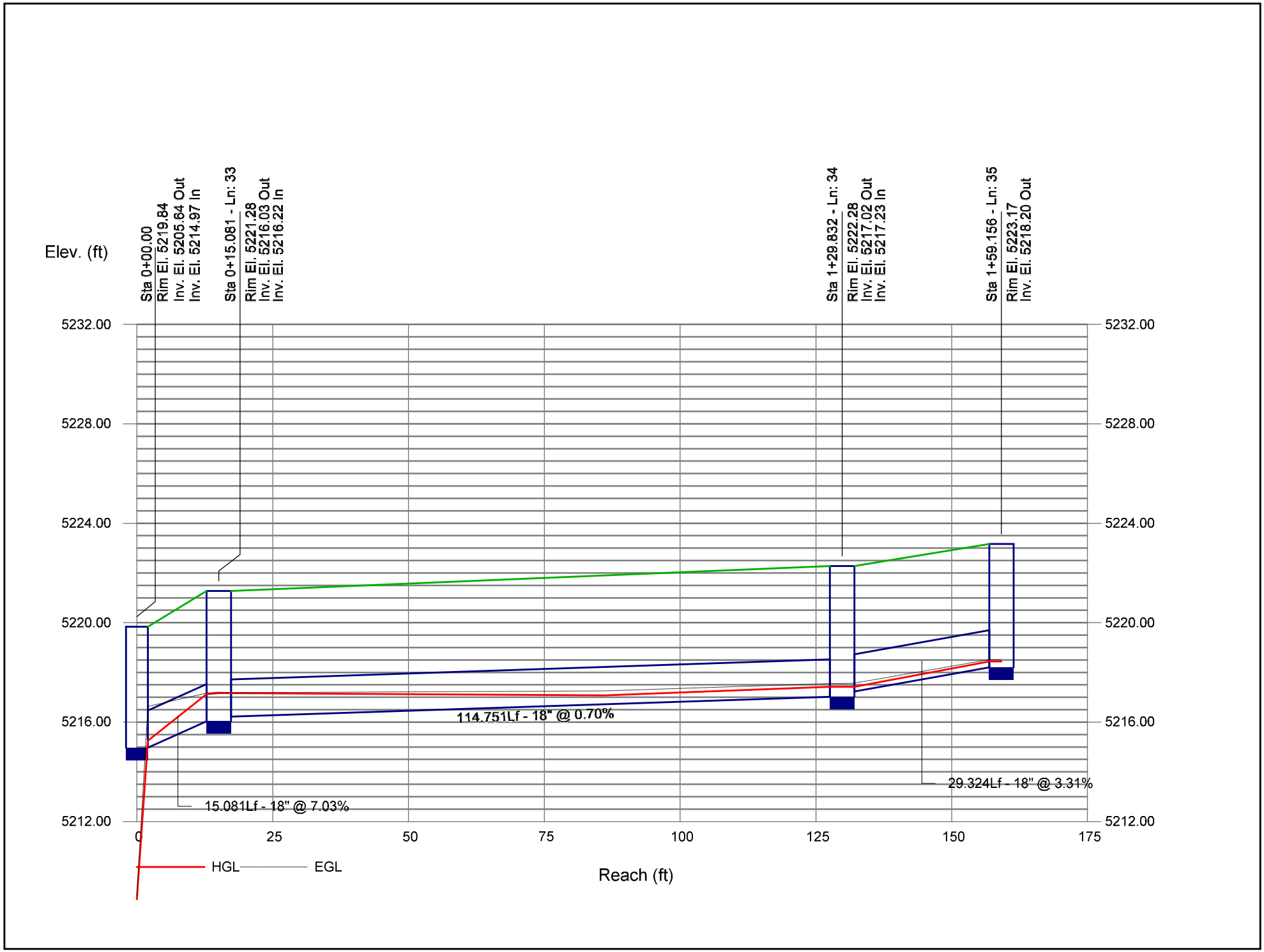

Storm Sewer Profile

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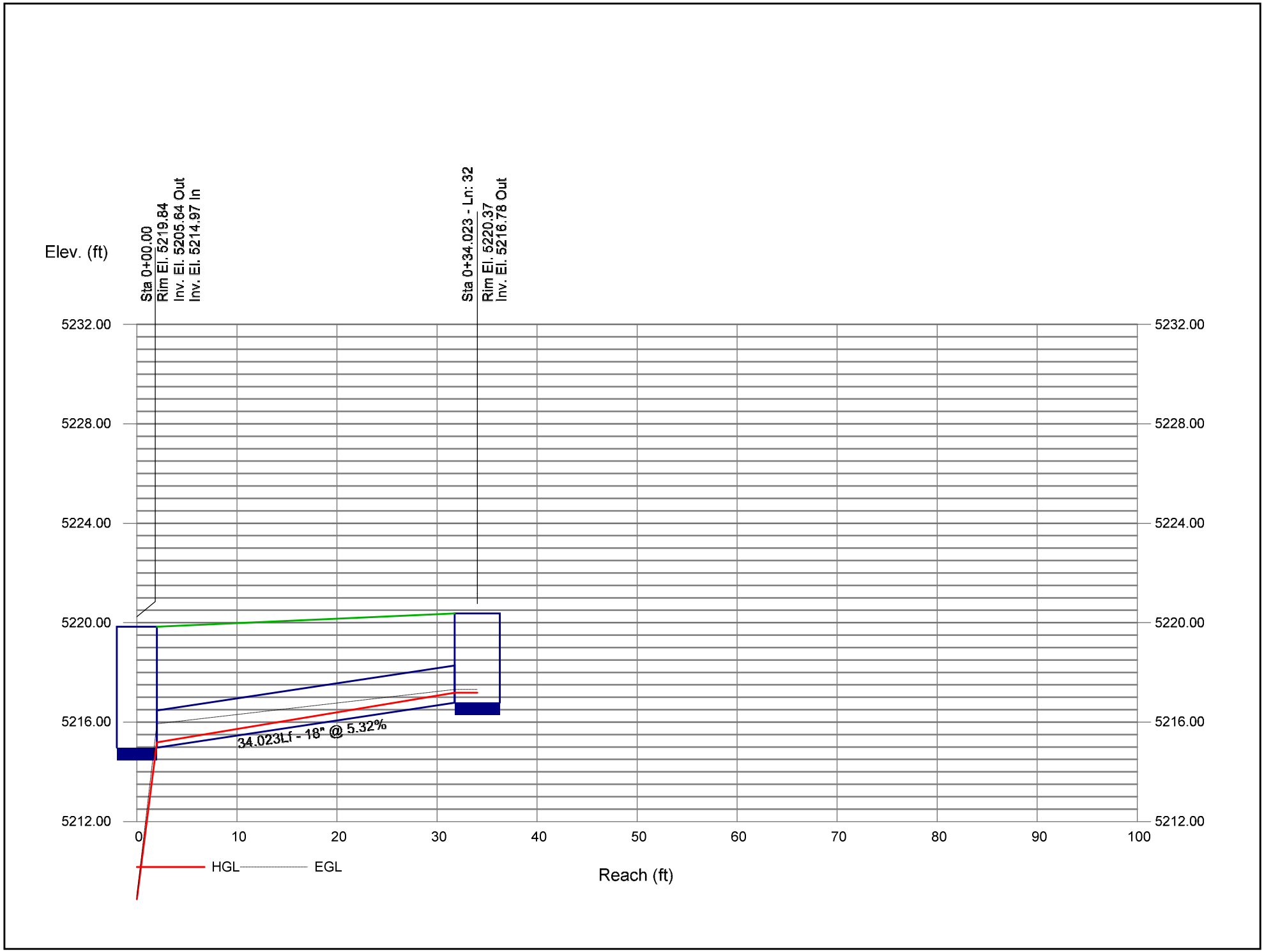

Storm Sewer Profile

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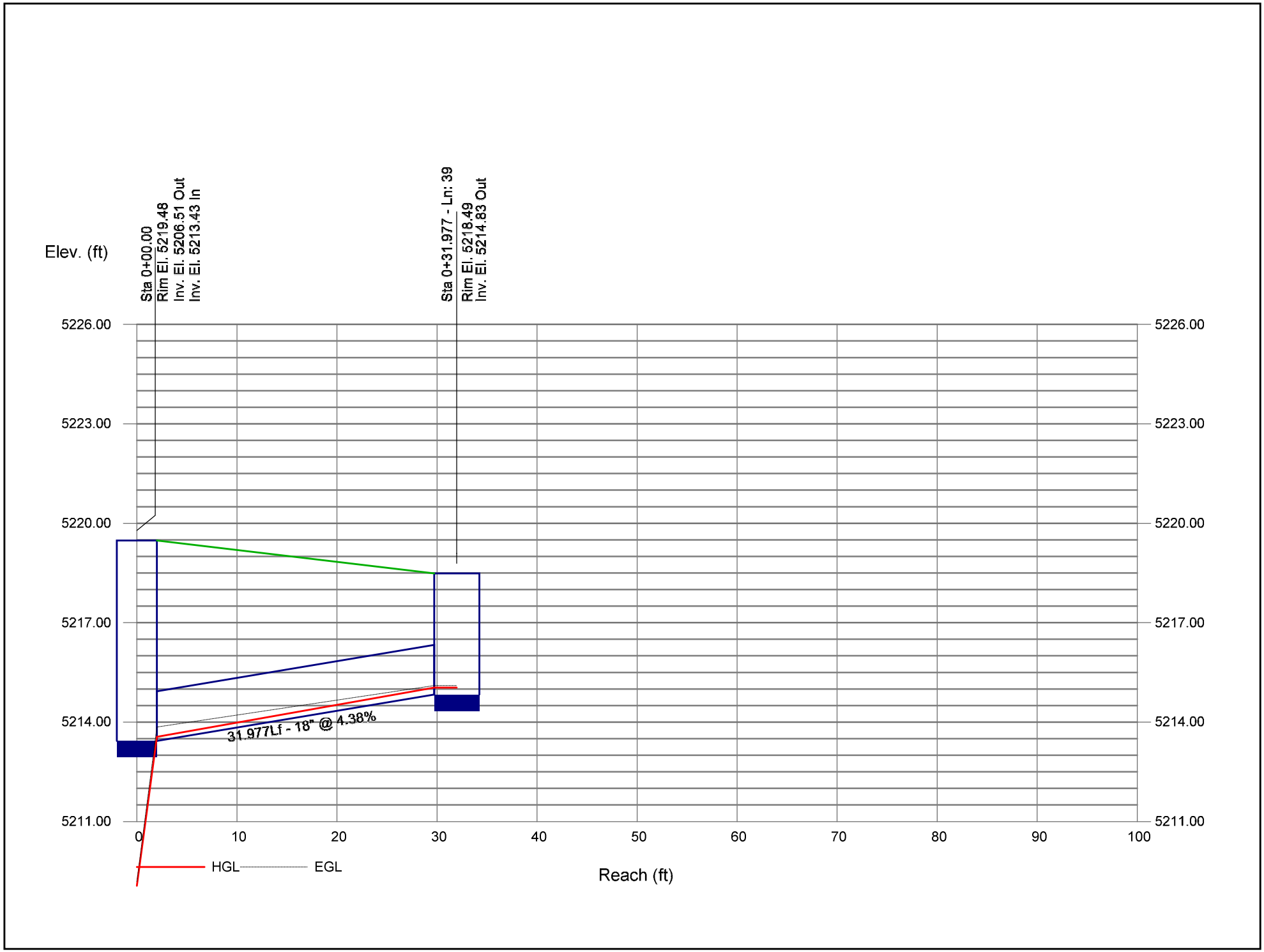

Storm Sewer Profile

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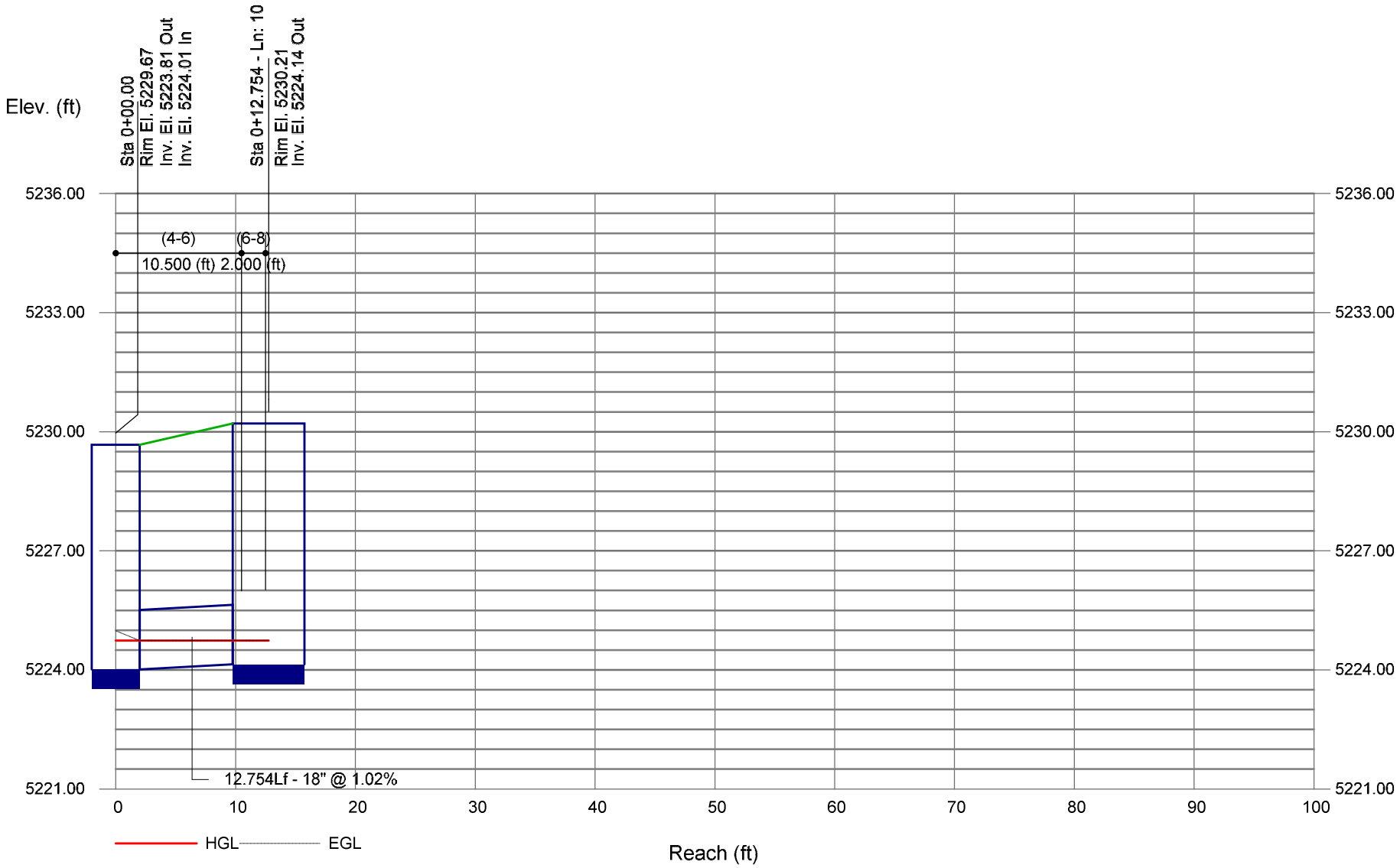

Storm Sewer Profile

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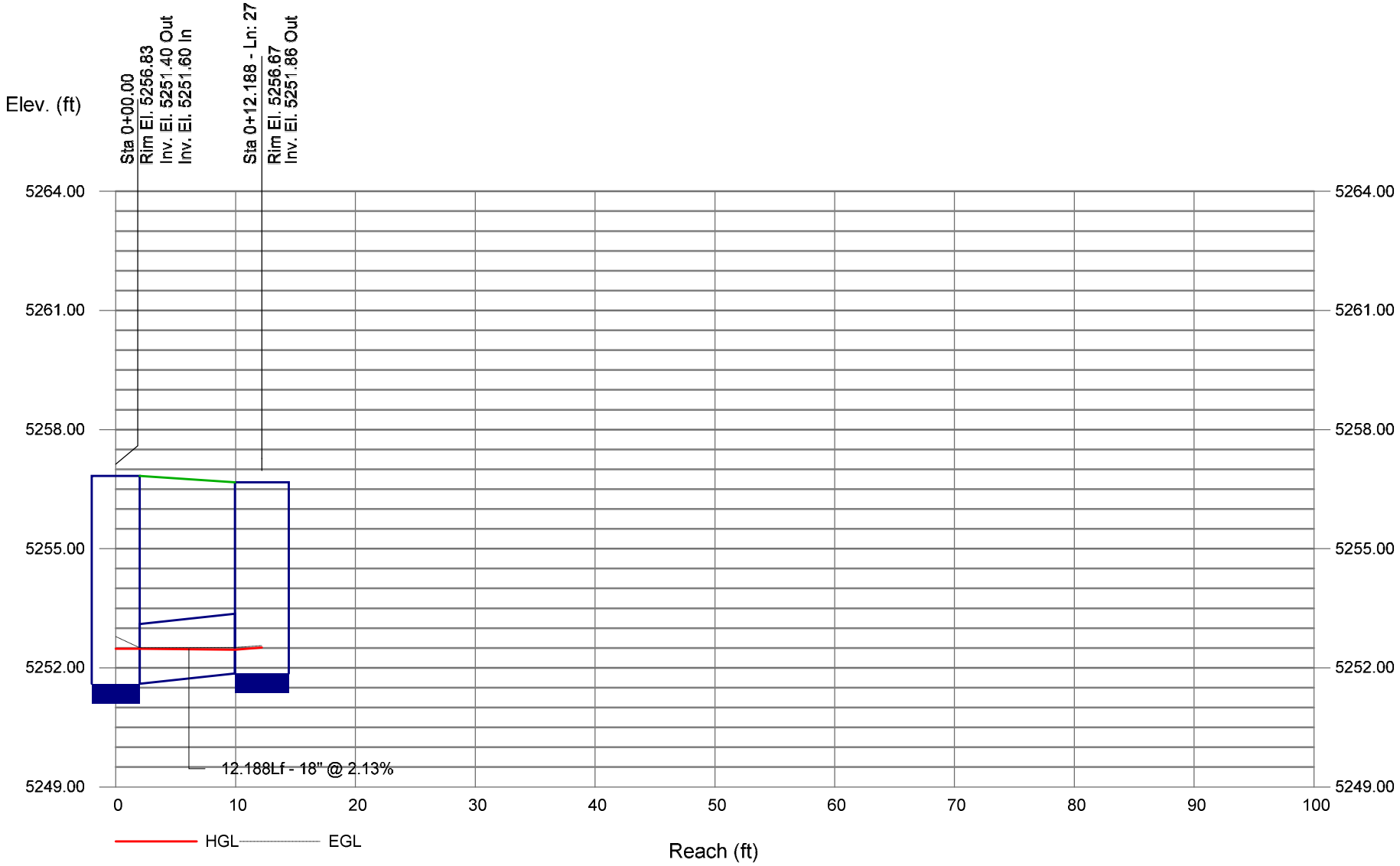

