Central Park Boulevard Interchange with I-70
CDOT Project No.: ES6 C010-103 (17334)
Denver Contract Control No.: CE 93041

Final Drainage Report

Central Park Boulevard Interchange with I-70
April 9, 2010

Revised May 30, 2010

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SEMA CONSTRUCTION WILSON & COMPANY

Certification

I hereby certify that this report for the drainage design of the Central Park Boulevard Interchange with I-70 Project, Denver Contract Control No.: CE 93041, CDOT Project No.:ES6 C010-103(17334) was prepared by me (or under my direct supervision).

Vancel Fossinger

Vancel S. Fossinger
State of Colorado PE No. 31972

COLORADO REGISTERED
VANCEL S FOSSINGER
31972
5-30-10
PROFESSIONAL ENGINEER

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- Added Certification/Document Revision Log Page
- Page 7 and Drainage Maps: References to "Type 5 Embankment Protectors" were changed to "Embankment Protectors".
- Page 11 and Drainage Maps: The water quality storage depth in the South Water Quality pond was changed from 4.8 feet above the invert of the outlet pipe to 4.9 feet above the invert of the outlet pipe. The 100 year maximum water surface of the South Water Quality Pond was changed to 5244.5 from 5244.6. The 100 year maximum water surface of the North Water Quality Pond was changed to 5240.1 from 5240.0. These changes are a result of minor grading changes and minor revisions to the Storm Water Management Model (SWMM).
- The CulvertMaster calculation spreadsheet for Culvert P-27 (the outlet pipe from the South WQ Pond) was revised to reflect a higher 100 year peak outflow rate from the pond (85cfs vs. 75cfs).
- The Permanent Water Quality BMPs Watershed Area Map DMP005 was updated to reflect the current submittal date. Copies of drainage plans sheets were updated to reflect the RFC submittal.
- Storage volume calculations for the proposed water quality ponds and the gore areas were revised to reflect minor grading changes.
- The Design Procedure Forms for EDBs were revised to reflect grading changes and modification to the proposed micro-pools to address comments from CDOT.
- SWMM input was revised to reflect minor grading changes. Revised input and output for the SWMM are included. Except for P-27, peak flow rates predicted by the revised model throughout the system were generally consistent with those presented in the previous submittal. Thus, associated graphical output was not updated.
- Drainage maps were revised to show minor changes in maximum water surface elevations, water quality water surface elevations, and the peak flow rate at Culvert P-27. They also were updated to show revised pipe lengths and reflect the current design widths of the WQ outlet structures.

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Introduction

This report describes the drainage improvements proposed for the Central Park Boulevard Interchange with I-70 Project. This report also discusses the drainage challenges associated with the project and presents the drainage analysis that has been performed to demonstrate the adequacy of the proposed drainage improvements.

The project site, shown on the vicinity map contained in this report's appendix section, is located within the I-70 corridor between the Quebec and Havana Street interchanges. The site is located in Sections 21 and 22, Township 3 South, Range 67 West of the 6th Principal Meridian. The adjacent land and portions of the project site was once occupied by the Stapleton International Airport. The adjacent land is currently under redevelopment.

The project is being constructed under a design-build contract managed and funded through the City and County of Denver (CCD). The majority of the project improvements will be located within existing or future CDOT right of way. Proposed roadway improvements include a new bridge to carry Central Park Boulevard over I-70 as well as braided ramps along the north and south sides of I-70 to provide connections between I-70, Central Park Boulevard and I-270.

A Master Drainage Report titled "Interstate 70 Interchange at Central Park Boulevard, Master Plan Drainage Report," by Vision Land Consultants, was prepared for CCD in the project development phase. The proposed drainage facilities have been designed utilizing the Master Plan Drainage Report as the general basis for design as specified in Section 12.4.1 of the project technical requirements.

Hydrology

Drainage Basin Description

General Watershed Characteristics

Drainage basin maps showing the on- and off-site watershed that impacts the project site are contained in the appendix section of this report. As shown on the maps, the watershed is approximately 3.2 miles long. The upper limit of the watershed is just above the Peoria Street/ I-70 Interchange and the lower limit is at the existing Quebec/I-270 Interchange. The total watershed area is approximately 531 acres.

Approximately 180 acres of this watershed is located above the west side of Havana Street. Due to detention and diversions that occur in the Havana/I-70 interchange only 20% of the peak flow rate at Havana is carried downstream to the project area. However, 61%, or approximately 110 acres, of this portion of the watershed will contribute flow to the project site in the water quality event.

Approximately 190 acres of the watershed are part of the Stapleton Filing No. 7 development located along the south side if the I-70 corridor between Havana Street and proposed Central Park Boulevard. Runoff from Stapleton Filing 7 is currently routed through a large, private

detention/water quality pond located south of the project corridor and discharged though a storm sewer to the project corridor at a low flow rate.

The remaining 160 acres of the watershed are made up of the project area and other areas that contribute runoff directly to the project area.

The watershed is long and narrow with typical slopes between 0.5 % and 1.5 %. Soils in the area as noted in previous reports can be classified as Hydrologic Soil Type B. The prevalent runoff pattern within the portion of the I-70 corridor within the studied watershed includes roadway pavement draining to adjacent vegetated roadside swales with relatively flat gradients. Several areas within the watershed store runoff during runoff events. These characteristics are all conducive to relatively low unit peak runoff rates. To the extent practical, these desirable watershed characteristics will be carried through to the proposed condition. Impervious area in the watershed will be increased, but storage capacity in the project area will be substantially increased as well.

There are no known irrigation facilities in the project area.

The Master Plan Drainage Report indicates that detention to a specified or historic rate is not required with construction of this project, but recommended that low points and swales within the project area be utilized to attenuate peak flow rates to minimize the size of downstream conveyance facilities.

Existing Condition Drainage Patterns

In the existing condition, runoff in the watershed is general conveyed from east to west along the north and south sides of I-70. A portion of the runoff from the north side of I-70 (**Basin 10**) reaching the Havana Street interchange is intercepted by an inlet and conveyed west across Havana in a storm sewer that outfalls in the interchange right of way. The remainder of this flow is diverted to the north in Havana Street. The majority of the runoff from **Basin 11** at the northeast quadrant of the interchange is routed through a shallow pond area and then routed west across Havana in an existing 24-inch culvert to outfall in the interchange right of way. The runoff from the south side of I-70 (**Basin 20**) that reaches Havana Street is routed through ponds located on both sides of the east bound I-70 entrance ramp. In large storm events runoff from adjacent **Basin 80** is expected to overwhelm its existing storm sewer outfall pipe in Havana Street and will also contribute runoff to the ponds. The analysis performed for the project Master Drainage Plan and the current study indicate that a portion of the east bound entrance ramp will be below the 100-year event water surface associated with these existing ponds. Runoff is conveyed west under Havana Street in an existing 24-inch culvert from the pond located on the north side of the east bound entrance ramp to outfall in the interchange right of way. This runoff is combined with runoff from local **Basin 21** and routed below I-70 at Havana Bridge in an existing storm sewer where it combines with the runoff from the previously described storm sewers and runoff from local **Basin 41**. The combined runoff is then conveyed west along the north side of I-70 in a broad, vegetated roadside swale along with runoff from the north side of I-70 (**Basin 40**) to an existing 30-inch RCP cross culvert labeled as **EX-P3** on the drainage maps.

It should be noted that there is an existing concrete channel that crosses Havana Street from east to west approximately 1000 feet north of I-70, which then turns north and parallels the west side of Havana Street. Previous reports indicate that the capacity of this channel may be insufficient to carry even its tributary 5-year design flow. Previous reports and drainage master plans for the area indicate that this flow is not considered tributary to the current project site.

The existing inlet end of the existing culvert **EX-P3** is depressed below the invert of the downstream roadside ditch. Hydraulic analysis indicates that in the 100-year storm, only a portion of the flow reaching the culvert will be conveyed by the culvert. The remaining flow will be conveyed west in the existing vegetated roadside swale along with runoff from the north side of I-70 to a low point located approximately 400 feet west of the proposed alignment for Central Park Boulevard. The low point is located at the inlet end of an existing 18-inch RCP culvert labeled as **EX-P2** on the drainage maps and drainage plans.

The hydraulic analysis indicates flow reaching culvert **EX-P2** in the 100-year storm in the existing condition is much greater than the capacity of the culvert. Topographic mapping indicates that the existing overflow point in the roadside swale is approximately 4 feet higher than the culvert invert resulting in a headwater/diameter (HW/D) ratio of 3.7 in the existing condition. This results in flooding of the adjacent traveled way of I-70. Runoff that overtops the existing high point in the roadside swale adjacent to the north side of I-70 continues west in the swale along with runoff from the northern portion of the I-70 right of way to an existing culvert passing under the north bound lanes of I-270. The culvert discharges to an existing pond (labeled as **North WQ Pond** on the drainage maps) and ultimately is discharged to Sand Creek through an existing 36-inch CMP culvert (**EX-P1**) under southbound I-270 and a short segment of drainage swale.

Runoff conveyed through the existing 30-inch culvert **EX-P3** is combined with runoff from the south side of the I-70 corridor (**Basin 60**) in the existing vegetated roadside swale adjacent to the south side of I-70 and is conveyed west to an existing 36-inch to 54-inch RCP culvert (**EX-P4**). The runoff is then conveyed west though the culvert where it is combined with runoff from a temporary private pond that detains flow from the adjacent Stapleton Filing No. 7 development. The private pond and discharge to the I-70 corridor are both a temporary condition. Ultimately, as future development occurs in the Filing 7 area, the pond is to be removed and the runoff from the development is to be conveyed west to Sand Creek south of the I-70 corridor.

The combined runoff is routed though the culvert and outfalls to the existing Sand Creek Overflow Channel at a point approximately 400 feet west of the proposed Central Park Boulevard corridor. The runoff is then combined with runoff collected and conveyed in the south I-70 roadside swale and runoff conveyed under I-70 through the existing 18-inch culvert **EX-P2**. The combined runoff is then conveyed west in the existing Sand Creek Overflow Channel to Sand Creek along with runoff from the adjacent southern portion of the I-70 corridor.

Proposed Condition Drainage Patterns

Consistent with project technical requirement Section 12.0, the proposed drainage system has been designed to

- intercept and remove surface runoff from the roadways, and maintain surface and conduit flow through the right of way consistent with the Master Drainage Plan;
- limit drainage related hazards within and outside of the right of way, minimize future operations and maintenance costs, public inconvenience and potential flood damages; and
- maintain existing drainage patterns to the extent practical.

Runoff to the project area from the offsite area to the east will remain unchanged from the existing condition. Runoff will be conveyed west in the vegetated, roadside swale adjacent to the north side of I-70 along with runoff from **Basin 40** to a proposed 4-foot bottom width roadside ditch that will be constructed adjacent to Ramp F. The runoff will concentrate in a low point shown at **Analysis Point 114** on the drainage maps, and will be conveyed under Ramp F in a proposed 48-inch RCP culvert (**P-16**) to a roadside ditch in the gore area then west to the inlet end of the existing 30-inch RCP culvert **EX-P3** along with runoff from **Basin 42**. Since existing drainage conveyance capacity from the north to south side of I-70 is limited, the overflow point to the downstream ditch at the existing culvert will be raised to provide a HW/D ratio of 2 at the culvert and the overflow point will be monumented with a 2-foot wide, 2-foot high strip of buried concrete across the ditch bottom that extends a short distance up the side slopes. In frequent runoff events, all ditch flow will be conveyed south under I-70 in the existing culvert. In large infrequent events such as the 100-year storm, approximately one half of the flow at the peak of the flow will overflow the high point in the ditch and will be conveyed in a shallow roadside swale to a shallow detention pond (**N.W. Gore Pond**) located in the northwest gore area of the proposed Central Park Boulevard Interchange.

Runoff from **Basins 50a, 50b, and 43** will also contribute to the **N.W. Gore Pond**. Runoff from the north side of the Central Park Boulevard Bridge will be collected in approach slab inlets with vane grates and additional runoff will be collected from the roadway with inlets to be located at the upstream side of the intersection with Ramps B and F. Runoff collected in the proposed inlets will be piped to the bottom of the slope in a proposed 18-inch storm sewer. Runoff from **Basin 43** will be conveyed under Ramp F in a proposed 24-inch storm sewer (**P-15**) to the northeast gore area and then will be conveyed to the **N.W. Gore Pond** in a shallow swale.

The primary outlet from the **N.W. Gore Pond** will be a proposed 24-inch culvert (**P-23**) under Ramp A. Culvert **P-23** will discharge to the proposed roadside ditch between Ramp A and I-70 immediately north of existing culvert **EX-P2**. Runoff from local **Basin 53** will be added to the flow at this point. Culvert **EX-P2** will have capacity to convey the discharge under I-70 in frequent storm events. In very large storm events such as the 100-year event analyzed for this report, the capacity of the culvert will be exceeded and a portion of the discharge will be routed over an overflow point in the south roadside ditch along Ramp A to a proposed storm sewer **P-2** near the north side of the Ramp B-2 Bridge. Flow passing through culvert **EX-P2** will combine with runoff from local **Basin 68** collected in a proposed inlet in the roadside

ditch and then will then be conveyed through a proposed 30-inch storm sewer pipe (**P-24**) to a proposed swale near the end of existing culvert **EX-4**. In the 100-year storm the **N.W. Gore Pond** will also discharge over a high point in the proposed roadside ditch along the north side of Ramp A and will be conveyed in the ditch to proposed culvert **P-3** (30-inch RCP) near the north side of the Ramp B-2 Bridge. The overflow runoff will be combined with runoff from local **Basin 73** and conveyed west under Ramp A in culvert **P-3**. The proposed high points in the Ramp A roadside ditches will be monumented with a 2-foot wide, 2-foot high strip of buried concrete across the ditch bottom and extending a short distance up the side slopes.

The overflow from the **N.W. Gore Pond** and runoff from **Basin 73,** as described above, will be combined with runoff from local **Basin 70** and will be conveyed through proposed 42-inch culvert segments **P-1** and **P-2** to a shallow swale between Ramps A and B-2 and I-70. The runoff will then be routed west in the swale along with runoff from **Basin 72** to the **North Water Quality Pond** at the NE corner of the intersection of south bound I-270 and I-70. More information about this pond is contained in the water quality section of this report. Discharge from this pond will be routed west through an existing 36-inch CMP culvert and swale adjacent to the north side of I-70 that will outfall to Sand Creek.

While the configuration of the **N.W. Gore Pond** is not conventional, it is very functional, and is an enhanced version of the configuration of the pond presented in the Master Plan Drainage Report. The enhancements provided with the current design include two overflow points (versus the one presented in the master plan) and a lower 100-year maximum water surface elevation in the pond. The EPA SWMM (Storm Water Management Model) simulation of this pond demonstrates that the maximum 100-year water surface in the pond and upstream ditch will not encroach on the traveled way of Ramp A. The analysis also demonstrates that while the 100-year HW/D ratio at the upstream end of the existing culvert **EX-P2** will be 2.4, exceeding the technical requirements maximum of 2, the hydraulic condition is greatly improved over the existing condition 100-year HW/D ratio of 3.7 at the culvert. In the existing condition the deep headwater will encroach well into the traveled way of adjacent I-70. In the proposed condition the 100-year headwater will not encroach beyond the shoulders of the adjacent I-70 and Ramp A. In addition the proposed 42-inch storm sewer consisting of pipe segments **P1** and **P2**, along with the roadside ditches along Ramp A offer additional emergency relief capacity if needed.

Runoff from **Basin 60** along the south side of I-70 will be collected and conveyed west in a roadside ditch adjacent to Ramp E to a low point at the inlet end of a proposed 36-inch culvert **P-18** below Ramp E. The runoff will be conveyed through the culvert to the gore area between Ramp E and I-70 (southeast gore area). The runoff conveyed south under I-70 through the existing 30-inch culvert (**EX-P3**) will be combined with a small amount of runoff intercepted in a inlet placed in the south I-70 ditch. The combined runoff will then be routed west through a proposed 36-inch RCP storm sewer **P-17** that will outfall to a shallow swale in the gore area. The grade in the southeast gore area will be lowered and the existing storm sewer in this area will be removed to the toes of the proposed slopes along Ramp E and Central Park Boulevard.

The runoff from culvert **P-17** will be routed west in the proposed shallow swale to the new inlet end of the existing 54-inch, RCP culvert (**EX-P4**) along with runoff discharged from the Stapleton Filing No. 7 temporary detention pond and runoff from proposed culvert **P-18** and

runoff from **Basins 61a and 63**. Runoff from the south side of the Central Park Boulevard Bridge will be collected in approach slab inlets with vane grates and additional runoff will be collected from the roadway with proposed inlets to be located at the upstream side of the intersection with Ramps D and E. Runoff collected in the proposed inlets will be piped to the bottom of the slope in a proposed 18-inch storm sewer. The combined runoff will be conveyed west through existing culvert **EX-P4**, and then outfall into a proposed swale in the southwest gore area. It will then be conveyed in a proposed swale and the remnants of the existing Sand Creek Overflow Channel along with runoff discharged from proposed culvert **P-24** and runoff from **Basins 61b** and **78** to the inlet end of proposed culvert **P-22**, a 54-inch RCP at **Analysis Point 159**. Runoff from **Basin 65a**, a portion of Ramp D and Central Park Boulevard, will be collected and conveyed in a ditch located at the south toe of the Ramp D embankment, to the end of a proposed 36-inch RCP culvert **P-31** under Ramp D. The runoff will be conveyed through the culvert to **Analysis Point 159**.

The combined flow at **Analysis Point 159** will then be routed west through the proposed 54-inch RCP culverts **P-22** and **P-21** where it will combine in a proposed inlet with runoff collected from **Basin 77** and will then be routed west through proposed 54-inch RCP culvert P-20 to outfall to the proposed **South Water Quality Pond**.

Runoff from **Basin 66** will be collected and conveyed in proposed roadside ditches to a low point at the end of proposed 30 inch RCP culvert **P-19** and then with be conveyed south through the culvert under Ramp D to the **South Water Quality Pond**. Runoff from **Basin 62** will contribute directly to the **South Water Quality Pond**. Runoff from the pond will discharge through an Urban Drainage and Flood Control Standard Water Quality Outlet and will be conveyed south through proposed 54-inch RCP culvert **P-27** under Ramp C to outfall in the proposed reconstructed Sand Creek Overflow Channel.

Runoff from **Basins 74 and 75** will be directed to Stapleton Filing 14 located on the north side of the project corridor consistent with the project Master Drainage Plan. For the purpose of quantifying peak runoff from this area Basins 74 and 74 have been combined at **Analysis Point 200** at the upstream end of **P-29** the 24-inch RCP culvert that will convey runoff from the project area to the existing **Stapleton Filing 14 Pond**. Based on current grading adjacent to the project corridor, a portion of **Basin 75** will sheet flow to the north and will be collected in the **Stapleton Filing No. 25 Detention Pond**. The combined area of **Basins 74 and 75** is 10.21 acres. Combined 100-year peak discharge from the basins is 14 cfs. This is considerable less than the 31.1 acres and 24 cfs anticipated to contribute to the Stapleton Filing 14 Pond from the I-70 corridor in the Stapleton Filing 14 Final Drainage Report, (Matrix Design Group, March 22, 2004) as summarized in the project master drainage plan.

Runoff from **Basin 90** will be collected and conveyed west in the existing median swale out of the project area. No increases to impervious areas are anticipated in this basin as a result of this project.

The **Ramp B-2 Bridge** will have a high point near the center of the bridge and will also include a cross slope reversal with the 0% cross slope point located east of the west abutment. A vane grate deck drain will be utilized to collect runoff at the location of the western pier above the cross slope reversal. Discharge from this deck drain will be piped down the west pier to a concrete splash pad at ground level. A second vane grate deck drain

will be installed approximately 15 feet east of the 0% cross slope point to collect nuisance flow from the shoulder. This inlet will not be close to a pier and thus, the very limited discharge will only be piped to the bottom of the girders and will then be allowed to drop to the concrete abutment slope paving below. This point of discharge will be more than thirty feet away from the Ramp A traveled way below the bridge so it will not present any hazard or inconvenience to the traveling public. An approach slab inlet with vane grates will be constructed on the low side of the roadway at both ends of the bridge. A second inlet will be constructed a short distance downstream of the approach slabs to collect flow concentrated by short segments of guardrail proposed at the ends of the bridge. These additional inlets will be connected to the approach slab inlets with 18-inch storm sewers and the combined runoff will be piped to the toe of the slope in 18-inch storm sewers. Runoff bypassing the inlets, along with additional runoff from the roadway that concentrates along the curb sections extending from both ends of the bridge will be removed from the roadway shoulder and conveyed to the toe of the slope with embankment protectors.

The **Ramp C Bridge** will have a high point near its center point and will be continuously sloped to the south. An approach slab inlet with vane grates will be constructed on the south side of the roadway at both ends of the bridge. A second inlet will be constructed a short distance downstream of the approach slabs to collect flow concentrated by short segments of guardrail proposed at the ends of the bridge. These additional inlets will be connected to the approach slab inlets with 18-inch storm sewers and the combined runoff will be piped to the toe of the slope in 18-inch storm sewers. Runoff bypassing the inlets, along with additional runoff from the roadway that concentrates along the curb sections extending from both ends of the bridge, will be removed from the roadway shoulder and conveyed to the toe of the slope with embankment protectors.

Drainage Criteria and Calculation Methods

Peak Runoff Calculations

CUHP/SWMM Analysis

Consistent with the project technical requirements Section 12.2.1, Colorado Urban Hydrograph Procedure (CUHP) Version 1.3.3 was utilized to generate hydrographs for the individual basins that are shown on the drainage maps. EPA SWMM, version 5.0, build 5.0.018, was then utilized to route and combine the hydrographs through the existing and proposed conveyances, detention ponds, and detention/water quality ponds that will exist upon completion of the project. The starting point for the current CUHP/SWMM Analysis was the CUHP/SWMM models that were prepared by Vision Land Consultants, Inc. for the project Master Plan Drainage Report. The model input data was reviewed and modified to simulate the current proposed project conditions.

CUHP input parameters included the following:

- 100-year, 1-hour point rainfall: 2.57 inches
- Initial infiltration rate : 4.5 inches/hour

- Final infiltration rate : 0.6 inches/hour
- Horton's decay coefficient: 0.0018 1/second
- Maximum depression storage:
    - Pervious: 0.035 watershed inch
    - Impervious: 0.1 watershed inch

Dynamic wave routing was utilized with the SWMM simulation. In critical locations, the model runs were executed then reviewed and compared with external hydraulic calculations performed with the Bentley FlowMaster and CulvertMaster Programs. The parameters associated with given critical conveyance elements, such as outlets from storage areas, were then adjusted if differentials were significant, until the SWMM simulation produced results that were similar to the independent hydraulic calculations.

The Stapleton Filing No. 7 area is the only known private development area to directly contribute significant runoff to the project site. While the discharge of drainage from this site to the I-70 right of way is considered temporary, the fully developed condition as defined in the Final Drainage Report for Stapleton Filing No. 7 was utilized in the analysis assuming routing through the existing temporary private detention pond. Ultimately, runoff from Filing 7 is to be conveyed west to Sand Creek and the discharge from the site to the I-70 right of way is to be discontinued.

Standard practice was the utilized Directly Connected Impervious Area (DCIA) parameter used in the modeling effort, consistent with the CUHP analysis performed in the preparation of the Master Plan Drainage Report. This practice is conservative, given that the existing and proposed drainage patterns in the project area are fairly consistent with DCIA Level 2 as defined by the Urban Drainage and Flood Control District Drainage Criteria Manual.

Rational Method/Flow Spread/ Inlet Interception Rate Analysis

Consistent with the project technical requirements, the basins analyzed with CUHP and SWMM were further subdivided and analyzed to determine peak 5-year and 100-year runoff rates for areas of the proposed roadways that will have curb or solid barrier and other small areas draining to depressed inlets adjacent to the roadway. The Standard Urban Drainage and Flood Control District spreadsheets for determining runoff rate, spread, and inlet interception rates were utilized in this analysis. Since the basins analyzed with the rational method are very small, design rainfall intensities associated with the minimum time of concentration of 5 minutes were utilized.

Copies of the input and output from the hydrologic and spread analysis are contained in the appendix section of this report.

Hydraulic Analysis

SWMM Simulation

The SWMM simulation described in the hydrologic analysis section of this report provides some hydraulic analysis of the proposed drainage system. In addition, the Bentley CulvertMaster program was utilized to analyze proposed culverts and storm sewers. Where CulvertMaster was utilized to analyze storm sewers made up of multiple segments, entrance loss coefficients were adjusted to account for inflow velocities. Headwater elevations from downstream segments were utilized as tailwater elevations for the next culvert upstream.

The majority of the discharge from the project area will outfall to the Sand Creek Overflow Channel adjacent to the south side of Ramp D. The storm sewer outfall will be submerged during infrequent runoff events in Sand Creek. The ratio of the watershed tributary to the storm sewer to watershed tributary to Sand Creek at this point is approximately 1:100. As recommended in the CDOT Drainage Design Manual, HEC-22 Table 7.3 was utilized to determine the frequency of coincidental occurrence at the outfall. The table indicates using the water surface associated with the 25-year event in Sand Creek as a tailwater condition for the 100-year analysis the project storm sewer improvements. Since a 25-year water surface in the Sand Creek Overflow Channel is not readily available, and the use of the 50-year elevation does not appear to have significant impacts on the proposed on the required size of proposed on-site improvements, the 50-year water surface in the Sand Creek Overflow Channel was utilized as a constant tailwater condition in the SWMM simulation.

Culvert Analysis

The project technical requirements call for culvert maximum HW/D ratios of 2 for culverts under 36 inches in diameter and 1.7 for 36-inch to 60-inch diameter culverts. As demonstrated by the hydraulic calculations performed with the Bentley CulvertMaster program (output included in the appendix section of this report) with the exception of the existing 18-inch diameter culvert (**EX-P2**) that crosses I-70 near Station 142+30, the proposed and existing culverts that will remain in the project area will meet these criteria.

The aforementioned 18-inch culvert will have a 100-year HW/D ratio of 2.4 in the proposed condition. This will be a significant improvement over the existing condition 3.7 HW/D ratio for this culvert as indicated by the current hydraulic analysis. This culvert is currently in a sump with an overflow point that is approximately 4 feet above its invert. The resulting 100-year headwater in the existing conditions will encroach well into the traveled way. In the proposed condition, the 100-year peak flow rate to this culvert will be significantly reduced by lowering the overflow point 1 foot, resulting in a 2-foot reduction in the 100-year headwater associated with this culvert.

The proposed design based on maintaining the existing 18-inch culvert **EX-P2** represents a practicable design in consideration of the existing site conditions and the proposed interchange improvements. Design alternatives requiring the replacement of the existing pipe would result in excessive construction costs and I-70 user delay costs that are not warranted as compared to the benefits of a replacement alternative.

As described in the hydrology section, the standard Urban Drainage and Flood Control District spreadsheets were utilized to calculate spread along roadway shoulders where proposed curbs or solid barriers are proposed. The project technical requirements for spread are as follows:

- Central Park Boulevard:
  - 5-year spread must be less than 18 feet
  - 100-year spread must be less than 0.5 street width

- All other roadway segments in the CDOT right of way:
  - 5-year spread shall not exceed the width of the shoulder
  - 100-year spread shall not encroach farther than 4 feet on the traveled way

The calculations for flow spread, contained in the appendix section of this report, demonstrate that the project requirements for maximum flow spread will be met.
Where runoff will be collected by inlets located outside the roadway areas, the CDOT standard inlet sizing graph was utilized to analyze inlet capacity. Copies of the input and output from the various hydraulic calculations performed in the preparation of this report are contained in the appendix section of this report.

Permanent Storm Water Quality Treatment

Compliance with the CDOT MS4 permit requires achievement of 80% removal of the Total Suspended Solids (TSS) from storm water runoff or 100% of the water quality capture volume. Common practice is to apply various methods, including Best Management Practices (BMPs) to achieve this goal.

The following BMPs will be used to treat runoff prior to discharge to adjacent Sand Creek:

Extended Detention Ponds

This BMP is used to capture and treat a specific volume (water quality capture volume) of storm water runoff. The pond allows sediment and some pollutants to settle out of the runoff before being discharged into the receiving channel. The pond is designed to slowly drain over a period of about 40 hours. Maintenance requirements include occasional mowing, litter control, removal of debris from trash rack on outlet works, periodic inspection for erosion and periodic removal of sediment. Extended detention ponds are reported to have TSS removal rates of about 55% to 75%, and satisfy the water quality capture volume requirement.