Storm Sewer Profile

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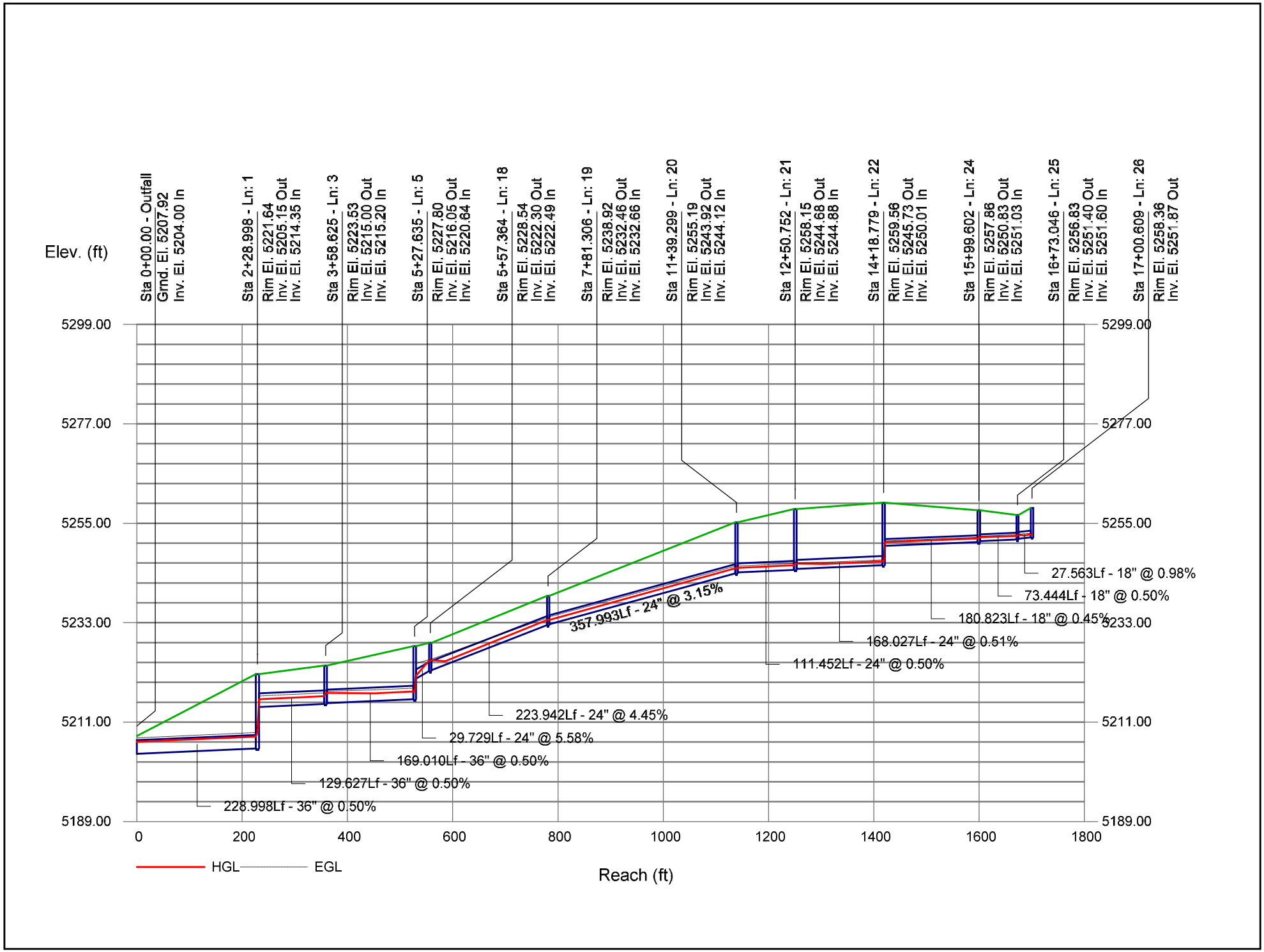
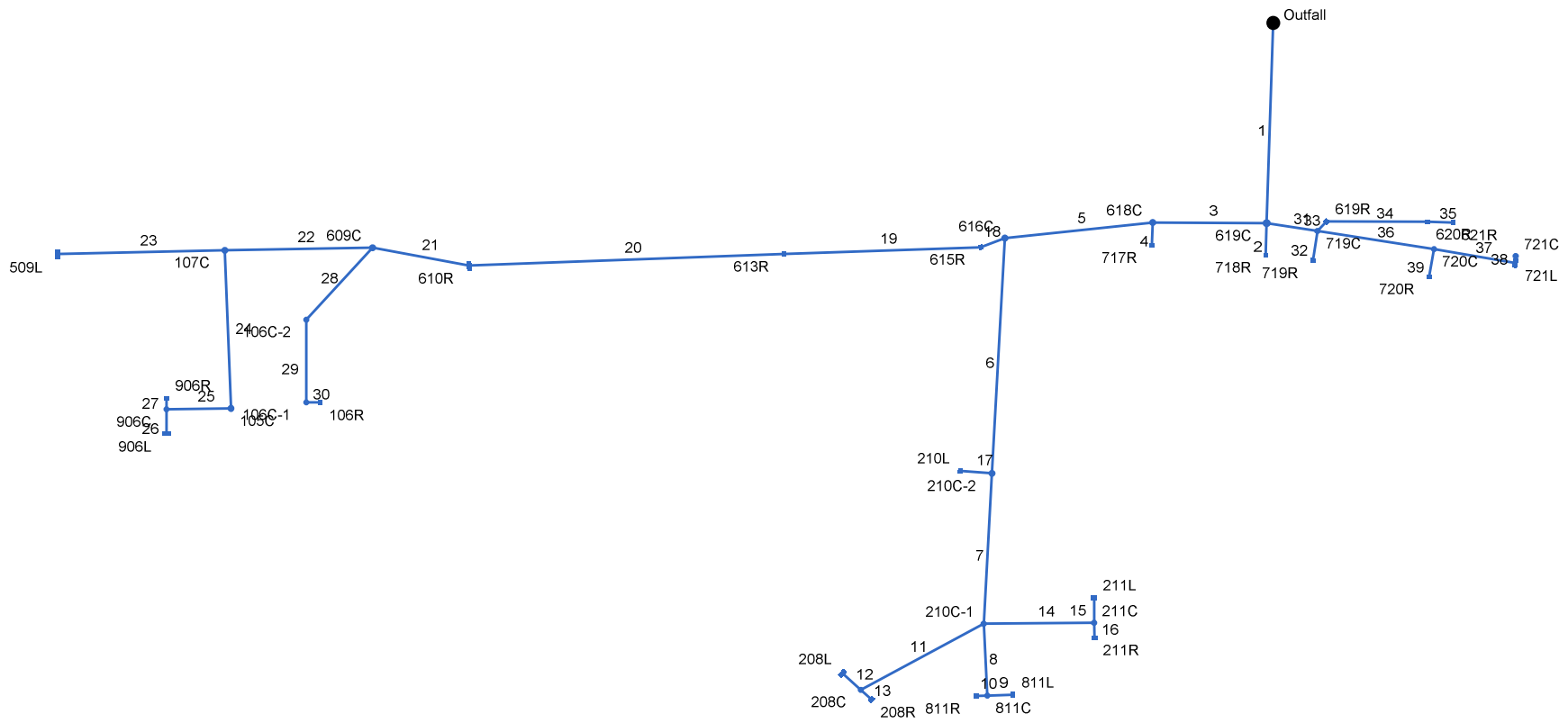


US6 & Fed Blvd: South Storm



Project File: Federal South System 50 YR 122010.stm	Number of lines: 39	Date: 12/21/2010

Storm Sewers v8.00

Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data								Line ID
	Dnstr Line No.	Line Length (ft)	Defl angle (deg)	Junc Type	Known Q (cfs)	Drng Area (ac)	Runoff Coeff (C)	Inlet Time (min)	Invert El Dn (ft)	Line Slope (%)	Invert El Up (ft)	Line Size (in)	Line Shape	N Value (n)	J-Loss Coeff (K)	Inlet/ Rim El (ft)	
1	End	228.998	91.877	MH	112.00	0.00	0.00	0.0	5204.00	0.50	5205.15	36	Cir	0.013	1.00	5221.64	Pipe - Under 6th
2	1	36.394	-0.007	Genr	3.70	0.00	0.00	0.0	5215.85	3.57	5217.15	18	Cir	0.013	1.00	5220.94	Pipe - SE Ramp (71
3	1	129.627	88.455	MH	68.90	0.00	0.00	0.0	5214.35	0.50	5215.00	36	Cir	0.013	1.00	5223.53	Pipe - SE Ramp (6)
4	3	26.327	-88.427	Genr	1.40	0.00	0.00	0.0	5218.40	2.32	5219.01	18	Cir	0.013	1.00	5223.04	Pipe - SE Ramp (71
5	3	169.010	-6.403	MH	68.90	0.00	0.00	0.0	5215.20	0.50	5216.05	36	Cir	0.013	0.99	5227.80	Pipe - SE Ramp (5)
6	5	269.151	-80.801	MH	34.10	0.00	0.00	0.0	5216.26	0.50	5217.60	36	Cir	0.013	1.00	5232.62	Pipe - BP ROW (1)
7	6	172.131	-0.006	MH	25.40	0.00	0.00	0.0	5218.60	0.51	5219.47	24	Cir	0.013	1.00	5230.84	Pipe - BP ROW (2)
8	7	82.166	-6.000	MH	7.70	0.00	0.00	0.0	5223.40	0.50	5223.81	18	Cir	0.013	1.00	5229.67	Pipe - Decatur (1)
9	8	28.510	-88.630	Genr	7.70	0.00	0.00	0.0	5224.01	0.60	5224.18	18	Cir	0.013	1.00	5229.57	Pipe - Decatur (3)
10	8	12.754	91.474	Genr	0.01	0.00	0.00	0.0	5224.01	1.02	5224.14	18	Cir	0.013	1.00	5230.21	Pipe - Decatur (2)
11	7	158.786	58.487	MH	16.50	0.00	0.00	0.0	5225.38	4.62	5232.72	18	Cir	0.013	1.00	5238.39	Pipe - 5th (2)
12	11	28.677	70.387	Genr	7.20	0.00	0.00	0.0	5232.92	0.98	5233.20	18	Cir	0.013	1.00	5238.41	Pipe - 5th - 208L
13	11	16.413	-109.233	Genr	9.50	0.00	0.00	0.0	5232.92	2.13	5233.27	18	Cir	0.013	1.00	5238.51	Pipe - 5th - 208R
14	7	125.505	-93.607	MH	1.90	0.00	0.00	0.0	5219.97	0.50	5220.60	18	Cir	0.013	1.00	5224.93	Pipe - 5th - 211C
15	14	28.375	-89.389	Genr	1.20	0.00	0.00	0.0	5220.80	1.02	5221.09	18	Cir	0.013	1.00	5225.00	Pipe - 5th - 211L
16	14	16.947	88.583	Genr	0.70	0.00	0.00	0.0	5220.80	1.01	5220.97	18	Cir	0.013	1.00	5225.05	Pipe - 5th - 211R
17	6	35.928	91.462	Genr	10.40	0.00	0.00	0.0	5223.49	9.99	5227.08	18	Cir	0.013	1.00	5232.00	Pipe - 5th - 210L
18	5	29.729	-14.612	Genr	21.10	0.00	0.00	0.0	5220.64	5.58	5222.30	24	Cir	0.013	0.56	5228.54	Pipe - SE Ramp (4)
19	18	223.942	18.732	Genr	20.20	0.00	0.00	0.0	5222.49	4.45	5232.46	24	Cir	0.013	0.50	5238.92	Pipe - SE Ramp (3)
20	19	357.993	-0.160	Genr	19.00	0.00	0.00	0.0	5232.66	3.15	5243.92	24	Cir	0.013	0.50	5255.19	Pipe - SE Ramp (2)
21	20	111.452	12.677	MH	16.60	0.00	0.00	0.0	5244.12	0.50	5244.68	24	Cir	0.013	0.87	5258.15	Pipe - SE Ramp (1)
22	21	168.027	-11.589	MH	12.00	0.00	0.00	0.0	5244.88	0.51	5245.73	24	Cir	0.013	1.00	5259.56	Pipe - S Fed (2)
23	22	190.236	-0.276	Genr	4.70	0.00	0.00	0.0	5250.71	1.00	5252.62	18	Cir	0.013	1.00	5257.41	Pipe - SW Ramp

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Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data								Line ID
	Dnstr Line No.	Line Length (ft)	Defl angle (deg)	Junc Type	Known Q (cfs)	Drng Area (ac)	Runoff Coeff (C)	Inlet Time (min)	Invert El Dn (ft)	Line Slope (%)	Invert El Up (ft)	Line Size (in)	Line Shape	N Value (n)	J-Loss Coeff (K)	Inlet/ Rim El (ft)	
24	22	180.823	-91.196	MH	7.80	0.00	0.00	0.0	5250.01	0.45	5250.83	18	Cir	0.013	1.00	5257.86	Pipe - S Fed (3)
25	24	73.444	91.438	MH	7.90	0.00	0.00	0.0	5251.03	0.50	5251.40	18	Cir	0.013	1.00	5256.83	Pipe - W 5th (1)
26	25	27.563	-89.090	Genr	5.30	0.00	0.00	0.0	5251.60	0.98	5251.87	18	Cir	0.013	1.00	5258.36	Pipe - W 5th (906L
27	25	12.188	90.780	Genr	2.60	0.00	0.00	0.0	5251.60	2.13	5251.86	18	Cir	0.013	1.00	5256.67	Pipe - W 5th (906R
28	21	111.614	-58.131	MH	5.20	0.00	0.00	0.0	5250.62	0.49	5251.17	18	Cir	0.013	0.72	5258.32	Pipe - S Fed (4)
29	28	94.375	-42.360	MH	5.30	0.00	0.00	0.0	5251.37	0.50	5251.84	18	Cir	0.013	1.00	5257.73	Pipe - S Fed (1)
30	29	15.438	-89.612	Genr	5.30	0.00	0.00	0.0	5252.04	0.97	5252.19	18	Cir	0.013	1.00	5257.89	Pipe - S Fed (106R
31	1	58.385	-83.009	MH	42.50	0.00	0.00	0.0	5205.35	0.50	5205.64	36	Cir	0.013	1.00	5219.84	Pipe - Slip Ramp (
32	31	34.023	89.903	Genr	2.00	0.00	0.00	0.0	5214.97	5.32	5216.78	18	Cir	0.013	1.00	5220.37	Pipe - SE Ramp (71
33	31	15.081	-56.051	Genr	3.90	0.00	0.00	0.0	5214.97	7.03	5216.03	18	Cir	0.013	1.16	5221.28	Pipe - SE Ramp (61
34	33	114.751	47.433	Genr	2.00	0.00	0.00	0.0	5216.22	0.70	5217.02	18	Cir	0.013	0.50	5222.28	Pipe - SE Ramp (62
35	34	29.324	1.338	Genr	0.80	0.00	0.00	0.0	5217.23	3.31	5218.20	18	Cir	0.013	1.00	5223.17	Pipe - SE Ramp (62
36	31	134.238	0.025	MH	36.70	0.00	0.00	0.0	5205.84	0.50	5206.51	36	Cir	0.013	1.00	5219.48	Pipe - Slip Ramp (
37	36	93.390	0.778	Genr	36.10	0.00	0.00	0.0	5206.71	0.60	5207.27	36	Cir	0.013	1.50	5215.56	Pipe - SE Ramp (72
38	37	7.911	-94.230	MH	35.20	0.00	0.00	0.0	5207.46	0.51	5207.50	36	Cir	0.013	1.00	5217.26	Pipe - Slip Ramp D
39	36	31.977	91.012	Genr	0.70	0.00	0.00	0.0	5213.43	4.38	5214.83	18	Cir	0.013	1.00	5218.49	Pipe - SE Ramp (72

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Structure Report

Struct No.	Structure ID	Junction Type	Rim Elev (ft)	Structure			Line Out			Line In		
				Shape	Length (ft)	Width (ft)	Size (in)	Shape	Invert (ft)	Size (in)	Shape	Invert (ft)
1	619C	Manhole	5221.64	Cir	6.00	6.00	36	Cir	5205.15	18 36 36	Cir Cir Cir	5215.85 5214.35 5205.35
2	718R	Generic	5220.94	Rect	4.50	5.00	18	Cir	5217.15			
3	618C	Manhole	5223.53	Cir	5.00	5.00	36	Cir	5215.00	18 36	Cir Cir	5218.40 5215.20
4	717R	Generic	5223.04	Rect	4.50	5.00	18	Cir	5219.01			
5	616C	Manhole	5227.80	Cir	5.00	5.00	36	Cir	5216.05	36 24	Cir Cir	5216.26 5220.64
6	210C-2	Manhole	5232.62	Cir	5.00	5.00	36	Cir	5217.60	24 18	Cir Cir	5218.60 5223.49
7	210C-1	Manhole	5230.84	Cir	4.50	4.50	24	Cir	5219.47	18 18 18	Cir Cir Cir	5223.40 5225.38 5219.97
8	811C	Manhole	5229.67	Cir	4.00	4.00	18	Cir	5223.81	18 18	Cir Cir	5224.01 5224.01
9	811L	Generic	5229.57	Rect	4.50	6.00	18	Cir	5224.18			
10	811R	Generic	5230.21	Rect	6.00	4.50	18	Cir	5224.14			
11	208C	Manhole	5238.39	Cir	4.00	4.00	18	Cir	5232.72	18 18	Cir Cir	5232.92 5232.92
12	208L	Generic	5238.41	Rect	4.50	9.00	18	Cir	5233.20			
13	208R	Generic	5238.51	Rect	4.50	6.00	18	Cir	5233.27			
14	211C	Manhole	5224.93	Cir	4.00	4.00	18	Cir	5220.60	18 18	Cir Cir	5220.80 5220.80
15	211L	Generic	5225.00	Rect	4.50	6.00	18	Cir	5221.09			
16	211R	Generic	5225.05	Rect	4.50	6.00	18	Cir	5220.97			
17	210L	Generic	5232.00	Rect	4.50	6.00	18	Cir	5227.08			
18	615R	Generic	5228.54	Rect	4.50	5.00	24	Cir	5222.30	24	Cir	5222.49

Structure Report

Struct No.	Structure ID	Junction Type	Rim Elev (ft)	Structure			Line Out			Line In		
				Shape	Length (ft)	Width (ft)	Size (in)	Shape	Invert (ft)	Size (in)	Shape	Invert (ft)
19	613R	Generic	5238.92	Rect	4.50	5.00	24	Cir	5232.46	24	Cir	5232.66
20	610R	Generic	5255.19	Rect	4.50	10.00	24	Cir	5243.92	24	Cir	5244.12
21	609C	Manhole	5258.15	Cir	5.00	5.00	24	Cir	5244.68	24 18	Cir Cir	5244.88 5250.62
22	107C	Manhole	5259.56	Cir	5.00	5.00	24	Cir	5245.73	18 18	Cir Cir	5250.71 5250.01
23	509L	Generic	5257.41	Rect	5.00	10.00	18	Cir	5252.62			
24	105C	Manhole	5257.86	Cir	5.00	5.00	18	Cir	5250.83	18	Cir	5251.03
25	906C	Manhole	5256.83	Cir	4.00	4.00	18	Cir	5251.40	18 18	Cir Cir	5251.60 5251.60
26	906L	Generic	5258.36	Rect	4.50	9.00	18	Cir	5251.87			
27	906R	Generic	5256.67	Rect	4.50	6.00	18	Cir	5251.86			
28	106C-2	Manhole	5258.32	Cir	4.00	4.00	18	Cir	5251.17	18	Cir	5251.37
29	106C-1	Manhole	5257.73	Cir	4.00	4.00	18	Cir	5251.84	18	Cir	5252.04
30	106R	Generic	5257.89	Rect	4.50	6.00	18	Cir	5252.19			
31	719C	Manhole	5219.84	Cir	4.00	4.00	36	Cir	5205.64	18 18 36	Cir Cir Cir	5214.97 5214.97 5205.84
32	719R	Generic	5220.37	Rect	4.50	5.00	18	Cir	5216.78			
33	619R	Generic	5221.28	Rect	4.50	5.00	18	Cir	5216.03	18	Cir	5216.22
34	620R	Generic	5222.28	Rect	4.50	5.00	18	Cir	5217.02	18	Cir	5217.23
35	621R	Generic	5223.17	Rect	4.50	5.00	18	Cir	5218.20			
36	720C	Manhole	5219.48	Cir	4.00	4.00	36	Cir	5206.51	36 18	Cir Cir	5206.71 5213.43
37	721L	Generic	5215.56	Rect	4.50	10.00	36	Cir	5207.27	36	Cir	5207.46
38	721C	Manhole	5217.26	Cir	4.00	4.00	36	Cir	5207.50			

Structure Report

Struct No.	Structure ID	Junction Type	Rim Elev (ft)	Structure			Line Out			Line In		
				Shape	Length (ft)	Width (ft)	Size (in)	Shape	Invert (ft)	Size (in)	Shape	Invert (ft)
39	720R	Generic	5218.49	Rect	4.50	5.00	18	Cir	5214.83			

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	Pipe - Under 6th	112.0	36	Cir	228.998	5204.00	5205.15	0.502	5207.00*	5213.46*	3.90	5217.36	End	Manhole
2	Pipe - SE Ramp (718R)	3.70	18	Cir	36.394	5215.85	5217.15	3.571	5217.36	5217.88	n/a	5217.88 j	1	Generic
3	Pipe - SE Ramp (6)	68.90	36	Cir	129.627	5214.35	5215.00	0.501	5217.36*	5218.75*	1.48	5220.23	1	Manhole
4	Pipe - SE Ramp (717R)	1.40	18	Cir	26.327	5218.40	5219.01	2.316	5220.23	5220.23	0.01	5220.24	3	Generic
5	Pipe - SE Ramp (5)	68.90	36	Cir	169.010	5215.20	5216.05	0.503	5220.23*	5222.03*	1.46	5223.49	3	Manhole
6	Pipe - BP ROW (1)	34.10	36	Cir	269.151	5216.26	5217.60	0.498	5223.49*	5224.20*	0.36	5224.56	5	Manhole
7	Pipe - BP ROW (2)	25.40	24	Cir	172.131	5218.60	5219.47	0.505	5224.56*	5226.73*	1.02	5227.75	6	Manhole
8	Pipe - Decatur (1)	7.70	18	Cir	82.166	5223.40	5223.81	0.499	5227.75*	5228.19*	0.30	5228.48	7	Manhole
9	Pipe - Decatur (3)	7.70	18	Cir	28.510	5224.01	5224.18	0.598	5228.48*	5228.64*	0.30	5228.93	8	Generic
10	Pipe - Decatur (2)	0.01	18	Cir	12.754	5224.01	5224.14	1.022	5228.48*	5228.48*	0.00	5228.48	8	Generic
11	Pipe - 5th (2)	16.50	18	Cir	158.786	5225.38	5232.72	4.623	5227.75	5234.16	n/a	5234.16 j	7	Manhole
12	Pipe - 5th - 208L	7.20	18	Cir	28.677	5232.92	5233.20	0.977	5234.16	5234.23	n/a	5234.23 j	11	Generic
13	Pipe - 5th - 208R	9.50	18	Cir	16.413	5232.92	5233.27	2.133	5234.16	5234.45	n/a	5234.45	11	Generic
14	Pipe - 5th - 211C	1.90	18	Cir	125.505	5219.97	5220.60	0.502	5227.75*	5227.79*	0.02	5227.81	7	Manhole
15	Pipe - 5th - 211L	1.20	18	Cir	28.375	5220.80	5221.09	1.022	5227.81*	5227.81*	0.01	5227.82	14	Generic
16	Pipe - 5th - 211R	0.70	18	Cir	16.947	5220.80	5220.97	1.006	5227.81*	5227.81*	0.00	5227.81	14	Generic
17	Pipe - 5th - 210L	10.40	18	Cir	35.928	5223.49	5227.08	9.992	5224.56	5228.31	0.70	5228.31	6	Generic
18	Pipe - SE Ramp (4)	21.10	24	Cir	29.729	5220.64	5222.30	5.583	5223.49	5223.93	0.52	5223.93	5	Generic
19	Pipe - SE Ramp (3)	20.20	24	Cir	223.942	5222.49	5232.46	4.452	5223.93	5234.05	n/a	5234.05	18	Generic
20	Pipe - SE Ramp (2)	19.00	24	Cir	357.993	5232.66	5243.92	3.145	5234.05	5245.46	0.41	5245.46	19	Generic
21	Pipe - SE Ramp (1)	16.60	24	Cir	111.452	5244.12	5244.68	0.503	5245.83	5246.39	0.46	5246.85	20	Manhole
22	Pipe - S Fed (2)	12.00	24	Cir	168.027	5244.88	5245.73	0.506	5246.85	5247.22	0.35	5247.58	21	Manhole
23	Pipe - SW Ramp	4.70	18	Cir	190.236	5250.71	5252.62	1.004	5251.41	5253.45	0.34	5253.45	22	Generic
24	Pipe - S Fed (3)	7.80	18	Cir	180.823	5250.01	5250.83	0.454	5251.51*	5252.51*	0.30	5252.81	22	Manhole

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NOTES: Return period = 5 Yrs. ; *Surcharged (HGL above crown). ; j - Line contains hyd. jump.

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
25	Pipe - W 5th (1)	7.90	18	Cir	73.444	5251.03	5251.40	0.504	5252.81*	5253.23*	0.31	5253.54	24	Manhole
26	Pipe - W 5th (906L)	5.30	18	Cir	27.563	5251.60	5251.87	0.980	5253.54*	5253.61*	0.14	5253.75	25	Generic
27	Pipe - W 5th (906R)	2.60	18	Cir	12.188	5251.60	5251.86	2.131	5253.54*	5253.55*	0.03	5253.58	25	Generic
28	Pipe - S Fed (4)	5.20	18	Cir	111.614	5250.62	5251.17	0.493	5251.55	5252.10	0.23	5252.33	21	Manhole
29	Pipe - S Fed (1)	5.30	18	Cir	94.375	5251.37	5251.84	0.498	5252.33	5252.77	0.33	5253.10	28	Manhole
30	Pipe - S Fed (106R)	5.30	18	Cir	15.438	5252.04	5252.19	0.971	5253.10	5253.07	n/a	5253.45 j	29	Generic
31	Pipe - Slip Ramp (2)	42.50	36	Cir	58.385	5205.35	5205.64	0.497	5217.36*	5217.60*	0.56	5218.16	1	Manhole
32	Pipe - SE Ramp (719R)	2.00	18	Cir	34.023	5214.97	5216.78	5.319	5218.16	5218.18	0.02	5218.20	31	Generic
33	Pipe - SE Ramp (619R)	3.90	18	Cir	15.081	5214.97	5216.03	7.026	5218.16*	5218.19*	0.09	5218.27	31	Generic
34	Pipe - SE Ramp (620R)	2.00	18	Cir	114.751	5216.22	5217.02	0.697	5218.27	5218.31	0.01	5218.32	33	Generic
35	Pipe - SE Ramp (621R)	0.80	18	Cir	29.324	5217.23	5218.20	3.309	5218.32	5218.54	n/a	5218.54 j	34	Generic
36	Pipe - Slip Ramp (1)	36.70	36	Cir	134.238	5205.84	5206.51	0.499	5218.16*	5218.57*	0.42	5218.99	31	Manhole
37	Pipe - SE Ramp (721L)	36.10	36	Cir	93.390	5206.71	5207.27	0.600	5218.99*	5219.26*	0.61	5219.87	36	Generic
38	Pipe - Slip Ramp Diversion	35.20	36	Cir	7.911	5207.46	5207.50	0.506	5219.87*	5219.90*	0.39	5220.28	37	Manhole
39	Pipe - SE Ramp (720R)	0.70	18	Cir	31.977	5213.43	5214.83	4.378	5218.99*	5218.99*	0.00	5218.99	36	Generic

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Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q Byp (cfs)	Junc Type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp Line No
							Ht (in)	L (ft)	Area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	619C	112.00*	432.70	0.00	544.70	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
2	718R	3.70*	0.00	2.10	1.60	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	1
3	618C	68.90*	241.40	0.00	310.30	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	1
4	717R	1.40*	0.00	0.80	0.60	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	3
5	616C	68.90*	171.90	0.00	240.80	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	3
6	210C-2	34.10*	72.20	0.00	106.30	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	5
7	210C-1	25.40*	41.50	0.00	66.90	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	6
8	811C	7.70*	4.60	0.00	12.30	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	7
9	811L	7.70*	0.00	3.10	4.60	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	8
10	811R	0.01*	0.00	0.01	0.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	8
11	208C	16.50*	9.90	0.00	26.40	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	7
12	208L	7.20*	0.00	3.20	4.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	11
13	208R	9.50*	0.00	3.60	5.90	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	11
14	211C	1.90*	0.90	0.00	2.80	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	7
15	211L	1.20*	0.00	0.60	0.60	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	14
16	211R	0.70*	0.00	0.40	0.30	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	14
17	210L	10.40*	0.00	5.10	5.30	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	6
18	615R	21.10*	55.00	10.50	65.60	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	5
19	613R	20.20*	44.90	10.10	55.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	18
20	610R	19.00*	63.50	37.60	44.90	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	19
21	609C	16.60*	46.90	0.00	63.50	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	20
22	107C	12.00*	22.00	0.00	34.00	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	21
23	509L	4.70*	0.00	2.10	2.60	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	22

US6 & Fed Blvd: South Storm | Number of lines: 39 | Run Date: 12/21/2010

NOTES: Inlet N-Values = 0.016; Intensity = 79.26 / (Inlet time + 14.60) ^ 0.84; Return period = 5 Yrs. ; * Indicates Known Q added. All curb inlets are Horiz throat.

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q Byp (cfs)	Junc Type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp Line No
							Ht (in)	L (ft)	Area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
24	105C	7.80*	11.60	0.00	19.40	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	22
25	906C	7.90*	3.70	0.00	11.60	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	24
26	906L	5.30*	0.00	3.00	2.30	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	25
27	906R	2.60*	0.00	1.20	1.40	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	25
28	106C-2	5.20*	7.70	0.00	12.90	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	21
29	106C-1	5.30*	2.40	0.00	7.70	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	28
30	106R	5.30*	0.00	2.90	2.40	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	29
31	719C	42.50*	78.30	0.00	120.80	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	1
32	719R	2.00*	0.00	1.10	0.90	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	31
33	619R	3.90*	1.30	2.20	3.00	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	31
34	620R	2.00*	0.40	1.10	1.30	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	33
35	621R	0.80*	0.00	0.40	0.40	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	34
36	720C	36.70*	37.70	0.00	74.40	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	31
37	721L	36.10*	35.20	34.00	37.30	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	36
38	721C	35.20*	0.00	0.00	35.20	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	37
39	720R	0.70*	0.00	0.30	0.40	Genr	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.000	0.30	12.00	0.30	12.00	0.0	36

US6 & Fed Blvd: South Storm | Number of lines: 39 | Run Date: 12/21/2010

NOTES: Inlet N-Values = 0.016; Intensity = 79.26 / (Inlet time + 14.60) ^ 0.84; Return period = 5 Yrs. ; * Indicates Known Q added. All curb inlets are Horiz throat.

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
	(in)	(cfs)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	(ft)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)	(K)	(ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1	36	112.0	5204.00	5207.00	3.00	7.07	15.85	3.90	5210.91	2.821	228.998	5205.15	5213.46	3.00	7.07	15.84	3.90	5217.36	2.820	2.821	6.460	1.00	3.90
2	18	3.70	5215.85	5217.36	1.50	1.77	2.09	0.07	5217.43	0.124	36.394	5217.15	5217.88 j	0.73**	0.86	4.30	0.29	5218.17	0.534	0.329	n/a	1.00	0.29
3	36	68.90	5214.35	5217.36	3.00	7.07	9.75	1.48	5218.84	1.068	129.627	5215.00	5218.75	3.00	7.07	9.75	1.48	5220.23	1.067	1.068	1.384	1.00	1.48
4	18	1.40	5218.40	5220.23	1.50	1.77	0.79	0.01	5220.24	0.018	26.327	5219.01	5220.23	1.22	1.53	0.91	0.01	5220.24	0.018	0.018	0.005	1.00	0.01
5	36	68.90	5215.20	5220.23	3.00	7.07	9.75	1.48	5221.70	1.068	169.010	5216.05	5222.03	3.00	7.07	9.75	1.48	5223.51	1.067	1.068	1.804	0.99	1.46
6	36	34.10	5216.26	5223.49	3.00	7.07	4.83	0.36	5223.85	0.262	269.151	5217.60	5224.20	3.00	7.07	4.82	0.36	5224.56	0.261	0.261	0.704	1.00	0.36
7	24	25.40	5218.60	5224.56	2.00	3.14	8.09	1.02	5225.58	1.262	172.131	5219.47	5226.73	2.00	3.14	8.09	1.02	5227.75	1.261	1.261	2.171	1.00	1.02
8	18	7.70	5223.40	5227.75	1.50	1.77	4.36	0.30	5228.04	0.538	82.166	5223.81	5228.19	1.50	1.77	4.36	0.30	5228.48	0.538	0.538	0.442	1.00	0.30
9	18	7.70	5224.01	5228.48	1.50	1.77	4.36	0.30	5228.78	0.538	28.510	5224.18	5228.64	1.50	1.77	4.36	0.30	5228.93	0.538	0.538	0.153	1.00	0.30
10	18	0.01	5224.01	5228.48	1.50	1.77	0.01	0.00	5228.48	0.000	12.754	5224.14	5228.48	1.50	1.77	0.01	0.00	5228.48	0.000	0.000	0.000	1.00	0.00
11	18	16.50	5225.38	5227.75	1.50	1.74	9.34	1.36	5229.10	2.470	158.786	5232.72	5234.16 j	1.43**	1.74	9.48	1.40	5235.55	2.145	2.307	n/a	1.00	1.40
12	18	7.20	5232.92	5234.16	1.23	1.56	4.63	0.33	5234.49	0.466	28.677	5233.20	5234.23 j	1.02**	1.29	5.60	0.49	5234.71	0.717	0.591	n/a	1.00	0.49
13	18	9.50	5232.92	5234.16	1.23	1.56	6.10	0.58	5234.73	0.812	16.413	5233.27	5234.45	1.18**	1.49	6.39	0.63	5235.08	0.892	0.852	n/a	1.00	n/a
14	18	1.90	5219.97	5227.75	1.50	1.77	1.08	0.02	5227.76	0.033	125.505	5220.60	5227.79	1.50	1.77	1.08	0.02	5227.81	0.033	0.033	0.041	1.00	0.02
15	18	1.20	5220.80	5227.81	1.50	1.77	0.68	0.01	5227.81	0.013	28.375	5221.09	5227.81	1.50	1.77	0.68	0.01	5227.82	0.013	0.013	0.004	1.00	0.01
16	18	0.70	5220.80	5227.81	1.50	1.77	0.40	0.00	5227.81	0.004	16.947	5220.97	5227.81	1.50	1.77	0.40	0.00	5227.81	0.004	0.004	0.001	1.00	0.00
17	18	10.40	5223.49	5224.56	1.07	1.35	7.73	0.93	5225.49	1.339	35.928	5227.08	5228.31	1.23**	1.55	6.70	0.70	5229.01	0.979	1.159	n/a	1.00	0.70
18	24	21.10	5220.64	5223.49	2.00	3.14	6.72	0.70	5224.19	0.871	29.729	5222.30	5223.93	1.63**	2.74	7.71	0.92	5224.85	0.882	0.876	n/a	0.56	0.52
19	24	20.20	5222.49	5223.93	1.44	2.42	8.36	1.09	5225.01	1.065	223.942	5232.46	5234.05	1.59**	2.68	7.53	0.88	5234.93	0.843	0.954	n/a	0.50	n/a
20	24	19.00	5232.66	5234.05	1.39	2.33	8.14	1.03	5235.08	1.023	357.993	5243.92	5245.46	1.54**	2.60	7.30	0.83	5246.29	0.795	0.909	n/a	0.50	0.41
21	24	16.60	5244.12	5245.83	1.71*	2.86	5.80	0.52	5246.35	0.503	111.452	5244.68	5246.39	1.71	2.86	5.80	0.52	5246.91	0.503	0.503	0.560	0.87	0.46

US6 & Fed Blvd: South Storm | Number of lines: 39 | Run Date: 12/21/2010

Notes: * Normal depth assumed.; ** Critical depth.; j-Line contains hyd. jump. ; c = cir e = ellip b = box

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
	(in)	(cfs)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	(ft)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)	(K)	(ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
22	24	12.00	5244.88	5246.85	1.97	3.13	3.83	0.23	5247.07	0.254	168.027	5245.73	5247.22	1.49	2.51	4.78	0.35	5247.58	0.343	0.298	0.501	1.00	0.35
23	18	4.70	5250.71	5251.41	0.70*	0.81	5.78	0.52	5251.93	1.003	190.236	5252.62	5253.45	0.83**	1.00	4.70	0.34	5253.79	0.578	0.791	n/a	1.00	0.34
24	18	7.80	5250.01	5251.51	1.50*	1.77	4.41	0.30	5251.81	0.552	180.823	5250.83	5252.51	1.50	1.77	4.41	0.30	5252.81	0.552	0.552	0.998	1.00	0.30
25	18	7.90	5251.03	5252.81	1.50	1.77	4.47	0.31	5253.12	0.566	73.444	5251.40	5253.23	1.50	1.77	4.47	0.31	5253.54	0.566	0.566	0.416	1.00	0.31
26	18	5.30	5251.60	5253.54	1.50	1.77	3.00	0.14	5253.68	0.255	27.563	5251.87	5253.61	1.50	1.77	3.00	0.14	5253.75	0.255	0.255	0.070	1.00	0.14
27	18	2.60	5251.60	5253.54	1.50	1.77	1.47	0.03	5253.57	0.061	12.188	5251.86	5253.55	1.50	1.77	1.47	0.03	5253.58	0.061	0.061	0.007	1.00	0.03
28	18	5.20	5250.62	5251.55	0.93*	1.15	4.52	0.32	5251.87	0.492	111.614	5251.17	5252.10	0.93	1.15	4.52	0.32	5252.42	0.493	0.493	0.550	0.72	0.23
29	18	5.30	5251.37	5252.33	0.96	1.19	4.45	0.31	5252.64	0.468	94.375	5251.84	5252.77	0.93	1.15	4.63	0.33	5253.10	0.517	0.493	0.465	1.00	0.33
30	18	5.30	5252.04	5253.10	1.06	1.33	3.98	0.25	5253.34	0.356	15.438	5252.19	5253.07 j	0.88**	1.08	4.90	0.37	5253.45	0.600	0.478	0.074	1.00	0.37
31	36	42.50	5205.35	5217.36	3.00	7.07	6.01	0.56	5217.93	0.406	58.385	5205.64	5217.60	3.00	7.07	6.01	0.56	5218.16	0.406	0.406	0.237	1.00	0.56
32	18	2.00	5214.97	5218.16	1.50	1.77	1.13	0.02	5218.18	0.036	34.023	5216.78	5218.18	1.40	1.71	1.17	0.02	5218.20	0.031	0.034	0.012	1.00	0.02
33	18	3.90	5214.97	5218.16	1.50	1.77	2.21	0.08	5218.24	0.138	15.081	5216.03	5218.19	1.50	1.77	2.21	0.08	5218.26	0.138	0.138	0.021	1.16	0.09
34	18	2.00	5216.22	5218.27	1.50	1.77	1.13	0.02	5218.29	0.036	114.751	5217.02	5218.31	1.29	1.62	1.24	0.02	5218.33	0.034	0.035	0.040	0.50	0.01
35	18	0.80	5217.23	5218.32	1.09	1.38	0.58	0.01	5218.33	0.008	29.324	5218.20	5218.54 j	0.34**	0.30	2.64	0.11	5218.65	0.450	0.229	n/a	1.00	n/a
36	36	36.70	5205.84	5218.16	3.00	7.07	5.19	0.42	5218.58	0.303	134.238	5206.51	5218.57	3.00	7.07	5.19	0.42	5218.99	0.303	0.303	0.407	1.00	0.42
37	36	36.10	5206.71	5218.99	3.00	7.07	5.11	0.41	5219.40	0.293	93.390	5207.27	5219.26	3.00	7.07	5.11	0.41	5219.67	0.293	0.293	0.274	1.50	0.61
38	36	35.20	5207.46	5219.87	3.00	7.07	4.98	0.39	5220.26	0.279	7.911	5207.50	5219.90	3.00	7.07	4.98	0.39	5220.28	0.279	0.279	0.022	1.00	0.39
39	18	0.70	5213.43	5218.99	1.50	1.77	0.40	0.00	5218.99	0.004	31.977	5214.83	5218.99	1.50	1.77	0.40	0.00	5218.99	0.004	0.004	0.001	1.00	0.00

US6 & Fed Blvd: South Storm | Number of lines: 39 | Run Date: 12/21/2010

Notes: * Normal depth assumed.; ** Critical depth.; j-Line contains hyd. jump. ; c = cir e = ellip b = box

Hydraflow HGL Computation Procedure

General Procedure:

Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

Col. 21 The average of the downstream and upstream friction slopes.

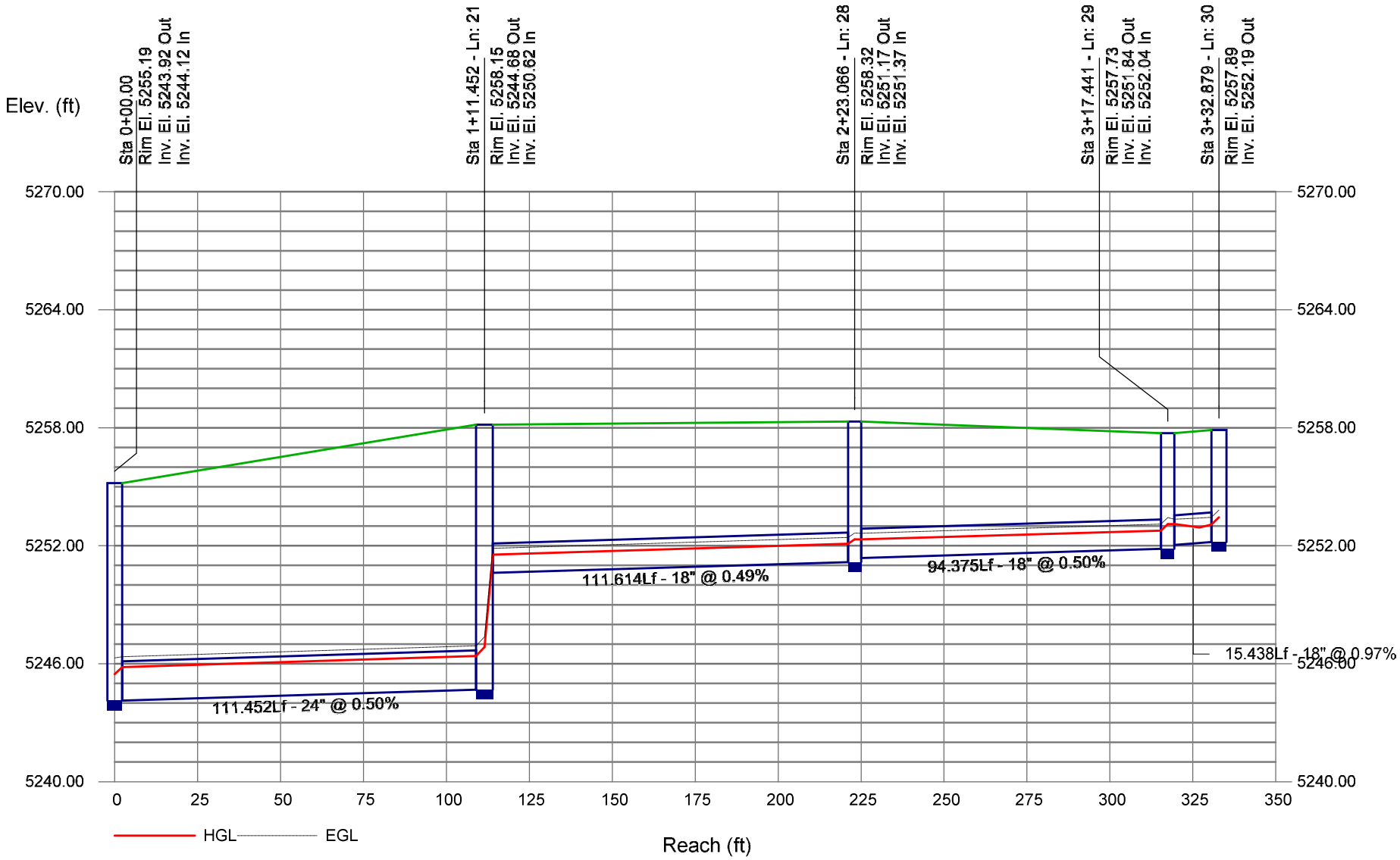
Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