Three extended detention ponds are proposed to be utilized in the treatment of runoff from the project area. One of these ponds will be new, one will be a retrofit of an existing detention pond and one is an existing regional facility located outside of the CDOT right of way. The locations of these ponds and the watershed that each of these ponds will treat are shown on an exhibit contained in the water quality section of this reports appendix. Calculations related to sizing the ponds with the exception of the adjacent regional facility are also contained in the appendix of this report.

Given the predominate drainage pattern of paved areas discharging as sheet flow to adjacent unpaved areas adjacent to shoulders and then being conveyed in vegetated ditches and swales with low gradients, a minimized directly connected impervious area (MDCIA) level of 2 was utilized in calculating the required water quality capture volume (WQCV).

The ponds are further described as follows:

South Water Quality Pond

This is the largest of the ponds to be constructed with this project and will treat runoff from 422.5 acres. The water quality storage volume to be provided in this pond is 7.8 acre feet. The water quality storage depth will be 4.9 feet above the invert of the outlet pipe for the facility and is designed to drain in 36 to 40 hours through an outlet conforming to the Urban Drainage and Flood Control District standards. The top of the water quality storage volume will be over 6 feet below adjacent road surfaces. The 100-year maximum water surface elevation in this pond will be approximately 5244.5, and will be approximately 1 foot below the lowest adjacent roadway surface (I-70) at the western end of the proposed pond.

North Water Quality Pond

This existing detention pond will be regraded and retrofitted with an Urban Drainage-style outlet to add water quality treatment capabilities to the facility. The facility will treat runoff from 19.3 acres. The water quality storage volume to be provided in this pond is 0.24 acre feet. The water quality storage depth will be 1.4 feet above the invert of the outlet pipe for the facility and is designed to drain in 36 to 40 hours through an outlet conforming to the Urban Drainage and Flood Control District standards. The top of the water quality storage volume will be lower than 5 feet below adjacent road surfaces. The 100-year maximum water surface elevation in this pond will be approximately 5241.1, and will be approximately 3 feet below the lowest adjacent roadway surface (I-70) at the western end of the proposed pond.

Existing Stapleton Filing 14 Regional Detention Pond (Northfield Pond)

Approximately 10.2 acres of the project area will be routed through this existing pond, maintained by CCD, for water quality treatment. No calculations have been provided for the water quality requirements for this flow as even a larger tributary area in the I-70 corridor was anticipated to contribute to the pond in the design of the facility.

Filter Strip – Horizontal

This BMP, also known as an **Ecology Embankment**, is used to filter pollutants through vegetative and filtering processes. This BMP has been used in areas that have limited potential for other treatment options and fits well with linear projects such as highways. The BMP runs along the edge of the roadway and treats runoff as it travels down the slope and through a filter media. **Ecology Embankments** are reported to have a TSS removal rate of over 80%. This BMP is proposed to treat runoff from approximately 750 linear feet of proposed Ramp D-2. This portion of Ramp D-2 is required to be super elevated to the south due to roadway criteria. Thus, drainage from the pavement is directed to the south slope of the embankment where it is difficult to collect and convey to the proposed water quality

ponds. The linear nature of this BMP and the fact that it can be constructed in the slope make it well suited for this location.

While not counted on to provide primary treatment for runoff from any impervious surfaces in the project area, the BMPs listed below will be present in the characteristics of the proposed drainage system.

Secondary BMPs

Sheet Flow to Buffer

This BMP is used to filter pollutants through the vegetation as storm water runoff moves from adjacent surfaces (such as the roadway surface) to swales or natural drainageways. The buffer area should be densely vegetated with a mix of native plants and can only be used in areas where the slope from the edge of asphalt to the swale is 4% or less for a minimum of 50 feet. Maintenance requirements include occasional mowing, litter control and periodic inspection for erosion and vegetation damage. Restorative seeding may be needed to increase vegetation density. Sheet flow to buffer is reported to have a TSS removal rate of about 10% to 20%.

Vegetated Swale

This BMP is similar to buffer areas in that storm water runoff is filtered through the vegetation. It is important that these swales be designed to slowly convey runoff to discharge points. A wide swale with slopes up to 1% encourages slow and shallow flow. Grade control checks may be needed to avoid steeper slopes. Maintenance requirements include occasional mowing, litter control and periodic inspection for erosion and vegetation damage. Restorative seeding may be needed to increase vegetation density. Vegetated swales are reported to have a TSS removal rate of about 20% to 40%.

FEMA Floodplain Issues

A portion of the project site is mapped as a FEMA regulatory 100-year floodplain due to overflow from a portion of Sand Creek that lies south of the project area. FEMA mapping of this floodplain is currently dynamic. Recent work along Sand Creek has improved the capacity of Sand Creek and a Letter of Map Revision (LOMR) was requested and approved to reflect current conditions. This LOMR, which became effective on February 12, 2010, was utilized to plot the pre-project 100-year floodplain limits shown on the Final Office Review (FOR) submittal drainage plan sheets. Copies of these plan sheets along with a copy of the LOMR Flood Insurance Rate Map (FIRM) that shows the project area have been included in the appendix of this report. The included drainage plan sheets also show the approximate limits of the post project 100-year floodplain in the project area.

CCD has requested and received a Conditional Letter of Map Revision (CLOMR) (FEMA Case No. 10-08-0069R) to accommodate grading changes that will occur in the regulatory floodplain with the current proposed project. This CLOMR was approved on February 26, 2010. A copy of

the approved CLOMR is included in the appendix of this report. The FOR roadway and drainage plans in the area adjacent to the regulatory floodplain reflect grading that is very close to the grading anticipated with the CLOMR request. A floodplain development permit will be requested from the CCD for grading in the regulatory floodplain prior to its start.

The primary changes that will occur to the floodplain as a result of current project construction include the following items. The southwest quadrant of the project site includes an existing, incised, broad, swale known as the Sand Creek Overflow Channel. This existing channel serves as the outfall from the existing 54-inch storm sewer that extends below the proposed Central Park Boulevard corridor along the south side of I-70. This pipe is labeled as **EX-P4** on the drainage maps included in this report. The swale also receives overflow from large flood events in adjacent Sand Creek. This existing swale will be partially displaced by the construction of the new ramps with the current project. In order to avoid negative impact to adjacent private properties, a new channel will be constructed along the south side of ramps C and D-2 to serve as a replacement conveyance facility for the existing Sand Creek Overflow Channel. According to the current CLOMR request, this channel will only receive flow from Sand Creek in design events greater than the 10-year frequency event associated with the Sand Creek watershed. The lower portion of the channel will also serve as the outfall point for the majority of the runoff from the project area.

Grading of the Sand Creek Overflow Channel will be generally consistent with the grading proposed in the preliminary (RFP) plans for the project as prepared by URS and the approved CLOMR. The proposed bank armoring of an approximately 365 linear foot long section of the channel through a constricted area will be with a buried 2-foot thick layer of D50 =12" soil riprap, consistent with the RFP plan.

The proposed South Water Quality Pond adjacent to Ramp C will be hydraulically connected to the revised regulatory floodplain associated with the reconstructed Sand Creek Overflow Channel and thus will also be mapped with a 100-year floodplain. At the point that the grading and other facilities that impact the proposed revision to the floodplain are completed, a request for a LOMR will be prepared and submitted.

Conclusions

The proposed drainage system has been designed to

- intercept and remove surface runoff from the roadways, and maintain surface and conduit flow through the right of way consistent with the Master Drainage Plan for the project;
- limit drainage related hazards within and outside of the right of way, minimize future operations and maintenance costs, public inconvenience and potential flood damages;
- maintain existing drainage patterns to the extent practical; and
- provide permanent BMPs that meet the requirements of the CDOT and CCD.

References

City & County of Denver Storm Drainage Design and Technical Criteria; City of Denver, January 2006.

Urban Storm Drainage Criteria Manual Volumes 1, 2, and 3; Urban Drainage and Flood Control District; June 2001, Revised April 2008.

Drainage Design Manual; Colorado Department of Transportation; 2004.

Request For Proposal-Central Park Boulevard Interchange, Technical Requirements. Section 12.0 Drainage, City and County of Denver, August 20, 2009.

Interstate 70 Interchange at Central Park Boulevard , Master Plan Drainage Report, 40% In Depth Analysis, Vision land Consultants, Inc., February 27, 2009.

FEMA CLOMR, Case No.:10-08-0069R.; FEMA, February 26, 2010.

Request for Conditional Letter of Map Revision (CLOMR), Sand Creek Overflow (Reach 1): Vision land Consultants, Inc., September 29, 2009.

Appendices

Appendix A

- Vicinity Map

Appendix B – Hydrologic Calculations

- CUHP Input
- 100-Year CUHP Output
- EPA SWMM Input
- EPA SWMM Output
- Rational Method/Spread Calculation

Sheets

Appendix C – Hydraulic Calculations (100-year Event)

- CulvertMaster and FlowMaster Printouts

Appendix D – Water Quality

- Permanent Water Quality Treatment Map
- Water Quality Pond Watershed Summary
- Water Quality Pond Calculation Sheets

Appendix E –Floodplain

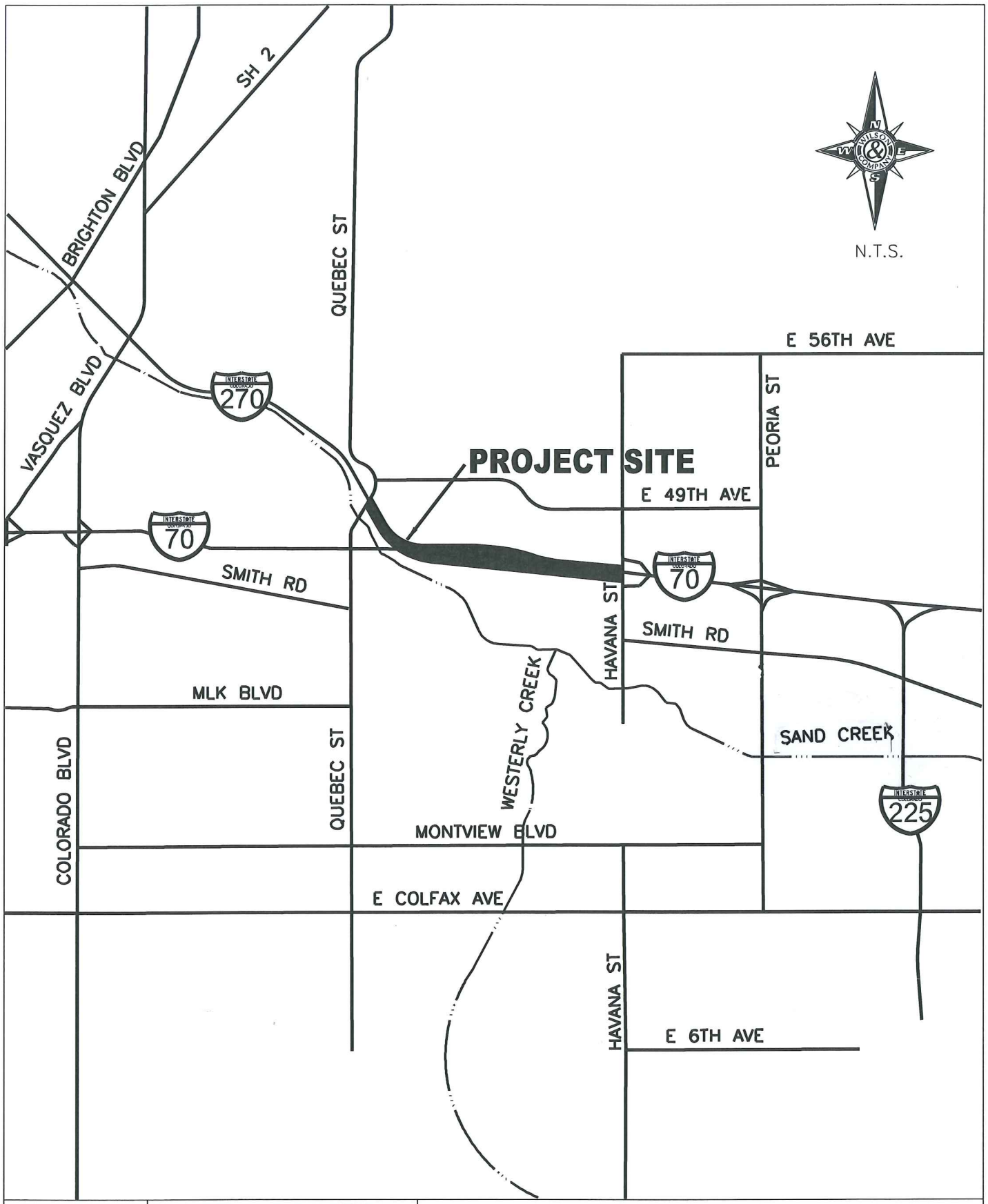
- FIRM Maps
- Drainage Plans Showing Floodplain Boundaries
- Copy of CLOMR

Appendix F-Drainage Maps

- DMP001
- DMP002
- DMP003
- DMP004

Appendix A

Vicinity Map



SHEET

FIG 1-1

CENTRAL PARK BOULEVARD

VICINITY MAP

DENVER, CO

Appendix B – Hydrologic Calculations

CUHP Input
100-Year CUHP Output
EPA SWMM Input
EPA SWMM Output
Rational Method/Spread Calculation Sheets

Summary of CUHP Input Parameters (Version 1.3.3)

							Depression Storage		Horton's Infiltration Parameters			DCIA Level and Fractions			
Catchment Name/ID	Raingage Name/ID	Area (sq.mi.)	Dist. to Centroid (miles)	Length (miles)	Slope (ft./ft.)	Percent Imperv.	Pervious (inches)	Imperv. (inches)	Initial Rate (in./hr.)	Final Rate (in.hr.)	Decay Coeff. (1/sec.)	DCIA Level	Dir. Con'ct Imperv. Fraction	Receiv. Perv. Fraction	Percent Eff. Imperv.
10	100YR	0.057	0.560	1.400	0.008	65.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.91	0.29	63.84
11	100YR	0.015	0.050	0.100	0.011	40.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.80	0.20	38.48
20	100YR	0.101	0.650	1.300	0.010	65.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.91	0.29	63.84
21	100YR	0.005	0.071	0.100	0.019	49.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.85	0.23	47.55
30	100YR	0.298	0.457	0.915	0.011	55.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.88	0.25	53.65
40	100YR	0.029	0.305	0.564	0.005	30.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.60	0.17	28.07
41	100YR	0.006	0.055	0.113	0.015	15.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.30	0.12	13.36
42	100YR	0.005	0.080	0.201	0.014	70.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.92	0.30	68.91
43	100YR	0.002	0.046	0.100	0.012	35.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.70	0.19	33.20
50a	100YR	0.016	0.116	0.241	0.008	30.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.60	0.17	28.07
50b	100YR	0.009	0.038	0.120	0.007	45.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.83	0.22	43.50
53	100YR	0.003	0.019	0.083	0.015	55.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.88	0.25	53.65
60	100YR	0.048	0.468	0.660	0.007	35.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.70	0.19	33.20
61a	100YR	0.011	0.084	0.143	0.005	50.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.85	0.23	48.56
61b	100YR	0.004	0.043	0.073	0.031	25.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.50	0.15	23.08
62	100YR	0.021	0.050	0.238	0.008	45.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.83	0.22	43.50
63	100YR	0.004	0.058	0.155	0.012	52.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.86	0.24	50.59
65a	100YR	0.003	0.094	0.172	0.012	49.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.85	0.23	47.55
65b	100YR	0.005	0.092	0.231	0.010	20.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.40	0.13	18.19
66	100YR	0.011	0.100	0.180	0.004	48.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.84	0.22	46.53
68	100YR	0.004	0.041	0.112	0.014	73.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.93	0.31	71.96
70	100YR	0.007	0.060	0.118	0.005	45.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.83	0.22	43.50
72	100YR	0.021	0.214	0.510	0.004	30.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.60	0.17	28.07
73	100YR	0.002	0.059	0.085	0.016	45.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.83	0.22	43.50
74	100YR	0.011	0.338	0.602	0.007	40.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.80	0.20	38.48
75	100YR	0.005	0.055	0.110	0.026	30.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.60	0.17	28.07
77	100YR	0.002	0.027	0.070	0.035	40.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.80	0.20	38.48
78	100YR	0.006	0.029	0.099	0.011	30.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.60	0.17	28.07
80	100YR	0.109	0.443	0.885	0.008	90.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.96	0.37	89.41
90	100YR	0.010	0.177	0.328	0.006	50.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.85	0.23	48.56

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 1.3.3)

		Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph		
Catchment Name/ID	User Comment for Catchment	Ct	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)
10		0.130	0.471	36.9	12.92	19.2	8.64	22.7	46	132,422	2.25	297,509	54.0	69	297,505
11		0.224	0.266	9.2	2.18	4.8	1.54	3.6	49	34,848	1.91	66,559	35.0	37	66,524
20		0.109	0.513	27.8	9.72	14.4	6.50	18.7	109	234,643	2.25	527,166	49.0	149	527,165
21		0.300	0.271	12.5	2.90	6.5	2.05	4.8	12	11,616	2.03	23,580	36.0	11	23,577
30		0.087	0.545	14.5	5.06	7.5	3.38	10.6	619	692,314	2.11	1,461,694	40.0	630	1,461,514
40		0.197	0.223	63.4	11.18	33.0	7.90	18.6	14	67,373	1.78	119,765	61.0	20	119,765
41		0.382	0.136	31.5	3.58	16.4	2.53	6.0	6	13,939	1.58	22,067	44.0	6	22,067
42		0.270	0.339	14.3	4.03	7.5	2.85	6.7	10	11,616	2.31	26,876	37.0	11	26,872
43		0.433	0.170	26.0	3.70	13.5	2.62	6.2	2	4,646	1.84	8,566	41.0	3	8,566
50a		0.237	0.204	31.1	5.19	16.2	3.66	8.6	15	37,171	1.78	66,077	45.0	18	66,073
50b		0.256	0.277	10.7	2.58	5.6	1.82	4.3	25	20,909	1.98	41,326	35.0	21	41,310
53		0.341	0.273	7.2	1.82	3.8	1.28	3.0	12	6,970	2.11	14,715	32.0	9	14,714
60		0.162	0.274	51.7	11.19	26.9	7.91	18.6	28	111,514	1.84	205,592	57.0	39	205,592
61a		0.234	0.310	15.1	3.89	7.8	2.75	6.5	22	25,555	2.04	52,220	37.0	22	52,217
61b		0.384	0.148	17.5	2.30	9.1	1.62	3.8	7	9,293	1.71	15,915	37.0	6	15,914
62		0.197	0.314	11.1	2.99	5.8	2.11	5.0	57	48,787	1.98	96,428	36.0	48	96,402
63		0.317	0.274	16.3	3.73	8.5	2.64	6.2	7	9,293	2.07	19,241	38.0	8	19,236
65a		0.352	0.251	26.2	5.35	13.6	3.78	8.9	3	6,970	2.03	14,148	43.0	4	14,147
65b		0.379	0.140	60.2	6.79	31.3	4.80	11.3	2	11,616	1.65	19,144	56.0	3	19,144
66		0.236	0.301	20.2	4.96	10.5	3.50	8.3	16	25,555	2.02	51,534	40.0	18	51,531
68		0.286	0.334	8.4	2.46	4.4	1.74	4.1	14	9,293	2.35	21,876	33.0	11	21,869
70		0.277	0.266	16.1	3.60	8.4	2.54	6.0	13	16,262	1.98	32,143	38.0	13	32,139
72		0.218	0.213	62.4	10.50	32.4	7.42	17.5	10	48,787	1.78	86,727	60.0	14	86,726
73		0.408	0.221	18.4	3.42	9.6	2.42	5.7	3	4,646	1.98	9,184	38.0	3	9,182
74		0.247	0.254	69.8	13.92	36.3	9.84	23.2	5	25,555	1.91	48,810	66.0	7	48,810
75		0.340	0.172	19.2	2.83	10.0	2.00	4.7	8	11,616	1.78	20,649	38.0	8	20,646
77		0.419	0.197	11.0	1.96	5.7	1.39	3.3	5	4,646	1.91	8,874	35.0	4	8,872
78		0.321	0.176	15.2	2.36	7.9	1.67	3.9	12	13,939	1.78	24,779	37.0	11	24,776
80		0.097	0.593	15.5	5.44	8.1	3.64	12.3	210	253,229	2.59	655,319	41.0	250	655,324
90		0.241	0.306	32.1	7.85	16.7	5.55	13.1	9	23,232	2.04	47,472	47.0	12	47,473

SWMM INPUT

Clean Print
JCH
5-27-10

```
[TITLE]

[OPTIONS]
FLOW_UNITS            CFS
INFILTRATION          HORTON
FLOW_ROUTING          DYNWAVE
START_DATE            01/01/2005
START_TIME            00:00:00
REPORT_START_DATE     01/01/2005
REPORT_START_TIME     00:00:00
END_DATE              01/01/2005
END_TIME              10:00:00
SWEEP_START           01/01
SWEEP_END             12/31
DRY_DAYS              0
REPORT_STEP           00:01:00
WET_STEP              00:15:00
DRY_STEP              01:00:00
ROUTING_STEP          0:00:01
ALLOW_PONDING         YES
INERTIAL_DAMPING      PARTIAL
VARIABLE_STEP         0.00
LENGTHENING_STEP      1
MIN_SURFAREA          20
NORMAL_FLOW_LIMITED   BOTH
SKIP_STEADY_STATE     NO
FORCE_MAIN_EQUATION   H-W
LINK_OFFSETS          DEPTH
MIN_SLOPE             0

[FILES]
USE INFLOWS "M:\TRN\09-100-308-00\17334\Hydraulics\Calculations\Hydrology_Ponds\RFC Submittal 100 yr CUHP ansd SWMM\CU

[EVAPORATION]
;;Type       Parameters
;;---------- ----------
CONSTANT     0.0

[JUNCTIONS]
;;                Invert     Max.       Init.      Surcharge  Ponded
;;Name            Elev.      Depth      Depth      Depth      Area
;;--------------- ---------- ---------- ---------- ---------- ----------
10                5283       10         0          0          0
11                5286       10         0          0          0
20                5285       10         0          0          0
30                5258       12         0          0          0
40                5262       10         0          0          0
41                5274.5     10         0          0          0
42                5253.62    10         0          0          0
43                5264       3          0          0          0
50a               5250.1     10         0          0          0
50b               5247.5     2.5        0          0          0
53                5247.5     10         0          0          0
60                5255.6     6          0          0          0
61a               5246.75    3.6        0          0          0
61b               5245.5     5          0          0          0
62                5236.5     7          0          0          0
63                5248.5     7.5        0          0          0
65a               5254       5          0          0          0
65b               0          0          0          0          0
66                5244       5          0          0          0
68                5246.5     5.2        0          0          0
70                5249.3     10         0          0          0
72                5240       3          0          0          0
73                5249       2.7        0          0          0
74                5230       0          0          0          0
75                5245.0     0          0          0          0
77                5240.5     7.5        0          0          0
78                5242.8     10         0          0          0
80                5290.0     6          0          0          0
90                0          0          0          0          0
D107              5275       6          0          0          0
D111              5274.5     10         0          0          0
D112              5274       10         0          0          0
D113              5273.1     10         0          0          0
D113b             5271.0     4          0          0          0
D113c             5267.8     4          0          0          0
D113d             5264.8     4          0          0          0
D113e             5263.0     5          0          0          0
D114              5261.75    5          0          0          0
D115              5261.74    5          0          0          0
D116              5256.6     4          0          0          0
D117              5253.6     6.4        0          0          0
D118              5257.49    0          0          0          0
```

D119	5253.0	3	0	0	0
D119a	5252	3	0	0	0
D120	5253.1	6	0	0	0
D134	5249.6	2.3	0	0	0
D135	5249.34	2.6	0	0	0
D136	5249.0	4.5	0	0	0
D140	5247.0	4	0	0	0
D142	5245.5	3.5	0	0	0
D145	5251	7	0	0	0
D146	5250	0	0	0	0
D147	5249.5	5.5	0	0	0
D148	5248.5	0	0	0	0
D152	5250	0	0	0	0
D154	5248.6	3	0	0	0
D158	5244.2	5	0	0	0
D162	5241.2	7.7	0	0	0
D163	5240.4	6.8	0	0	0
D164	5239.9	5.2	0	0	0
D168	5236.5	0	0	0	0
D172	5250	3	0	0	0
D174	5249	3	0	0	0
D176	5250.0	2	0	0	0
D178	5248.8	6.7	0	0	0
D180	5248.5	4	0	0	0
D182	5248.10	9.25	0	0	0
D184	5247.5	3.5	0	0	0
D186	5246.0	2	0	0	0
D188	5243	3	0	0	0
D190	5242	3	0	0	0
D192	5240	3	0	0	0
D198	0	0	0	0	0
D200	5229.50	0	0	0	0

[OUTFALLS]

;;Name	Invert Elev.	Outfall Type	Stage/Table Time Series	Tide Gate
D101	5287.7	NORMAL		NO
D110	5283.8	FREE		NO
D170	5236.25	FIXED	5243.76	NO
D196	5238	FREE		YES

[DIVIDERS]

;;Name	Invert Elev.	Diverted Link	Divider Type	Parameters			
21	5276	30	OVERFLOW	10	0	0	0
D99	5290.0	61	OVERFLOW	7	0	0	0
D106	5278	67	OVERFLOW	0	0	0	0
D108	5279.5	25	OVERFLOW	0	0	0	0

[STORAGE]

;;Name	Invert Elev.	Max. Depth	Init. Depth	Storage Curve	Curve Params			Ponded Area	Evap. Frac.	Infiltration Param
D151	5250	12	2.4	TABULAR	F7_POND			0	0	
D159	5242.80	6.7	0	TABULAR	SW_CPB_RAMP-STORAGE			0	0	
HAVANA_at_40th_POND	5281	5	0	TABULAR	HAVANA_40TH			0	0	
N_WQ_POND	5238.5	3	0	TABULAR	NORTH_WQ-POND-STORAGE			0	0	
NE_GORE_AREA	5250.1	2.2	0	TABULAR	NE_CPB_GORE-STORAGE			0	0	
NE-HAVANA_POND	5283	3	0	TABULAR	NE_HAVANA_RAMP-STORE			10000	0	
NW_GORE_POND	5247.5	4.5	0	TABULAR	NW_CPB_GORE-POND_STORAGE			0	0	
S_WQ_POND	5236.5	8.6	4.8	TABULAR	SOUTH_WQ-POND-STORAGE			0	0	
SE_GORE_AREA	5246.6	5.25	0	TABULAR	SE_CPB_RAMP-STORAGE			0	0	
SE_Havana_Pond	5278	8	0	TABULAR	SE_HAVANA_RAMP-STORE			0	0	

[CONDUITS]

;;Name	Inlet Node	Outlet Node	Length	Manning N	Inlet Offset	Outlet Offset	Init. Flow	Max. Flow
1	80	D99	1	0.01	.05	0	0	0
4	D99	D101	460	0.016	0	0	0	0
7	20	SE_Havana_Pond	400	0.01	0	0	0	0
16	21	D107	434	0.015	0	0	0	0
19	11	NE-HAVANA_POND	400	0.01	0	0	0	0
20	D106	D107	70	0.016	0	1	0	0
21	NE-HAVANA_POND	D106	115	0.016	0	1.5	0	0
22	10	D108	400	0.01	.01	0	0	0
25	D108	D110	50	0.015	4.5	0	0	0
30	21	D107	189	0.035	2	0	0	0
33	D111	D112	29	0.016	0	0	0	0
38	D112	D113	600	0.035	0	0	0	0
39	D107	D113	743	0.035	0	0	0	0
41	D113	D113b	480	0.035	0	0	0	0