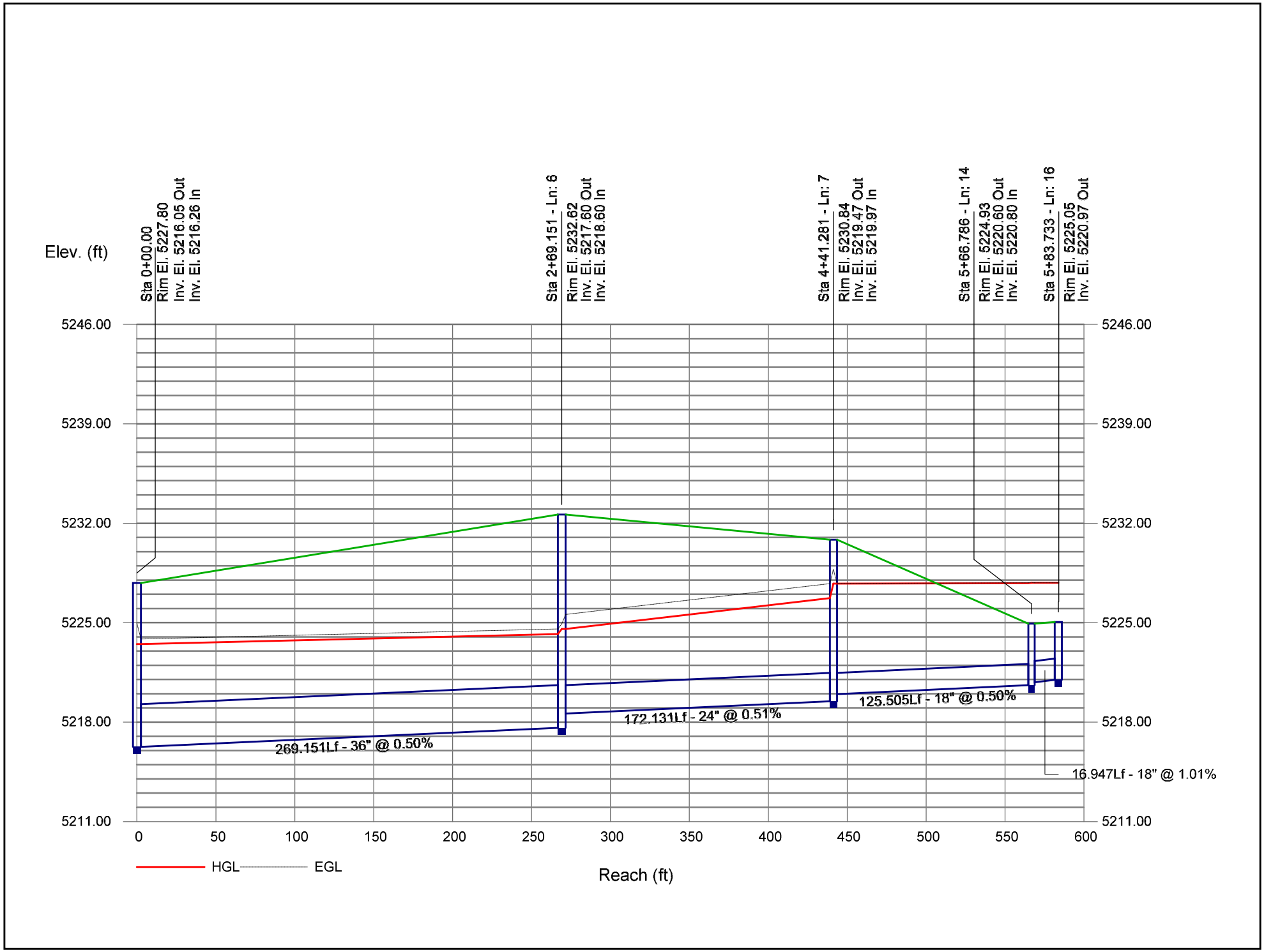
Storm Sewer Profile

Proj. file: Federal South System 50 YR 122010.stm



Storm Sewer Profile

Proj. file: Federal South System 50 YR 122010.stm



Storm Sewer Profile

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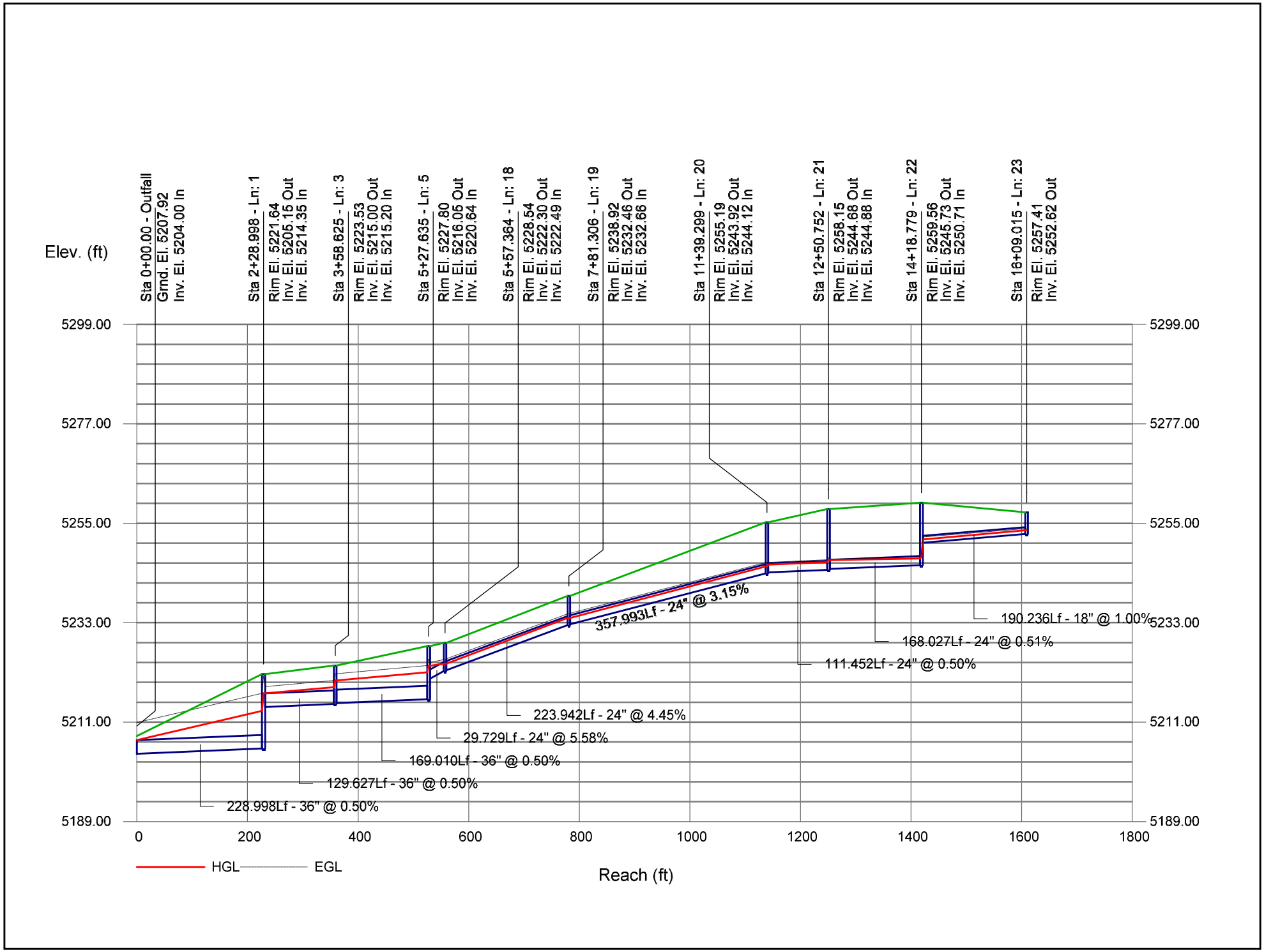

Storm Sewer Profile

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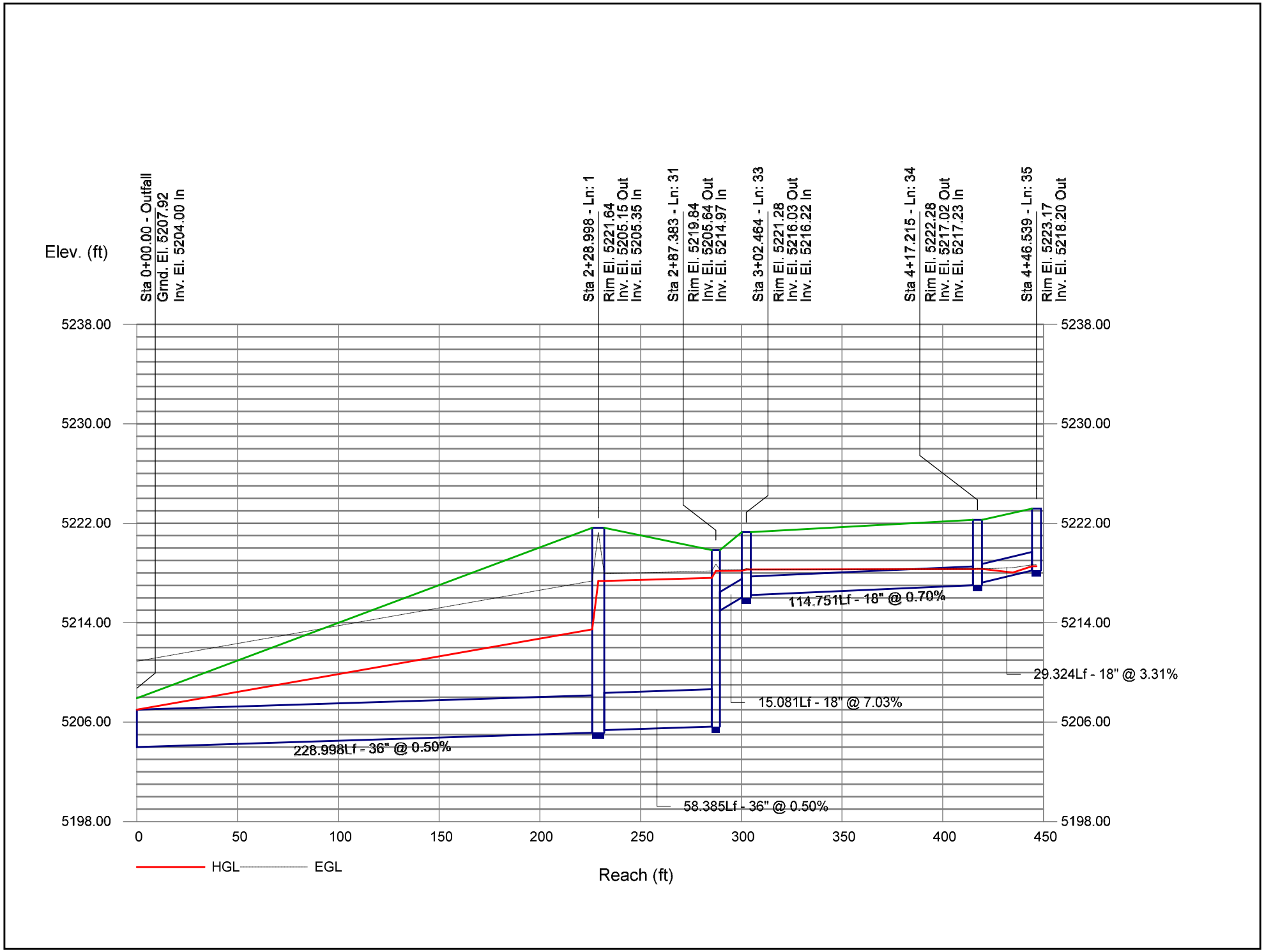

Storm Sewer Profile

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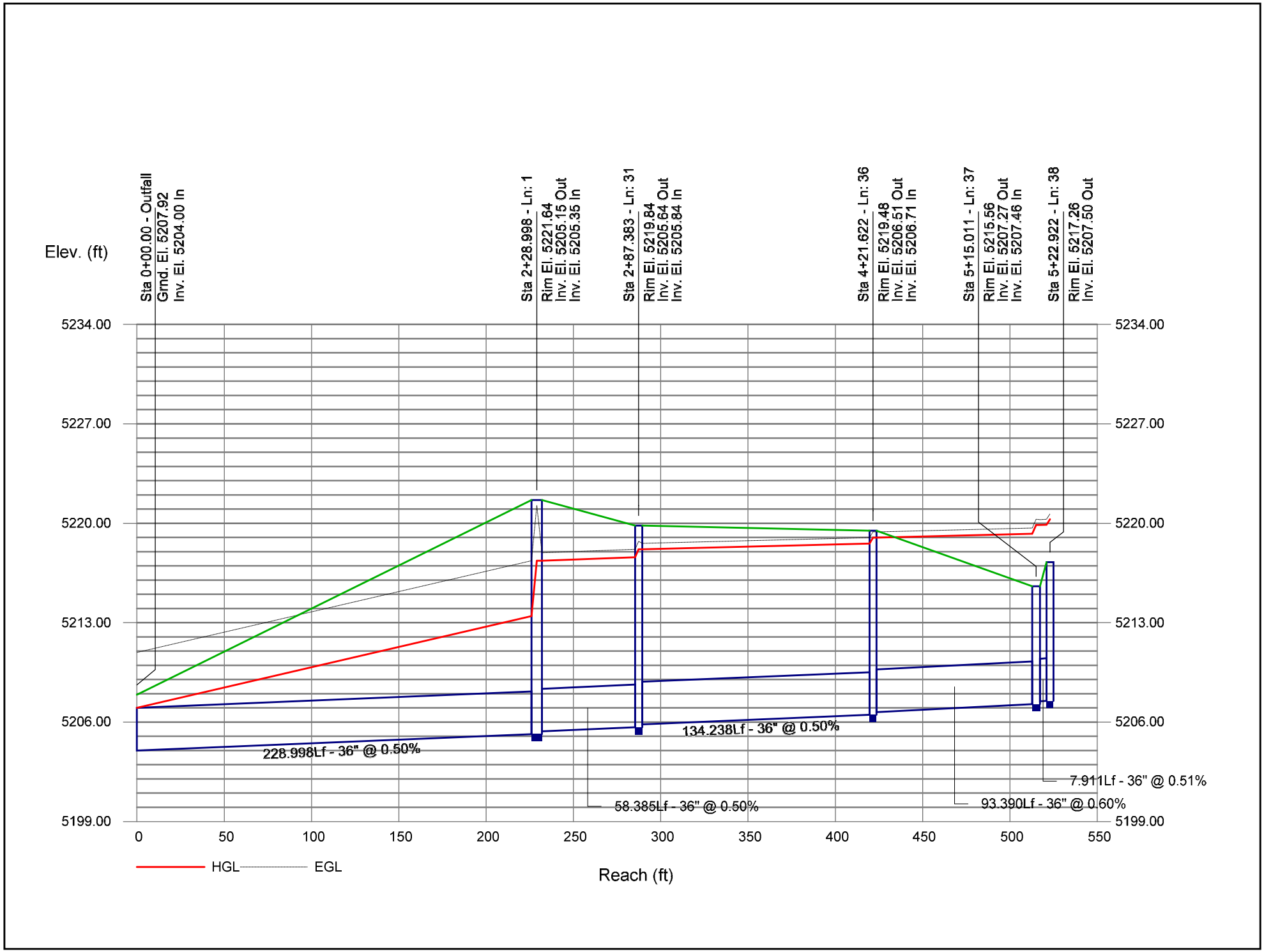
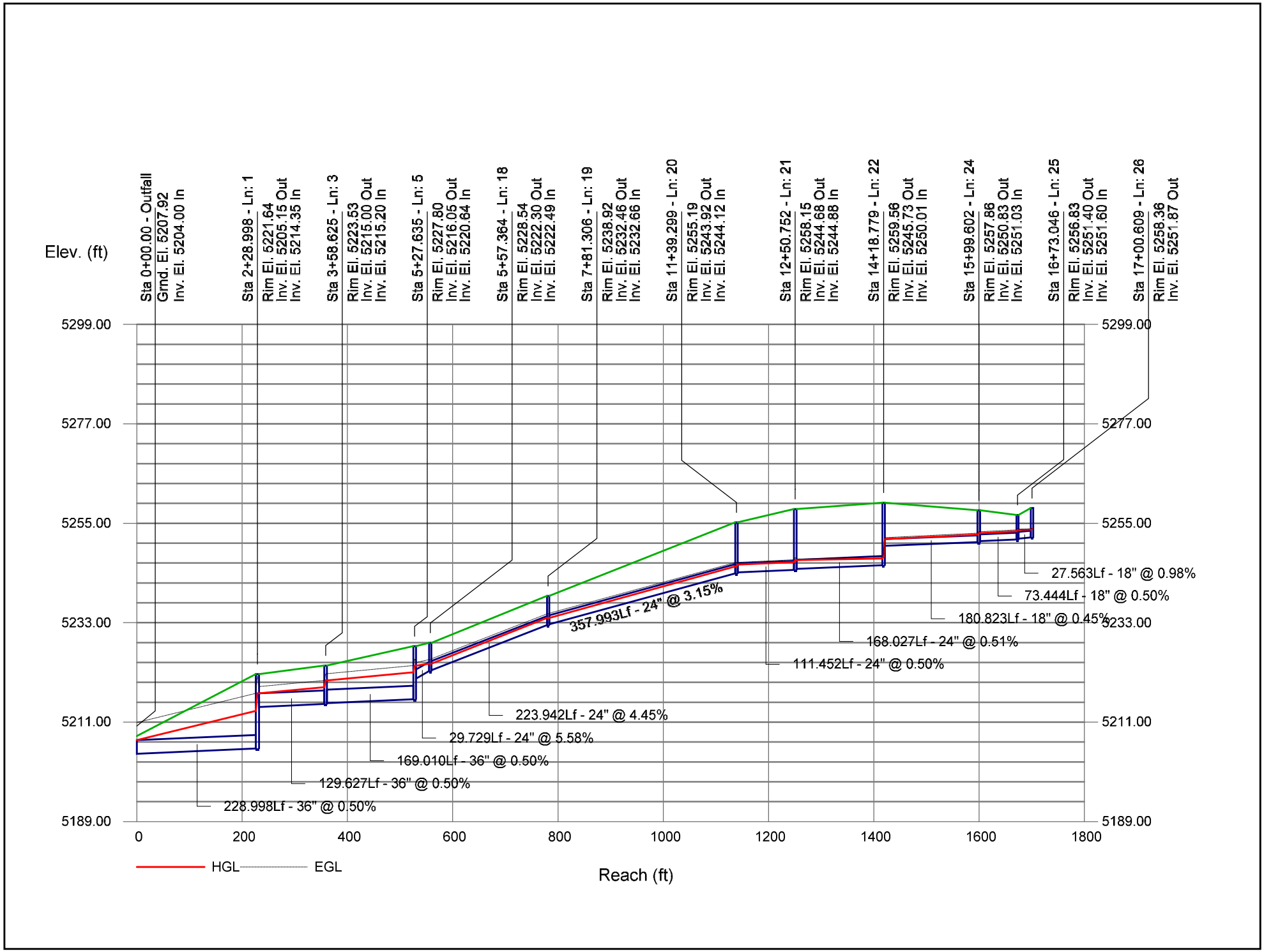


Storm Sewer Profile

Proj. file: Federal South System 50 YR 122010.stm



Hydraflow Storm Sewers Extension for AutoCAD® Civil 3D® 2011 Plan

Project File: Outfall System 122110.stm	Number of lines: 6	Date: 1/3/2011

Storm Sewers v8.00

Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data								Line ID
	Dnstr Line No.	Line Length (ft)	Defl angle (deg)	Junc Type	Known Q (cfs)	Drng Area (ac)	Runoff Coeff (C)	Inlet Time (min)	Invert El Dn (ft)	Line Slope (%)	Invert El Up (ft)	Line Size (in)	Line Shape	N Value (n)	J-Loss Coeff (K)	Inlet/ Rim El (ft)	
1	End	94.498	-179.916	MH	40.79	0.00	0.00	0.0	5198.40	0.31	5198.69	24X48	Box	0.013	0.15	5205.18	US6 WQ Pond Outfal
2	1	398.750	0.286	MH	40.79	0.00	0.00	0.0	5198.69	0.30	5199.87	24X48	Box	0.013	0.15	5204.86	US6 WQ Pond Outfal
3	2	400.000	-0.900	MH	40.79	0.00	0.00	0.0	5199.87	0.30	5201.06	24X48	Box	0.013	0.15	5205.16	US6 WQ Pond Outfal
4	3	364.713	0.193	None	40.79	0.00	0.00	0.0	5201.06	0.30	5202.16	24X48	Box	0.013	0.92	5207.29	US6 WQ Pond Outfal
5	4	77.168	64.854	None	40.79	0.00	0.00	0.0	5202.16	0.30	5202.39	24X48	Box	0.013	0.93	5209.46	US6 WQ Pond Outfal
6	5	7.941	-65.574	MH	40.79	0.00	0.00	0.0	5202.39	0.25	5202.41	24X48	Box	0.013	1.00	5209.25	US6 WQ Pond Outfal

Project File: Outfall System 122110.stm | Number of lines: 6 | Date: 1/3/2011

Structure Report

Struct No.	Structure ID	Junction Type	Rim Elev (ft)	Structure			Line Out			Line In		
				Shape	Length (ft)	Width (ft)	Size (in)	Shape	Invert (ft)	Size (in)	Shape	Invert (ft)
1	301C	Manhole	5205.18	Cir	5.00	5.00	24x48	Box	5198.69	24x48	Box	5198.69
2	305C	Manhole	5204.86	Cir	5.00	5.00	24x48	Box	5199.87	24x48	Box	5199.87
3	309C	Manhole	5205.16	Cir	5.00	5.00	24x48	Box	5201.06	24x48	Box	5201.06
4	Structure-(222)	None	5207.29	n/a	n/a	n/a	24x48	Box	5202.16	24x48	Box	5202.16
5	Structure-(223)	None	5209.46	n/a	n/a	n/a	24x48	Box	5202.39	24x48	Box	5202.39
6	314C	Manhole	5209.25	Cir	10.00	10.00	24x48	Box	5202.41			

Project File: Outfall System 122110.stm | Number of Structures: 6 | Run Date: 1/3/2011

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	US6 WQ Pond Outfall-5	40.79	24x48	Box	94.498	5198.40	5198.69	0.307	5200.12	5200.40	0.08	5200.48	End	Manhole
2	US6 WQ Pond Outfall-4	40.79	24x48	Box	398.750	5198.69	5199.87	0.296	5200.48	5201.57	0.08	5201.65	1	Manhole
3	US6 WQ Pond Outfall-3	40.79	24x48	Box	400.000	5199.87	5201.06	0.297	5201.65	5202.76	0.08	5202.84	2	Manhole
4	US6 WQ Pond Outfall-2	40.79	24x48	Box	364.713	5201.06	5202.16	0.302	5202.84	5203.85	0.52	5204.37	3	None
5	US6 WQ Pond Outfall-1 (1)	40.79	24x48	Box	77.168	5202.16	5202.39	0.298	5204.37*	5204.63*	0.38	5205.01	4	None
6	US6 WQ Pond Outfall-1	40.79	24x48	Box	7.941	5202.39	5202.41	0.252	5205.01*	5205.04*	0.40	5205.44	5	Manhole

Project File: Outfall System 122110.stm | Number of lines: 6 | Run Date: 1/3/2011

NOTES: Return period = 5 Yrs. ; *Surcharged (HGL above crown).

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q Byp (cfs)	Junc Type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp Line No
							Ht (in)	L (ft)	Area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	301C	40.79*	0.00	0.00	40.79	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
2	305C	40.79*	0.00	0.00	40.79	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
3	309C	40.79*	0.00	0.00	40.79	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
4	Structure-(222)	40.79*	0.00	0.00	40.79	None	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
5	Structure-(223)	40.79*	0.00	0.00	40.79	None	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
6	314C	40.79*	0.00	0.00	40.79	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off

Project File: Outfall System 122110.stm | Number of lines: 6 | Run Date: 1/3/2011

NOTES: Inlet N-Values = 0.016; Intensity = 79.26 / (Inlet time + 14.60) ^ 0.84; Return period = 5 Yrs. ; * Indicates Known Q added. All curb inlets are Horiz throat.

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
	(in)	(cfs)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	(ft)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)	(K)	(ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1	24 48 B	40.79	5198.40	5200.12	1.72	6.88	5.93	0.55	5200.67	0.299	94.498	5198.69	5200.40	1.71	6.84	5.97	0.55	5200.95	0.304	0.301	0.285	0.15	0.08
2	24 48 B	40.79	5198.69	5200.48	1.79	7.17	5.69	0.50	5200.99	0.267	398.750	5199.87	5201.57	1.70	6.80	6.00	0.56	5202.13	0.309	0.288	1.148	0.15	0.08
3	24 48 B	40.79	5199.87	5201.65	1.78	7.13	5.72	0.51	5202.16	0.271	400.000	5201.06	5202.76	1.70	6.80	6.00	0.56	5203.32	0.309	0.290	1.159	0.15	0.08
4	24 48 B	40.79	5201.06	5202.84	1.78	7.13	5.72	0.51	5203.35	0.271	364.713	5202.16	5203.85	1.69	6.76	6.04	0.57	5204.42	0.314	0.292	1.066	0.92	0.52
5	24 48 B	40.79	5202.16	5204.37	2.00	8.00	5.10	0.40	5204.78	0.342	77.168	5202.39	5204.63	2.00	8.00	5.10	0.40	5205.04	0.342	0.342	0.264	0.93	0.38
6	24 48 B	40.79	5202.39	5205.01	2.00	8.00	5.10	0.40	5205.42	0.342	7.941	5202.41	5205.04	2.00	8.00	5.10	0.40	5205.44	0.342	0.342	0.027	1.00	0.40

Project File: Outfall System 122110.stm | Number of lines: 6 | Run Date: 1/3/2011

; c = cir e = ellip b = box

Hydraflow HGL Computation Procedure

General Procedure:

Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

Col. 21 The average of the downstream and upstream friction slopes.

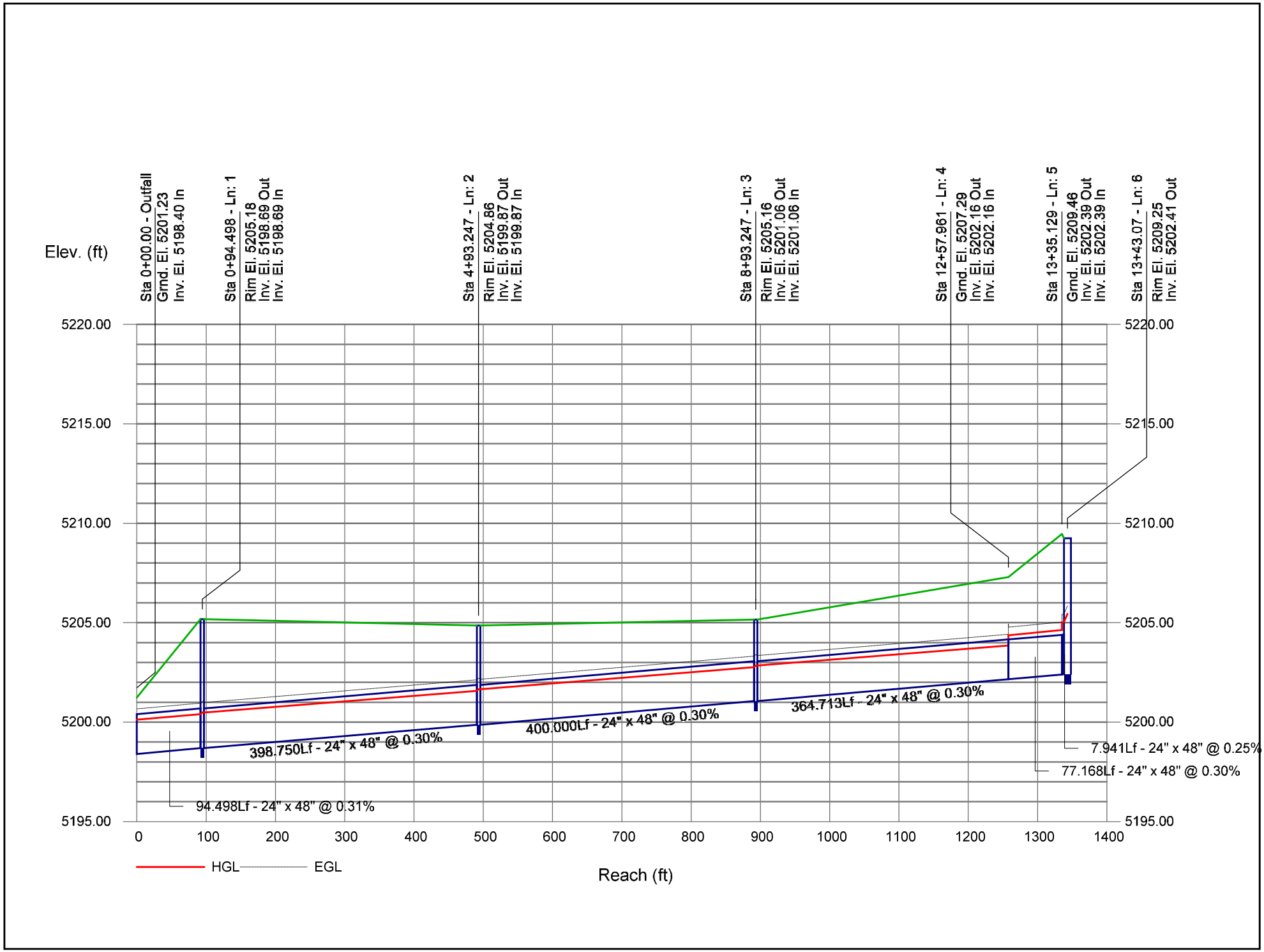
Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

Storm Sewer Profile

Proj. file: Outfall System 122110.stm



APPENDIX F

WQCV and Detention Pond Design Calculations

WQ Pond Contribution - US 6 Pond

Detention Formula per UDFCD criteria:

$V = K_I A$

$K_{100} = (1.78I-0.002I^2-3.56)/1000$

$K_5 = (0.77I-2.65)/1000$

Basin	Area (Ac)	%I	A*%I
SW1	0.73	100.00	73.0
SW2	0.58	56.90	33.0
SW3	1.06	57.26	60.7
SE1	0.76	97.37	74.0
SE2	0.42	98.33	41.3
SE3	0.41	75.61	31.0
SE4	0.28	78.57	22.0
SE5	0.19	100.00	19.0
SE6	0.51	100.00	51.0
SE7	0.28	98.21	27.5
SE8	0.28	100.00	28.0
SE9	0.17	100.00	17.0
SE10	0.11	100.00	11.0
OS-9	0.47	100.00	47.0
SR1	0.15	53.33	8.0
SR2	0.20	35.00	7.0
WQ1*	3.92	18.25	71.5
WG1	0.54	64.81	35.0
WG2	0.65	55.38	36.0
EB1	0.87	50.57	44.0
EB2	0.67	46.27	31.0
EB3	0.97	52.58	51.0
EB4	0.87	67.82	59.0
WB1	0.83	55.42	46.0
WB2	0.68	42.65	29.0
WB3	1.33	67.67	90.0
WB4	0.31	100.00	31.0
WB5	0.55	41.82	23.0
WB6	0.53	100.00	53.0
WB7	0.82	100.00	82.0
NW1	0.78	91.03	71.0
NF1	0.22	98.64	21.7
NF2	0.29	96.55	28.0
NF3	0.36	75.00	27.0
NF4	0.40	65.00	26.0
NF5	0.25	99.60	24.9
NF6	1.11	85.68	95.1
NF7	0.54	97.96	52.9
NF8	1.02	90.59	92.4
NF9	0.32	98.75	31.6
NE1	0.80	94.75	75.8
NE2	0.61	57.05	34.8
BPE1	2.03	71.91	146.2
BPE2	6.22	15.18	94.4
5TH1	1.12	69.64	78.0
5TH2	0.96	55.94	53.7
5TH3	0.47	36.17	17.0
5TH4	1.49	26.98	40.2
5TH5	1.32	27.42	36.2
5TH6	0.24	66.67	16.0
5TH7	0.10	100.00	10.0
	40.79		2305

*Area modified during final edits. Required WQ volume reduced; larger required volume used in design calculations.

Where: V = volume of the 100-year or 5-year storm (acre-feet)

I = developed basin imperviousness (%) = 56.50 %

A = tributary area (acres) = 40.79 acres

K_{100}= 0.0906 K_5= 0.0409

V_{100}= 3.6971 ac-ft V_5= 1.6667 ac-ft

= 161,046 ft^3 = 72,602 ft^3

From Table SO-1 (UDFCDCriteria) for Type 'C' soils

5-Year Release Rate = 0.17 cfs/acre x 40.79 = 6.93

100-Year Release Rate = 1.00 cfs/acre x 40.79 = 40.79

Water Quality Capture Volume

Volume Formula per UDFCD (Volume 3)

V_{WQCV}=(WQCV/12)*A*1.2

$WQCV = 1.0*(0.91*I^3-1.19*I^2+0.78*I)$

Where: V_{WQCV} = storage volume

WQCV = watershed inches of runoff (Figure EDB-2) = 0.22 in

A = tributary area (acres)

1.2 Factor = Multiplier of 1.2 to account for the additional 20% of required storage for sediment accumulation

V_{WQCV}= 0.9177 ac-ft

= 39,974 ft^3

Total Detention Pond Volume

100-yr & WQCV **5-yr & WQCV**

$V_{Total} = V_{100} + V_{WQCV}$ $V_{Total} = V_5 + V_{WQCV}$

V_{Total}= 4.6148 ac-ft V_{Total}= 2.5844 ac-ft

= 201,020 ft^3 = 112,576 ft^3

WQ Pond Contribution - US 6 Pond - North Forebay

Detention Formula per UDFCD criteria:

$V = K_iA$

$K_{100} = (1.78I-0.002I^2-3.56)/1000$

$K_5 = (0.77I-2.65)/1000$

Basin	Area (Ac)	%I	A*%I
NW1	0.78	91.03	71.0
NF1	0.22	98.64	21.7
NF2	0.29	96.55	28.0
NF3	0.36	75.00	27.0
NF4	0.40	65.00	26.0
NF5	0.25	99.60	24.9
NF6	1.11	85.68	95.1
NF7	0.54	97.96	52.9
NF8	1.02	90.59	92.4
NF9	0.32	98.75	31.6
NE1	0.80	94.75	75.8
NE2	0.61	57.05	34.8
	6.70		581

Where: V = volume of the 100-year or 5-year storm (acre-feet)

I = developed basin imperviousness (%) = 86.75 %

A = tributary area (acres) = 6.70 acres

K_{100}= 0.1358 K_5= 0.0641

V_{100}= 0.9099 ac-ft V_5= 0.4298 ac-ft

= 39,633 ft^3 = 18,721 ft^3

From Table SO-1 (UDFCDCriteria) for Type 'C' soils

5-Year Release Rate = 0.17 cfs/acre x 6.70 = 1.14

100-Year Release Rate = 1.00 cfs/acre x 6.70 = 6.7

Water Quality Capture Volume

Volume Formula per UDFCD (Volume 3)

$V_{WQCV}=(WQCV/12)*A*1.2$

$WQCV = 1.0*(0.91*I^3-1.19*I^2+0.78*I)$

Where: V_{WQCV} = storage volume

WQCV = watershed inches of runoff (Figure EDB-2) = 0.38 in

A = tributary area (acres)

1.2 Factor = Multiplier of 1.2 to account for the additional 20% of required storage for sediment accumulation

V_{WQCV}= 0.2514 ac-ft

= 10,949 ft^3 328.478892 262.8

Total Detention Pond Volume

100-yr & WQCV **5-yr & WQCV**

$V_{Total} = V_{100} + V_{WQCV}$ $V_{Total} = V_5 + V_{WQCV}$

V_{Total}= 1.1612 ac-ft V_{Total}= 0.6811 ac-ft

= 50,582 ft^3 = 29,670 ft^3

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WQ Pond Contribution - US 6 Pond - South Forebay

Detention Formula per UDFCD criteria:

$V = K_iA$

$K_{100} = (1.78I-0.002I^2-3.56)/1000$

$K_5 = (0.77I-2.65)/1000$

Basin	Area (Ac)	%I	A*%I
SW1	0.73	100.00	73.0
SW2	0.58	56.90	33.0
SW3	1.06	57.26	60.7
SE1	0.76	97.37	74.0
SE2	0.42	98.33	41.3
SE3	0.41	75.61	31.0
SE4	0.28	78.57	22.0
SE5	0.19	100.00	19.0
SE6	0.51	100.00	51.0
SE7	0.28	98.21	27.5
SE8	0.28	100.00	28.0
SE9	0.17	100.00	17.0
SE10	0.11	100.00	11.0
SR1	0.15	53.33	8.0
SR2	0.23	34.78	8.0
WG1	0.54	64.81	35.0
WG2	0.65	55.38	36.0
EB1	0.87	50.57	44.0
EB2	0.67	46.27	31.0
EB3	0.97	52.58	51.0
EB4	0.87	67.82	59.0
WB1	0.83	55.42	46.0
WB2	0.68	42.65	29.0
WB3	1.33	67.67	90.0
WB4	0.31	100.00	31.0
WB5	0.55	41.82	23.0
WB6	0.53	100.00	53.0
WB7	0.82	100.00	82.0
OS-9	0.47	100.00	47.0
BPE1	2.03	71.91	146.2
BPE2	6.22	15.18	94.4
5TH1	1.12	69.64	78.0
5TH2	0.96	55.94	53.7
5TH3	0.47	36.17	17.0
5TH4	1.49	26.98	40.2
5TH5	1.32	27.42	36.2
5TH6	0.24	66.67	16.0
5TH7	0.10	100.00	10.0
	30.20		1653

Where: V = volume of the 100-year or 5-year storm (acre-feet)
I = developed basin imperviousness (%) = 54.74 %
A = tributary area (acres) = 30.20 acres

K_{100}= 0.0879 K_5= 0.0395

V_{100}= 2.6542 ac-ft V_5= 1.1929 ac-ft

= 115,617 ft^3 = 51,964 ft^3

From Table SO-1 (UDFCDCriteria) for Type 'C' soils

5-Year Release Rate = 0.17 cfs/acre x 30.20 = 5.13

100-Year Release Rate = 1.00 cfs/acre x 30.20 = 30.203

Water Quality Capture Volume

Volume Formula per UDFCD (Volume 3)

V_{WQCV}=(WQCV/12)*A*1.2

WQCV = $1.0*(0.91*I^3-1.19*I^2+0.78*I)$

Where: V_{WQCV} = storage volume
WQCV = watershed inches of runoff (Figure EDB-2) = 0.22 in
A = tributary area (acres)
1.2 Factor = Multiplier of 1.2 to account for the additional 20% of required storage for sediment accumulation

V_{WQCV}= 0.6634 ac-ft

= 28,898 ft^3 866.92548 693.5

Total Detention Pond Volume

100-yr & WQCV **5-yr & WQCV**

$V_{Total} = V_{100} + V_{WQCV}$ $V_{Total} = V_5 + V_{WQCV}$

V_{Total}= 3.3176 ac-ft V_{Total}= 1.8563 ac-ft

= 144,514 ft^3 = 80,861 ft^3

Design Procedure Form: Extended Detention Basin (EDB)

Designer:	**Megan Guthrie**
Company:	**Olsson Associates**
Date:	**December 28, 2010**
Project:	**US 6 & Federal Blvd Interchange Improvements**
Location:	**Denver, CO**

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a	I_a = 56.5 %
B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)	i = 0.565
C) Contributing Watershed Area	Area = 40.790 ac
D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = ____ in
E) Design Concept (Select EURV when also designing for flood control)	Choose One: (●) Water Quality Capture Volume (WQCV) ( ) Excess Urban Runoff Volume (EURV)
F) Design Volume (1.2 WQCV) Based on 40-hour Drain Time ($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area * 1.2)$)	V_{DESIGN}= 0.918 ac-ft
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume ($V_{WQCV\ OTHER} = (d_6*(V_{DESIGN}/0.43))$)	$V_{DESIGN\ OTHER}$= ____ ac-ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{DESIGN\ USER}$= ____ ac-ft
I) Predominant Watershed NRCS Soil Group	Choose One: ( ) A ( ) B (●) C / D
J) Excess Urban Runoff Volume (EURV) Design Volume For HSG A: EURVA = (0.1878i - 0.0104)*Area For HSG B: $EURV_B$ = (0.1178i - 0.0042)*Area For HSG C/D: $EURV_{C/D}$ = (0.1043i - 0.0031)*Area	EURV = ____ ac-f t
2. Basin Shape: Length to Width Ratio (A basin length to width ratio of at least 2:1 will improve TSS reduction.)	L : W = 2.0 : 1
3. Basin Side Slopes A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Z = 4.00 ft / ft
4. Inlet A) Describe means of providing energy dissipation at concentrated inflow locations:	Concrete Forebays

Design Procedure Form: Extended Detention Basin (EDB)

Designer:	**Megan Guthrie**
Company:	**Olsson Associates**
Date:	**December 28, 2010**
Project:	**US 6 & Federal Blvd Interchange Improvements**
Location:	**Denver, CO**

5. Forebay	
A) Minimum Forebay Volume (V_{FMIN} = 3% of the WQCV)	V_{FMIN} = 0.023 ac-ft
B) Actual Forebay Volume	V_F = ac-ft
C) Forebay Depth (D_F = 30 inch maximum)	D_F = 18.0 in
D) Forebay Discharge	
i) Undetained 100-year Peak Discharge	Q_{100} = 131.10 cfs
ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$)	Q_F = 2.62 cfs
E) Forebay Discharge Design	Choose One: ○ Berm With Pipe ◉ Wall with Rect. Notch ○ Wall with V-Notch Weir
F) Discharge Pipe Size (minimum 8-inches)	Calculated D_P = in
G) Rectangular Notch Width	Calculated W_N = 8.7 in
6. Trickle Channel	
A) Type of Trickle Channel	Choose One: ◉ Concrete ○ Soft Bottom
F) Slope of Trickle Channel	S = 0.0050 ft / ft
7. Micropool and Outlet Structure	
A) Depth of Micropool (2.5-feet minimum)	D_M = 2.5 ft
B) Surface Area of Micropool (10 ft^2 minimum)	A_M = 86 sq ft
C) Outlet Type	Choose One: ◉ Orifice Plate ○ Other (Describe):
D) Depth of Design Volume (EURV or 1.2 WQCV) Based on the Design Concept Chosen Under 1.E.	H = 2.93 feet
E) Volume to Drain Over Prescribed Time	WQCV = 0.765 ac-ft
F) Drain Time (Min T_D for WQCV= 40 hours; Max T_D for EURV= 72 hours)	T_D = 40 hours
G) Recommended Maximum Outlet Area per Row, (A_o)	A_o = 1.59 square inches
H) Orifice Dimensions: i) Circular Orifice Diameter or	$D_{orifice}$ = 1 - 3 / 8 inch inches
ii) Width of 2" High Rectangular Orifice	$W_{orifice}$ = inches
I) Number of Columns	n_c = 1 number
J) Actual Design Outlet Area per Row (A_o)	A_o = 1.5 square inches
K) Number of Rows (nr)	n_r = 8 number
L) Total Outlet Area (A_{ot})	A_{ot} = 13.1 square inches
M) Depth of WQCV (H_{WQCV}) (Estimate using actual stage-area-volume relationship and V_{WQCV})	H_{WQCV} = feet
N) Ensure Minimum 40 Hour Drain Time for WQCV	$T_{D\ WQCV}$ = hours

Design Procedure Form: Extended Detention Basin (EDB)

Designer:	**Megan Guthrie**
Company:	**Olsson Associates**
Date:	**December 28, 2010**
Project:	**US 6 & Federal Blvd Interchange Improvements**
Location:	**Denver, CO**

8. Initial Surcharge Volume	
A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches)	D_{IS} = 14.0 in
B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV)	V_{IS} = 99.9 cu ft
C) Initial Surcharge Provided Above Micropool	V_s= 100.3 cu ft
9. Trash Rack	
A) Type of Water Quality Orifice Used	Choose One: (●) Circular (up to 2" diameter) ( ) Rectangular (2" high)
B) Water Quality Screen Open Area: $A_t = 38.5*(e^{-0.095D})*A_{o,t}$	A_t = 441 square inches
C) For 2", or Smaller, **Circular Opening** (See Fact Sheet T-12):	
i) Width of Water Quality Screen and Concrete Opening ($W_{opening}$)	$W_{opening}$ = 12.0 inches
ii) Height of Water Quality Screen (H_{TR})	H_{TR} = 63.2 inches
iii) Type of Screen, Describe if "Other"	Choose One: (●) S.S. Well Screen with 60% Open Area* ( ) Other (Describe):
D) For 2" High **Rectangular Opening**:	
i) Width of Rectangular Opening ($W_{orifice}$)	W = inches
ii) Width of Water Quality Screen Opening ($W_{opening}$)	$W_{opening}$ = ft
iii) Height of Water Quality Screen (H_{TR})	H_{TR} = ft
iv) Type of Screen, Describe if "Other"	Choose One: ( ) Aluminum Amico-Klemp SR Series (or equal) ( ) Other (Describe):
v) Cross-bar Spacing	inches
vi) Minimum Bearing Bar Size	

Design Procedure Form: Extended Detention Basin (EDB)

Designer:	**Megan Guthrie**
Company:	**Olsson Associates**
Date:	**December 28, 2010**
Project:	**US 6 & Federal Blvd Interchange Improvements**
Location:	**Denver, CO**

10. Overflow Embankment A) Describe embankment protection for 100-year and greater overtopping:	
B) Slope of Overflow Embankment (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Z_E = 4.00 ft / ft
11. Vegetation	Choose One ○ Irrigated ◉ Not Irrigated
12. Access A) Describe Sediment Removal Procedures	

Notes:

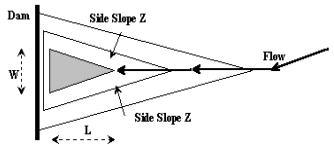
Design Procedure Form: Extended Detention Basin (EDB)

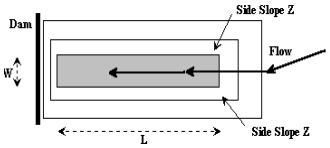
Designer:	**Megan Guthrie**
Company:	**Olsson Associates**
Date:	**December 28, 2010**
Project:	**US 6 & Federal Blvd Interchange Improvements**
Location:	**Denver, CO**

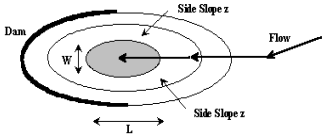
5. Forebay	
A) Minimum Forebay Volume (V_{FMIN} = 3% of the WQCV)	V_{FMIN} = 0.023 ac-ft
B) Actual Forebay Volume	V_F = ac-ft
C) Forebay Depth (D_F = 30 inch maximum)	D_F = 18.0 in
D) Forebay Discharge	
i) Undetained 100-year Peak Discharge	Q_{100} = 37.80 cfs
ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$)	Q_F = 0.76 cfs
E) Forebay Discharge Design	Choose One: ○ Berm With Pipe ◉ Wall with Rect. Notch ○ Wall with V-Notch Weir
F) Discharge Pipe Size (minimum 8-inches)	Calculated D_P = in
G) Rectangular Notch Width	Calculated W_N = 5.1 in
6. Trickle Channel	
A) Type of Trickle Channel	Choose One: ◉ Concrete ○ Soft Bottom
F) Slope of Trickle Channel	S = 0.0050 ft / ft
7. Micropool and Outlet Structure	
A) Depth of Micropool (2.5-feet minimum)	D_M = 2.5 ft
B) Surface Area of Micropool (10 ft^2 minimum)	A_M = 86 sq ft
C) Outlet Type	Choose One: ◉ Orifice Plate ○ Other (Describe):
D) Depth of Design Volume (EURV or 1.2 WQCV) Based on the Design Concept Chosen Under 1.E.	H = 2.93 feet
E) Volume to Drain Over Prescribed Time	WQCV = 0.765 ac-ft
F) Drain Time (Min T_D for WQCV= 40 hours; Max T_D for EURV= 72 hours)	T_D = 40 hours
G) Recommended Maximum Outlet Area per Row, (A_o)	A_o = 1.59 square inches
H) Orifice Dimensions: i) Circular Orifice Diameter or	$D_{orifice}$ = 1 - 3 / 8 inch inches
ii) Width of 2" High Rectangular Orifice	$W_{orifice}$ = inches
I) Number of Columns	n_c = 1 number
J) Actual Design Outlet Area per Row (A_o)	A_o = 1.5 square inches
K) Number of Rows (nr)	n_r = 8 number
L) Total Outlet Area (A_{ot})	A_{ot} = 13.1 square inches
M) Depth of WQCV (H_{WQCV}) (Estimate using actual stage-area-volume relationship and V_{WQCV})	H_{WQCV} = feet
N) Ensure Minimum 40 Hour Drain Time for WQCV	$T_{D\ WQCV}$ = hours

STAGE-STORAGE SIZING FOR POLYGONAL, ELLIPTICAL, OR IRREGULAR PONDS

Project: US 6 Pond
Basin ID: 12/14/2010







Design Information (Input):

Width of Pond Bottom, W =		ft
Length of Pond Bottom, L =		ft
Dam Side-slope (H:V), Z_d =		ft/ft

Check Pond Shape

Right Triangle		OR…
Isosceles Triangle		OR…
Rectangle		OR…
Circle / Ellipse		OR…
Irregular	X	(Use Overide values in cells G32:G52)

Stage-Storage Relationship:

	MINOR	MAJOR	
Storage Requirement from Sheet 'Modified FAA':			acre-ft.
Storage Requirement from Sheet 'Hydrograph':			acre-ft.
Storage Requirement from Sheet 'Full-Spectrum':			acre-ft.