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42              D113b           D113c           480       0.032     0         0         0         0
43              D113c           D113d           480       0.032     0         0         0         0
44              D113d           D113e           480       0.032     0         0         0         0
45              D113e           D114            480       0.032     0         0         0         0
55              SE_Havana_Pond  21              160       0.016     0         1         0         0
61              D99             HAVANA_at_40th_POND 460     0.016     6         0         0         0
62              HAVANA_at_40th_POND SE_Havana_Pond  140     0.016     0         2.5       0         0
80              D108            D111            494       0.016     0         1         0         0
82              41              D111            400       0.01      .05       0         0         0
110             40              D114            400       0.01      .05       0         0         0
114             D116            D117            170       0.035     0         0         0         0
116             42              D117            400       0.01      .00       0         0         0
117             D117            D118            2         .013      3.9       0         0         0
118             D118            D119            260       0.032     0         0         0         0
119             D119            D119a           330       0.035     0         0         0         0
120             D119a           NE_GORE_AREA    10        .035      0         0         0         0
124             D120            NE_GORE_AREA    150       0.035     0         0         0         0
126             50a             NE_GORE_AREA    400       0.01      .05       0         0         0
133             NE_GORE_AREA    D134            130       0.034     0         0         0         0
134             D134            D135            140       .040      0         0         0         0
135             D136            NW_GORE_POND    10        .034      0         1.4       0         0
135a            D135            D136            70        .040      0         0         0         0
136             50b             NW_GORE_POND    400       0.01      .05       0         0         0
137             NW_GORE_POND    D172            120       .034      1.75      0         0         0
140             53              D140            400       0.01      0         0         0         0
144             68              D142            400       0.01      0         0         0         0
152             D146            D148            270       0.033     0         0         0         0
154             63              D148            10        0.01      .05       0         0         0
158             D147            D148            175       0.01      0         0         0         0
160             D148            SE_GORE_AREA    660       .010      0         0         0         0
162             61a             SE_GORE_AREA    400       0.01      .05       0         0         0
164             30              D151            10        0.01      0         7.9       0         0
168             D154            SE_GORE_AREA    10        0.01      0         1.8       0         0
174             61b             D158            400       0.01      0         0         0         0
176             D158            D159            398       .034      0         0         0         0
178             78              D159            400       0.01      .05       0         0         0
185             D164            S_WQ_POND       10        .016      0         3.3       0         0
186             77              D163            150       0.035     0         0         0         0
187             65a             D159            400       .013      0         0         0         0
196             62              D164            400       0.01      0         0         0         0
200             D172            D174            55        .034      0         .75       0         0
202             73              D174            400       0.01      .05       0         0         0
206             D176            D178            300       0.034     0         0         0         0
207             D140            D176            540       .034      0         0         0         0
208             70              D178            400       0.01      0         0         0         0
210             D178            D180            50        0.035     0         0         0         0
215             D184            D186            500       0.035     0         0         0         0
216             D186            D188            720       0.035     0         0         0         0
217             D188            D190            350       0.035     0         0         0         0
218             D190            D192            400       0.035     0         0         0         0
219             D192            N_WQ_POND       10        .035      0         1.46      0         0
220             72              N_WQ_POND       10        .013      0         1.46      0         0
224             90              D198            400       0.01      .05       0         0         0
225             75              D200            1600      .034      0         0         0         0
226             74              D200            1         0.01      .05       0         0         0
EX-P1           N_WQ_POND       D196            280       .024      0         0         0         0
EX-P2           D140            D142            155       .015      0         1.0       0         0
EX-P3           D117            D145            207       .0132     0         2.1       0         0
EX-P4           SE_GORE_AREA    D158            650       .017      0         .1        0         0
EX-P5           D152            D154            190       0.016     0         0         0         0
P-1             D182            D184            257       0.015     0         0         0         0
P-2             D180            D182            112       .016      0         .1        0         0
P-3             D174            D180            170       .014      0         .1        0         0
P-15            43              D120            116       0.016     0         0         0         0
;STM-40
P-16            D115            D116            147       0.016     0         0         0         0
P-17            D145            D146            222       .016      0         0         0         0
P-18            60              D147            88        0.016     0         0         0         0
P-19            66              D164            90        0.016     0         0         0         0
P-20            D163            D164            199       .013      0         0         0         0
P-21            D162            D163            285       .013      .1        0         0         0
P-22            D159            D162            628       .0135     0         .1        0         0
P-23            NW_GORE_POND    D140            86        .017      0         0         0         0
P-24            D142            D158            111       0.016     0         0         0         0
P-27            D168            D170            121       .016      0         0         0         0

[ORIFICES]
;;              Inlet           Outlet          Orifice     Crest       Disch.      Flap Open/Close
;;Name          Node            Node            Type        Height      Coeff.      Gate Time
;;--------------- ---------------- ---------------- ------------ ---------- ---------- ---- ----------
3               D114            D115            SIDE        0           .52         NO   0

[WEIRS]
;;              Inlet           Outlet          Weir        Crest       Disch.      Flap End      End
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SWMM INPUT

;;Name	Node	Node	Type	Height	Coeff.	Gate	Con.	Coeff.
63	HAVANA_at_40th_POND	SE_Havana_Pond	TRAPEZOIDAL	4	3.33	NO	0	0
67	D106	D107	TRAPEZOIDAL	.5	3.33	NO	0	0
O2	S_WQ_POND	D168	TRAPEZOIDAL	5	3	NO	1	2.5

[OUTLETS]

;;Name	Inlet Node	Outlet Node	Outflow Height	Outlet Type	Qcoeff/ QTable	Qexpon	Flap Gate
O1	D151	D152	0	TABULAR/HEAD	DP-7-RP-OUTLET		NO

[XSECTIONS]

;;Link	Shape	Geom1	Geom2	Geom3	Geom4	Barrels
1	DUMMY	0	0	0	0	1
4	CIRCULAR	4	0	0	0	1
7	DUMMY	0	0	0	0	1
16	CIRCULAR	1.5	0	0	0	1
19	DUMMY	0	0	0	0	1
20	CIRCULAR	1.5	0	0	0	1
21	CIRCULAR	2	0	0	0	1
22	DUMMY	2	0	0	0	1
25	TRAPEZOIDAL	2	200	50	50	1
30	TRIANGULAR	2	36	0	0	1
33	CIRCULAR	2	0	0	0	1
38	TRAPEZOIDAL	3	30	3	10	1
39	TRAPEZOIDAL	3	30	3	10	1
41	TRAPEZOIDAL	3	10	3	10	1
42	TRAPEZOIDAL	3	4	3	6	1
43	TRAPEZOIDAL	4	4	4	6	1
44	TRAPEZOIDAL	4	4	4	3	1
45	TRAPEZOIDAL	5	4	4	3	1
55	CIRCULAR	2	0	0	0	1
61	IRREGULAR	HAVANA_XSEC_1	0	0	0	1
62	CIRCULAR	1.5	0	0	0	1
80	CIRCULAR	2	0	0	0	1
82	DUMMY	0	0	0	0	1
110	DUMMY	0	0	0	0	1
114	TRIANGULAR	4	50	0	0	1
116	DUMMY	0	0	0	0	1
117	TRAPEZOIDAL	1.5	10	4	4	1
118	TRAPEZOIDAL	2.5	4	6	6	1
119	TRAPEZOIDAL	2	4	6	80	1
120	TRIANGULAR	2	18	0	0	1
124	TRIANGULAR	1	4	0	0	1
126	DUMMY	0	0	0	0	1
133	TRAPEZOIDAL	2.1	10	4	6	1
134	TRAPEZOIDAL	2.3	6	.5	6	1
135	TRAPEZOIDAL	4.5	10	6	4	1
135a	TRAPEZOIDAL	2.6	4	3	5	1
136	DUMMY	0	0	0	0	1
137	TRAPEZOIDAL	2.5	5.5	3	4	1
140	DUMMY	0	0	0	0	1
144	DUMMY	0	0	0	0	1
152	TRIANGULAR	2	40	0	0	1
154	DUMMY	4	0	0	0	1
158	TRIANGULAR	1	60	0	0	1
160	TRIANGULAR	2	60	0	0	1
162	DUMMY	0	0	0	0	1
164	CIRCULAR	12	0	0	0	1
168	TRIANGULAR	3	20	0	0	1
174	DUMMY	0	0	0	0	1
176	TRAPEZOIDAL	4	8	4	4	1
178	DUMMY	0	0	0	0	1
185	CIRCULAR	5	0	0	0	1
186	DUMMY	0	0	0	0	1
187	DUMMY	0	0	0	0	1
196	DUMMY	0	0	0	0	1
200	TRAPEZOIDAL	3	5.5	3	4	1
202	DUMMY	0	0	0	0	1
206	TRAPEZOIDAL	2	4	4	3	1
207	TRAPEZOIDAL	2	4	4	3	1
208	DUMMY	0	0	0	0	1
210	TRAPEZOIDAL	4	6	3	4	1
215	TRAPEZOIDAL	2	4	4	4	1
216	TRAPEZOIDAL	2	4	4	4	1
217	TRIANGULAR	3	70	0	0	1
218	TRIANGULAR	3	120	0	0	1
219	TRIANGULAR	2	50	0	0	1
220	TRAPEZOIDAL	2	4	4	4	1
224	DUMMY	0	0	0	0	1
225	TRIANGULAR	1.6	30	0	0	1
226	DUMMY	0	0	0	0	1

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EX-P1            CIRCULAR     3                0          0          0          1
EX-P2            CIRCULAR     1.5              0          0          0          1
EX-P3            CIRCULAR     2.5              0          0          0          1
EX-P4            CIRCULAR     4.5              0          0          0          1
EX-P5            CIRCULAR     3                0          0          0          1
P-1              CIRCULAR     3.5              0          0          0          1
P-2              CIRCULAR     3.5              0          0          0          1
P-3              CIRCULAR     2.5              0          0          0          1
P-15             CIRCULAR     2                0          0          0          1
P-16             CIRCULAR     4                0          0          0          1
P-17             CIRCULAR     3                0          0          0          1
P-18             CIRCULAR     3                0          0          0          1
P-19             CIRCULAR     2.5              0          0          0          1
P-20             CIRCULAR     4.5              0          0          0          1
P-21             CIRCULAR     4.5              0          0          0          1
P-22             CIRCULAR     4.5              0          0          0          1
P-23             CIRCULAR     2                0          0          0          1
P-24             CIRCULAR     2.5              0          0          0          1
P-27             CIRCULAR     4.5              0          0          0          1
3                CIRCULAR     4                0          0          0
63               TRAPEZOIDAL  4                135        50         50
67               TRAPEZOIDAL  1                50         50         50
O2               TRAPEZOIDAL  3.8              7          3          3

[TRANSECTS]

;HAVANA ST CROSS SECTION S. OF I-70
NC 0.01     0.01     0.01
X1 HAVANA_XSEC_1     3        0.0      0.0      0.0      0.0      0.0      0.0      0.0
GR 1        0        0        45       1        45.5

[LOSSES]
;;Link           Inlet      Outlet     Average    Flap Gate
;;-------------- ---------- ---------- ---------- ----------
4                .3         1          0          NO
16               .3         .3         0          NO
20               .1         .3         0          NO
21               .3         .3         0          NO
33               .3         .3         0          NO
55               .2         .3         0          NO
62               .1         .3         0          NO
80               .3         .3         0          NO
117              .3         0          0          NO
133              .3         .3         0          NO
134              .3         .2         0          NO
135a             .7         .2         0          NO
219              .2         .2         0          NO
220              .2         .2         0          NO
EX-P2            .3         .2         0          NO
EX-P3            .5         .2         0          NO
EX-P4            1.8        .2         0          NO
EX-P5            0          .3         0          NO
P-1              .65        .3         0          NO
P-2              1.3        0          0          NO
P-3              1.2        .2         0          NO
P-15             .3         .3         0          NO
P-16             .2         .3         0          NO
P-17             1          .5         0          NO
P-18             .3         .3         0          NO
P-19             .3         .3         0          NO
P-20             .65        .3         0          NO
P-21             .45        0          0          NO
P-22             1.5        0          0          NO
P-23             .3         .2         0          NO
P-24             .6         .3         0          NO
P-27             .7         .3         0          NO

[CURVES]
;;Name           Type       X-Value    Y-Value
;;-------------- ---------- ---------- ----------
RAIL1            Diversion  0          0
RAIL1                       1          .5
RAIL1                       2          1
RAIL1                       4          2
RAIL1                       10         5
RAIL1                       20         10
RAIL1                       50         25
;OUTFALL FOR SE HAVANA RAMP VIA 24-INCH CULVERT

SE-HAVANA-RAMP-OUT1 Rating     0          0
SE-HAVANA-RAMP-OUT1            1          11.87
SE-HAVANA-RAMP-OUT1            2          18.72
SE-HAVANA-RAMP-OUT1            3          22.03
SE-HAVANA-RAMP-OUT1            4          25.09
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SE-HAVANA-RAMP-OUT1            5          27.88
SE-HAVANA-RAMP-OUT1            6          30.46
SE-HAVANA-RAMP-OUT1            7          32.84

DP-7-RP-OUTLET   Rating     1          0.1
DP-7-RP-OUTLET              2          2.5
DP-7-RP-OUTLET              3          13.2
DP-7-RP-OUTLET              4          15.8
DP-7-RP-OUTLET              5          18.1
DP-7-RP-OUTLET              6          20.1
DP-7-RP-OUTLET              7          22.0
DP-7-RP-OUTLET              8          23.7
DP-7-RP-OUTLET              9          25.2
DP-7-RP-OUTLET              10         26.7
DP-7-RP-OUTLET              11         950
;STORAGE W/IN THE SE HAVANA/I-70 RAMP AREA

SE_HAVANA_RAMP-STORE Storage    0          50
SE_HAVANA_RAMP-STORE            1          1915
SE_HAVANA_RAMP-STORE            2          21470
SE_HAVANA_RAMP-STORE            3          48875
SE_HAVANA_RAMP-STORE            4          69857
SE_HAVANA_RAMP-STORE            5          88134
SE_HAVANA_RAMP-STORE            6          101877
SE_HAVANA_RAMP-STORE            7          102506
SE_HAVANA_RAMP-STORE            8          116490
;STORAGE IN THE NE HAVANA/I-70 POCKET

NE_HAVANA_RAMP-STORE Storage    0          130
NE_HAVANA_RAMP-STORE            1          22481
NE_HAVANA_RAMP-STORE            2          47425
NE_HAVANA_RAMP-STORE            3          72398

I-270/I-70       Storage    0          2552
I-270/I-70                  1          6243
I-270/I-70                  2          9731
I-270/I-70                  2.5        15551
;FILING 7 DETENTION POND

F7_POND          Storage    0          27526
F7_POND                     1          64469
F7_POND                     2          125105
F7_POND                     3          207750
F7_POND                     4          290857
F7_POND                     5          376063
F7_POND                     6          443250
F7_POND                     7          491873
F7_POND                     8          525401
F7_POND                     9          545999
F7_POND                     10         573775
;STORAGE S. OF HAVANA TO EB I-70 RAMP

HAVANA_40TH      Storage    0          265
HAVANA_40TH                 1          2389
HAVANA_40TH                 2          11094
HAVANA_40TH                 3          23091
HAVANA_40TH                 4          41503
HAVANA_40TH                 5          41503
;STORAGE IN WEST BND I70, BASIN 50, AT MOUTH OF 18" CULVERT

I70_BSN50        Storage    0          3551
I70_BSN50                   1          16391
I70_BSN50                   2          40328
I70_BSN50                   3          66653
I70_BSN50                   4          99536
I70_BSN50                   5          99536
I70_BSN50                   6          99536

SW_CPB_RAMP-STORAGE Storage    .2         1124
SW_CPB_RAMP-STORAGE            1.2        9132
SW_CPB_RAMP-STORAGE            2.2        13156
SW_CPB_RAMP-STORAGE            3.2        17013
SW_CPB_RAMP-STORAGE            4.2        20546
SW_CPB_RAMP-STORAGE            5.2        23523

SE_CPB_RAMP-STORAGE Storage    .4         1404
SE_CPB_RAMP-STORAGE            1.4        30277
SE_CPB_RAMP-STORAGE            2.4        75041
SE_CPB_RAMP-STORAGE            3.4        106035
SE_CPB_RAMP-STORAGE            4.4        118746
SE_CPB_RAMP-STORAGE            5.4        132492

SOUTH_WQ-POND-STORAGE Storage    .5         5254
SOUTH_WQ-POND-STORAGE            1.5        8578
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SOUTH_WQ-POND-STORAGE            2.5        62559
SOUTH_WQ-POND-STORAGE            3.5        120419
SOUTH_WQ-POND-STORAGE            4.5        156931
SOUTH_WQ-POND-STORAGE            5.5        175507
SOUTH_WQ-POND-STORAGE            6.5        196204
SOUTH_WQ-POND-STORAGE            7.5        213571
SOUTH_WQ-POND-STORAGE            8.5        229263
SOUTH_WQ-POND-STORAGE            8.6        229471

NW_CPB_GORE-POND_STORAGE Storage    0          0
NW_CPB_GORE-POND_STORAGE            .5         4056
NW_CPB_GORE-POND_STORAGE            1.5        41668
NW_CPB_GORE-POND_STORAGE            2.5        59495
NW_CPB_GORE-POND_STORAGE            3.5        66723
NW_CPB_GORE-POND_STORAGE            4.5        78195

NORTH_WQ-POND-STORAGE Storage    .5         1964
NORTH_WQ-POND-STORAGE            1.5        20140
NORTH_WQ-POND-STORAGE            2.5        90368
NORTH_WQ-POND-STORAGE            3.5        141065

NE_CPB_GORE-STORAGE Storage    0          0
NE_CPB_GORE-STORAGE            .9         11737
NE_CPB_GORE-STORAGE            1.9        47244
NE_CPB_GORE-STORAGE            2.9        115045

BASIN-40-STORAGE Storage    1          100
BASIN-40-STORAGE            2          200
BASIN-40-STORAGE            3          300
BASIN-40-STORAGE            4          400
BASIN-40-STORAGE            5          500

BASIN-63-STORAGE Storage    .4         38
BASIN-63-STORAGE            1.4        204
BASIN-63-STORAGE            2.4        1367
BASIN-63-STORAGE            3.4        3462
BASIN-63-STORAGE            4.4        6332
BASIN-63-STORAGE            5.4        9149
BASIN-63-STORAGE            6.4        10778

BASIN-53-STORAGE Storage    1          710
BASIN-53-STORAGE            2          3746
BASIN-53-STORAGE            3          3746
BASIN-53-STORAGE            4          12786
BASIN-53-STORAGE            5          26685

[REPORT]
INPUT      NO
CONTROLS   NO
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]

[MAP]
DIMENSIONS -1505.282 631.480 11976.536 10631.480
Units      None

[COORDINATES]
;;Node           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
10               8304.872           6125.331
11               7870.742           6129.691
20               8117.377           5897.169
30               4682.841           6187.081
40               5544.753           6689.795
41               7275.008           6460.395
42               5468.114           6433.071
43               4766.018           6970.951
50a              4583.549           6882.579
50b              4293.919           6874.799
53               4450.668           6612.395
60               4961.581           6245.533
61a              4611.219           6563.904
61b              4259.988           6299.616
62               3191.633           6648.677
63               4879.669           6512.180
65a              4142.627           6317.765
65b              3733.758           6354.698
66               3364.046           6657.146
68               4179.674           6556.156
70               3632.774           6660.742
72               2286.594           7016.907
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73                  3815.213            7001.840
74                  1794.348            8101.322
75                  3723.687            7078.381
77                  3537.041            6484.274
78                  4054.134            6558.856
80                  8184.541            5455.806
90                  1861.909            7846.653
D107                7076.334            6271.369
D111                7207.447            6551.121
D112                7158.175            6405.997
D113                6992.011            6351.252
D113b               6502.092            6371.632
D113c               6120.388            6443.813
D113d               5889.503            6494.736
D113e               5659.046            6566.981
D114                5500.718            6597.138
D115                5506.192            6572.674
D116                5485.330            6523.382
D117                5365.241            6529.773
D118                5318.148            6568.457
D119                5137.542            6598.278
D119a               4990.540            6636.751
D120                4722.951            6857.254
D134                4628.511            6742.925
D135                4517.246            6730.734
D136                4417.774            6736.857
D140                4297.891            6602.456
D142                4263.103            6503.422
D145                5315.622            6401.880
D146                5049.278            6436.080
D147                4878.969            6371.456
D148                4767.937            6443.831
D152                4604.465            6248.139
D154                4546.797            6360.099
D158                4245.294            6426.842
D162                3744.020            6465.324
D163                3495.085            6570.137
D164                3303.179            6539.041
D168                3042.555            6475.086
D172                3940.313            6904.125
D174                3720.476            6967.221
D176                4000.475            6671.912
D178                3679.907            6759.178
D180                3654.973            6898.091
D182                3528.527            6905.215
D184                3366.462            6903.434
D186                3150.285            6894.113
D188                2941.687            6895.859
D190                2701.164            6901.655
D192                2480.926            6913.246
D198                1729.620            8061.286
D200                1861.475            8163.503
D101                7313.223            4948.400
D110                7352.529            6885.868
D170                3025.195            6418.046
D196                2205.398            6826.345
21                  7264.852            5993.251
D99                 7330.598            5369.452
D106                7331.173            6218.604
D108                7388.618            6608.565
D151                4619.636            6199.956
D159                4033.975            6386.224
HAVANA_at_40th_POND 7567.658               5570.614
N_WQ_POND           2342.500            6918.690
NE_GORE_AREA        4657.545            6777.622
NE-HAVANA_POND      7571.223            6186.936
NW_GORE_POND        4338.807            6761.228
S_WQ_POND           3107.012            6524.161
SE_GORE_AREA        4461.710            6451.714
SE_Havana_Pond      7623.615            5962.904

[VERTICES]
;;Link              X-Coord             Y-Coord
;;-------------- ------------------ ------------------
16                  7109.677            6102.445
22                  7981.485            6199.408
22                  7875.941            6312.147
22                  7770.398            6424.887
22                  7410.591            6592.797
30                  7241.115            6139.248
61                  7416.952            5570.944
117                 5325.606            6561.217
63                  7464.926            5844.398
67                  7186.675            6338.533
```

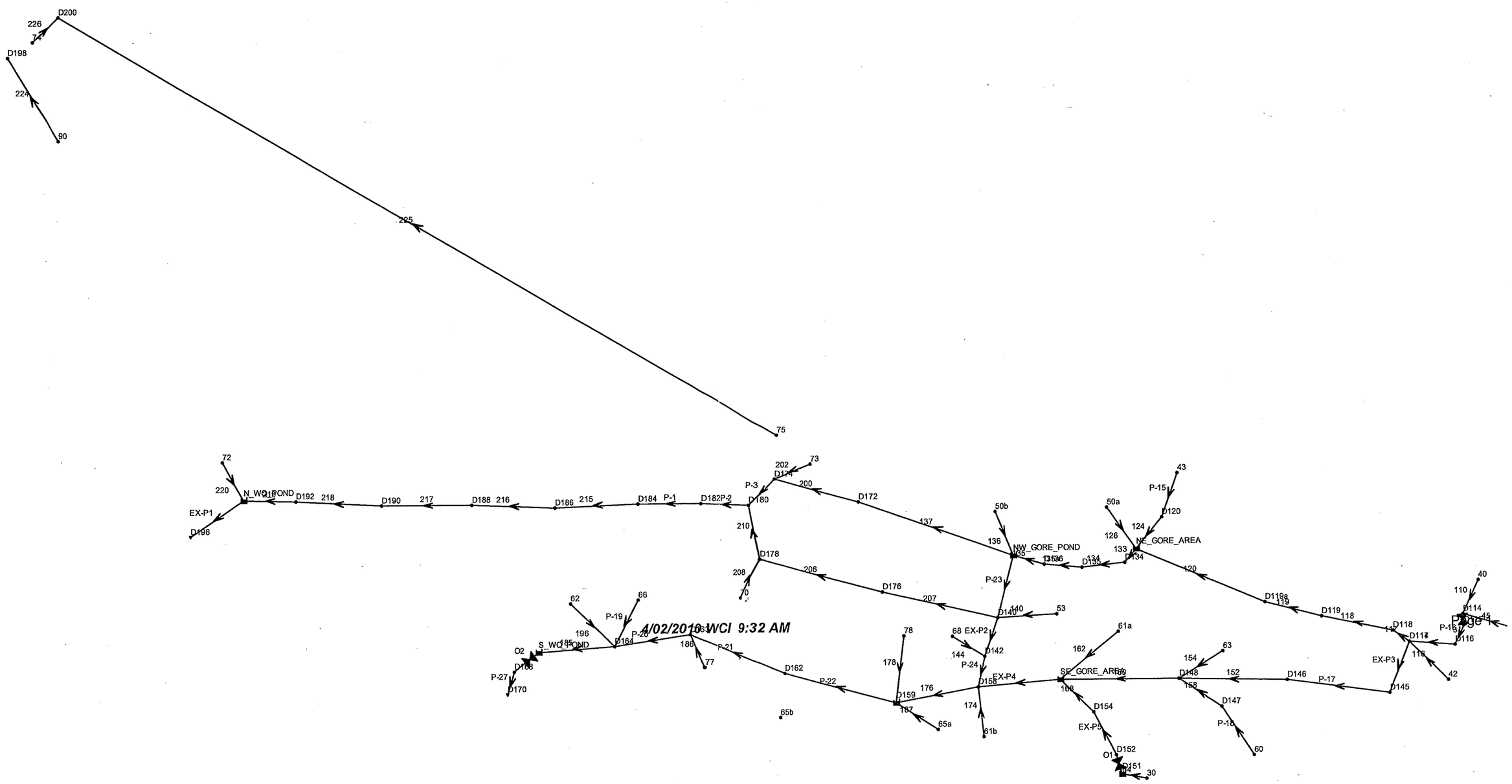
```
O2                3059.939          6488.324


[PROFILES]
;;Name           Links
;;-------------- ----------
"South Pond Outlet Through EX-P3" P-27 O2 185 P-20 P-21
"South Pond Outlet Through EX-P3" P-22 176 EX-P4 160 152
"South Pond Outlet Through EX-P3" P-17 EX-P3
"North WQ Pond Through P-2" EX-P1 219 218 217 216
"North WQ Pond Through P-2" 215 P-1 P-2
"                " P-1 P-2 210 206 207
"                " EX-P2 P-24 EX-P4 160 152
"                " P-17 EX-P3 114 P-16 3
"P1 Through P18  " P-1 P-2 210 206 207
"P1 Through P18  " EX-P2 P-24 EX-P4 160 152
"P1 Through P18  " P-17 EX-P3 114 P-16 3
"P3 Through P16  " 200 137 135 135a 134
"P3 Through P16  " 133 120 119 118 117
"P3 Through P16  " 114 P-16 3
```

SWMM SCHEMATIC

01/01/2005 00:01:00

Clean Print
TDS 4.8.10



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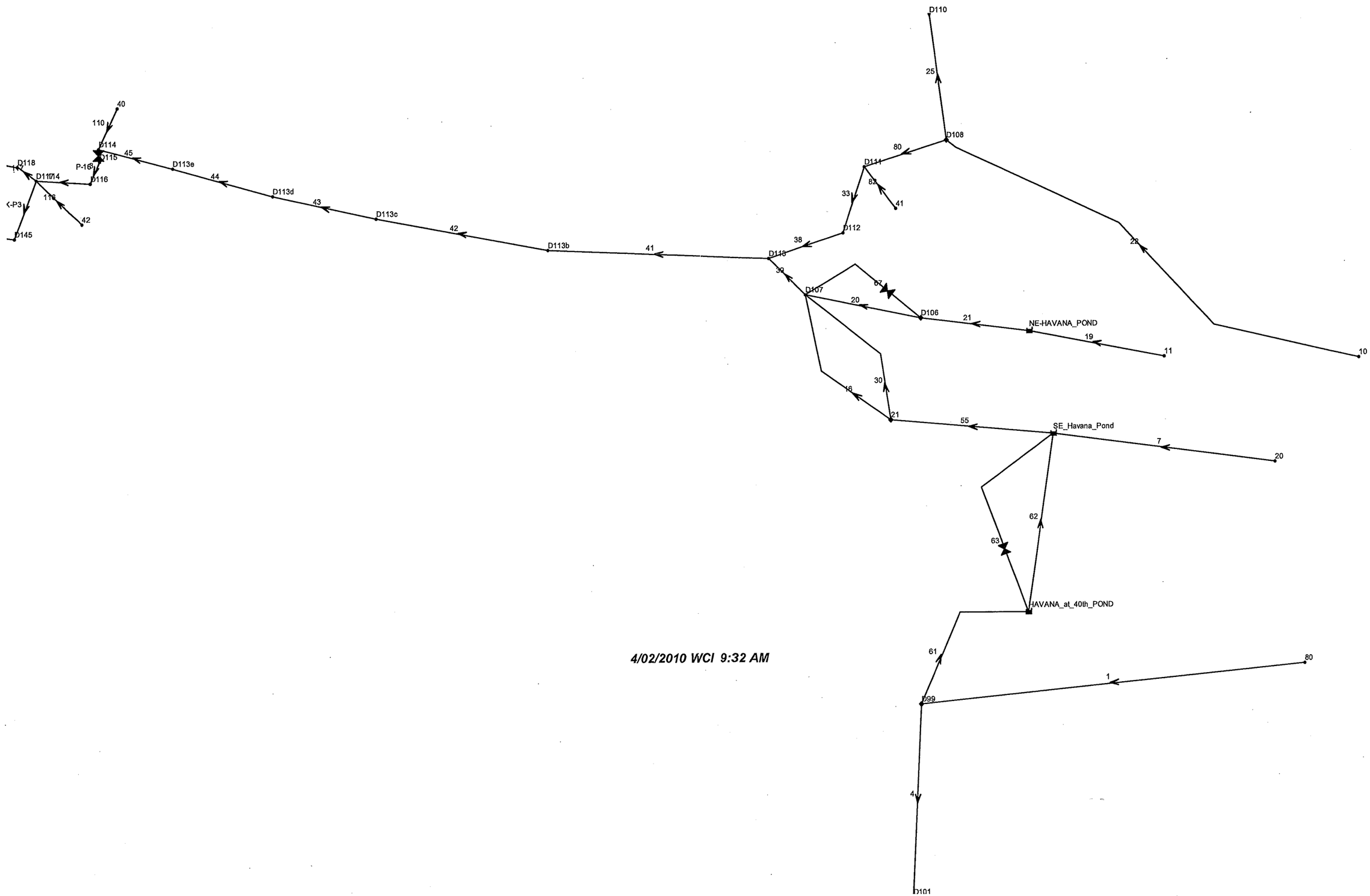

4/02/2010 WCI 9:32 AM

SWMM OUTPUT

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.0 (Build 5.0.018)
--------------------------------------------------------------


*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ YES
  Water Quality .......... NO
Flow Routing Method ...... DYNWAVE
Starting Date ............ JAN-01-2005 00:00:00
Ending Date .............. JAN-01-2005 10:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:01:00
Routing Time Step ........ 1.00 sec

WARNING 02: maximum depth increased for Node D174

**************************        Volume         Volume
Flow Routing Continuity        acre-feet       10^6 gal
**************************     ---------      ---------
Dry Weather Inflow .......         0.000          0.000
Wet Weather Inflow .......         0.000          0.000
Groundwater Inflow .......         0.000          0.000
RDII Inflow ..............         0.000          0.000
External Inflow ..........       100.045         32.601
External Outflow .........        64.148         20.903
Internal Outflow .........         2.786          0.908
Storage Losses ...........         0.000          0.000
Initial Stored Volume ....        11.944          3.892
Final Stored Volume ......        45.037         14.676
Continuity Error (%) .....         0.016


*************************
Highest Continuity Errors
*************************
Node HAVANA_at_40th_POND (3.02%)


*********************************
Highest Flow Instability Indexes
*********************************
Link O2 (5)
Link P-27 (3)
Link 63 (1)
Link EX-P5 (1)
Link 168 (1)


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     1.00 sec
Average Time Step           :     1.00 sec
Maximum Time Step           :     1.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     2.03


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

----------------------------------------------------------------------
                                Average  Maximum  Maximum  Time of Max
                                  Depth    Depth      HGL   Occurrence
Node                 Type          Feet     Feet     Feet  days hr:min
----------------------------------------------------------------------
10                   JUNCTION      0.00     0.00  5283.00     0  00:00
11                   JUNCTION      0.00     0.00  5286.00     0  00:00
```

20	JUNCTION	0.00	0.00	5285.00	0	00:00
30	JUNCTION	0.36	3.46	5261.46	0	00:40
40	JUNCTION	0.00	0.00	5262.00	0	00:00
41	JUNCTION	0.00	0.00	5274.50	0	00:00
42	JUNCTION	0.00	0.00	5253.62	0	00:00
43	JUNCTION	0.04	0.29	5264.29	0	00:41
50a	JUNCTION	0.00	0.00	5250.10	0	00:00
50b	JUNCTION	0.00	0.00	5247.50	0	00:00
53	JUNCTION	0.00	0.00	5247.50	0	00:00
60	JUNCTION	0.27	1.41	5257.01	0	00:57
61a	JUNCTION	0.00	0.00	5246.75	0	00:00
61b	JUNCTION	0.00	0.00	5245.50	0	00:00
62	JUNCTION	0.00	0.00	5236.50	0	00:00
63	JUNCTION	0.00	0.00	5248.50	0	00:00
65a	JUNCTION	0.00	0.00	5254.00	0	00:00
65b	JUNCTION	0.00	0.00	0.00	0	00:00
66	JUNCTION	0.33	0.86	5244.86	0	00:40
68	JUNCTION	0.00	0.00	5246.50	0	00:00
70	JUNCTION	0.00	0.00	5249.30	0	00:00
72	JUNCTION	0.36	1.01	5241.01	0	03:26
73	JUNCTION	0.00	0.00	5249.00	0	00:00
74	JUNCTION	0.00	0.00	5230.00	0	00:00
75	JUNCTION	0.15	0.62	5245.62	0	00:44
77	JUNCTION	0.00	0.00	5240.50	0	00:00
78	JUNCTION	0.00	0.00	5242.80	0	00:00
80	JUNCTION	0.00	0.00	5290.00	0	00:00
90	JUNCTION	0.00	0.00	0.00	0	00:00
D107	JUNCTION	0.47	0.87	5275.87	0	00:37
D111	JUNCTION	0.51	2.65	5277.15	0	00:43
D112	JUNCTION	0.16	0.72	5274.72	0	01:05
D113	JUNCTION	0.75	1.47	5274.57	0	01:05
D113b	JUNCTION	0.93	1.75	5272.75	0	01:06
D113c	JUNCTION	0.92	1.71	5269.51	0	01:09
D113d	JUNCTION	1.13	2.12	5266.92	0	01:26
D113e	JUNCTION	1.42	3.63	5266.63	0	01:29
D114	JUNCTION	2.06	4.83	5266.58	0	01:29
D115	JUNCTION	0.97	1.96	5263.70	0	01:29
D116	JUNCTION	1.05	2.03	5258.63	0	01:26
D117	JUNCTION	2.73	4.99	5258.59	0	01:26
D118	JUNCTION	0.20	1.05	5258.54	0	01:26
D119	JUNCTION	0.18	0.84	5253.84	0	01:28
D119a	JUNCTION	0.22	0.95	5252.95	0	01:30
D120	JUNCTION	0.12	0.69	5253.79	0	00:38
D134	JUNCTION	0.63	2.02	5251.62	0	01:44
D135	JUNCTION	0.69	2.07	5251.41	0	02:22
D136	JUNCTION	0.77	2.35	5251.35	0	02:28
D140	JUNCTION	1.94	3.56	5250.56	0	02:31
D142	JUNCTION	1.05	2.03	5247.53	0	03:34
D145	JUNCTION	2.02	3.61	5254.61	0	01:14
D146	JUNCTION	1.04	1.43	5251.43	0	01:13
D147	JUNCTION	0.24	0.69	5250.19	0	02:32
D148	JUNCTION	0.95	1.69	5250.19	0	02:32
D152	JUNCTION	1.27	1.36	5251.36	0	01:58
D154	JUNCTION	0.96	1.97	5250.57	0	02:35
D158	JUNCTION	2.05	3.17	5247.37	0	03:36
D162	JUNCTION	3.59	4.53	5245.73	0	03:44
D163	JUNCTION	4.05	4.74	5245.14	0	04:06
D164	JUNCTION	4.16	4.59	5244.49	0	04:28
D168	JUNCTION	7.59	7.89	5244.39	0	04:29
D172	JUNCTION	0.26	1.28	5251.28	0	02:28
D174	JUNCTION	0.59	2.25	5251.25	0	02:28
D176	JUNCTION	0.10	0.52	5250.52	0	02:31
D178	JUNCTION	0.46	1.70	5250.50	0	02:31
D180	JUNCTION	0.61	2.00	5250.50	0	02:31
D182	JUNCTION	0.56	1.80	5249.90	0	02:31
D184	JUNCTION	0.39	1.25	5248.75	0	02:31
D186	JUNCTION	0.36	1.11	5247.11	0	02:37
D188	JUNCTION	0.47	1.24	5244.24	0	02:39
D190	JUNCTION	0.30	0.79	5242.79	0	02:43
D192	JUNCTION	0.41	1.04	5241.04	0	03:21
D198	JUNCTION	0.00	0.00	0.00	0	00:09
D200	JUNCTION	1.49	1.60	5231.10	0	00:57
D101	OUTFALL	0.57	4.00	5291.70	0	00:28
D110	OUTFALL	0.01	0.12	5283.92	0	00:54
D170	OUTFALL	7.51	7.51	5243.76	0	00:00
D196	OUTFALL	0.66	1.40	5239.40	0	03:26
21	DIVIDER	2.22	3.01	5279.01	0	02:00
D99	DIVIDER	0.81	6.70	5296.70	0	00:41
D106	DIVIDER	0.12	0.71	5278.71	0	00:48
D108	DIVIDER	0.91	4.64	5284.14	0	00:54
D151	STORAGE	5.79	6.53	5256.53	0	02:13
D159	STORAGE	3.21	4.51	5247.31	0	03:38
HAVANA_at_40th_POND	STORAGE	2.13	4.35	5285.35	0	01:55
N_WQ_POND	STORAGE	1.22	2.51	5241.01	0	03:26

NE_GORE_AREA	STORAGE	0.43	1.63	5251.73	0	01:41
NE-HAVANA_POND	STORAGE	0.16	1.35	5284.35	0	00:48
NW_GORE_POND	STORAGE	1.82	3.85	5251.35	0	02:28
S_WQ_POND	STORAGE	7.55	7.99	5244.49	0	04:29
SE_GORE_AREA	STORAGE	2.67	3.57	5250.17	0	02:33
SE_Havana_Pond	STORAGE	3.78	7.35	5285.35	0	01:55

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days	hr:min	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal
10	JUNCTION	69.33	69.33	0	00:54	2.225	2.225
11	JUNCTION	36.74	36.74	0	00:35	0.498	0.498
20	JUNCTION	148.85	148.85	0	00:49	3.943	3.943
30	JUNCTION	629.87	629.87	0	00:40	10.932	10.932
40	JUNCTION	19.54	19.54	0	01:01	0.896	0.896
41	JUNCTION	6.11	6.11	0	00:44	0.165	0.165
42	JUNCTION	10.93	10.93	0	00:37	0.201	0.201
43	JUNCTION	2.57	2.57	0	00:41	0.064	0.064
50a	JUNCTION	17.91	17.91	0	00:45	0.494	0.494
50b	JUNCTION	20.83	20.83	0	00:35	0.309	0.309
53	JUNCTION	8.65	8.65	0	00:32	0.110	0.110
60	JUNCTION	39.00	39.00	0	00:57	1.538	1.538
61a	JUNCTION	21.66	21.66	0	00:37	0.391	0.391
61b	JUNCTION	6.35	6.35	0	00:37	0.119	0.119
62	JUNCTION	47.98	47.98	0	00:36	0.721	0.721
63	JUNCTION	7.55	7.55	0	00:38	0.144	0.144
65a	JUNCTION	4.13	4.13	0	00:43	0.106	0.106
65b	JUNCTION	3.26	3.26	0	00:56	0.143	0.143
66	JUNCTION	18.01	18.01	0	00:40	0.385	0.385
68	JUNCTION	11.41	11.41	0	00:33	0.164	0.164
70	JUNCTION	12.92	12.92	0	00:38	0.240	0.240
72	JUNCTION	14.29	14.29	0	01:00	0.649	0.649
73	JUNCTION	3.38	3.38	0	00:38	0.069	0.069
74	JUNCTION	7.31	7.31	0	01:06	0.365	0.365
75	JUNCTION	7.67	7.67	0	00:38	0.154	0.154
77	JUNCTION	4.46	4.46	0	00:35	0.066	0.066
78	JUNCTION	10.70	10.70	0	00:37	0.185	0.185
80	JUNCTION	250.32	250.32	0	00:41	4.902	4.902
90	JUNCTION	12.20	12.20	0	00:47	0.355	0.355
D107	JUNCTION	0.00	54.56	0	00:53	0.000	6.103
D111	JUNCTION	0.00	27.53	0	00:44	0.000	1.388
D112	JUNCTION	0.00	27.53	0	00:44	0.000	1.387
D113	JUNCTION	0.00	80.83	0	00:50	0.000	7.499
D113b	JUNCTION	0.00	79.35	0	01:05	0.000	7.483
D113c	JUNCTION	0.00	79.34	0	01:07	0.000	7.479
D113d	JUNCTION	0.00	79.28	0	01:09	0.000	7.479
D113e	JUNCTION	0.00	79.15	0	01:11	0.000	7.480
D114	JUNCTION	0.00	90.21	0	01:18	0.000	8.364
D115	JUNCTION	0.00	88.27	0	01:29	0.000	8.365
D116	JUNCTION	0.00	88.27	0	01:29	0.000	8.365
D117	JUNCTION	0.00	89.84	0	01:26	0.000	8.564
D118	JUNCTION	0.00	46.01	0	01:26	0.000	1.894
D119	JUNCTION	0.00	46.01	0	01:27	0.000	1.894
D119a	JUNCTION	0.00	45.98	0	01:28	0.000	1.903
D120	JUNCTION	0.00	2.57	0	00:41	0.000	0.064
D134	JUNCTION	0.00	51.95	0	01:37	0.000	2.452
D135	JUNCTION	0.00	51.86	0	01:37	0.000	2.452
D136	JUNCTION	0.00	51.68	0	01:37	0.000	2.452
D140	JUNCTION	0.00	14.70	0	02:20	0.000	1.979
D142	JUNCTION	0.00	17.76	0	00:35	0.000	1.997
D145	JUNCTION	0.00	43.84	0	01:26	0.000	6.670
D146	JUNCTION	0.00	43.87	0	01:26	0.000	6.670
D147	JUNCTION	0.00	39.00	0	00:57	0.000	1.538
D148	JUNCTION	0.00	84.49	0	01:03	0.000	8.353
D152	JUNCTION	0.00	18.50	0	02:12	0.000	4.436
D154	JUNCTION	0.00	28.14	0	02:35	0.000	4.472
D158	JUNCTION	0.00	81.72	0	02:32	0.000	14.997
D162	JUNCTION	0.00	78.46	0	03:01	0.000	15.149
D163	JUNCTION	0.00	78.42	0	03:02	0.000	15.193
D164	JUNCTION	0.00	93.50	0	00:44	0.000	16.301
D168	JUNCTION	0.00	150.71	0	00:00	0.000	16.434
D172	JUNCTION	0.00	17.32	0	02:25	0.000	0.902
D174	JUNCTION	0.00	17.34	0	02:26	0.000	0.967
D176	JUNCTION	0.00	3.25	0	02:05	0.000	0.149
D178	JUNCTION	0.00	12.92	0	00:38	0.000	0.386
D180	JUNCTION	0.00	20.51	0	02:30	0.000	1.346

D182	JUNCTION	0.00	20.51	0	02:31	0.000	1.347
D184	JUNCTION	0.00	20.51	0	02:31	0.000	1.346
D186	JUNCTION	0.00	20.52	0	02:33	0.000	1.348
D188	JUNCTION	0.00	20.49	0	02:37	0.000	1.349
D190	JUNCTION	0.00	20.48	0	02:40	0.000	1.348
D192	JUNCTION	0.00	20.47	0	02:43	0.000	1.351
D198	JUNCTION	0.00	12.20	0	00:47	0.000	0.355
D200	JUNCTION	0.00	13.45	0	00:54	0.000	0.542
D101	OUTFALL	0.00	103.63	0	00:41	0.000	3.374
D110	OUTFALL	0.00	47.87	0	00:54	0.000	1.004
D170	OUTFALL	0.00	150.71	0	00:00	0.000	16.419
D196	OUTFALL	0.00	19.15	0	03:26	0.000	1.994
21	DIVIDER	10.86	35.04	0	01:07	0.176	5.605
D99	DIVIDER	0.00	250.32	0	00:41	0.000	4.902
D106	DIVIDER	0.00	21.76	0	00:48	0.000	0.498
D108	DIVIDER	0.00	69.33	0	00:54	0.000	2.225
D151	STORAGE	0.00	629.98	0	00:40	0.000	12.409
D159	STORAGE	0.00	81.07	0	02:34	0.000	15.272
HAVANA_at_40th_POND	STORAGE	0.00	146.55	0	00:41	0.000	1.655
N_WQ_POND	STORAGE	0.00	30.25	0	00:57	0.000	1.994
NE_GORE_AREA	STORAGE	0.00	56.06	0	01:21	0.000	2.452
NE-HAVANA_POND	STORAGE	0.00	36.74	0	00:35	0.000	0.498
NW_GORE_POND	STORAGE	0.00	52.19	0	01:36	0.000	2.763
S_WQ_POND	STORAGE	0.00	157.65	0	00:40	0.000	20.579
SE_GORE_AREA	STORAGE	0.00	111.76	0	01:04	0.000	13.219
SE_Havana_Pond	STORAGE	0.00	247.65	0	00:51	0.000	5.548

****
Node Surcharge Summary
****

Surcharging occurs when water rises above the top of the highest conduit.

Node	Type	Hours Surcharged	Max. Height Above Crown Feet	Min. Depth Below Rim Feet
11	JUNCTION	10.00	0.000	10.000
20	JUNCTION	10.00	0.000	10.000
42	JUNCTION	10.00	0.000	10.000
53	JUNCTION	10.00	0.000	10.000
61b	JUNCTION	10.00	0.000	5.000
62	JUNCTION	10.00	0.000	7.000
65a	JUNCTION	10.00	0.000	5.000
65b	JUNCTION	10.00	0.000	0.000
68	JUNCTION	10.00	0.000	5.200
70	JUNCTION	10.00	0.000	10.000
77	JUNCTION	10.00	0.000	7.500
D140	JUNCTION	5.52	1.559	0.441
D163	JUNCTION	3.59	0.243	2.057
D198	JUNCTION	10.00	0.000	0.000
D200	JUNCTION	9.05	0.000	0.000
D159	STORAGE	0.34	0.007	2.193

****
Node Flooding Summary
****

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

Node	Hours Flooded	Maximum Rate CFS	Time of Max Occurrence days hr:min	Total Flood Volume 10^6 gal	Maximum Ponded Volume acre-in
65b	10.00	3.26	0 00:56	0.143	0.00
D198	9.85	12.20	0 00:47	0.355	0.00
D200	9.05	13.36	0 00:57	0.410	0.00

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 ft3	Avg Pcnt Full	E&I Pcnt Loss	Maximum Volume 1000 ft3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CFS
D151	1237.810	27	0	1539.904	34	0 02:13	18.50
D159	34.030	31	0	56.694	51	0 03:38	78.46
HAVANA_at_40th_POND	25.258	26	0	72.091	73	0 01:55	100.07

N_WQ_POND	21.383	18	0	68.079	58	0	03:26	19.15
NE_GORE_AREA	4.298	8	0	23.410	45	0	01:41	51.95
NE-HAVANA_POND	1.566	1	0	20.607	19	0	00:48	21.76
NW_GORE_POND	56.965	27	0	161.353	77	0	02:28	32.01
S_WQ_POND	846.518	79	0	936.951	87	0	04:29	76.11
SE_GORE_AREA	101.099	27	0	177.212	47	0	02:33	79.67
SE_Havana_Pond	160.207	33	0	420.415	85	0	01:55	52.50

****
Outfall Loading Summary
****

Outfall Node	Flow Freq. Pcnt.	Avg. Flow CFS	Max. Flow CFS	Total Volume 10^6 gal
D101	30.98	40.45	103.63	3.374
D110	15.23	24.48	47.87	1.004
D170	100.00	60.97	150.71	16.419
D196	97.41	7.60	19.15	1.994
System	60.90	133.49	210.49	22.790

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days	hr:min	Maximum Velocity ft/sec	Max/ Full Flow	Max/ Full Depth
1	DUMMY	250.32	0	00:41			
4	CONDUIT	103.63	0	00:41	8.25	1.26	1.00
7	DUMMY	148.85	0	00:49			
16	CONDUIT	6.88	0	01:00	5.35	1.57	0.79
19	DUMMY	36.74	0	00:35			
20	CONDUIT	5.92	0	00:48	7.47	0.41	0.46
21	CONDUIT	21.76	0	00:48	10.27	0.68	0.64
22	DUMMY	69.33	0	00:54			
25	CONDUIT	47.87	0	00:54	1.77	0.01	0.07
30	CONDUIT	28.16	0	01:07	4.30	0.15	0.46
33	CONDUIT	27.53	0	00:44	12.33	1.14	0.68
38	CONDUIT	27.43	0	00:48	1.13	0.07	0.36
39	CONDUIT	54.38	0	00:56	1.75	0.10	0.39
41	CONDUIT	79.35	0	01:05	2.45	0.22	0.54
42	CONDUIT	79.34	0	01:07	3.88	0.28	0.58
43	CONDUIT	79.28	0	01:09	3.31	0.14	0.48
44	CONDUIT	79.15	0	01:11	3.31	0.23	0.72
45	CONDUIT	72.67	0	01:26	1.80	0.15	0.85
55	CONDUIT	33.88	0	01:55	10.78	2.33	1.00
61	CHANNEL	146.55	0	00:41	9.75	0.39	0.85
62	CONDUIT	12.88	0	00:47	7.33	2.53	1.00
80	CONDUIT	21.46	0	00:54	7.13	1.30	0.91
82	DUMMY	6.11	0	00:44			
110	DUMMY	19.54	0	01:01			
114	CONDUIT	88.30	0	01:29	1.56	0.10	0.75
116	DUMMY	10.93	0	00:37			
117	CONDUIT	46.01	0	01:26	3.47	0.23	0.71
118	CONDUIT	46.01	0	01:27	5.04	0.13	0.38
119	CONDUIT	45.98	0	01:28	1.35	0.11	0.45
120	CONDUIT	45.94	0	01:30	8.02	0.14	0.65
124	CONDUIT	2.57	0	00:42	3.13	0.37	0.80
126	DUMMY	17.91	0	00:45			
133	CONDUIT	51.95	0	01:37	1.50	0.36	0.87
134	CONDUIT	51.86	0	01:37	2.23	0.85	0.88
135	CONDUIT	51.25	0	01:37	3.17	0.04	0.53
135a	CONDUIT	51.68	0	01:37	3.42	0.41	0.85
136	DUMMY	20.83	0	00:35			
137	CONDUIT	17.32	0	02:25	1.01	0.11	0.68
140	DUMMY	8.65	0	00:32			
144	DUMMY	11.41	0	00:33			
152	CONDUIT	44.82	0	01:18	2.85	0.33	0.75
154	DUMMY	7.55	0	00:38			
158	CONDUIT	38.99	0	00:57	2.33	0.18	0.84
160	CONDUIT	84.25	0	01:05	2.43	0.18	0.92
162	DUMMY	21.66	0	00:37			
164	CONDUIT	629.98	0	00:40	23.37	0.18	0.29
168	CONDUIT	44.10	0	02:35	10.19	0.05	0.62
174	DUMMY	6.35	0	00:37			
176	CONDUIT	80.95	0	02:38	1.88	0.18	0.90

178	DUMMY	10.70	0	00:37			
185	CONDUIT	93.08	0	00:44	10.73	0.44	0.93
186	DUMMY	4.46	0	00:35			
187	DUMMY	4.13	0	00:43			
196	DUMMY	47.98	0	00:36			
200	CONDUIT	17.30	0	02:27	1.88	0.08	0.46
202	DUMMY	3.38	0	00:38			
206	CONDUIT	3.17	0	02:44	0.41	0.05	0.55
207	CONDUIT	3.25	0	02:05	0.33	0.04	0.63
208	DUMMY	12.92	0	00:38			
210	CONDUIT	11.42	0	00:43	0.75	0.03	0.46
215	CONDUIT	20.52	0	02:33	1.99	0.33	0.59
216	CONDUIT	20.49	0	02:37	2.08	0.28	0.59
217	CONDUIT	20.48	0	02:40	1.69	0.07	0.34
218	CONDUIT	20.47	0	02:43	1.58	0.03	0.30
219	CONDUIT	20.11	0	02:44	2.53	0.15	0.52
220	CONDUIT	14.29	0	01:00	3.69	0.07	0.52
224	DUMMY	12.20	0	00:47			
225	CONDUIT	7.20	0	00:44	1.92	0.08	0.69
226	DUMMY	7.31	0	01:06			
EX-P1	CONDUIT	19.15	0	03:26	3.92	1.25	0.65
EX-P2	CONDUIT	11.52	0	02:31	6.73	2.23	0.93
EX-P3	CONDUIT	43.84	0	01:26	9.15	2.21	0.94
EX-P4	CONDUIT	70.18	0	02:33	6.14	0.78	0.73
EX-P5	CONDUIT	19.30	0	02:19	8.07	0.41	0.55
P-1	CONDUIT	20.51	0	02:31	5.10	0.49	0.44
P-2	CONDUIT	20.51	0	02:31	3.98	0.48	0.53
P-3	CONDUIT	17.33	0	02:27	3.99	0.94	0.83
P-15	CONDUIT	2.57	0	00:41	4.33	0.05	0.24
P-16	CONDUIT	88.27	0	01:29	14.09	0.40	0.50
P-17	CONDUIT	43.87	0	01:26	8.05	1.21	0.74
P-18	CONDUIT	39.00	0	00:57	19.73	0.27	0.32
P-19	CONDUIT	18.01	0	00:40	5.14	0.25	0.67
P-20	CONDUIT	78.42	0	03:02	4.93	0.80	1.00
P-21	CONDUIT	78.42	0	03:02	4.95	0.71	0.99
P-22	CONDUIT	78.46	0	03:01	5.02	0.85	0.99
P-23	CONDUIT	14.69	0	02:23	4.68	1.11	1.00
P-24	CONDUIT	17.75	0	00:35	7.48	0.49	0.91
P-27	CONDUIT	150.71	0	00:00	9.65	2.08	1.00
3	ORIFICE	88.27	0	01:29			1.00
63	WEIR	88.74	0	00:51			0.09
67	WEIR	15.85	0	00:48			0.21
O2	WEIR	122.36	0	00:00			0.79
O1	DUMMY	18.50	0	02:12			

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	--- Fraction of Time in Flow Class ---- Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Avg. Froude Number	Avg. Flow Change
4	1.00	0.66	0.00	0.00	0.34	0.00	0.00	0.00	0.18	0.0001
16	1.00	0.02	0.00	0.00	0.94	0.04	0.00	0.00	0.80	0.0001
20	1.00	0.02	0.00	0.00	0.00	0.00	0.00	0.98	0.90	0.0000
21	1.00	0.02	0.00	0.00	0.00	0.00	0.00	0.98	0.91	0.0000
25	1.00	0.85	0.00	0.00	0.15	0.00	0.00	0.00	0.12	0.0000
30	1.00	0.02	0.23	0.00	0.09	0.66	0.00	0.00	0.85	0.0000
33	1.00	0.02	0.40	0.00	0.18	0.41	0.00	0.00	0.89	0.0001
38	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.04	0.0000
39	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.18	0.0000
41	1.00	0.03	0.00	0.00	0.97	0.00	0.00	0.00	0.33	0.0000
42	1.00	0.04	0.00	0.00	0.96	0.00	0.00	0.00	0.56	0.0000
43	1.00	0.05	0.00	0.00	0.95	0.00	0.00	0.00	0.44	0.0000
44	1.00	0.06	0.00	0.00	0.94	0.00	0.00	0.00	0.36	0.0000
45	1.00	0.02	0.05	0.00	0.93	0.00	0.00	0.00	0.22	0.0000
55	1.00	0.02	0.00	0.00	0.75	0.00	0.00	0.23	0.56	0.0001
61	1.00	0.05	0.87	0.00	0.02	0.06	0.00	0.00	0.13	0.0000
62	1.00	0.05	0.00	0.00	0.62	0.00	0.00	0.33	0.29	0.0002
80	1.00	0.02	0.00	0.00	0.00	0.01	0.00	0.98	0.48	0.0001
114	1.00	0.02	0.01	0.00	0.98	0.00	0.00	0.00	0.24	0.0000
117	7.20	0.24	0.47	0.00	0.29	0.00	0.01	0.00	0.14	0.0000
118	1.00	0.09	0.15	0.00	0.58	0.18	0.00	0.00	0.28	0.0000
119	1.00	0.09	0.00	0.00	0.91	0.00	0.00	0.00	0.09	0.0000
120	2.41	0.02	0.08	0.00	0.17	0.73	0.00	0.00	2.36	0.0000
124	1.00	0.02	0.00	0.00	0.95	0.03	0.00	0.00	0.17	0.0000
133	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.11	0.0000
134	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.13	0.0000
135	1.75	0.04	0.00	0.00	0.59	0.00	0.00	0.38	0.19	0.0000
135a	1.00	0.03	0.00	0.00	0.97	0.00	0.00	0.00	0.19	0.0000
137	1.00	0.30	0.00	0.00	0.53	0.00	0.00	0.17	0.07	0.0000