Labels for WQCV, Minor, & Major Storage Stages (input)	Stage ft (input)	Side Slope (H:V) ft/ft Below El.	Pond Width at Stage ft (output)	Pond Length at Stage ft (output)	Surface Area at Stage ft^2 (output)	Surface Area at Stage ft^2 User Overide	Volume Below Stage ft^3 (output)	Surface Area at Stage acres (output)	Volume Below Stage acre-ft (output)	Target Volumes for WQCV, Minor, & Major Storage Volumes (for goal seek)
	5202.50	(input)				0		0.000	0.000	
	5203.00		0.00	0.00		497	124	0.011	0.003	
	5203.50		0.00	0.00		2,752	936	0.063	0.021	
	5204.00		0.00	0.00		10,770	4,317	0.247	0.099	
	5204.50		0.00	0.00		21,659	12,424	0.497	0.285	
	5205.00		0.00	0.00		30,320	25,419	0.696	0.584	
WQCV	5205.44		0.00	0.00		35,987	40,006	0.826	0.918	0.918
	5205.50		0.00	0.00		36,869	42,192	0.846	0.969	
	5206.00		0.00	0.00		41,864	61,875	0.961	1.420	
	5206.50		0.00	0.00		45,374	83,685	1.042	1.921	
	5207.00		0.00	0.00		48,334	107,112	1.110	2.459	
5-YR + WQCV	5207.11		0.00	0.00		48,988	112,464	1.125	2.582	2.585
	5207.50		0.00	0.00		51,279	132,016	1.177	3.031	
	5208.00		0.00	0.00		54,461	158,452	1.250	3.638	
	5208.50		0.00	0.00		57,883	186,538	1.329	4.282	
100-YR + WQCV	5208.75		0.00	0.00		59,129	201,164	1.357	4.618	4.616
	5209.00		0.00	0.00		60,393	216,104	1.386	4.961	
	5209.50		0.00	0.00		62,673	246,871	1.439	5.667	
	5210.00		0.00	0.00		64,979	278,784	1.492	6.400	
	5210.50		0.00	0.00		67,311	311,856	1.545	7.159	
	5211.00		0.00	0.00		69,670	346,102	1.599	7.945	
							#N/A		#N/A	
							#N/A		#N/A	
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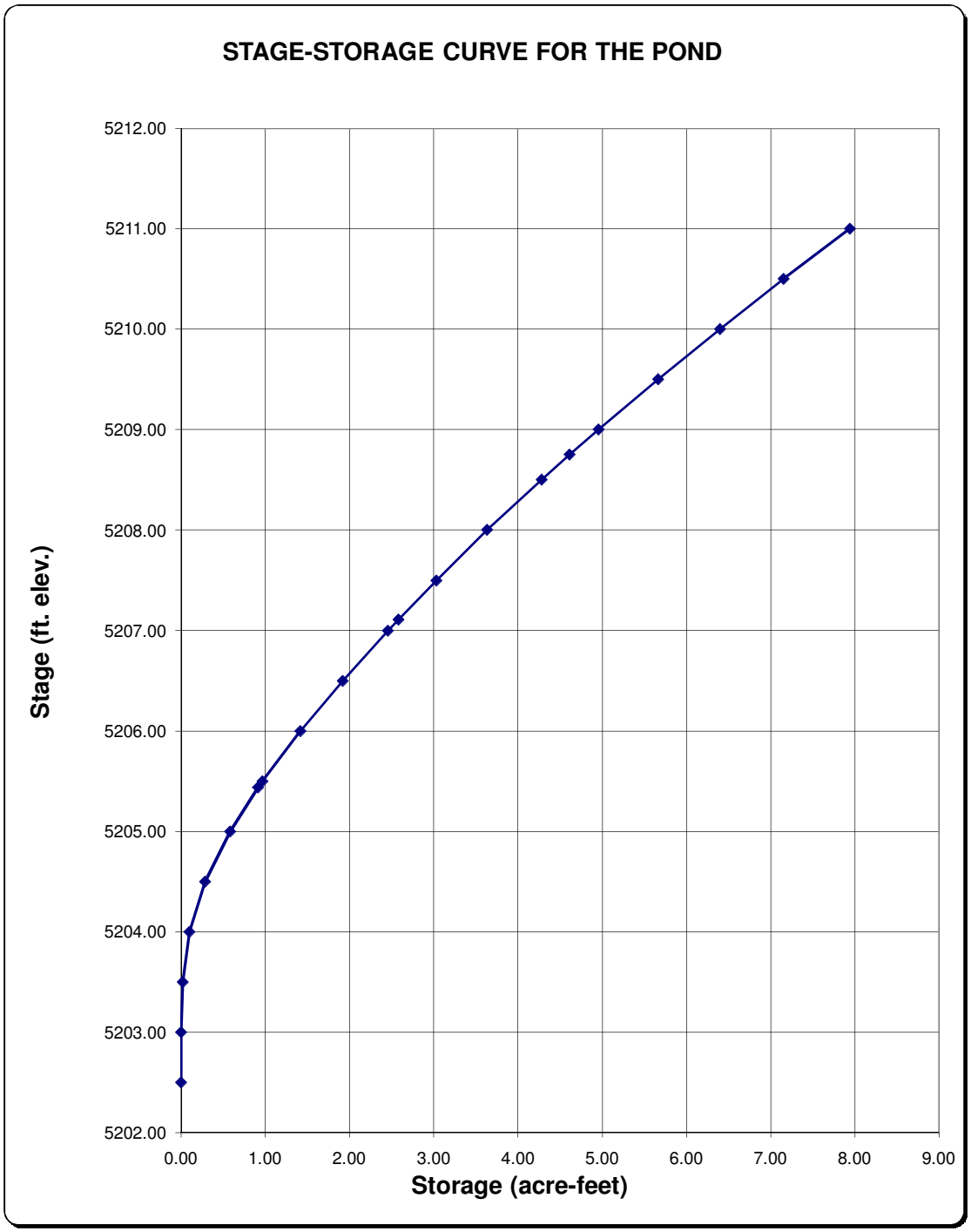
							#N/A		#N/A	

STAGE-STORAGE SIZING FOR POLYGONAL, ELLIPTICAL, OR IRREGULAR PONDS

Project: _____

Basin ID: _____



OLSSON ASSOCIATES

DETENTION POND 1 CALCULATIONS (US6POND)

5-YR WEIR OPENING

5-YR Q = 6.93 cfs (release rate)

CDOT Equation 12.7 for sharp-crested weir w/ 2 end contractions:

$$Q = [1.805 + 0.221(H/H_c)](L - 0.2H)H^{1.5}$$

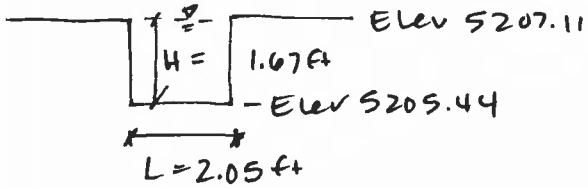
$Q = 6.93$

$H_c = 5205.44 - 5200.01 = 5.43$ ft

$H = 5207.11 - 5205.44 = 1.67$ ft

Solving, $L = 2.05$ ft

WQCV = 5205.44
5YR = 5207.11
100YR = 5208.75
Outlet = 5202.51



100-YR WEIR OVERFLOW

100-YR Q = 40.79 cfs

Section 1: Area of 5-YR weir

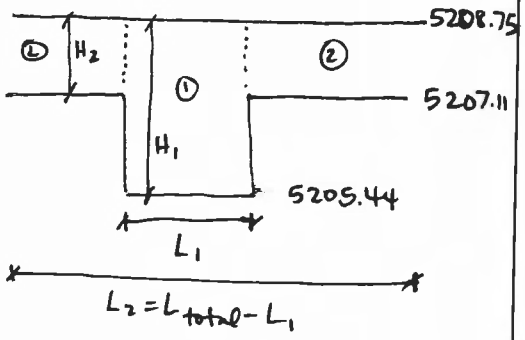
(CDOT EQ 12.7) $Q = [1.805 + 0.221(H/H_c)](L - 0.2H)H^{1.5}$

$H_1 = 5208.75 - 5205.44 = 3.31$ ft

$H_c = 5205.44 - 5200.01 = 5.43$ ft

$L_1 = 2.05$ ft

$\therefore Q = 16.21$ cfs



Section 2: Area of 100-YR overflow

(CDOT EQ 12.6) $Q = [1.805 + 0.221(H/H_c)]LH^{1.5}$

$Q = 40.79 - 16.21 = 24.58$ cfs

$H_c = 5207.11 - 5200.01 = 7.10$ ft

$H_2 = 5208.75 - 5207.11 = 1.64$ ft

$\therefore L_2 = 6.31$ ft

[trash rack: 1" Bars @ 6" centers
$\frac{\text{5" open space}}{\text{6" trash rack (LF)}} = 0.83$ ratio]

$L_{total} = 2.05 \text{ ft} + 6.31 \text{ ft} = \frac{8.36 \text{ ft}}{0.83 \text{ ratio (trash rack)}} = \boxed{10.07 \text{ ft}}$ min width req'd for overflow

project: US 6 + FEDERAL BLVD INTERCHANGE IMPROVEMENTS			
subject US 6 POND OUTLET STRUCTURE DESIGN CALCS			
drawn by: MEG	date: 1/7/11	project no.: 009-2064	sheet 1 of 2

OLSSON ASSOCIATES

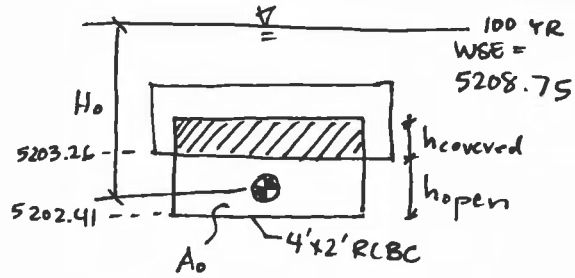
100-YR ORIFICE CONTROL PLATE

100-YR Q = 40.79 cfs

$Q = C_o A_o (2gH_o)^{0.5}$ (Orifice Eq. 5O-15, UDFCD Drainage Criteria Manual)

$C_o = 0.61$

$A_o = 3.42\ ft^2$, $H_o = 5.91\ ft$ } measured in CAD



when $h_{covered}$ = 1.15 ft (1'-1 3/4"), Q = 40.67 cfs ✓ (trial + error)

4'x2' RCBC, h = 2 ft
− 1.15 ft

h_{open} = 0.85 ft = 10 1/4" [Bottom of orifice plate = Elev. 5203.26 ft]

WQCV OUTLET TRASH RACK

USING FIGURE OS-5 AND TABLE OS-26 AND OS-29 (DCM V.3)

DIA of Circular Orifice (in) = 1 3/8", ≤ 1 3/4" at H = 2.0'

Wopening = 12" ✓ (already at 2' 0 5/8" for 5 YR weir opening)

Specs: (listed also on plans)

Screen #93 VEE Wire slot opening = 0.139"

Support Rod type : TE 0.074" x 0.50"

Support Rod, O.C. Spacing = 1"

Total Screen thickness = 0.655"

Carbon Steel Frame type = 3/4" x 1.0 angle

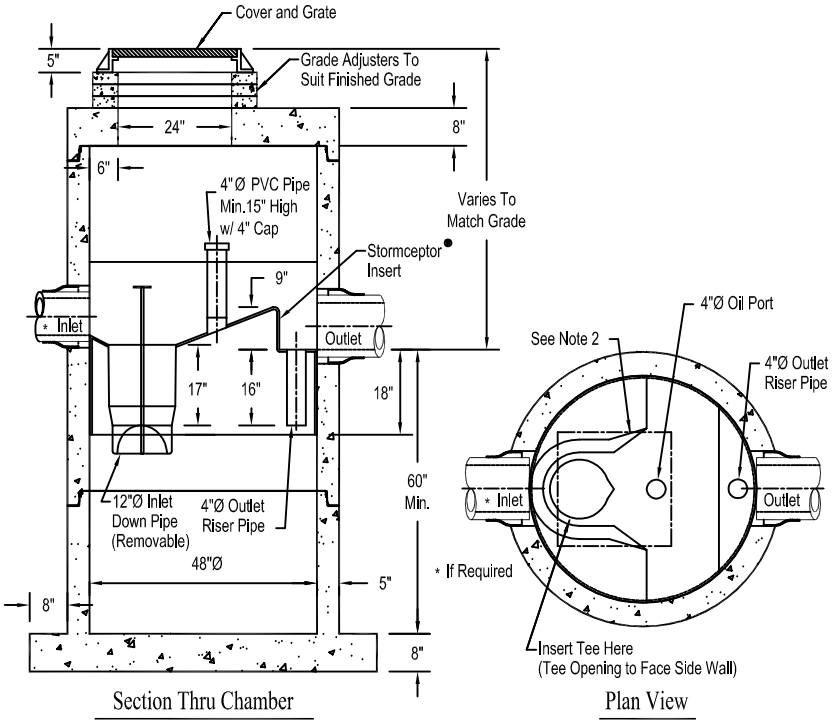
(Using Johnson Screens, St Paul, Minnesota, USA (1-800-833-9473), or approved equal)

project: US 6 + FEDERAL BLVD INTERCHANGE IMPROVEMENTS			
subject US 6 POND OUTLET STRUCTURE DESIGN CALCS			
drawn by: MEG	date: 1/7/11	project no.: 009-2064	sheet 2 of 2

Rinker MATERIALS™

Concrete Pipe Division

STC 450i Precast Concrete Stormceptor®
(450 U.S. Gallon Capacity)



Section Thru Chamber

Plan View

Notes:

1. The Use Of Flexible Connection is Recommended at The Inlet and Outlet Where Applicable.
2. The Cover Should be Positioned Over The Inlet Drop Pipe and The Oil Port.
3. The Stormceptor System is protected by one or more of the following U.S. Patents: #4985148, #5498331, #5725760, #5753115, #5849181, #6068765, #6371690.
4. Contact a Concrete Pipe Division representative for further details not listed on this drawing.

Stormceptor Sizing Detailed Report

PCSWMM for Stormceptor

Project Information

Date	12/23/10
Project Name	US 6 & Federal slip ramp
Project Number	16628
Location	Denver

Stormwater Quality Objective

This report outlines how Stormceptor System can achieve a defined water quality objective through the removal of total suspended solids (TSS). Attached to this report is the Stormceptor Sizing Summary.

Stormceptor System Recommendation

The Stormceptor System model STC 450i achieves the water quality objective removing 92% TSS for a Fine (organics, silts and sand) particle size distribution.

The Stormceptor System

The Stormceptor oil and sediment separator is sized to treat stormwater runoff by removing pollutants through gravity separation and flotation. Stormceptor's patented design generates positive TSS removal for all rainfall events, including large storms. Significant levels of pollutants such as heavy metals, free oils and nutrients are prevented from entering natural water resources and the re-suspension of previously captured sediment (scour) does not occur.

Stormceptor provides a high level of TSS removal for small frequent storm events that represent the majority of annual rainfall volume and pollutant load. Positive treatment continues for large infrequent events, however, such events have little impact on the average annual TSS removal as they represent a small percentage of the total runoff volume and pollutant load.

Stormceptor is the only oil and sediment separator on the market sized to remove TSS for a wide range of particle sizes, including fine sediments (clays and silts), that are often overlooked in the design of other stormwater treatment devices.

Small storms dominate hydrologic activity, US EPA reports

"*Early efforts in stormwater management focused on flood events ranging from the 2-yr to the 100-yr storm. Increasingly stormwater professionals have come to realize that small storms (i.e. < 1 in. rainfall) dominate watershed hydrologic parameters typically associated with water quality management issues and BMP design. These small storms are responsible for most annual urban runoff and groundwater recharge. Likewise, with the exception of eroded sediment, they are responsible for most pollutant washoff from urban surfaces. Therefore, the small storms are of most concern for the stormwater management objectives of ground water recharge, water quality resource protection and thermal impacts control.*"

"*Most rainfall events are much smaller than design storms used for urban drainage models. In any given area, most frequently recurrent rainfall events are small (less than 1 in. of daily rainfall).*"

"Continuous simulation offers possibilities for designing and managing BMPs on an individual site-by-site basis that are not provided by other widely used simpler analysis methods. Therefore its application and use should be encouraged."

– US EPA Stormwater Best Management Practice Design Guide, Volume 1 – General Considerations, 2004

Design Methodology

Each Stormceptor system is sized using PCSWMM for Stormceptor, a continuous simulation model based on US EPA SWMM. The program calculates hydrology from up-to-date local historical rainfall data and specified site parameters. With US EPA SWMM's precision, every Stormceptor unit is designed to achieve a defined water quality objective.

The TSS removal data presented follows US EPA guidelines to reduce the average annual TSS load. Stormceptor's unit process for TSS removal is settling. The settling model calculates TSS removal by analyzing (summary of analysis presented in Appendix 2):

- Site parameters
- Continuous historical rainfall, including duration, distribution, peaks (Figure 1)
- Interevent periods
- Particle size distribution
- Particle settling velocities (Stokes Law, corrected for drag)
- TSS load (Figure 2)
- Detention time of the system

The Stormceptor System maintains continuous positive TSS removal for all influent flow rates. Figure 3 illustrates the continuous treatment by Stormceptor throughout the full range of storm events analyzed. It is clear that large events do not significantly impact the average annual TSS removal. There is no decline in cumulative TSS removal, indicating scour does not occur as the flow rate increases.

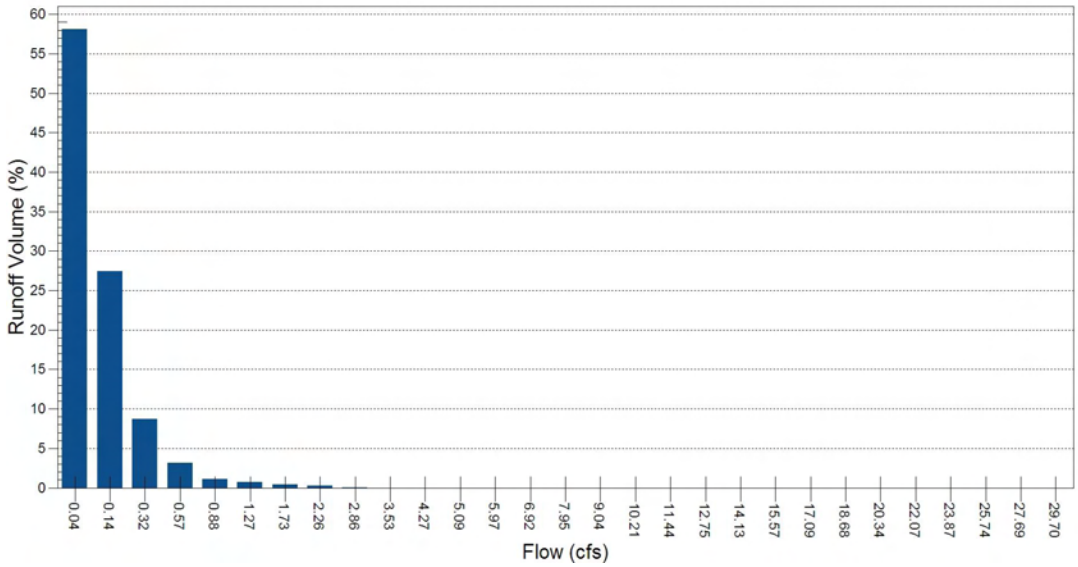


Figure 1. Runoff Volume by Flow Rate for DENVER WSO CITY – CO 2225, 1948 to 1975 for 0.52 ac, 43% impervious. Small frequent storm events represent the majority of annual rainfall volume. Large infrequent events have little impact on the average annual TSS removal, as they represent a small percentage of the total annual volume of runoff.