152	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.50	0.0000
158	1.00	0.02	0.00	0.00	0.97	0.02	0.00	0.00	0.13	0.0000
160	1.00	0.00	0.02	0.00	0.98	0.00	0.00	0.00	0.18	0.0000
164	5.06	0.72	0.00	0.00	0.00	0.00	0.00	0.28	0.64	0.0000
168	3.37	0.00	0.00	0.00	0.40	0.27	0.00	0.33	1.72	0.0004
176	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.17	0.0000
185	2.35	0.00	0.00	0.00	0.99	0.01	0.00	0.00	0.27	0.0001
200	1.00	0.29	0.01	0.00	0.29	0.00	0.00	0.41	0.16	0.0000
206	1.00	0.02	0.04	0.00	0.94	0.00	0.00	0.00	0.11	0.0000
207	1.00	0.02	0.04	0.00	0.94	0.00	0.00	0.00	0.01	0.0000
210	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.04	0.0000
215	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.22	0.0000
216	1.00	0.03	0.00	0.00	0.97	0.00	0.00	0.00	0.17	0.0000
217	1.00	0.04	0.00	0.00	0.96	0.00	0.00	0.00	0.29	0.0000
218	1.00	0.05	0.00	0.00	0.95	0.00	0.00	0.00	0.21	0.0000
219	1.00	0.06	0.00	0.00	0.41	0.00	0.00	0.53	0.36	0.0000
220	1.42	0.38	0.00	0.00	0.42	0.00	0.00	0.20	0.21	0.0000
225	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.04	0.0000
EX-P1	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.43	0.0001
EX-P2	1.00	0.02	0.00	0.00	0.00	0.00	0.00	0.98	0.72	0.0001
EX-P3	1.00	0.02	0.00	0.00	0.00	0.00	0.00	0.98	0.73	0.0001
EX-P4	1.00	0.00	0.00	0.00	0.47	0.00	0.00	0.53	0.69	0.0000
EX-P5	1.00	0.00	0.00	0.00	0.12	0.88	0.00	0.00	1.37	0.0002
P-1	1.00	0.02	0.00	0.00	0.97	0.01	0.00	0.00	0.54	0.0000
P-2	1.00	0.02	0.00	0.00	0.43	0.00	0.00	0.55	0.46	0.0000
P-3	1.00	0.02	0.00	0.00	0.45	0.00	0.00	0.53	0.32	0.0001
P-15	1.00	0.02	0.63	0.00	0.23	0.12	0.00	0.00	0.27	0.0000
P-16	1.00	0.02	0.00	0.00	0.00	0.98	0.00	0.00	1.93	0.0000
P-17	1.00	0.02	0.00	0.00	0.50	0.48	0.00	0.00	0.94	0.0001
P-18	1.00	0.02	0.47	0.00	0.17	0.35	0.00	0.00	1.16	0.0000
P-19	1.00	0.00	0.07	0.00	0.93	0.00	0.00	0.00	0.07	0.0000
P-20	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.14	0.0001
P-21	1.00	0.00	0.00	0.00	0.99	0.00	0.01	0.00	0.27	0.0000
P-22	1.00	0.01	0.00	0.00	0.99	0.00	0.00	0.00	0.38	0.0000
P-23	1.00	0.02	0.00	0.00	0.98	0.01	0.00	0.00	0.15	0.0001
P-24	1.00	0.00	0.01	0.00	0.93	0.05	0.00	0.00	0.34	0.0000
P-27	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.0002

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Conduit Surcharge Summary
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Conduit	Hours Full Both Ends	Hours Full Upstream	Hours Full Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
1	10.00	10.00	10.00	10.00	0.01
4	0.84	0.84	0.84	0.84	0.84
7	10.00	10.00	10.00	10.00	0.01
16	0.01	0.01	0.01	7.49	0.01
19	10.00	10.00	10.00	10.00	0.01
22	10.00	10.00	10.00	10.00	0.01
33	0.01	0.01	0.01	0.88	0.01
55	1.35	1.35	1.35	7.06	1.35
62	5.26	5.26	5.26	3.57	3.04
80	0.01	0.01	0.01	1.81	0.01
82	10.00	10.00	10.00	10.00	0.01
110	10.00	10.00	10.00	10.00	0.01
116	10.00	10.00	10.00	10.00	0.01
126	10.00	10.00	10.00	10.00	0.01
136	10.00	10.00	10.00	10.00	0.01
140	10.00	10.00	10.00	10.00	0.01
144	10.00	10.00	10.00	10.00	0.01
154	10.00	10.00	10.00	10.00	0.01
162	10.00	10.00	10.00	10.00	0.01
174	10.00	10.00	10.00	10.00	0.01
178	10.00	10.00	10.00	10.00	0.01
186	10.00	10.00	10.00	10.00	0.01
187	10.00	10.00	10.00	10.00	0.01
196	10.00	10.00	10.00	10.00	0.01
202	10.00	10.00	10.00	10.00	0.01
208	10.00	10.00	10.00	10.00	0.01
224	10.00	10.00	10.00	10.00	0.01
226	10.00	10.00	10.00	10.00	0.01
EX-P1	0.01	0.01	0.01	2.37	0.01
EX-P2	0.01	0.01	0.01	6.94	0.01
EX-P3	0.01	0.01	0.01	6.88	0.01
P-17	0.01	0.01	0.01	2.88	0.01
P-20	2.91	2.91	2.91	0.01	2.74
P-23	4.75	4.75	4.75	1.47	2.03
P-27	10.00	10.00	10.00	2.57	7.07

SWMM OUTPUT

```
Analysis begun on:  Thu May 27 14:00:41 2010
Analysis ended on:  Thu May 27 14:00:48 2010
Total elapsed time: 00:00:07
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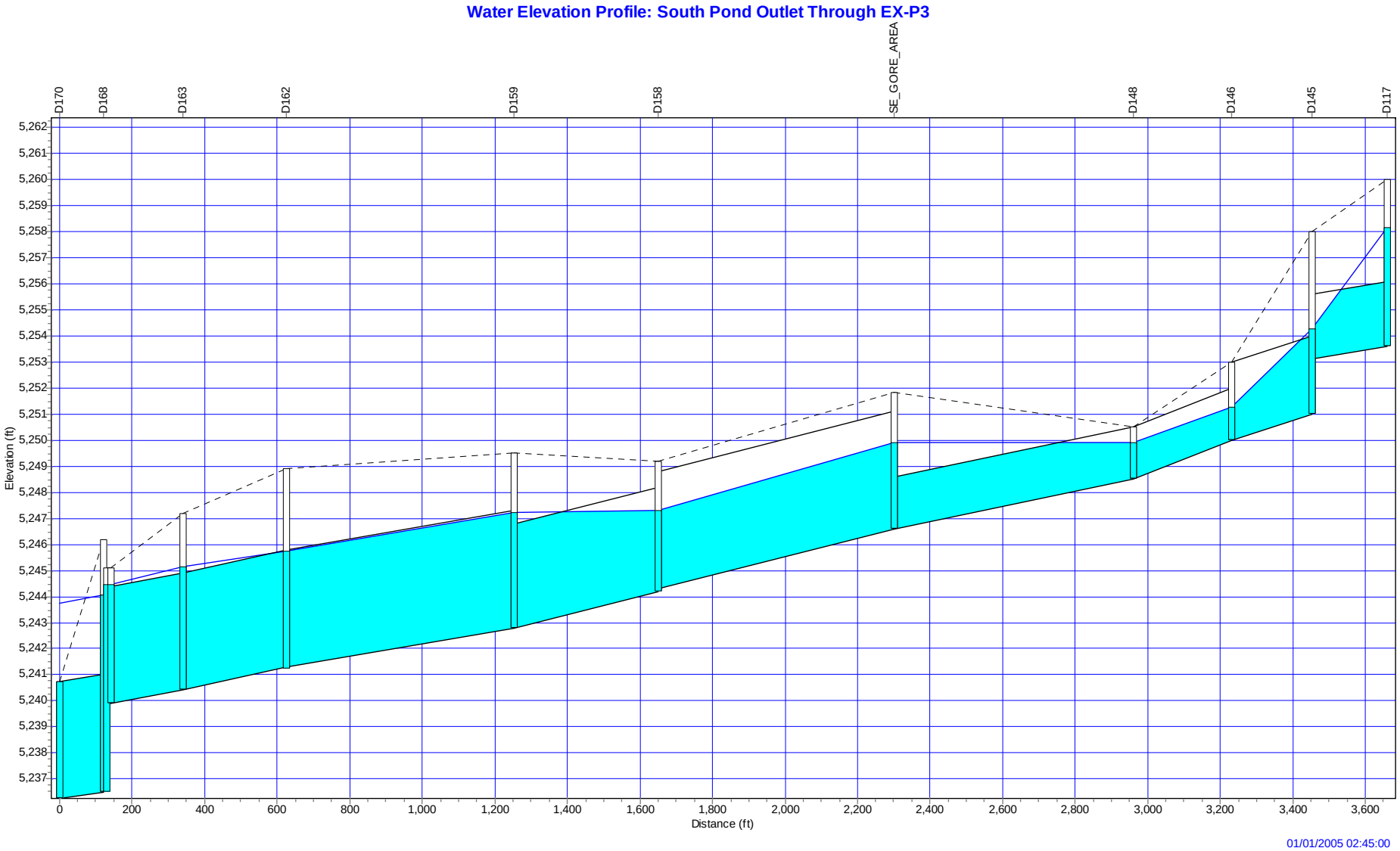

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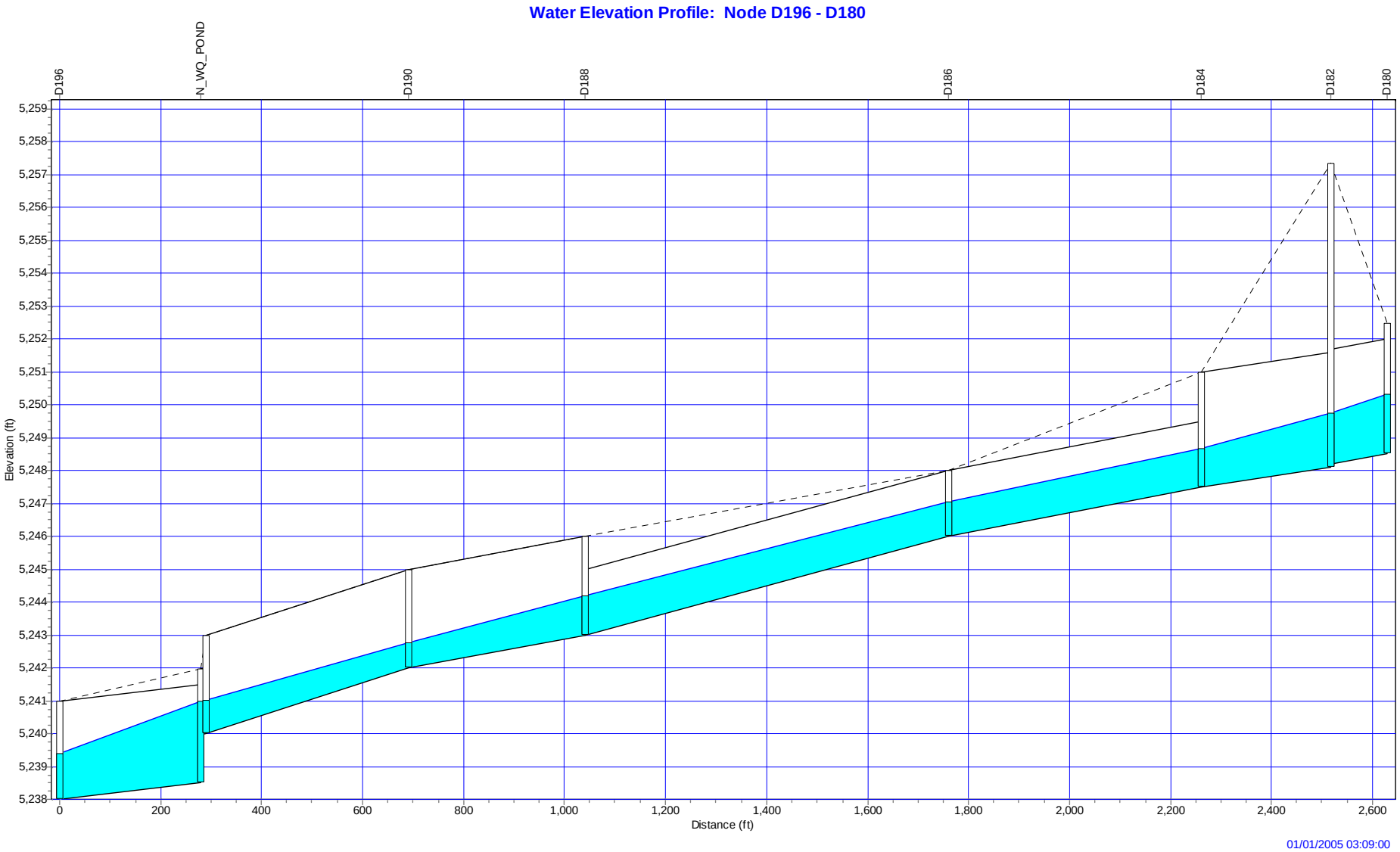
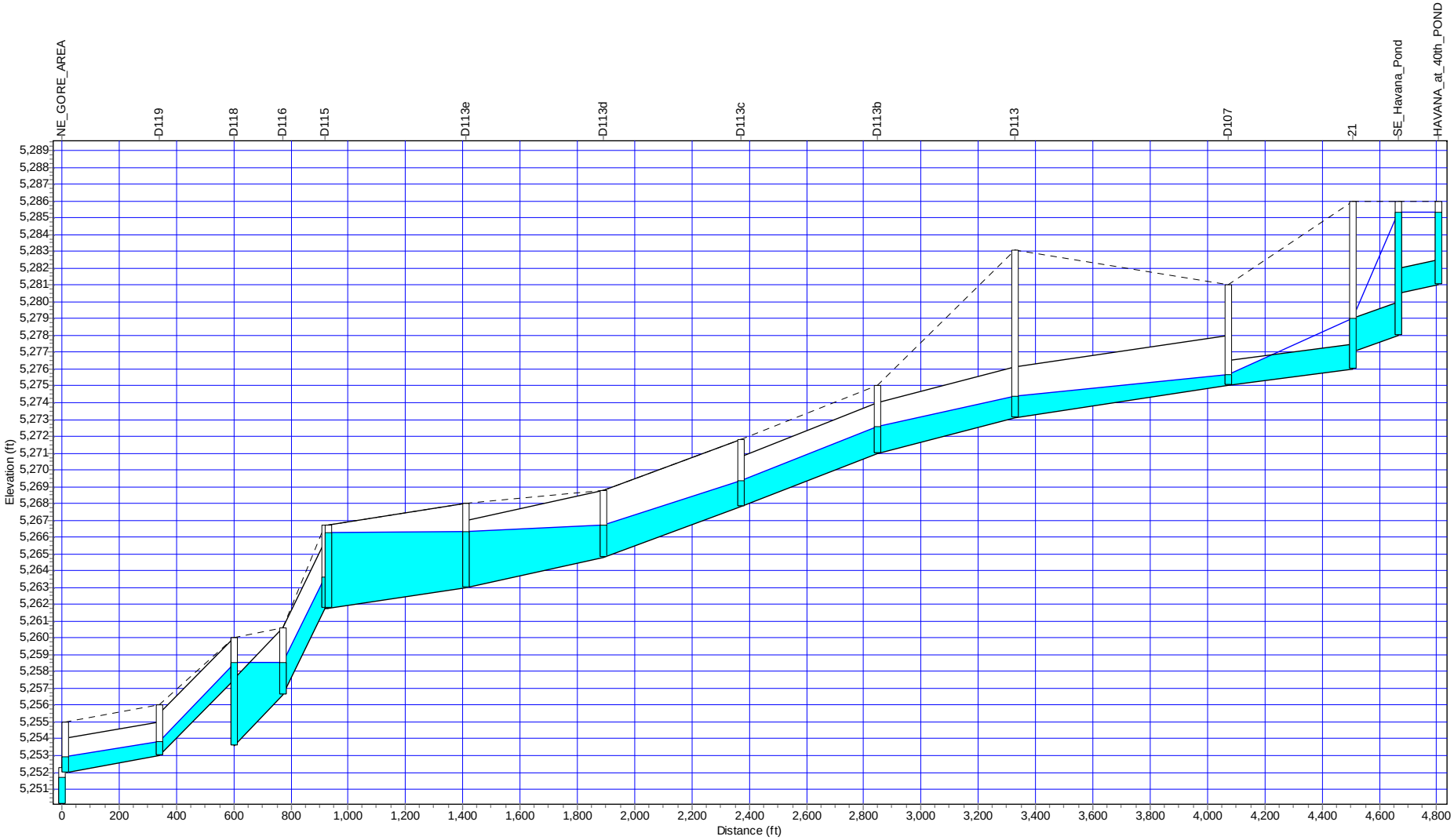


SWMM OUTPUT DATA

Water Elevation Profile: Node NE_GORE_AREA - HAVANA_at_40th_POND



01/01/2005 01:51:00

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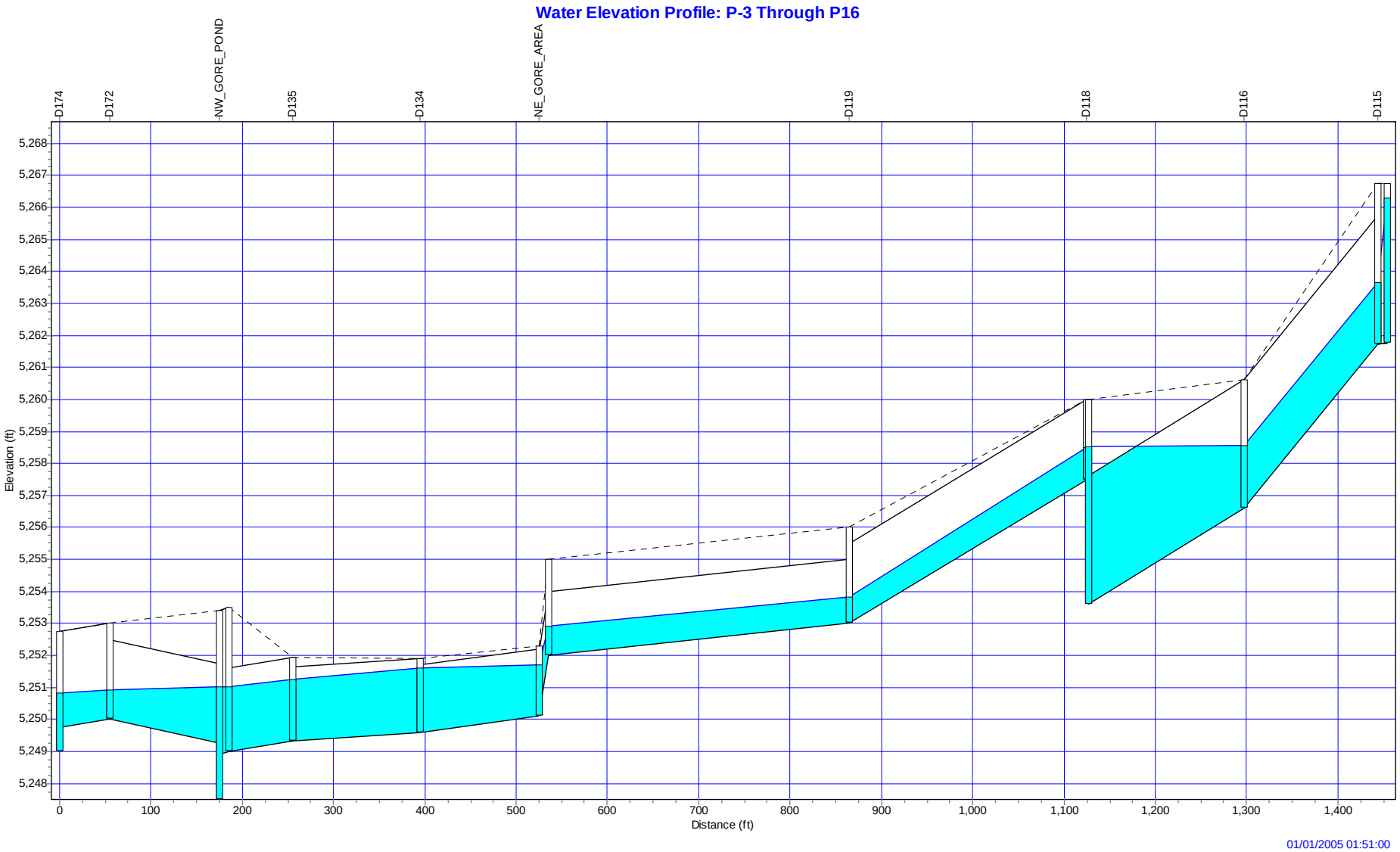
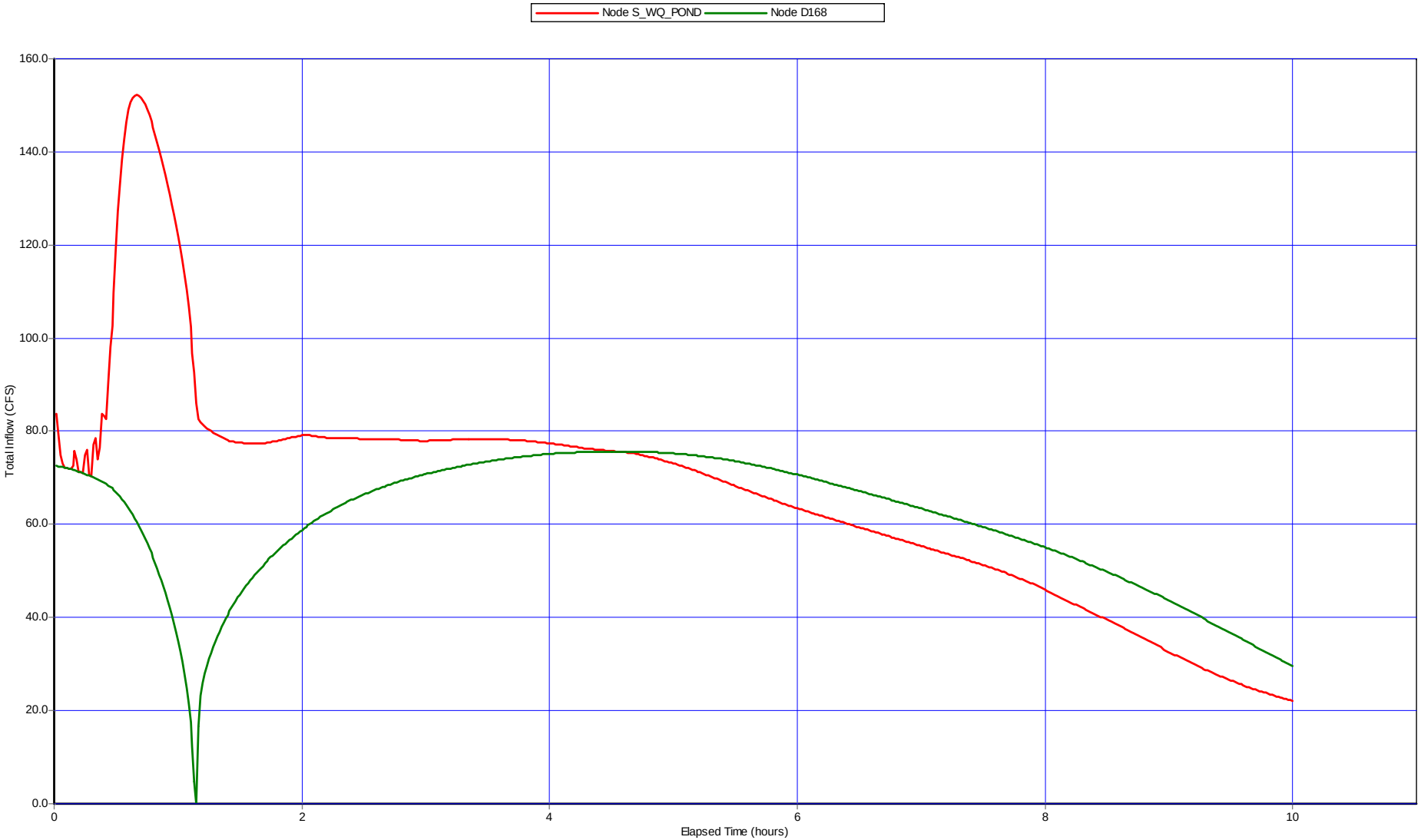
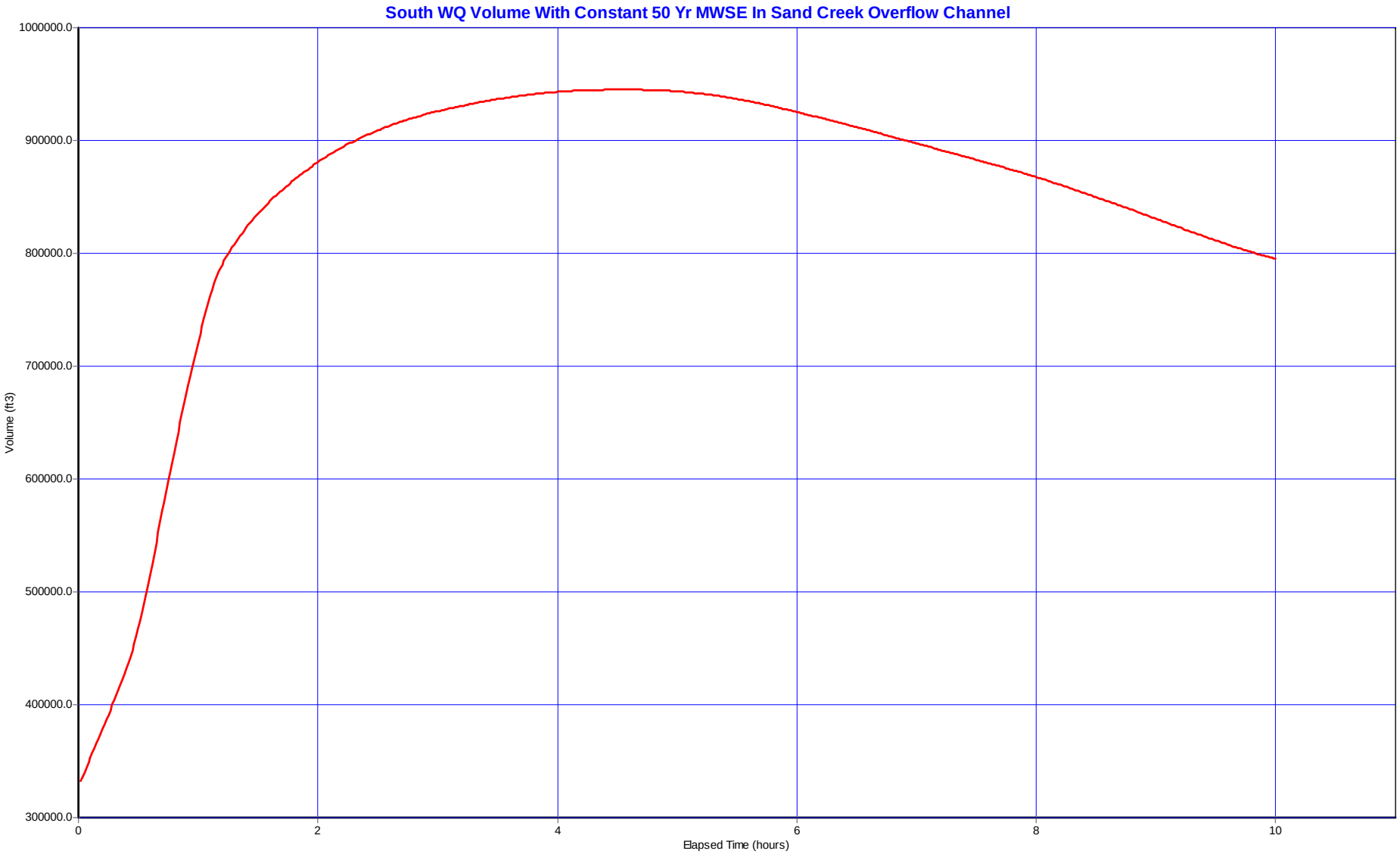
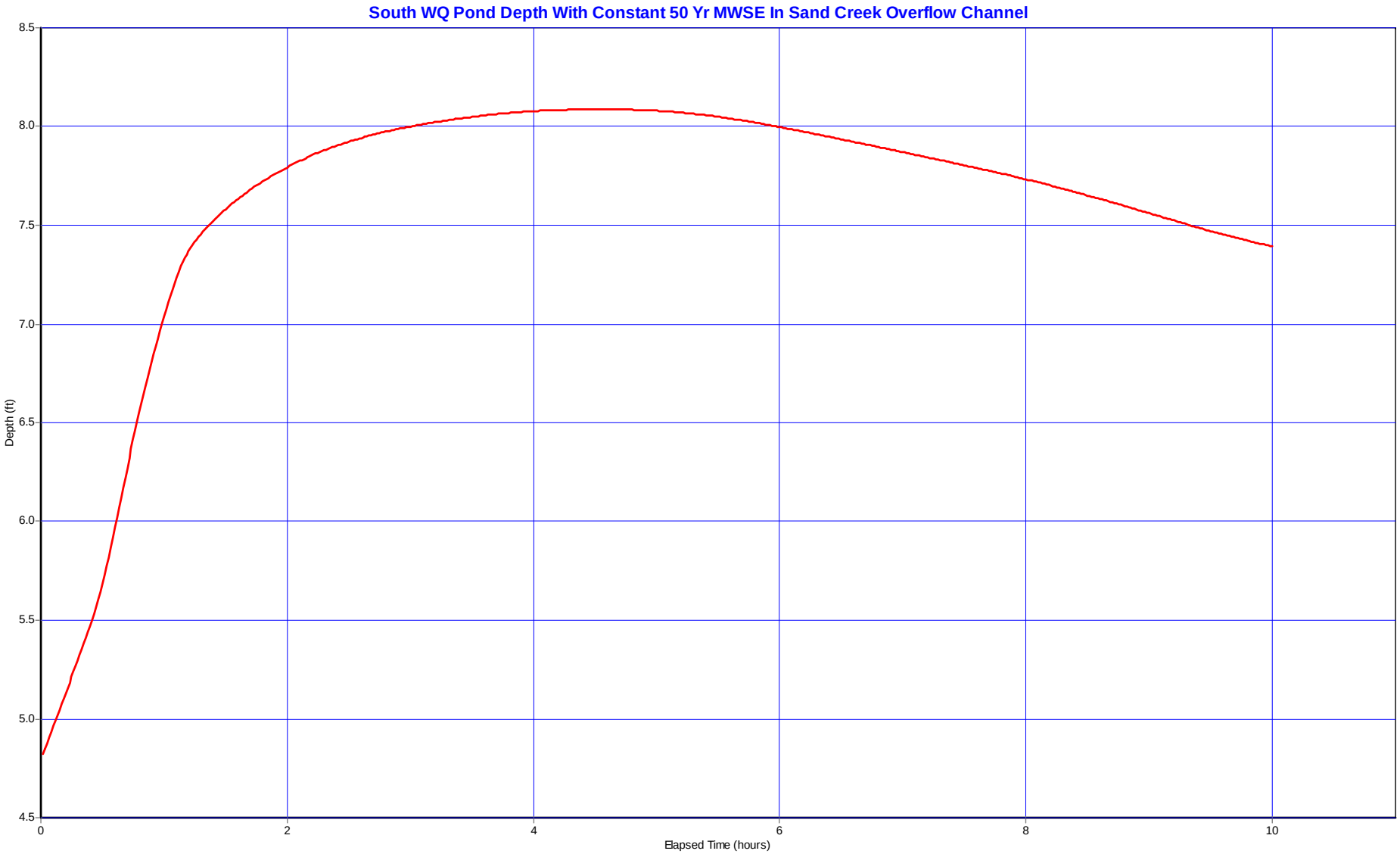
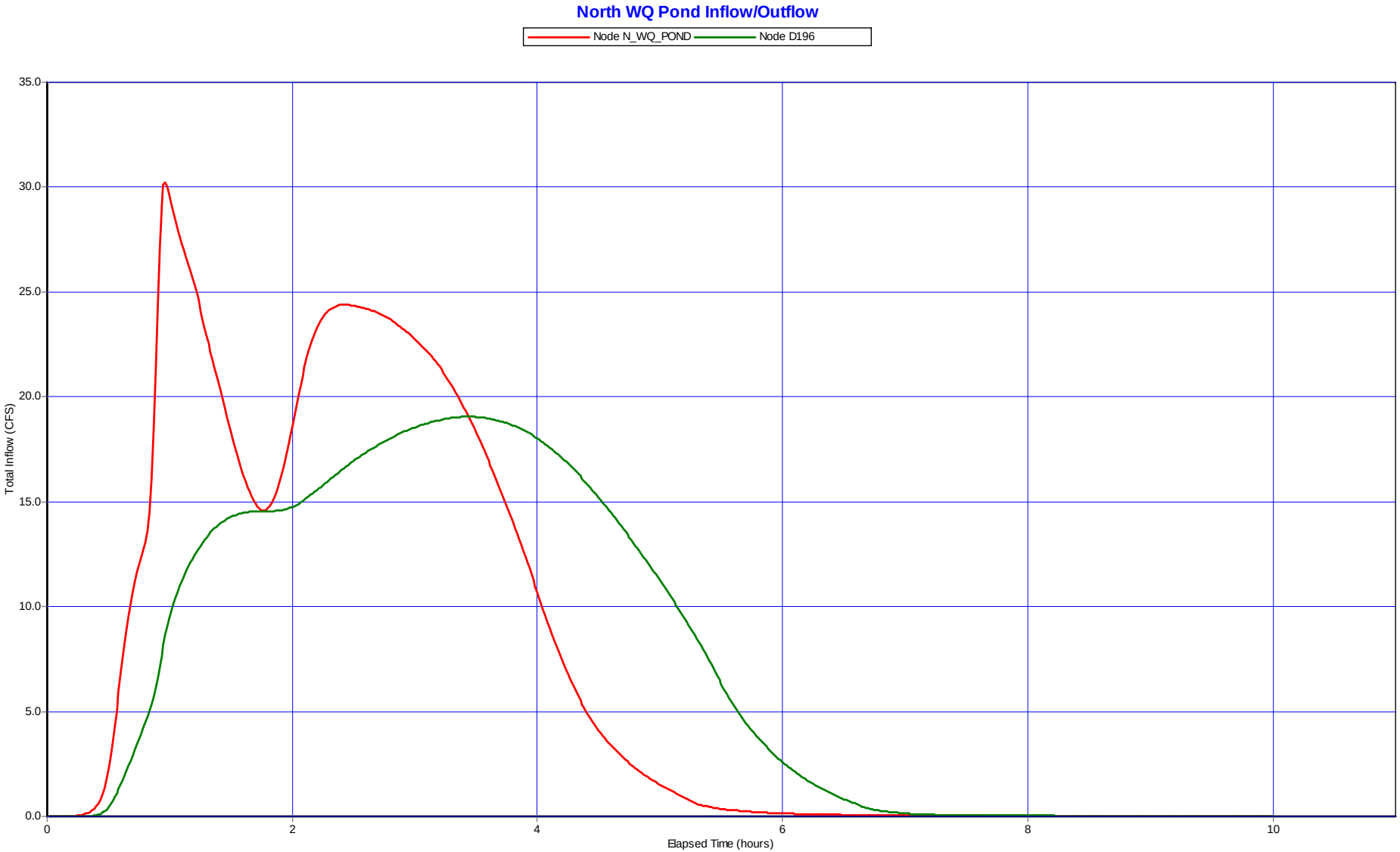


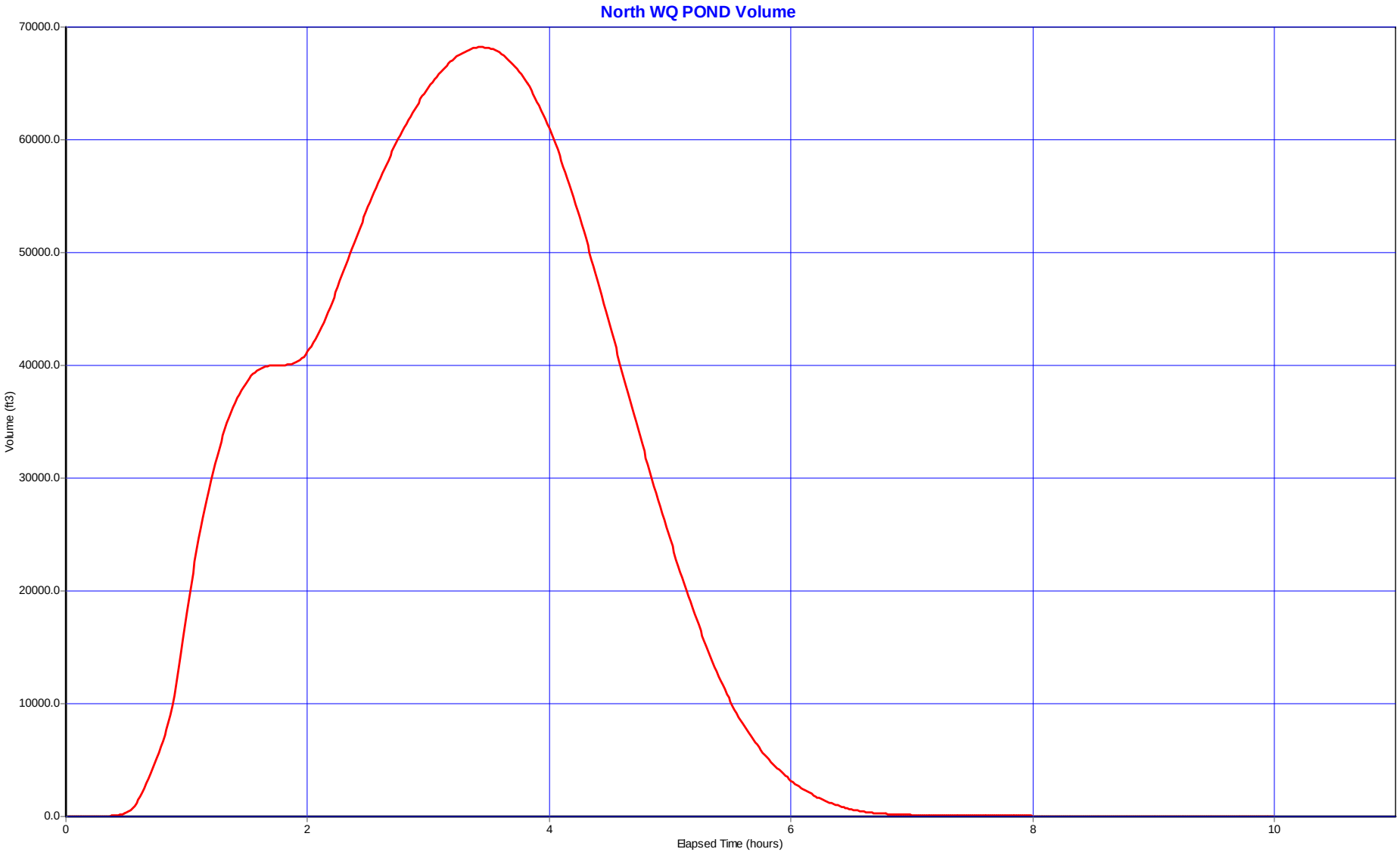
South WQ Pond Inflow and Outflow Starting with Inflow from Sand Creek Overflow Channel

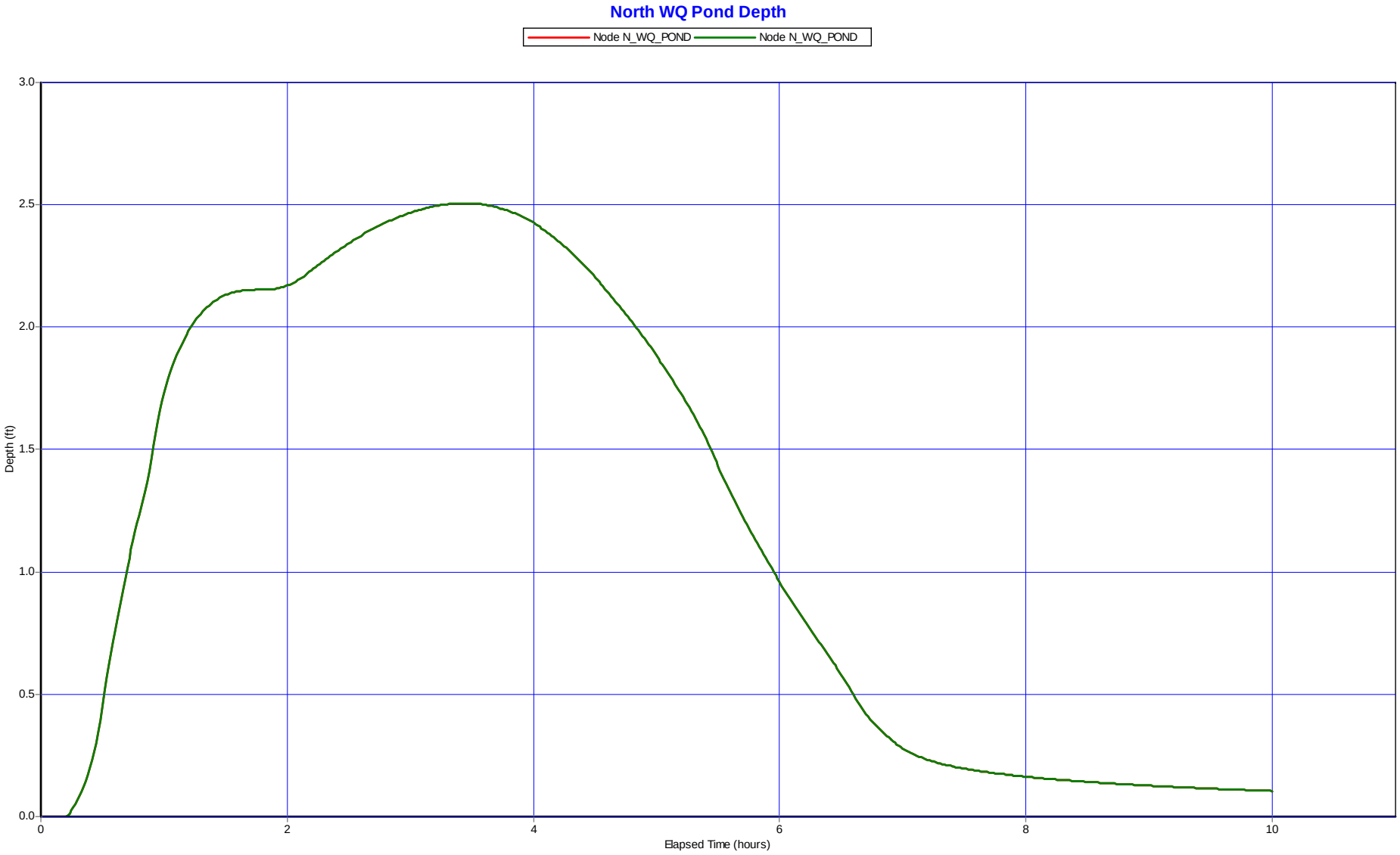


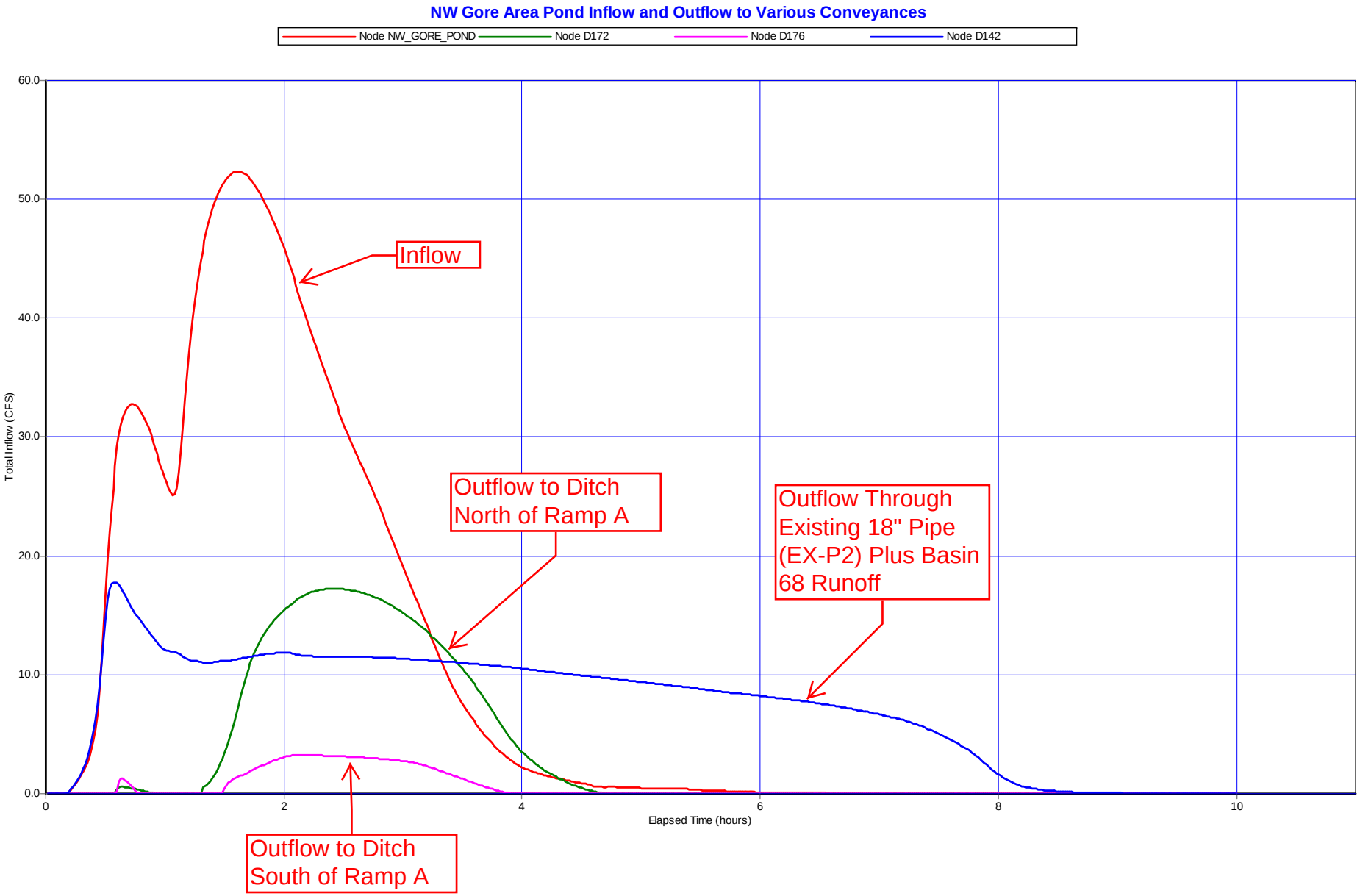

South WQ Volume With Constant 50 Yr MWSE In Sand Creek Overflow Channel
1000000.0
900000.0
800000.0
700000.0
600000.0
500000.0
400000.0
300000.0
Volume (ft3)
0
2
4
6
8
10
Elapsed Time (hours)

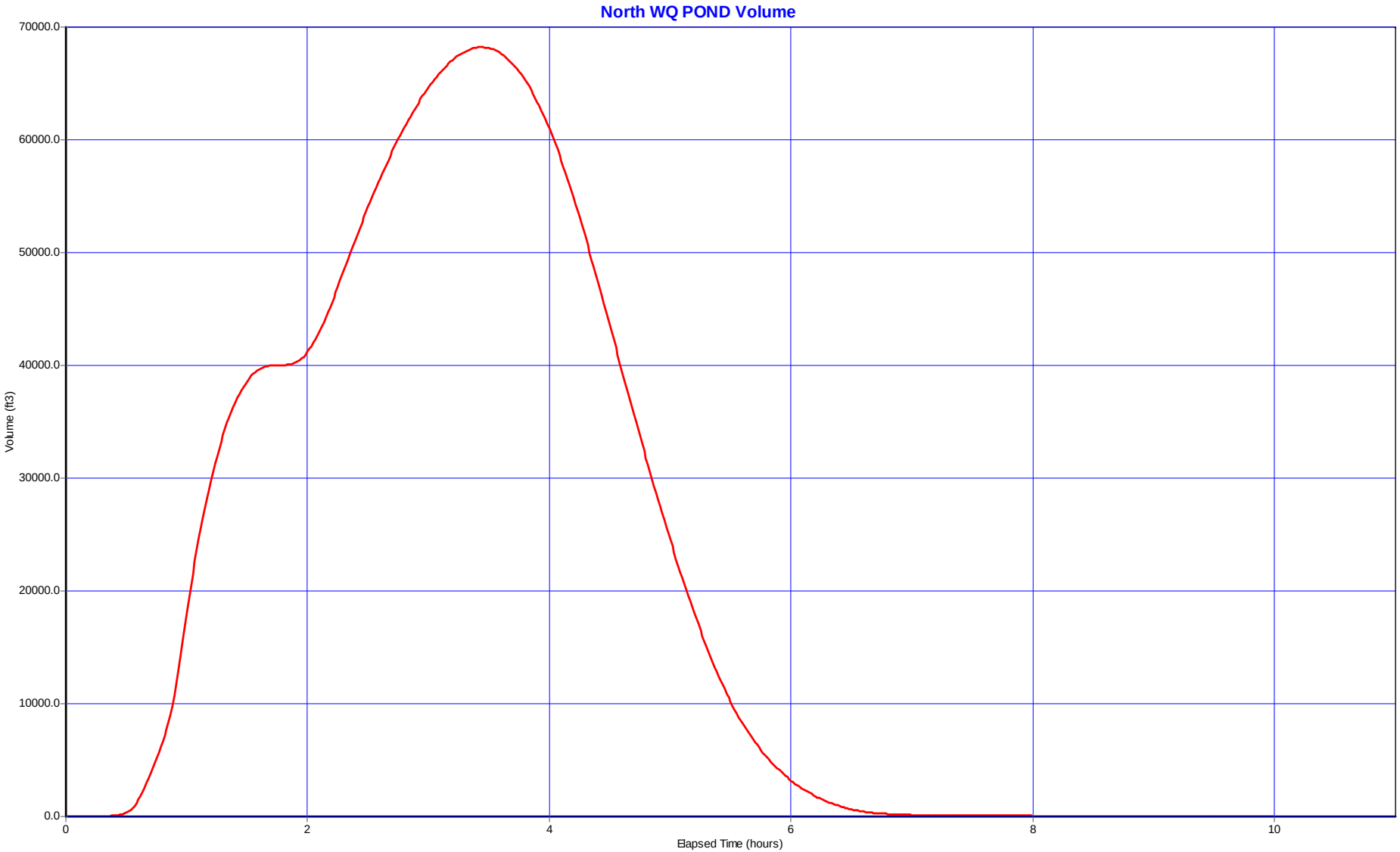

South WQ Pond Depth With Constant 50 Yr MWSE In Sand Creek Overflow Channel
Depth (ft)
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
0
2
4
6
8
10
Elapsed Time (hours)

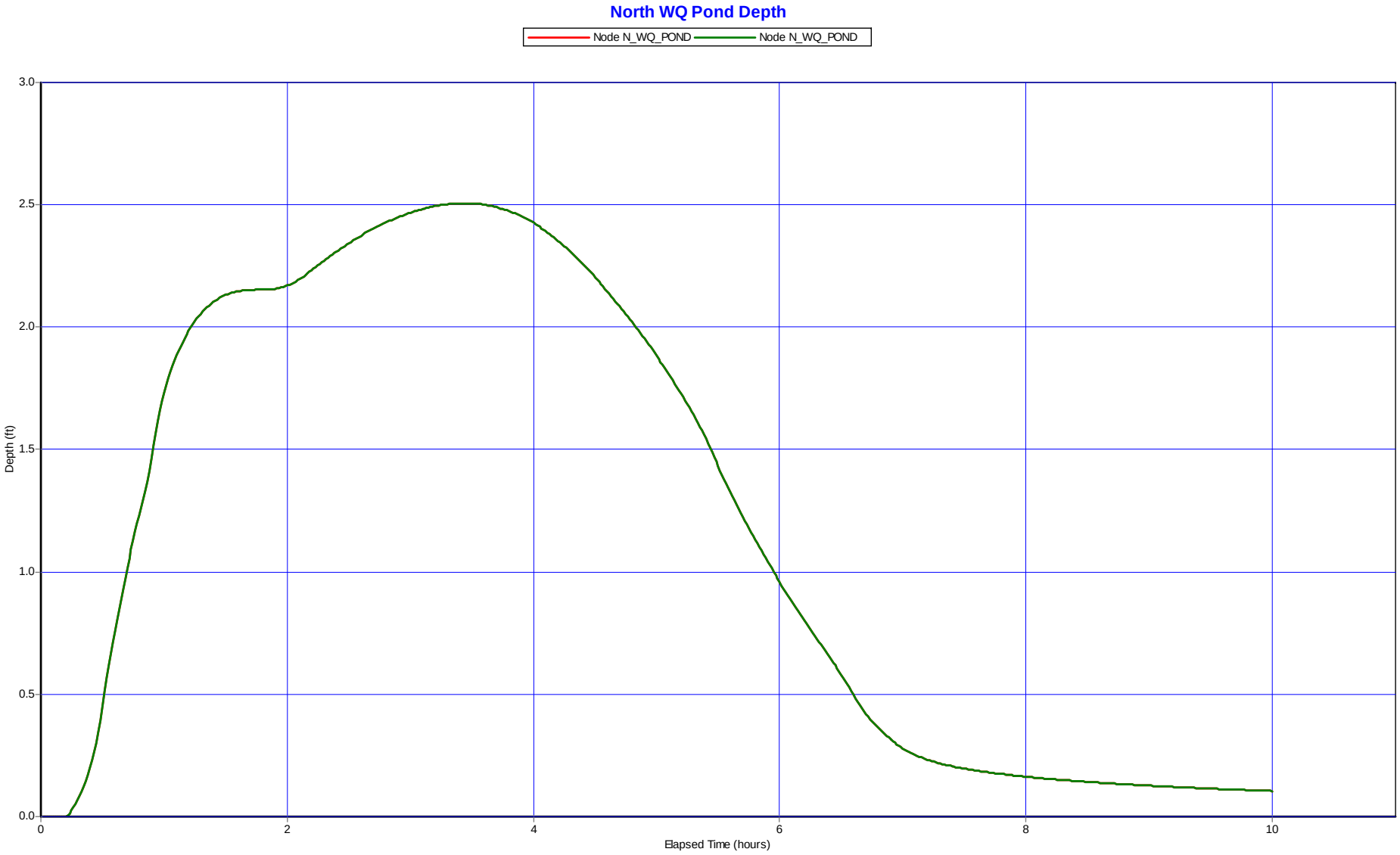

North WQ Pond Inflow/Outflow
Node N_WQ_POND
Node D196
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Total Inflow (CFS)
0
2
4
6
8
10
Elapsed Time (hours)


North WQ POND Volume
70000.0
60000.0
50000.0
40000.0
30000.0
20000.0
10000.0
0.0
Volume (ft3)
0
2
4
6
8
10
Elapsed Time (hours)


North WQ Pond Depth
Node N_WQ_POND
Node N_WQ_POND
Depth (ft)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
2
4
6
8
10
Elapsed Time (hours)


NW Gore Area Pond Inflow and Outflow to Various Conveyances
Node NW_GORE_POND
Node D172
Node D176
Node D142
Total Inflow (CFS)
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0
2
4
6
8
10
Elapsed Time (hours)
Inflow
Outflow to Ditch North of Ramp A
Outflow Through Existing 18" Pipe (EX-P2) Plus Basin 68 Runoff
Outflow to Ditch South of Ramp A


North WQ POND Volume
70000.0
60000.0
50000.0
40000.0
30000.0
20000.0
10000.0
0.0
Volume (ft3)
0
2
4
6
8
10
Elapsed Time (hours)


North WQ Pond Depth
Node N_WQ_POND
Node N_WQ_POND
Depth (ft)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
2
4
6
8
10
Elapsed Time (hours)

Small Basin Pipe Flows Based on Spreadsheet Intercepted Rates from Rational Calculations

Central Park Boulevard

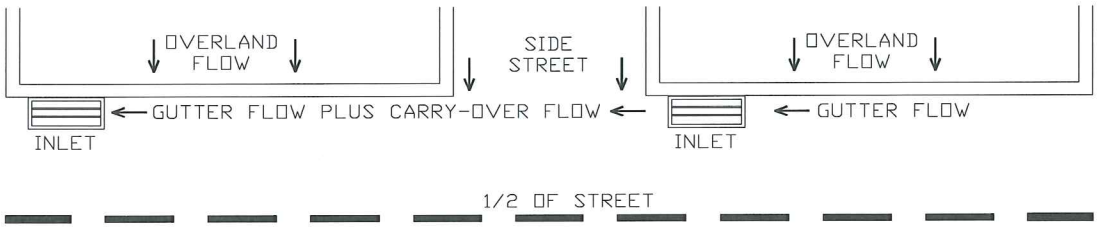
	Contributing Basin / Pipe Flows				
Pipe ID	**Basin**	**Q_{100}**	**Pipe**	**Q_{100}**	**Total Q_{100}**
P5A	S50b-5	1.42			1.42
P5	S50b-6	0.61	P5A	1.42	2.03
P6	S70-1	5.66			5.66
P10	S50b-2	1.06			1.06
P9	S50b-1	1.04	P10	1.06	2.10
P8	S50b-4	2.23			2.23
P7	S50b-3	2.11	P8 & P9	4.33	6.44
P11	S61a-1	0.95			0.95
P12	S61a-2	0.94	P11	0.95	1.89
P13	S61a-3	2.58			2.58
P14	S61a-4	2.53	P12 & P13	4.47	7.00
	S72-1	0.59			
P4A	S72-2	1.07			1.66
P4	S72-3	0.55	P4A	1.66	2.21
P25	S77-1	0.77			0.77
P26A	S78-1	0.61			0.61
P26	S78-2	0.65	P26A	0.61	1.26

Clean Print

TDS 4.8.10

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

Central Park Boulevard
SUB-BASIN 43-1
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 =			cfs

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

Subcatchment Area =	0.22	Acres
Percent Imperviousness =	100.00	%
NRCS Soil Type =	C	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 =	5	100	years
Return Period One-Hour Precipitation, P_1 =	1.35	2.61	inches
C_1 =	28.5	28.5	
C_2 =	10.0	10.0	
C_3 =	0.786	0.786	
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 =	0.900	0.950	
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.10**	**1.03**	**cfs**

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

	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	0.896	0.956	
Calculated 5-yr. Runoff Coefficient, C5 =	0.896	0.896	
Overland Flow Velocity, V_O =	0.06	0.08	fps
Gutter Flow Velocity, V_G =	2.21	2.21	fps
Overland Flow Time, t_O =	0.29	0.22	minutes
Gutter Flow Time, t_G =	0.87	0.87	minutes
Calculated Time of Concentration, T_c =	1.15	1.08	minutes
Time of Concentration by Regional Formula, T_c =	10.64	10.64	minutes
Recommended T_c =	5.00	5.00	minutes
Time of Concentration Selected by User, T_c =	**5.00**	**5.00**	**minutes**
Design Rainfall Intensity, I =	4.58	8.85	inch/hr
Calculated Local Peak Flow, Q_p =	0.90	1.86	cfs
Total Design Peak Flow, Q =	**1.00**	**2.89**	**cfs**

NOTE: For the MINOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

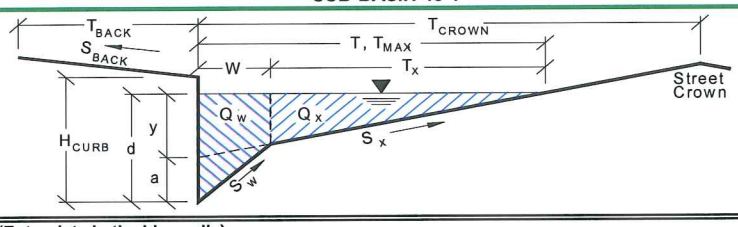
NOTE: For the MAJOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

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

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

Project: Central Park Boulevard

Inlet ID: SUB-BASIN 43-1



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} =	0.0200	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} =	36.0	ft
Gutter Depression	a =	2.00	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 =	0.0050	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0150	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	8.0	12.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	6.00	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 =	0.1033	0.1033	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	1.92	2.88	inches
Water Depth with a Gutter Depression	d =	3.92	4.88	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	6.0	10.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.722	0.522	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.5	1.8	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	1.2	2.0	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 =**	**1.7**	**3.8**	**cfs**
Flow Velocity Within the Gutter Section	V =	2.7	3.2	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.9	1.3	

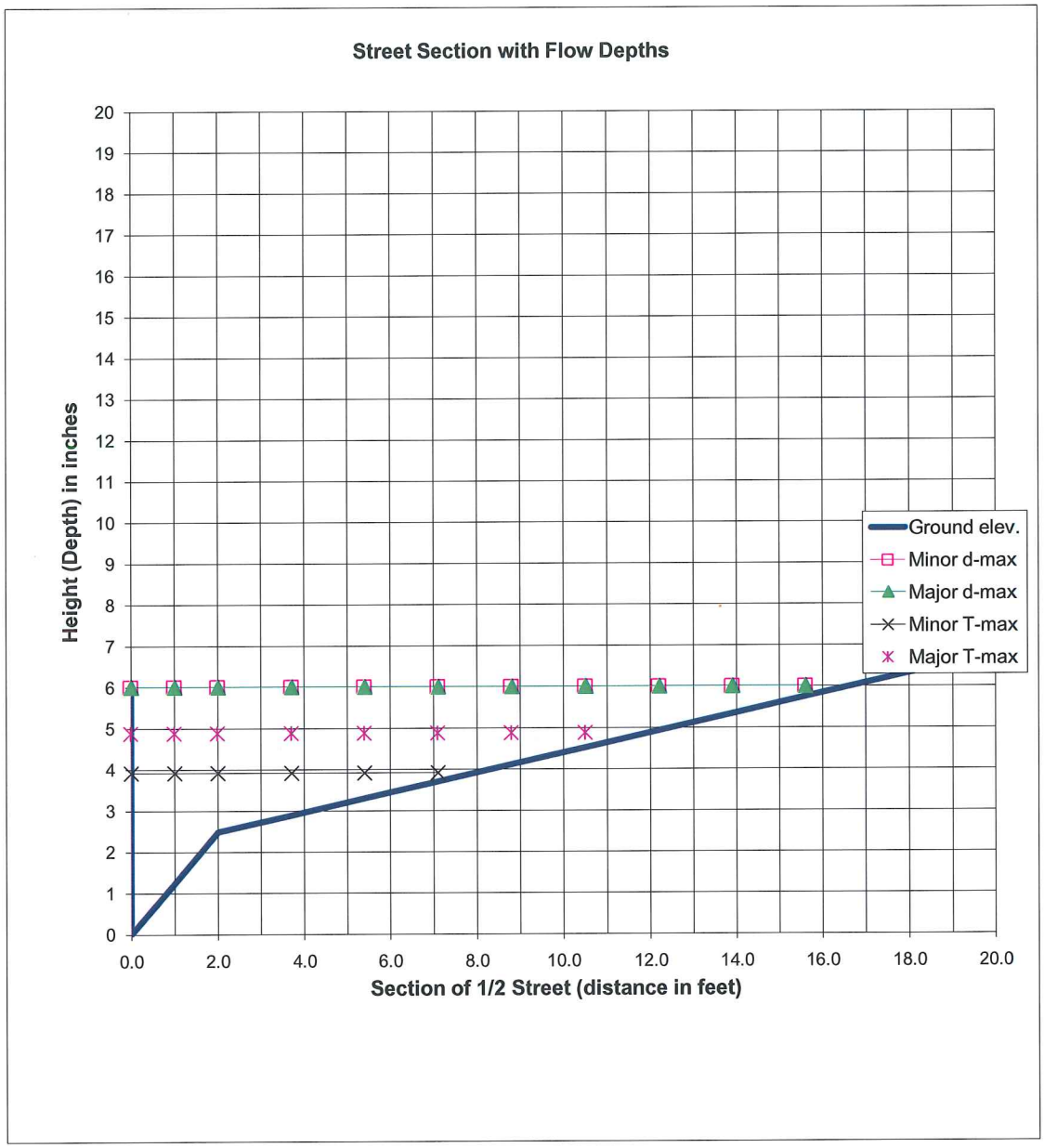
Maximum Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	16.7	16.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	14.7	14.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.378	0.378	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	5.0	5.0	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	5.0	5.0	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	3.1	3.1	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**8.1**	**8.1**	**cfs**
Flow Velocity Within the Gutter Section	V =	3.8	3.8	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	1.9	1.9	
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 =**	**8.1**	**8.1**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	6.00	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} =**	**1.7**	**3.8**	**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'



$$Q_x = \frac{0.56}{n} S_x^{5/3} S_L^{1/2} T_x^{8/3} \qquad E_o = \frac{1}{1 + \dfrac{S_w / S_x}{\left[1 + \dfrac{S_w / S_x}{(T/W) - 1}\right]^{8/3} - 1}}$$

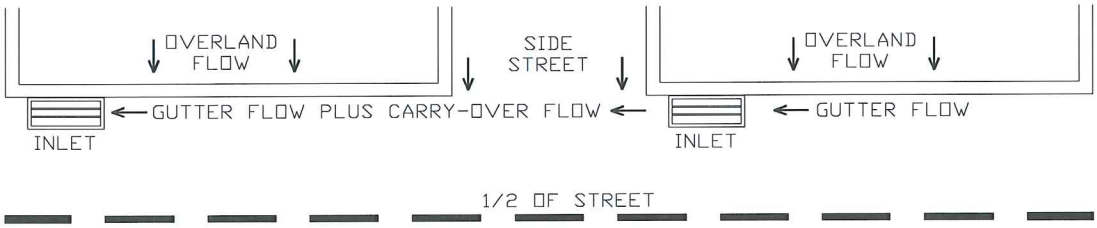
$$Q = \frac{Q_x}{1 - E_o}; \; Q_w = Q - Q_x$$

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

Central Park Boulevard

SUB-BASIN 50B-1

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 =			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 =	0.23	Acres
Percent Imperviousness =	100.00	%
NRCS Soil Type =	C	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 =	5	100	years
Return Period One-Hour Precipitation, P_1 =	1.35	2.61	inches
C_1 =	28.5	28.5	
C_2 =	10.0	10.0	
C_3 =	0.786	0.786	
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 =	0.900	0.950	
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 =	0.896	0.956	
Calculated 5-yr. Runoff Coefficient, C5 =	0.896	0.896	
Overland Flow Velocity, V_O =	0.06	0.08	fps
Gutter Flow Velocity, V_G =	2.62	2.62	fps
Overland Flow Time, t_O =	0.29	0.22	minutes
Gutter Flow Time, t_G =	0.73	0.73	minutes
Calculated Time of Concentration, T_c =	1.02	0.95	minutes
Time of Concentration by Regional Formula, T_c =	10.64	10.64	minutes
Recommended T_c =	5.00	5.00	minutes
Time of Concentration Selected by User, T_c =	**5.00**	**5.00**	**minutes**
Design Rainfall Intensity, I =	4.58	8.85	inch/hr
Calculated Local Peak Flow, Q_p =	0.94	1.95	cfs
Total Design Peak Flow, Q =	**0.94**	**1.95**	**cfs**

NOTE: For the MINOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

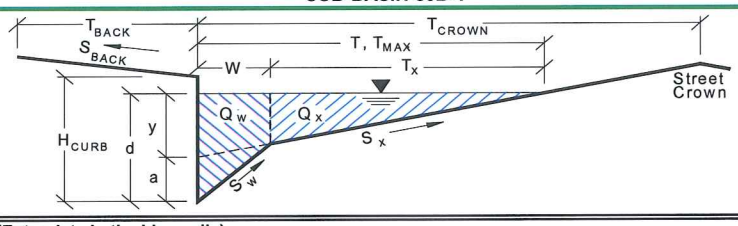
NOTE: For the MAJOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

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

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

Project: Central Park Boulevard

Inlet ID: SUB-BASIN 50B-1



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} =	0.0200	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} =	45.0	ft
Gutter Depression	a =	0.00	inches
Gutter Width	W =	3.00	ft
Street Transverse Slope	S_X =	0.0200	ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0222	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0150	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	12.0	18.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	6.00	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	4.32	inches
Water Depth with a Gutter Depression	d =	2.88	4.32	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	9.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.536	0.385	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	2.9	11.2	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 =**	**6.2**	**18.2**	**cfs**
Flow Velocity Within the Gutter Section	V =	11.8	16.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.8	5.7	

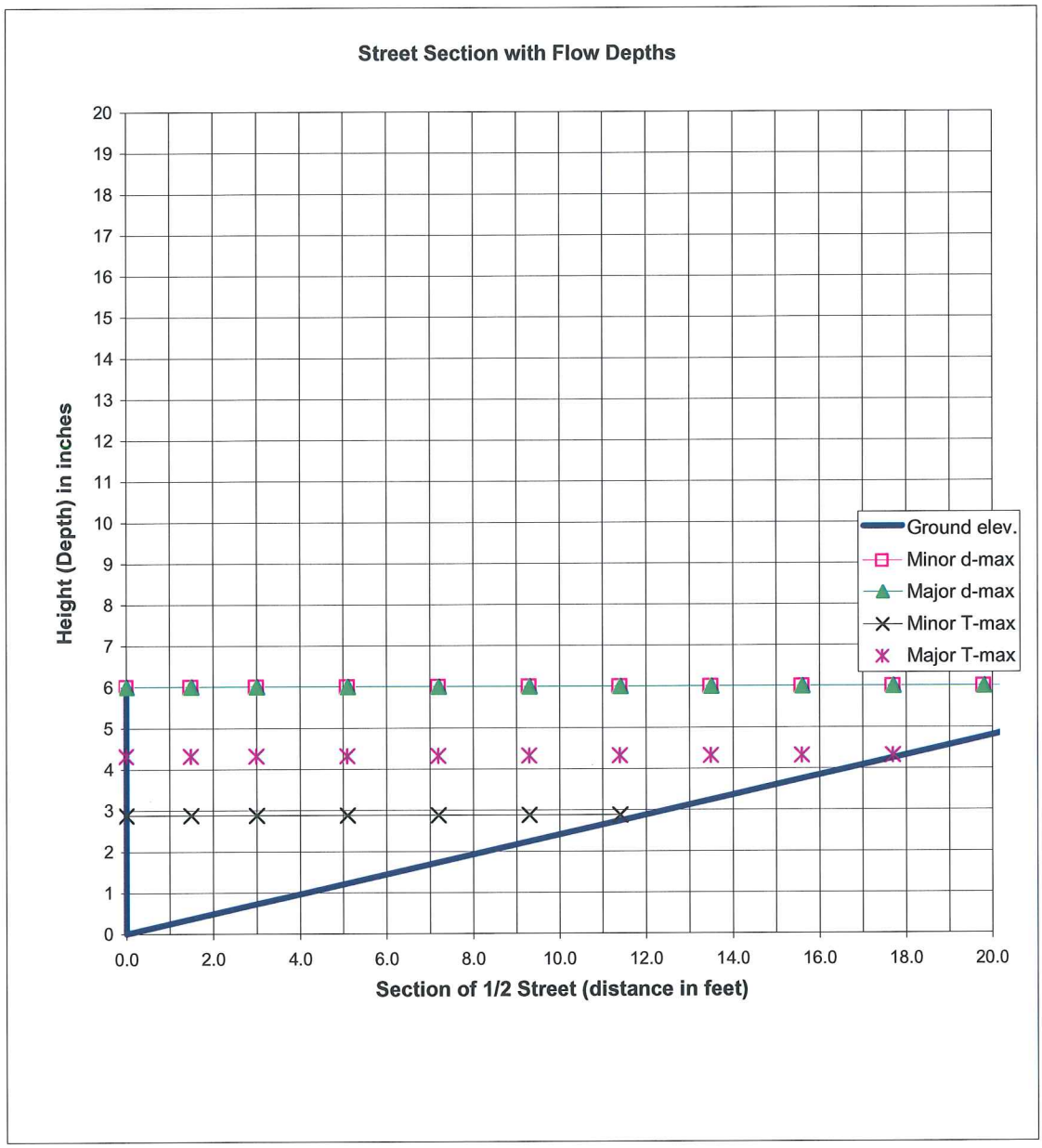
Maximum Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	25.0	25.0	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	22.0	22.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.289	0.289	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	31.1	31.1	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	31.1	31.1	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	12.7	12.7	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**43.8**	**43.8**	**cfs**
Flow Velocity Within the Gutter Section	V =	20.2	20.2	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	10.1	10.1	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d ≥ 6") Storm	R =	0.95	0.95	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**41.5**	**41.5**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.88	5.88	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} =**	**6.2**	**18.2**	**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'

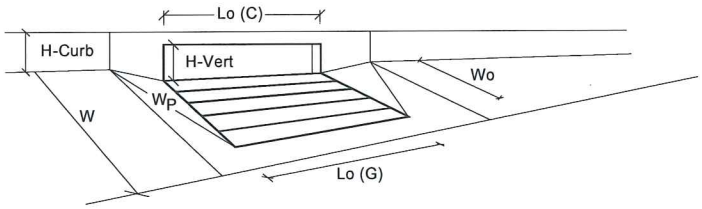


$$Q_x = \frac{0.56}{n} S_x^{5/3} S_L^{1/2} T_x^{8/3} \qquad E_o = \frac{1}{1 + \dfrac{S_w / S_x}{\left[1 + \dfrac{S_w / S_x}{(T/W) - 1}\right]^{8/3} - 1}}$$

$$Q = \frac{Q_x}{1 - E_o}; \; Q_w = Q - Q_x$$

INLET ON A CONTINUOUS GRADE

Project: Central Park Boulevard
Inlet ID: SUB-BASIN 50B-1



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} =	0.5	0.5	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 =	2.00	2.00	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	

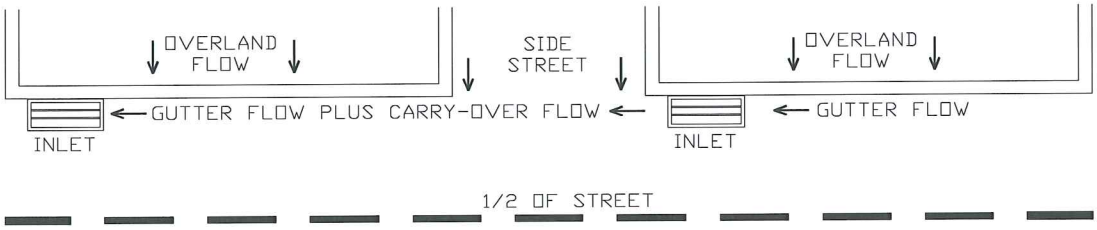
Street Hydraulics: OK - Q < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	Q_o =	**0.94**	**1.95**	**cfs**
Water Spread Width	T =	5.9	7.8	ft