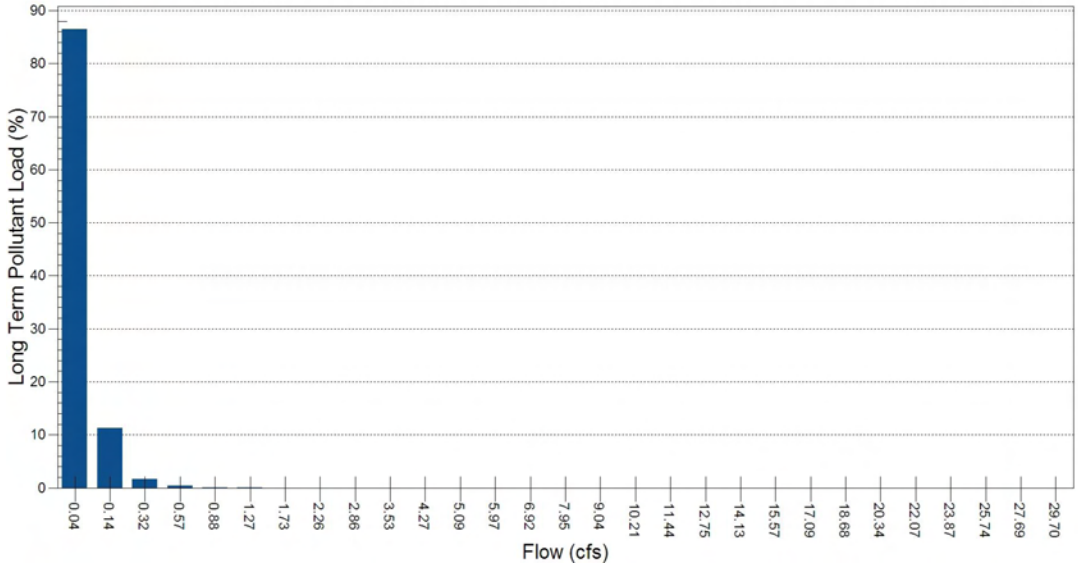
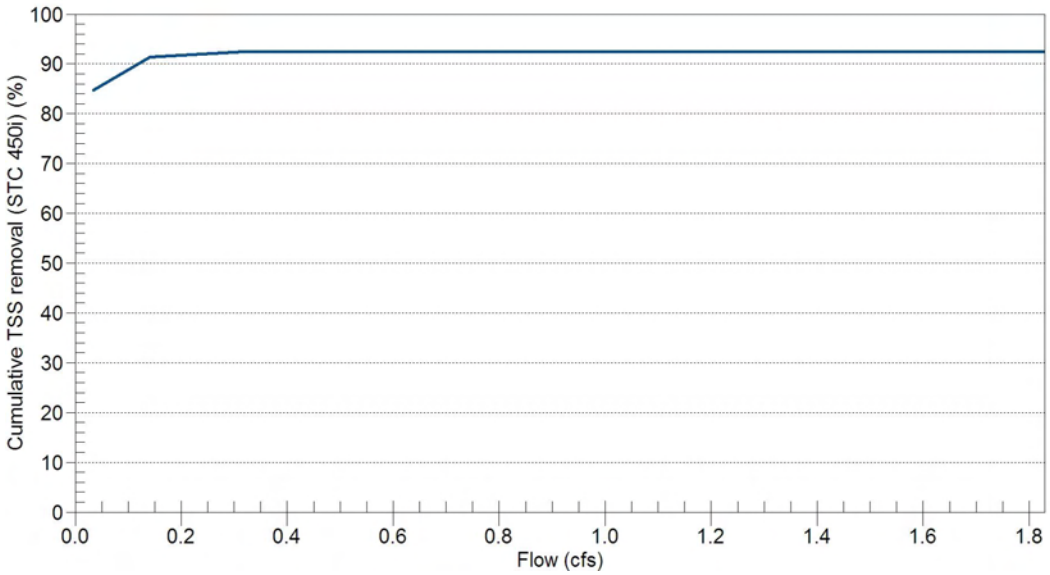


Figure 2. Long Term Pollutant Load by Flow Rate for DENVER WSO CITY – 2225, 1948 to 1975 for 0.52 ac, 43% impervious. The majority of the annual pollutant load is transported by small frequent storm events. Conversely, large infrequent events carry an insignificant percentage of the total annual pollutant

load.



Stormceptor Model	STC 450i	Drainage Area (ac)	0.52
TSS Removal (%)	92	Impervious (%)	43

Figure 3. Cumulative TSS Removal by Flow Rate for DENVER WSO CITY – 2225, 1948 to 1975. Stormceptor continuously removes TSS throughout the full range of storm events analyzed. Note that large events do not significantly impact the average annual TSS removal. Therefore no decline in cumulative TSS removal indicates scour does not occur as the flow rate increases.

Appendix 1
Stormceptor Design Summary

Project Information

Date	12/23/10
Project Name	US 6 & Federal slip ramp
Project Number	16628
Location	Denver

Designer Information

Company	Olsson Associates
Contact	David Krickbaum

Notes

N/A

Drainage Area

Total Area (ac)	0.52
Imperviousness (%)	43

The Stormceptor System model STC 450i achieves the water quality objective removing 92% TSS for a Fine (organics, silts and sand) particle size distribution.

Rainfall

Name	DENVER WSO CITY
State	CO
ID	2225
Years of Records	1948 to 1975
Latitude	39°45'0"N
Longitude	104°59'0"W

Water Quality Objective

TSS Removal (%)	80

Upstream Storage

Storage (ac-ft)	Discharge (cfs)
0	0

Stormceptor Sizing Summary

Stormceptor Model	TSS Removal %
STC 450i	**92**
STC 900	96
STC 1200	96
STC 1800	96
STC 2400	97
STC 3600	98
STC 4800	98
STC 6000	98
STC 7200	99
STC 11000	99
STC 13000	99
STC 16000	99

Particle Size Distribution

Removing silt particles from runoff ensures that the majority of the pollutants, such as hydrocarbons and heavy metals that adhere to fine particles, are not discharged into our natural water courses. The table below lists the particle size distribution used to define the annual TSS removal.

Fine (organics, silts and sand)

Particle Size µm	Distribution %	Specific Gravity	Settling Velocity ft/s		Particle Size µm	Distribution %	Specific Gravity	Settling Velocity ft/s
20	20	1.3	0.0013					
60	20	1.8	0.0051					
150	20	2.2	0.0354					
400	20	2.65	0.2123					
2000	20	2.65	0.9417					

Stormceptor Design Notes

- Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor.
- Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal.
- Only the STC 450i is adaptable to function with a catch basin inlet and/or inline pipes.
- Only the Stormceptor models STC 450i to STC 7200 may accommodate multiple inlet pipes.
- Inlet and outlet invert elevation differences are as follows:

Inlet and Outlet Pipe Invert Elevations Differences

Inlet Pipe Configuration	STC 450i	STC 900 to STC 7200	STC 11000 to STC 16000
Single inlet pipe	3 in.	1 in.	3 in.
Multiple inlet pipes	3 in.	3 in.	Only one inlet pipe.

- Design estimates are based on stable site conditions only, after construction is completed.
- Design estimates assume that the storm drain is not submerged during zero flows. For submerged applications, please contact your local Stormceptor representative.
- Design estimates may be modified for specific spills controls. Please contact your local Stormceptor representative for further assistance.
- For pricing inquiries or assistance, please contact Rinker Materials 1 (800) 909-7763 www.rinkerstormceptor.com

Stormceptor®

Appendix 2
Summary of Design Assumptions

SITE DETAILS

Site Drainage Area

Total Area (ac)	0.52	Imperviousness (%)	43

Surface Characteristics

Width (ft)	301
Slope (%)	2
Impervious Depression Storage (in.)	0.02
Pervious Depression Storage (in.)	0.2
Impervious Manning's n	0.015
Pervious Manning's n	0.25

Infiltration Parameters

Horton's equation is used to estimate infiltration	
Max. Infiltration Rate (in/hr)	2.44
Min. Infiltration Rate (in/hr)	0.4
Decay Rate (s^{-1})	0.00055
Regeneration Rate (s^{-1})	0.01

Maintenance Frequency

Sediment build-up reduces the storage volume for sedimentation. Frequency of maintenance is assumed for TSS removal calculations.	
Maintenance Frequency (months)	12

Evaporation

Daily Evaporation Rate (inches/day)	0.1

Dry Weather Flow

Dry Weather Flow (cfs)	No

Upstream Attenuation

Stage-storage and stage-discharge relationship used to model attenuation upstream of the Stormceptor System is identified in the table below.

Storage ac-ft	Discharge cfs
0	0

Rinker MATERIALS™

PARTICLE SIZE DISTRIBUTION

Particle Size Distribution

Removing fine particles from runoff ensures the majority of pollutants, such as heavy metals, hydrocarbons, free oils and nutrients are not discharged into natural water resources. The table below identifies the particle size distribution selected to define TSS removal for the design of the Stormceptor System.

Fine (organics, silts and sand)

Particle Size µm	Distribution %	Specific Gravity	Settling Velocity ft/s		Particle Size µm	Distribution %	Specific Gravity	Settling Velocity ft/s
20	20	1.3	0.0013					
60	20	1.8	0.0051					
150	20	2.2	0.0354					
400	20	2.65	0.2123					
2000	20	2.65	0.9417					

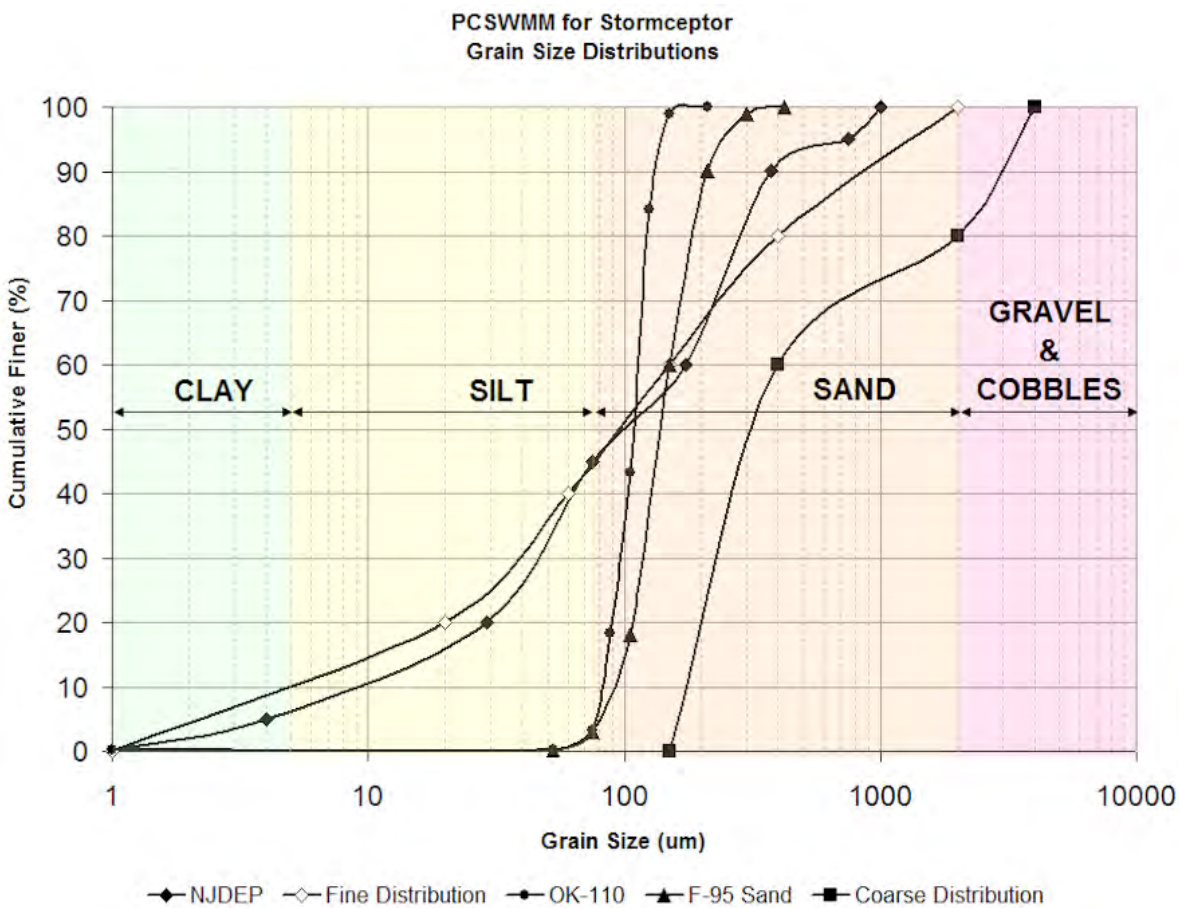


Figure 1. PCSWMM for Stormceptor standard design grain size distributions.

TSS LOADING

TSS Loading Parameters

TSS Loading Function	Buildup / Washoff

Parameters

Target Event Mean Concentration (EMC) (mg/L)	125
Exponential Buildup Power	0.4
Exponential Washoff Exponential	0.2

HYDROLOGY ANALYSIS

PCSWMM for Stormceptor calculates annual hydrology with the US EPA SWMM and local continuous historical rainfall data. Performance calculations of the Stormceptor System are based on the average annual removal of TSS for the selected site parameters. The Stormceptor System is engineered to capture fine particles (silts and sands) by focusing on average annual runoff volume ensuring positive removal efficiency is maintained during all rainfall events, while preventing the opportunity for negative removal efficiency (scour).

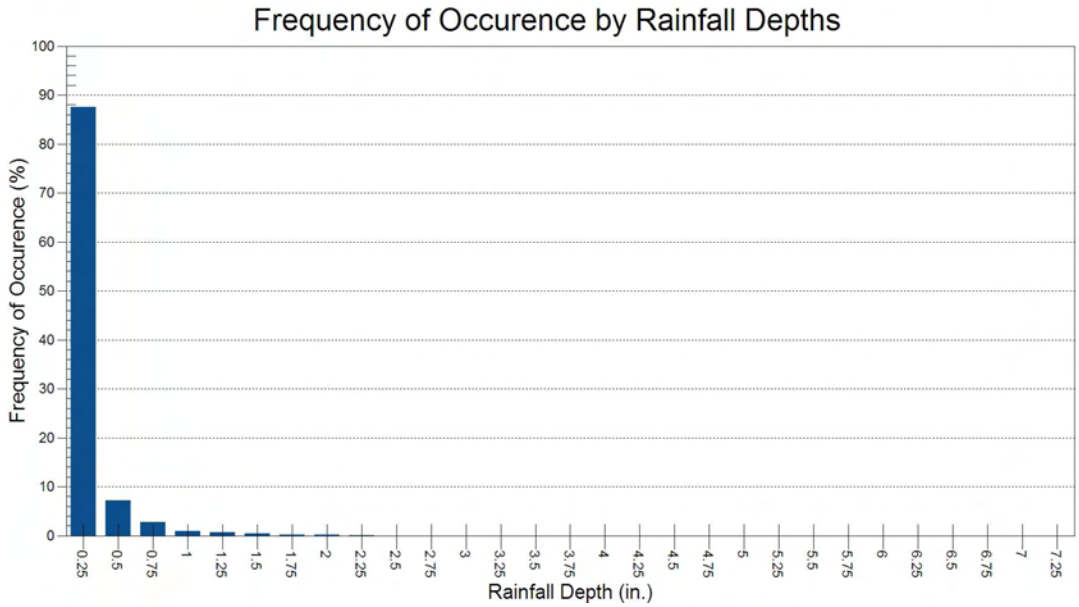
Smaller recurring storms account for the majority of rainfall events and average annual runoff volume, as observed in the historical rainfall data analyses presented in this section.

Rainfall Station

Rainfall Station	DENVER WSO CITY		
Rainfall File Name	CO2225.NDC	Total Number of Events	2403
Latitude	39°45'0"N	Total Rainfall (in.)	301.0
Longitude	104°59'0"W	Average Annual Rainfall (in.)	10.7
Elevation (ft)	5325	Total Evaporation (in.)	21.4
Rainfall Period of Record (y)	28	Total Infiltration (in.)	170.3
Total Rainfall Period (y)	28	Percentage of Rainfall that is Runoff (%)	37.7

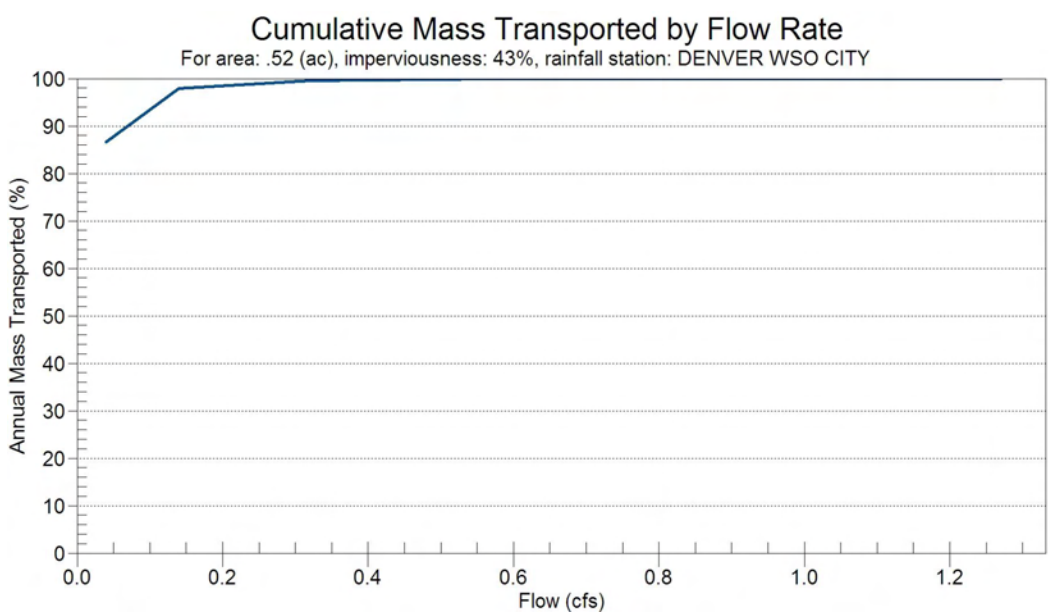
Rainfall Event Analysis

Rainfall Depth in.	No. of Events	Percentage of Total Events %	Total Volume in.	Percentage of Annual Volume %
0.25	2104	87.6	123	40.8
0.50	173	7.2	62	20.5
0.75	66	2.7	40	13.4
1.00	21	0.9	18	6.0
1.25	16	0.7	18	6.1
1.50	10	0.4	14	4.6
1.75	5	0.2	8	2.8
2.00	4	0.2	8	2.5
2.25	2	0.1	4	1.4
2.50	0	0.0	0	0.0
2.75	1	0.0	3	0.9
3.00	0	0.0	0	0.0
3.25	1	0.0	3	1.0
3.50	0	0.0	0	0.0
3.75	0	0.0	0	0.0
4.00	0	0.0	0	0.0
4.25	0	0.0	0	0.0
4.50	0	0.0	0	0.0
4.75	0	0.0	0	0.0
5.00	0	0.0	0	0.0
5.25	0	0.0	0	0.0
5.50	0	0.0	0	0.0
5.75	0	0.0	0	0.0
6.00	0	0.0	0	0.0
6.25	0	0.0	0	0.0
6.50	0	0.0	0	0.0
6.75	0	0.0	0	0.0
7.00	0	0.0	0	0.0
7.25	0	0.0	0	0.0
7.50	0	0.0	0	0.0
7.75	0	0.0	0	0.0
8.00	0	0.0	0	0.0
8.25	0	0.0	0	0.0
>8.25	0	0.0	0	0.0



Pollutograph

Flow Rate cfs	Cumulative Mass %
0.035	86.6
0.141	97.9
0.318	99.5
0.565	99.9
0.883	99.9
1.271	100.0
1.73	100.0
2.26	100.0
2.86	100.0
3.531	100.0
4.273	100.0
5.085	100.0
5.968	100.0
6.922	100.0
7.946	100.0
9.041	100.0
10.206	100.0
11.442	100.0
12.749	100.0
14.126	100.0
15.574	100.0
17.092	100.0
18.681	100.0
20.341	100.0
22.072	100.0
23.873	100.0
25.744	100.0
27.687	100.0
29.7	100.0
31.783	100.0



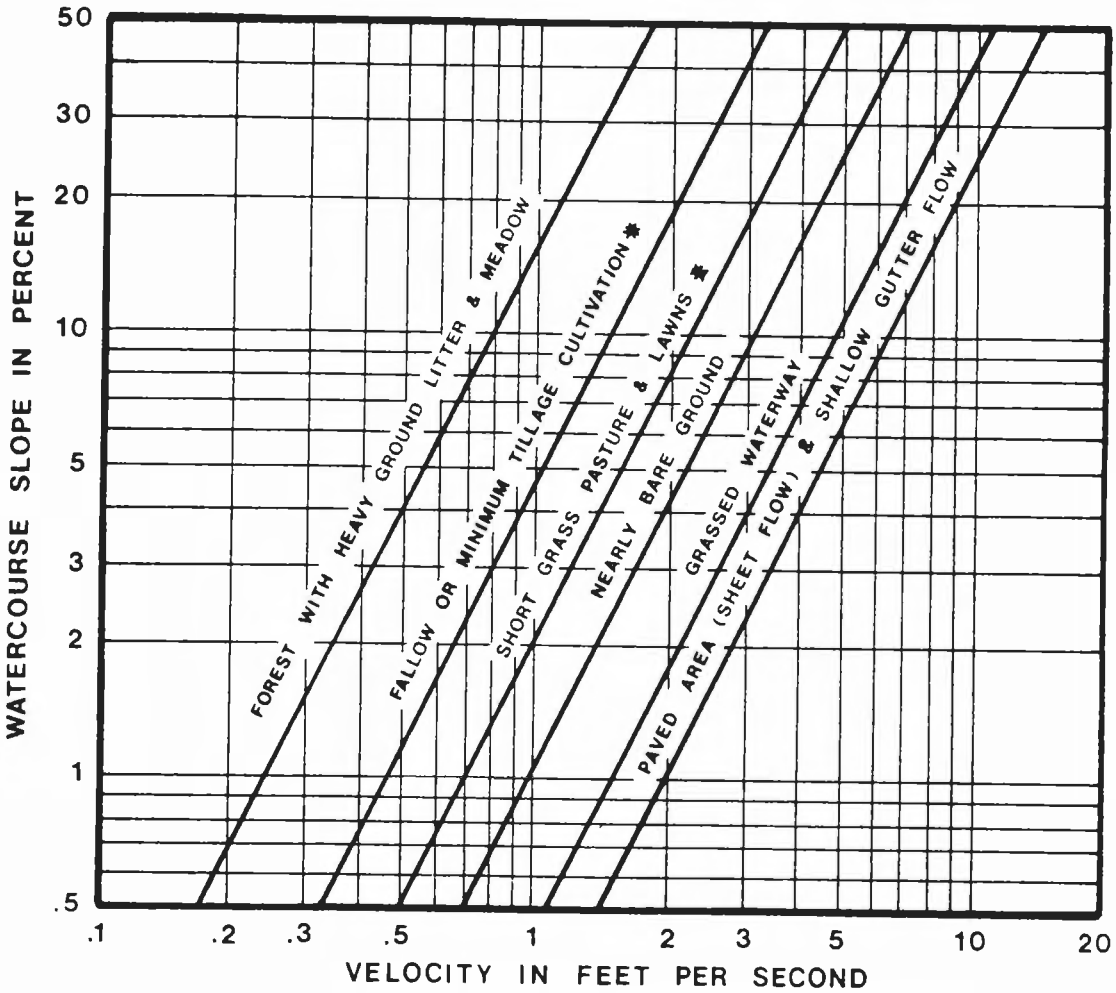


FIGURE 3-2. ESTIMATE OF AVERAGE FLOW VELOCITY FOR USE WITH THE RATIONAL FORMULA.