Water Depth at Flowline (outside of local depression)	d =	1.4	1.9	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.847	0.727	
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 =	0.80	1.42	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.35	0.61	sq ft
Street Flow Velocity	V_s =	2.69	3.22	fps
Water Depth for Design Condition	d_{LOCAL} =	1.9	2.4	inches

Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	2.00	2.00	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	0.847	0.727	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =	5.96	5.96	fps
Interception Rate of Frontal Flow	R_f =	1.00	1.00	
Interception Rate of Side Flow	R_x =	0.10	0.07	
Interception Capacity	Q_i =	0.69	1.06	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 =	1.00	1.00	ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =	3.99	3.99	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 =	**0.68**	**1.04**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	Q_b =	**0.26**	**0.91**	**cfs**

Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	**0.68**	**1.04**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	**0.26**	**0.91**	**cfs**
Capture Percentage = Q_a/Q_o =	C% =	**72.2**	**53.2**	**%**

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

Central Park Boulevard
SUB-BASIN 50B-2
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 =			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 =	0.24	Acres
Percent Imperviousness =	100.00	%
NRCS Soil Type =	C	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 =	5	100	years
Return Period One-Hour Precipitation, P_1 =	1.35	2.61	inches
C_1 =	28.5	28.5	
C_2 =	10.0	10.0	
C_3 =	0.786	0.786	
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 =	0.900	0.950	
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 =	0.896	0.956	
Calculated 5-yr. Runoff Coefficient, C5 =	0.896	0.896	
Overland Flow Velocity, V_O =	0.06	0.08	fps
Gutter Flow Velocity, V_G =	2.62	2.62	fps
Overland Flow Time, t_O =	0.29	0.22	minutes
Gutter Flow Time, t_G =	0.73	0.73	minutes
Calculated Time of Concentration, T_c =	1.02	0.95	minutes
Time of Concentration by Regional Formula, T_c =	10.64	10.64	minutes
Recommended T_c =	5.00	5.00	minutes
Time of Concentration Selected by User, T_c =	**5.00**	**5.00**	**minutes**
Design Rainfall Intensity, I =	4.58	8.85	inch/hr
Calculated Local Peak Flow, Q_p =	0.98	2.03	cfs
Total Design Peak Flow, Q =	**0.98**	**2.03**	**cfs**

NOTE: For the MINOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

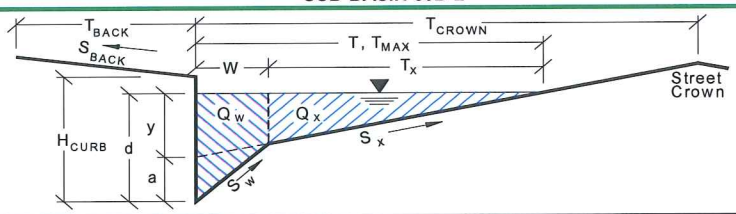
NOTE: For the MAJOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

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

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

Project: Central Park Boulevard

Inlet ID: SUB-BASIN 50B-2



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} =	0.0200	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} =	45.0	ft
Gutter Depression	a =	0.00	inches
Gutter Width	W =	3.00	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} =	0.0150	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	12.0	18.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	6.00	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	4.32	inches
Water Depth with a Gutter Depression	d =	2.88	4.32	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	9.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.536	0.385	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	2.9	11.2	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 =**	**6.2**	**18.2**	**cfs**
Flow Velocity Within the Gutter Section	V =	11.8	15.9	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.8	5.7	

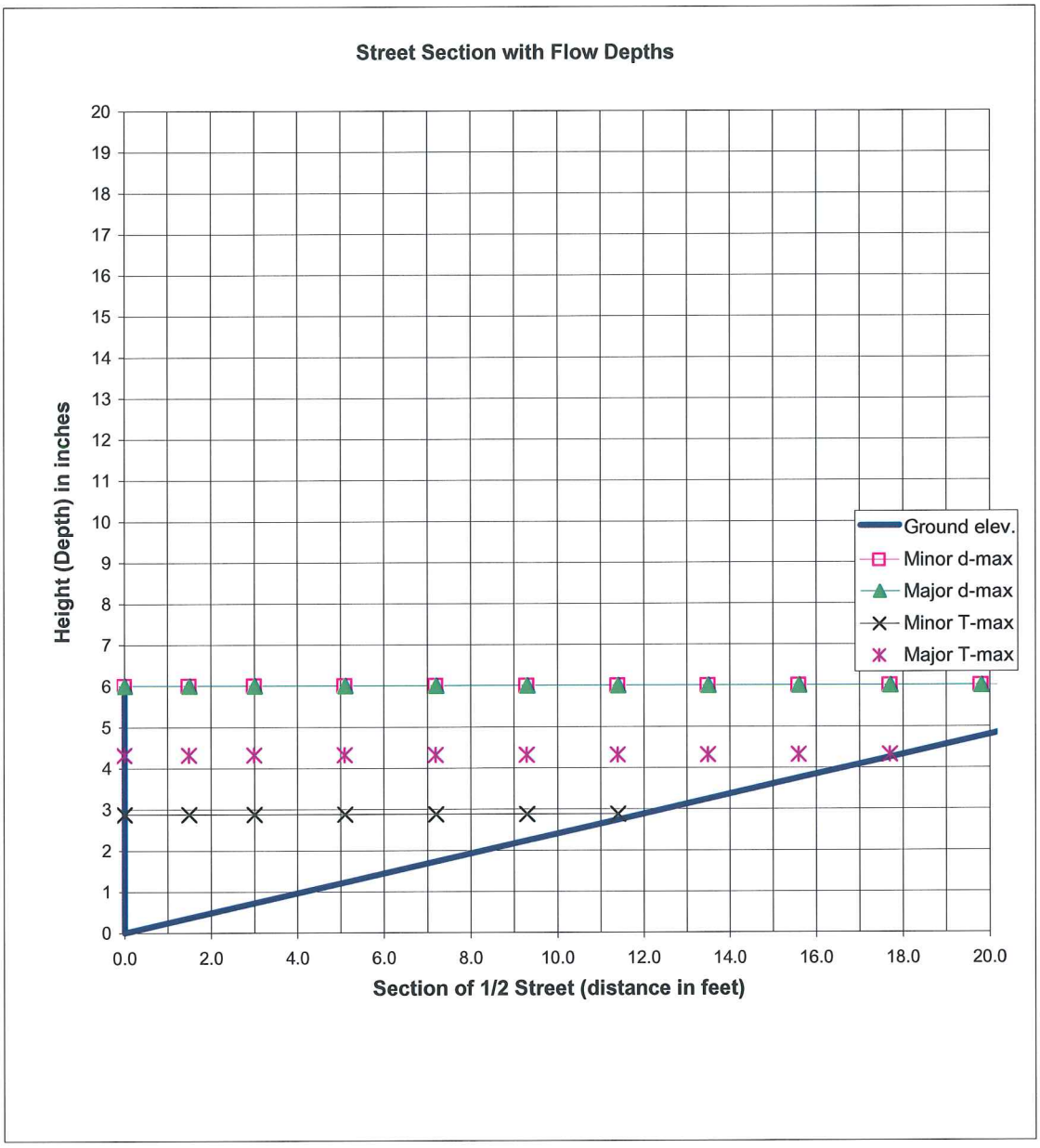
Maximum Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	25.0	25.0	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	22.0	22.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.289	0.289	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	31.0	31.0	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	31.0	31.0	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	12.6	12.6	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**43.6**	**43.6**	**cfs**
Flow Velocity Within the Gutter Section	V =	20.1	20.1	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	10.0	10.0	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d ≥ 6") Storm	R =	0.95	0.95	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**41.6**	**41.6**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.90	5.90	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} =**	**6.2**	**18.2**	**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'

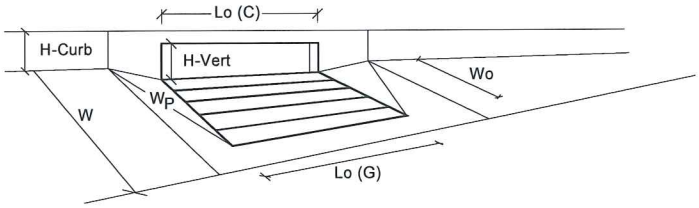


$$Q_x = \frac{0.56}{n} S_x^{5/3} S_L^{1/2} T_x^{8/3} \qquad E_o = \frac{1}{1 + \dfrac{S_w / S_x}{\left[1 + \dfrac{S_w / S_x}{(T/W) - 1}\right]^{8/3} - 1}}$$

$$Q = \frac{Q_x}{1 - E_o}; \; Q_w = Q - Q_x$$

INLET ON A CONTINUOUS GRADE

Project: Central Park Boulevard
Inlet ID: SUB-BASIN 50B-2



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} =	0.5	0.5	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 =	2.00	2.00	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 =**	**0.98**	**2.03**	**cfs**
Water Spread Width	T =	6.1	7.9	ft
Water Depth at Flowline (outside of local depression)	d =	1.5	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 =	0.840	0.719	
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 =	0.83	1.46	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.36	0.63	sq ft
Street Flow Velocity	V_s =	2.71	3.24	fps
Water Depth for Design Condition	d_{LOCAL} =	1.9	2.4	inches

Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	2.00	2.00	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	0.840	0.719	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =	5.96	5.96	fps
Interception Rate of Frontal Flow	R_f =	1.00	1.00	
Interception Rate of Side Flow	R_x =	0.10	0.07	
Interception Capacity	Q_i =	0.71	1.08	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 =	1.00	1.00	ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =	3.99	3.99	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 =**	**0.70**	**1.06**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**0.29**	**0.97**	**cfs**

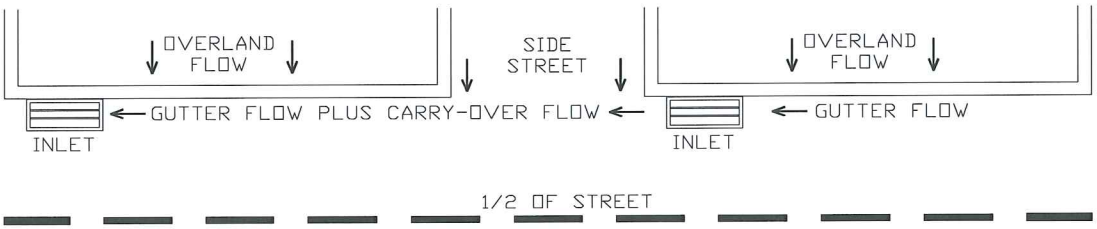
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.70**	**1.06**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.29**	**0.97**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**71.0**	**52.1**	**%**

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

Central Park Boulevard

SUB-BASIN 50B-3

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 =			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 =	0.25	Acres
Percent Imperviousness =	100.00	%
NRCS Soil Type =	C	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 =	5	100	years
Return Period One-Hour Precipitation, P_1 =	1.35	2.61	inches
C_1 =	28.5	28.5	
C_2 =	10.0	10.0	
C_3 =	0.786	0.786	
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 =	0.900	0.950	
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.26**	**0.91**	**cfs**

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

	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	0.896	0.956	
Calculated 5-yr. Runoff Coefficient, C5 =	0.896	0.896	
Overland Flow Velocity, V_O =	0.06	0.08	fps
Gutter Flow Velocity, V_G =	3.22	3.22	fps
Overland Flow Time, t_O =	0.29	0.22	minutes
Gutter Flow Time, t_G =	0.60	0.60	minutes
Calculated Time of Concentration, T_c =	0.88	0.81	minutes
Time of Concentration by Regional Formula, T_c =	10.64	10.64	minutes
Recommended T_c =	5.00	5.00	minutes
Time of Concentration Selected by User, T_c =	**5.00**	**5.00**	**minutes**
Design Rainfall Intensity, I =	4.58	8.85	inch/hr
Calculated Local Peak Flow, Q_p =	1.03	2.12	cfs
Total Design Peak Flow, Q =	**1.29**	**3.03**	**cfs**

NOTE: For the MINOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

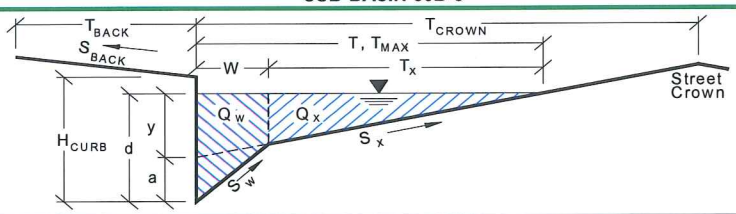
NOTE: For the MAJOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

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

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

Project: Central Park Boulevard

Inlet ID: SUB-BASIN 50B-3



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} =	0.0200	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} =	45.0	ft
Gutter Depression	a =	2.00	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 =	0.0274	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0150	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	12.0	18.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	6.00	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 =	0.1033	0.1033	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	2.88	4.32	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 =	10.0	16.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.522	0.350	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	4.2	14.8	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	4.6	8.0	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 =**	**8.8**	**22.8**	**cfs**
Flow Velocity Within the Gutter Section	V =	7.6	9.4	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	3.1	4.9	

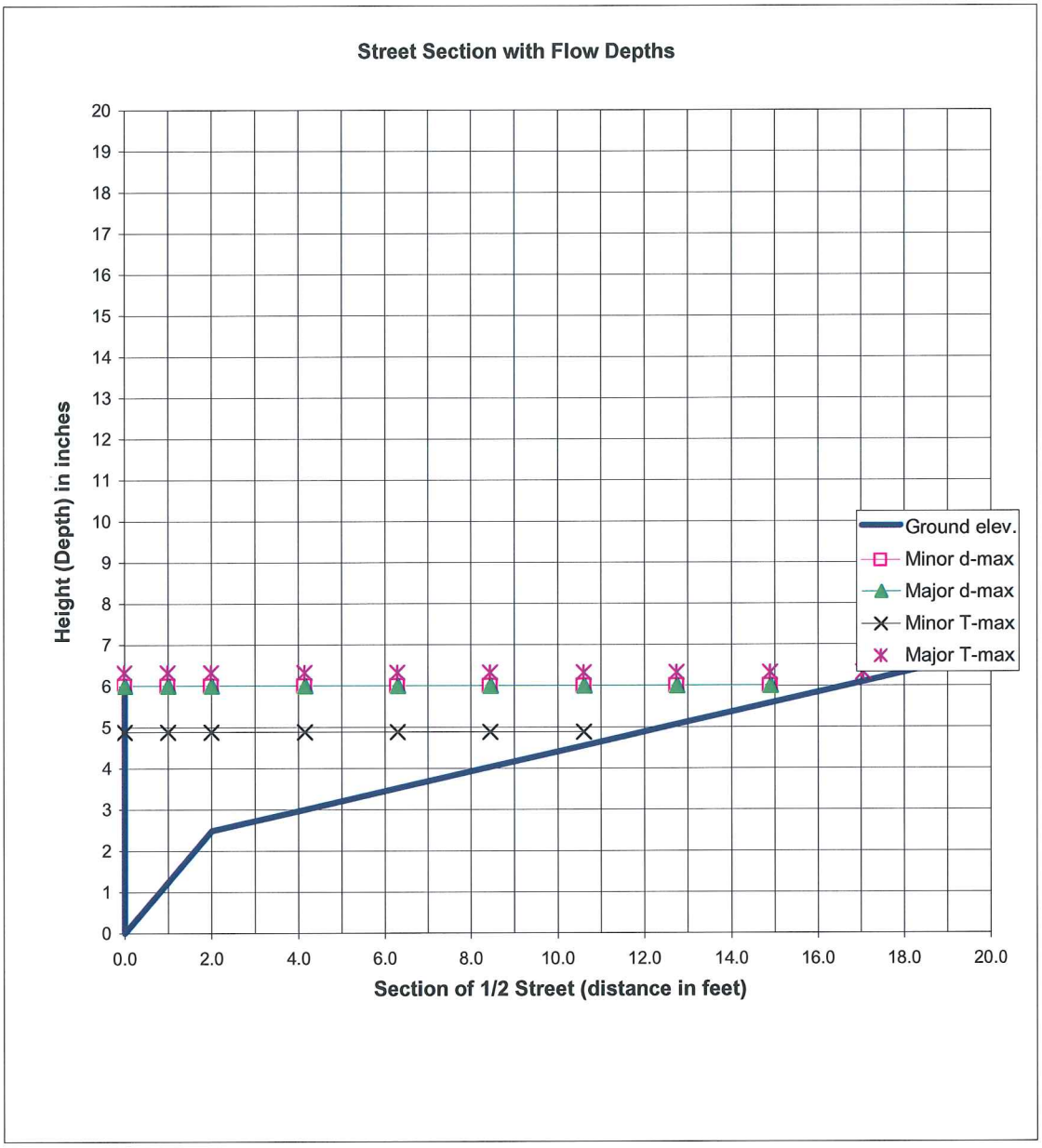
Maximum Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	16.7	16.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	14.7	14.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.378	0.378	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	11.7	11.7	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	11.7	11.7	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	7.1	7.1	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**18.9**	**18.9**	**cfs**
Flow Velocity Within the Gutter Section	V =	9.0	9.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	4.5	4.5	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d ≥ 6") Storm	R =	0.80	0.80	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**15.1**	**15.1**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.64	5.64	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} =**	**8.8**	**15.1**	**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'

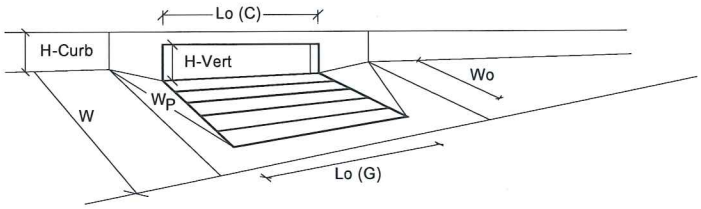


$$Q_x = \frac{0.56}{n} S_x^{5/3} S_L^{1/2} T_x^{8/3} \qquad E_o = \frac{1}{1 + \dfrac{S_w / S_x}{\left[1 + \dfrac{S_w / S_x}{(T/W) - 1}\right]^{8/3} - 1}}$$

$$Q = \frac{Q_x}{1 - E_o}; \; Q_w = Q - Q_x$$

INLET ON A CONTINUOUS GRADE

Project: Central Park Boulevard
Inlet ID: SUB-BASIN 50B-3



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 =	**1.29**	**3.03**	**cfs**
Water Spread Width	T =	2.3	6.9	ft
Water Depth at Flowline (outside of local depression)	d =	2.6	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 =	1.000	0.791	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.00	0.63	cfs
Discharge within the Gutter Section W	Q_w =	1.30	2.40	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.22	0.64	sq ft
Street Flow Velocity	V_s =	5.90	4.70	fps
Water Depth for Design Condition	d_{LOCAL} =	5.6	6.7	inches

Curb or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.2283	0.1847	ft/ft
Required Length L_T to Have 100% Interception	L_T =	6.84	11.12	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 =	1.26	2.28	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 =	**1.21**	**2.11**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	Q_b =	**0.08**	**0.92**	**cfs**

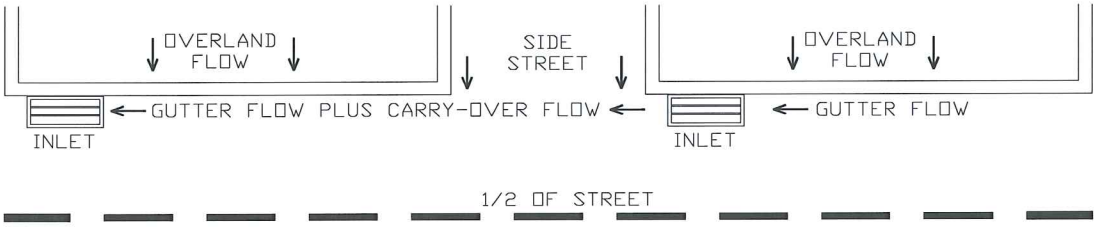