* MOST FREQUENTLY OCCURRING "UNDEVELOPED" LAND SURFACES IN THE DENVER REGION.

REFERENCE: "Urban Hydrology For Small Watersheds" Technical Release No. 55, USDA, SCS Jan. 1975.

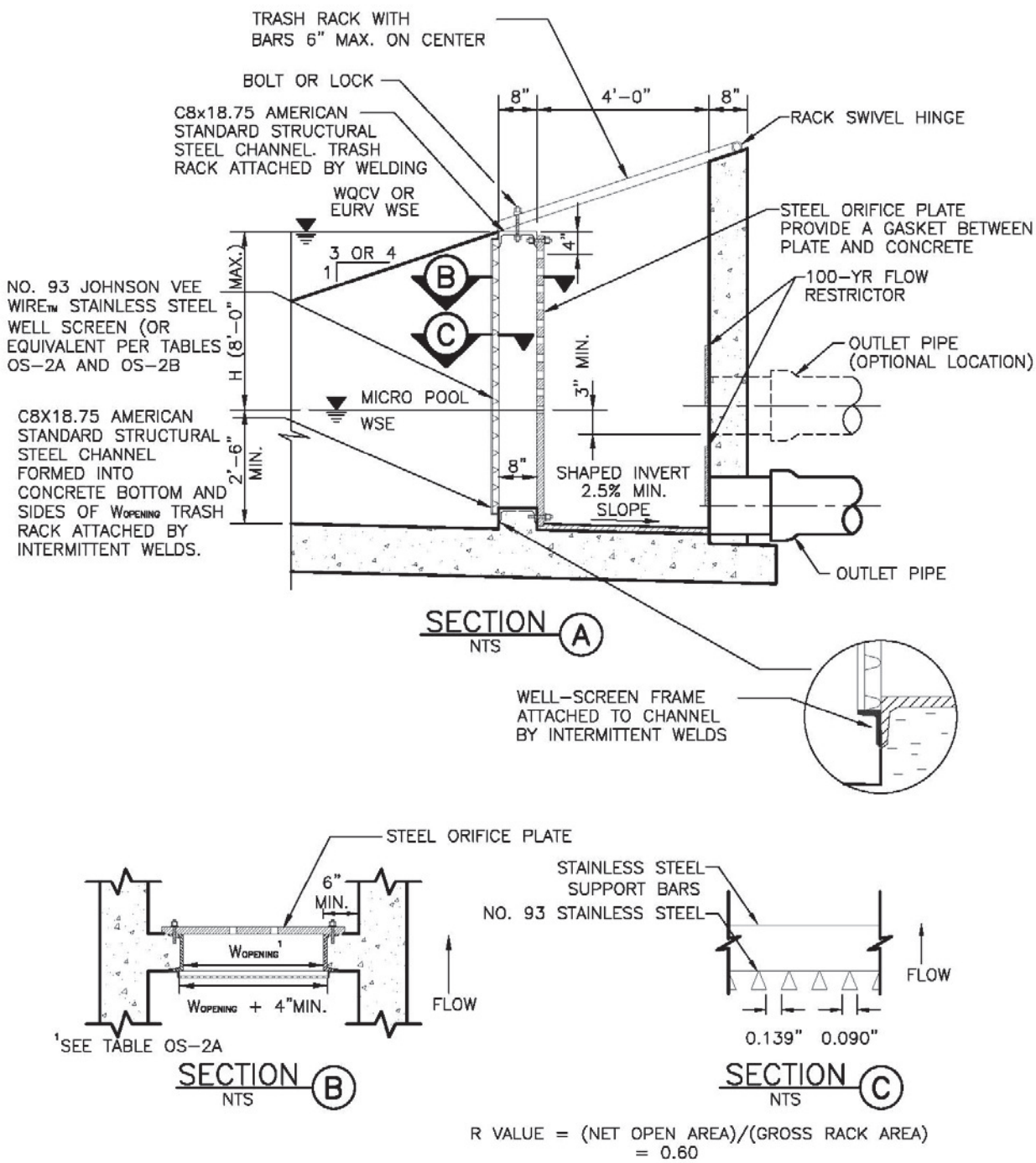


Figure OS-5. Typical Outlet Structure with Circular Orifice Plate

Table OS-1. Orifice Sizing

Hole Dia. (in) [1]	Hole Dia. (in)	Area per Row (in^2)	
		n = 1	n = 2
1/4	0.250	0.05	-
5/16	0.313	0.08	-
3/8	0.375	0.11	-
7/16	0.438	0.15	-
1/2	0.500	0.2	-
9/16	0.563	0.25	-
5/8	0.625	0.31	-
11/16	0.688	0.37	-
3/4	0.750	0.44	-
13/16	0.813	0.52	-
7/8	0.875	0.6	-
15/16	0.938	0.69	-
1	1.000	0.79	-
1-1/16	1.063	0.89	-
1-1/8	1.125	0.99	-
1-3/16	1.188	1.11	-
1-1/4	1.250	1.23	-
1-5/16	1.313	1.35	-
1-3/8	1.375	1.48	-
1-7/16	1.438	1.62	3.24
1-1/2	1.500	1.77	3.54
1-9/16	1.563	1.92	3.84
1-5/8	1.625	2.07	-
1-11/16	1.688	2.24	-
1-3/4	1.750	2.41	-
1-13/16	1.813	2.58	-
1-7/8	1.875	2.76	-
1-15/16	1.938	2.95	-
2	2.000	3.14	-
n = Number of Columns of Orifices			
Steel Thickness (Min.)		1/4”	5/16”
[1] If desired, interpolate to the nearest 32" to better match the needed area.			

Use one column of rectangular orifices when the needed area exceeds 3.84 in^2

Rectangular Height (in) = 2
Rectangular Width (in) = Required Area / 2 in

Rectangular Width (in)	Steel Thickness (in)
≤6	≥1/4
≤8	≥5/16
≤10	≥3/8
>10	≥1/2

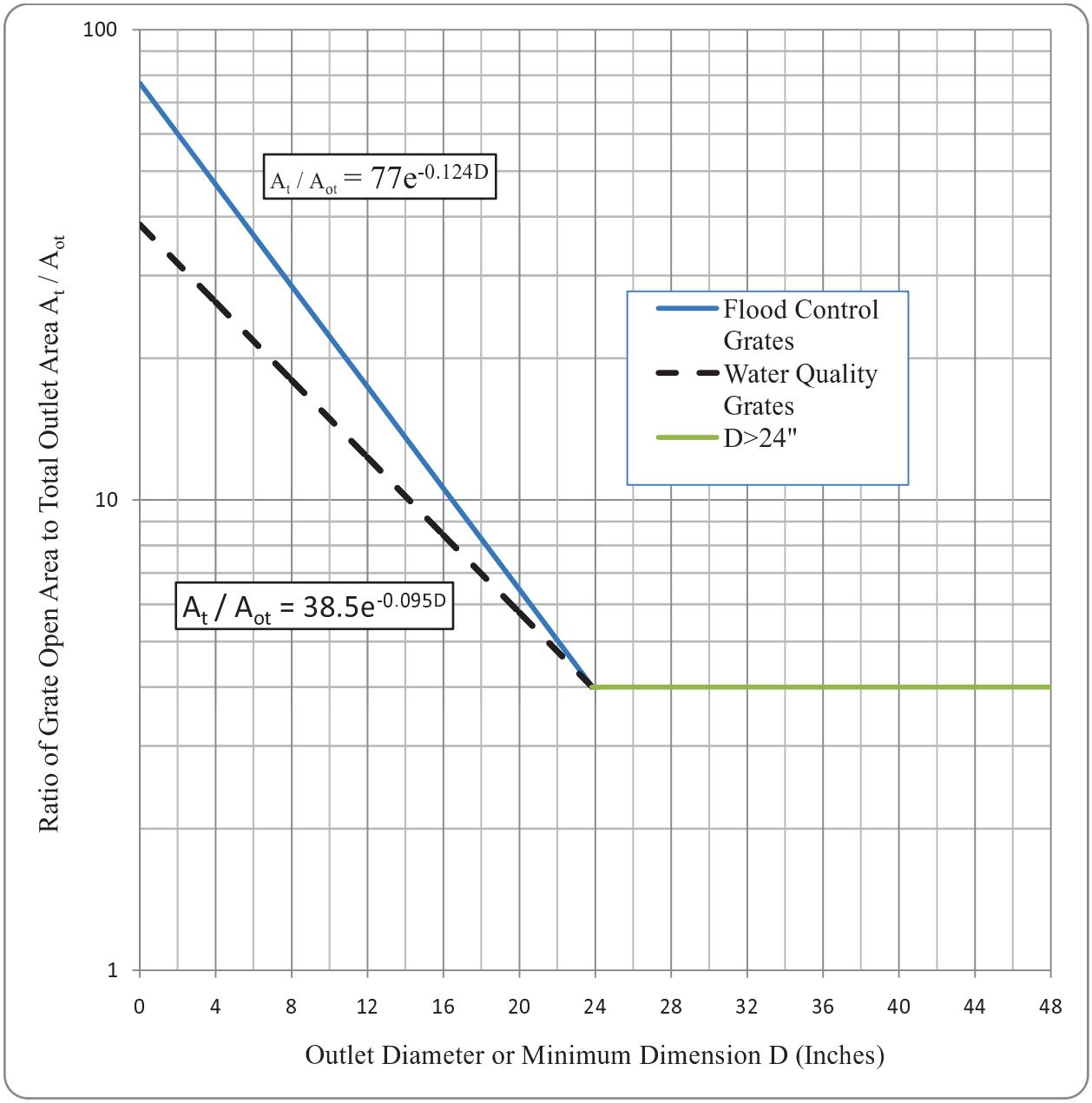


Figure OS-1. Trash Rack Sizing

Table OS-2a. Trash Rack Sizing for Circular Orifices[1,3]

Number of Columns	Diameter of Circular Orifice (in)	Width of Trash Rack Opening ($W_{opening}$) as a Function of Water Depth H Above Lowest Perforation				
		H=2.0'	H=3.0'	H=4.0'	H=5.0'	H=6.0'
1	≤ 1-1/4	12"[2]	12"[2]	12"[2]	12"	13"
1	≤ 1-1/2	12"[2]	14"	16"	17"	18"
1	≤ 1-3/4	15"	18"	21"	22"	24"
1	≤ 2	19"	23"	26"	28"	30"
2	1-7/16	21"	26"	29"	31"	33"
2	1-1/2	23"	28"	31"	34"	35"
2	1-9/16	24"	30"	34"	36"	38"

[1] For use with Johnson VEE WireTM Stainless Steel Screen1 (or equivalent screen with 60% open area). Assumes inundation of well screen into the permanent pool 2'4".

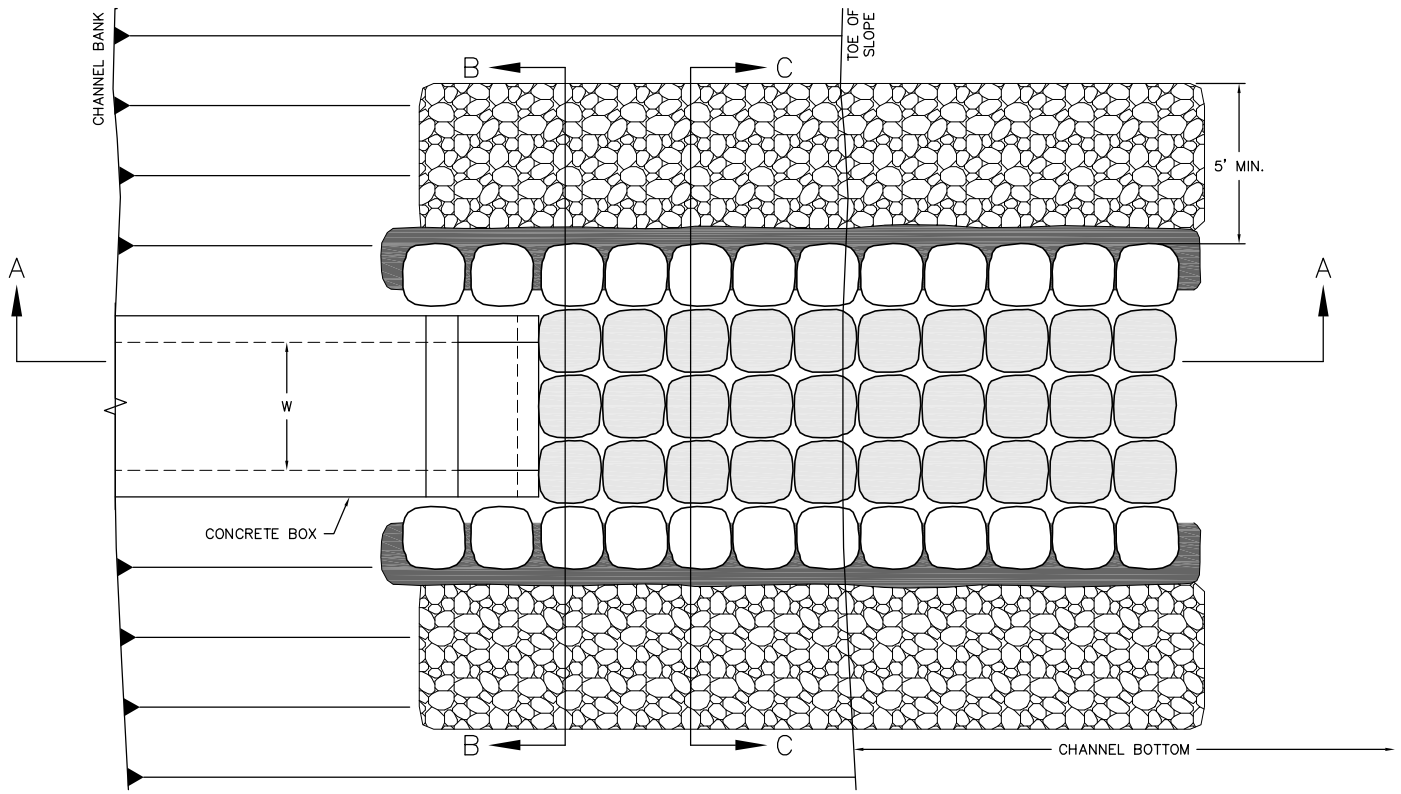
[2] Represents the minimum recommended width of 12 inches, otherwise width is calculated based on Figure OS-1.

[3] This table provides the minimum opening in the concrete, not the minimum width of the well screen. Ensure the well screen is wide enough to properly attach to the structure.

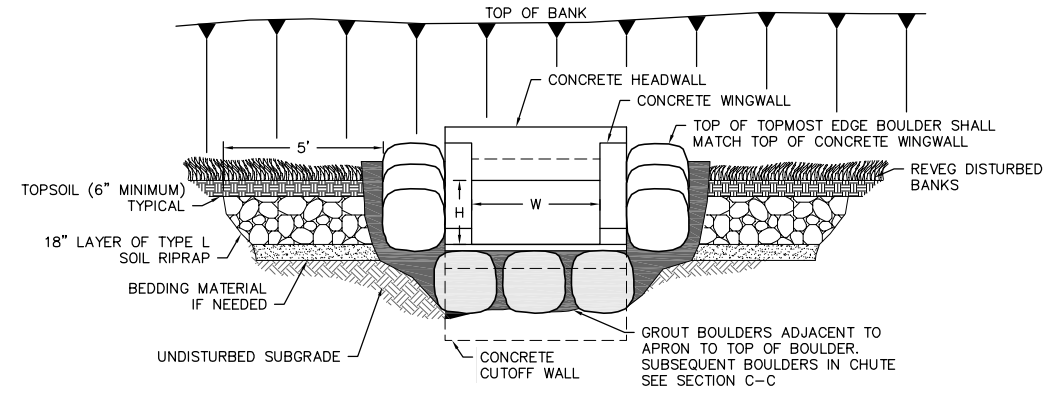
Table OS-2b. Trash Rack Specifications for Circular Orifice Plates

Max. Width of Trash Rack Opening (in)	Screen #93 VEE Wire Slot Opening (in)	Support Rod Type	Support Rod, On Center, Spacing	Total Screen Thickness	Carbon Steel Frame Type
≤9	0.139	#156 VEE	¾"	0.31"	$^3/_8$"x1.0" flat bar
≤18	0.139	TE 0.074"x0.50"	1"	0.655"	¾" x 1.0 angle
≤24	0.139	TE 0.074"x0.75"	1"	1.03"	1.0" x 1½" angle
≤27	0.139	TE 0.074"x0.75"	1"	1.03"	1.0" x 1½" angle
≤30	0.139	TE 0.074"x1.0"	1"	1.155"	1 $^1/_4$"x 1½" angle
≤36	0.139	TE 0.074"x1.0"	1"	1.155"	1 $^1/_4$"x 1½" angle
≤42	0.139	TE 0.105"x1.0"	1"	1.155"	1 $^1/_4$"x 1½" angle

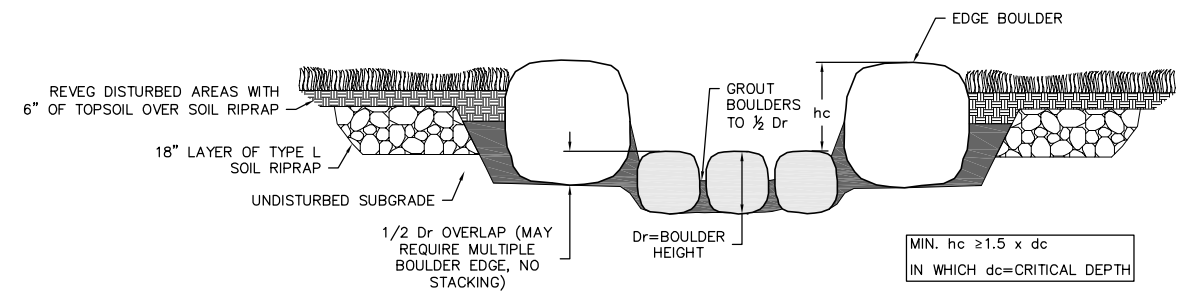
[1] Johnson Screens, St. Paul, Minnesota, USA (1-800-833-9473)



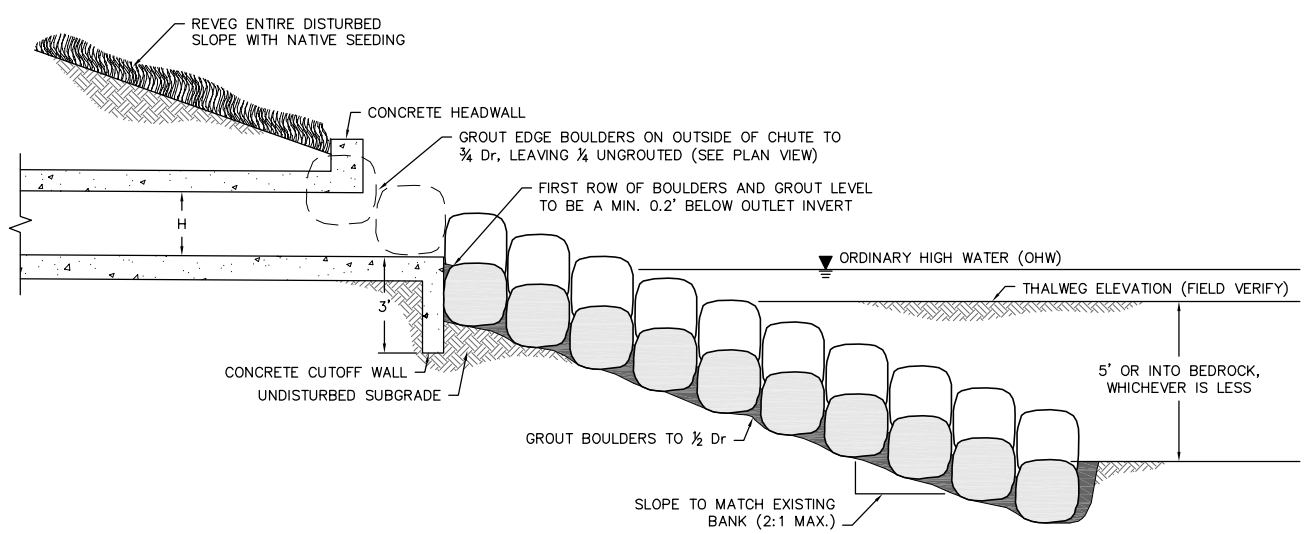
1 DTX STORMWATER OUTLET WITH GROUTED BOULDER RUNDOWN: PLAN VIEW
Scale:1"=3'



3 DTX BOULDER RUNDOWN: CROSS SECTION B-B
Scale:1"=3'



4 DTX BOULDER RUNDOWN: CROSS SECTION C-C
Scale:1"=3'



2 DTX BOULDER RUNDOWN: CROSS SECTION A-A
Scale:1"=3'

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REV. NO.	DATE	REVISIONS DESCRIPTION

REVISIONS

GROUTED BOULDER RUNDOWN DETAILS

FEDERAL BOULEVARD & US 6 INTERCHANGE IMPROVEMENT

DENVER, COLORADO

2010

drawn by:	AG
checked by:	DK
approved by:	DK
QA/QC by:	DK
project no.:	009-2064
drawing no.:	
date:	01.07.11

SHEET DT1

DWG: F:\Projects\009-2064_WTRS\Final_Plans\92064_DTX.dwg USER: mguthrie
DATE: Jan 07, 2011 9:46am XREFS: 092064_22x34TB