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	**1.21**	**2.11**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	**0.07**	**0.91**	**cfs**
Capture Percentage = Q_a/Q_o =	C% =	**94.3**	**69.9**	**%**

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

Central Park Boulevard

SUB-BASIN 50B-4

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 =			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 =	0.27	Acres
Percent Imperviousness =	100.00	%
NRCS Soil Type =	C	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 =	5	100	years
Return Period One-Hour Precipitation, P_1 =	1.35	2.61	inches
C_1 =	28.5	28.5	
C_2 =	10.0	10.0	
C_3 =	0.786	0.786	
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 =	0.900	0.950	
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.29**	**0.97**	**cfs**

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

	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	0.896	0.956	
Calculated 5-yr. Runoff Coefficient, C5 =	0.896	0.896	
Overland Flow Velocity, V_O =	0.06	0.08	fps
Gutter Flow Velocity, V_G =	3.22	3.22	fps
Overland Flow Time, t_O =	0.29	0.22	minutes
Gutter Flow Time, t_G =	0.60	0.60	minutes
Calculated Time of Concentration, T_c =	0.88	0.81	minutes
Time of Concentration by Regional Formula, T_c =	10.64	10.64	minutes
Recommended T_c =	5.00	5.00	minutes
Time of Concentration Selected by User, T_c =	**5.00**	**5.00**	**minutes**
Design Rainfall Intensity, I =	4.58	8.85	inch/hr
Calculated Local Peak Flow, Q_p =	1.11	2.29	cfs
Total Design Peak Flow, Q =	**1.40**	**3.26**	**cfs**

NOTE: For the MINOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

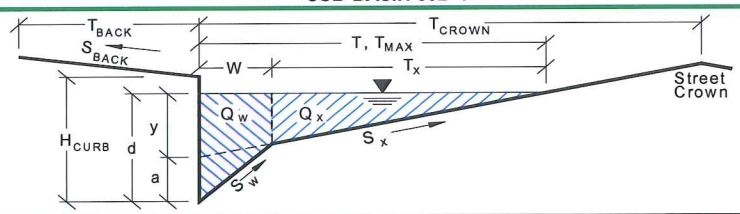
NOTE: For the MAJOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

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

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

Project: Central Park Boulevard

Inlet ID: SUB-BASIN 50B-4



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} =	0.0200	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} =	45.0	ft
Gutter Depression	a =	2.00	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 =	0.0250	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0150	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	12.0	18.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	6.00	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 =	0.1033	0.1033	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	2.88	4.32	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 =	10.0	16.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.522	0.350	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	4.0	14.1	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	4.4	7.6	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 =**	**8.4**	**21.7**	**cfs**
Flow Velocity Within the Gutter Section	V =	7.3	9.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	3.0	4.7	

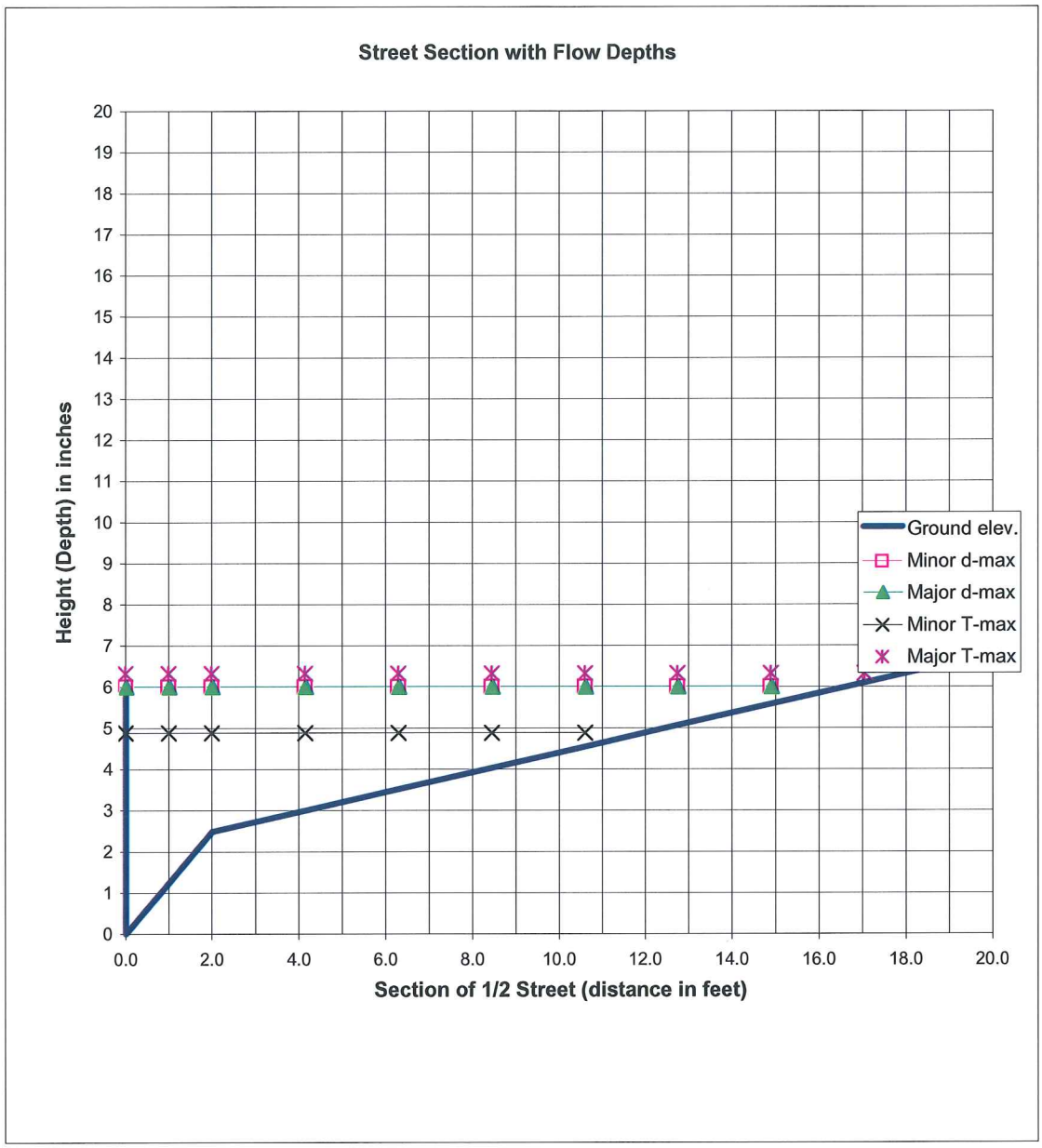
Maximum Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	16.7	16.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	14.7	14.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.378	0.378	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	11.2	11.2	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	11.2	11.2	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	6.8	6.8	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**18.0**	**18.0**	**cfs**
Flow Velocity Within the Gutter Section	V =	8.6	8.6	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	4.3	4.3	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	0.86	0.86	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**15.5**	**15.5**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.76	5.76	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} =**	**8.4**	**15.5**	**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'

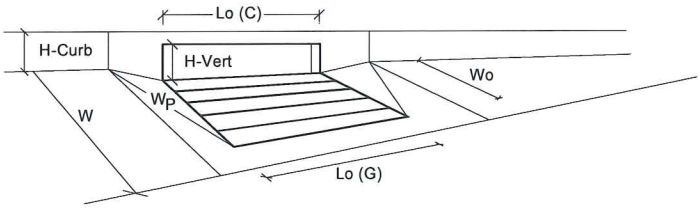


$$Q_x = \frac{0.56}{n} S_x^{5/3} S_L^{1/2} T_x^{8/3} \qquad E_o = \frac{1}{1 + \dfrac{S_w / S_x}{\left[1 + \dfrac{S_w / S_x}{(T/W) - 1}\right]^{8/3} - 1}}$$

$$Q = \frac{Q_x}{1 - E_o}; \; Q_w = Q - Q_x$$

INLET ON A CONTINUOUS GRADE

Project: Central Park Boulevard
Inlet ID: SUB-BASIN 50B-4



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	

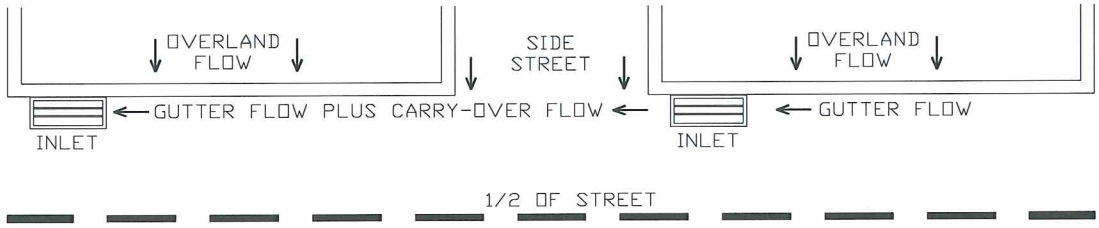
Street Hydraulics: OK - Q < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	**Q_o =**	**1.40**	**3.26**	**cfs**
Water Spread Width	T =	4.0	7.4	ft
Water Depth at Flowline (outside of local depression)	d =	3.0	3.8	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.962	0.758	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.05	0.79	cfs
Discharge within the Gutter Section W	Q_w =	1.35	2.47	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.32	0.72	sq ft
Street Flow Velocity	V_s =	4.32	4.55	fps
Water Depth for Design Condition	d_{LOCAL} =	6.0	6.8	inches

Curb or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.2205	0.1780	ft/ft
Required Length L_T to Have 100% Interception	L_T =	7.03	11.41	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 =	1.36	2.41	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 =**	**1.30**	**2.23**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.10**	**1.03**	**cfs**

Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.30**	**2.23**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.10**	**1.02**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**92.9**	**68.6**	**%**

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

Central Park Boulevard
SUB-BASIN 50B-5
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 =			cfs

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

Subcatchment Area =	0.20	Acres
Percent Imperviousness =	100.00	%
NRCS Soil Type =	C	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 =	5	100	years
Return Period One-Hour Precipitation, P_1 =	1.35	2.61	inches
C_1 =	28.5	28.5	
C_2 =	10.0	10.0	
C_3 =	0.786	0.786	
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 =	0.900	0.950	
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 =	0.896	0.956	
Calculated 5-yr. Runoff Coefficient, C5 =	0.896	0.896	
Overland Flow Velocity, V_O =	0.06	0.08	fps
Gutter Flow Velocity, V_G =	2.62	2.62	fps
Overland Flow Time, t_O =	0.29	0.22	minutes
Gutter Flow Time, t_G =	0.73	0.73	minutes
Calculated Time of Concentration, T_c =	1.02	0.95	minutes
Time of Concentration by Regional Formula, T_c =	10.64	10.64	minutes
Recommended T_c =	5.00	5.00	minutes
Time of Concentration Selected by User, T_c =	**5.00**	**5.00**	**minutes**
Design Rainfall Intensity, I =	4.58	8.85	inch/hr
Calculated Local Peak Flow, Q_p =	0.82	1.69	cfs
Total Design Peak Flow, Q =	**0.82**	**1.69**	**cfs**

NOTE: For the MINOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

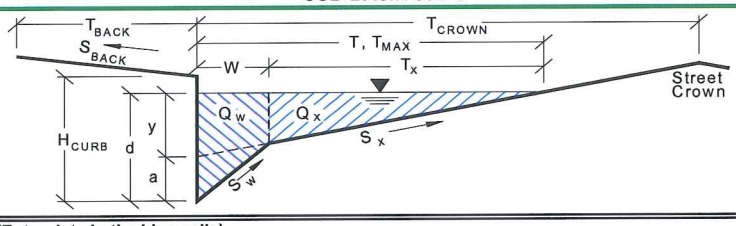
NOTE: For the MAJOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

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

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

Project: Central Park Boulevard

Inlet ID: SUB-BASIN 50B-5



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} =	0.0200	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} =	36.0	ft
Gutter Depression	a =	0.00	inches
Gutter Width	W =	3.00	ft
Street Transverse Slope	S_X =	0.0343	ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0333	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0150	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	4.0	8.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	6.00	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 =	0.0343	0.0343	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	1.65	3.29	inches
Water Depth with a Gutter Depression	d =	1.65	3.29	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	1.0	5.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.975	0.714	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.0	1.8	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	1.0	4.5	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 =**	**1.0**	**6.3**	**cfs**
Flow Velocity Within the Gutter Section	V =	8.5	15.2	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	1.2	4.2	

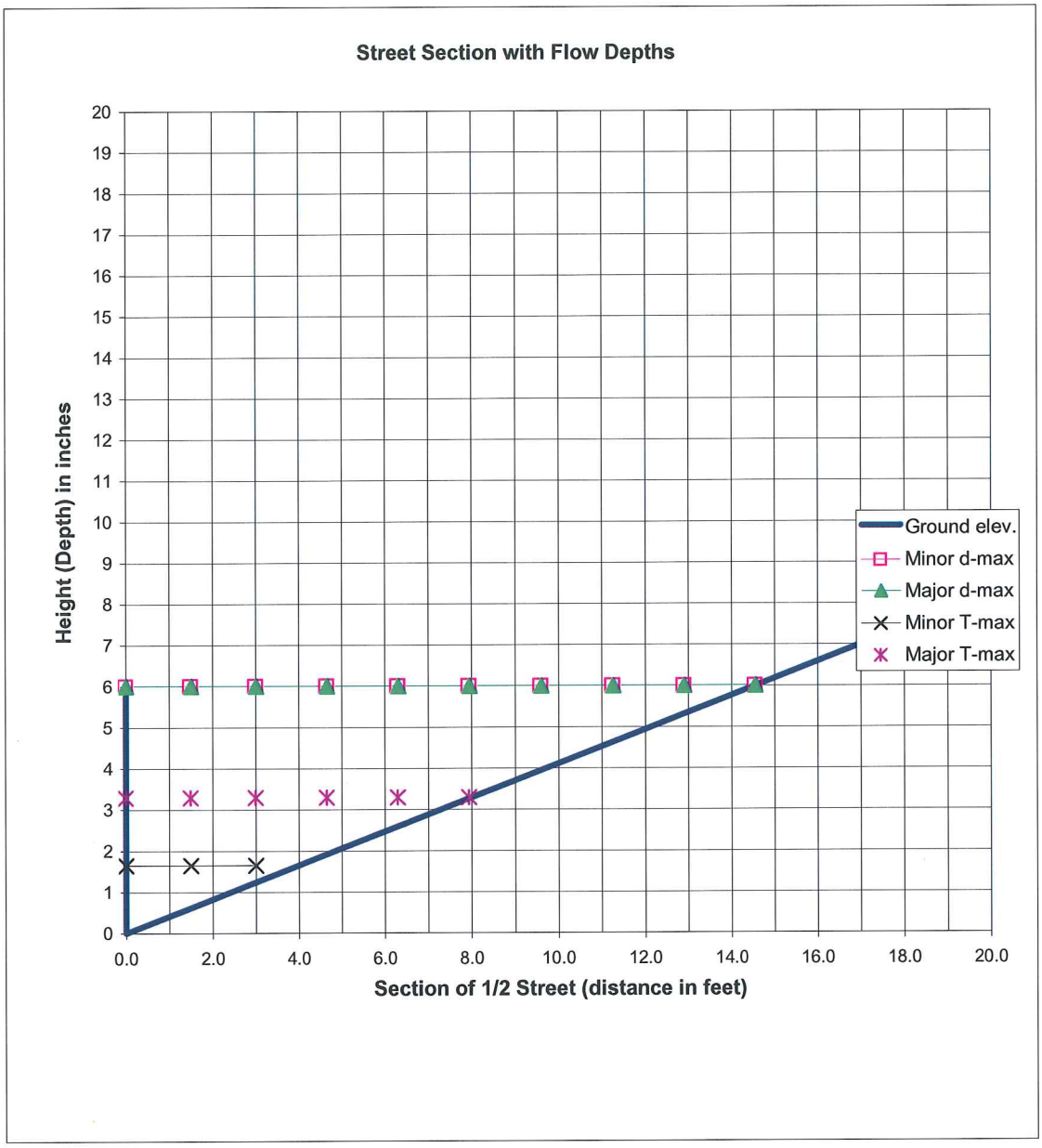
Maximum Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	14.6	14.6	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	11.6	11.6	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.459	0.459	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	16.9	16.9	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	16.9	16.9	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	14.4	14.4	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**31.3**	**31.3**	**cfs**
Flow Velocity Within the Gutter Section	V =	24.0	24.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	12.0	12.0	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d ≥ 6") Storm	R =	0.68	0.68	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**21.4**	**21.4**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.21	5.21	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} =**	**1.0**	**6.3**	**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'



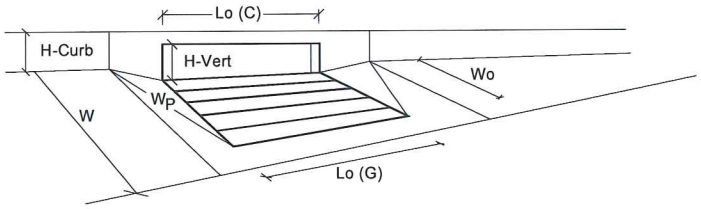
$$Q_x = \frac{0.56}{n} S_x^{5/3} S_L^{1/2} T_x^{8/3}$$

$$E_o = \frac{1}{1 + \dfrac{S_w / S_x}{\left[1 + \dfrac{S_w / S_x}{(T/W) - 1}\right]^{8/3} - 1}}$$

$$Q = \frac{Q_x}{1 - E_o}; \; Q_w = Q - Q_x$$

INLET ON A CONTINUOUS GRADE

Project: Central Park Boulevard
Inlet ID: SUB-BASIN 50B-5



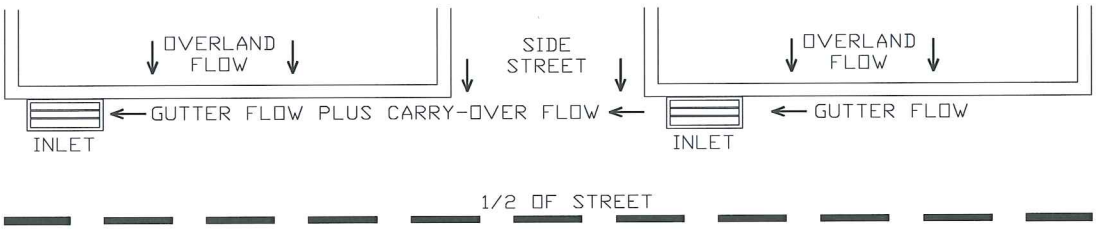
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Directional Cast Vane Grate		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	0.5	0.5	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	2.00	2.00	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 =	**0.82**	**1.69**	**cfs**
Water Spread Width	T =	3.7	4.9	ft
Water Depth at Flowline (outside of local depression)	d =	1.5	2.0	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 =	0.987	0.921	
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 =	0.81	1.56	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.24	0.41	sq ft
Street Flow Velocity	V_s =	3.46	4.14	fps
Water Depth for Design Condition	d_{LOCAL} =	2.0	2.5	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	2.00	2.00	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	0.987	0.921	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =	5.96	5.96	fps
Interception Rate of Frontal Flow	R_f =	1.00	1.00	
Interception Rate of Side Flow	R_x =	0.11	0.08	
Interception Capacity	Q_i =	0.81	1.45	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 =	1.00	1.00	ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =	3.99	3.99	fps
Interception Rate of Frontal Flow	R_f =	1.00	0.99	
Interception Rate of Side Flow	R_x =	0.02	0.02	
Actual Interception Capacity	Q_a =	**0.80**	**1.42**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	Q_b =	**0.02**	**0.27**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	**0.80**	**1.42**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	**0.02**	**0.27**	**cfs**
Capture Percentage = Q_a/Q_o =	C% =	**98.0**	**84.1**	**%**

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

Central Park Boulevard

SUB-BASIN 50B-6

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 =			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 =	0.04	Acres
Percent Imperviousness =	100.00	%
NRCS Soil Type =	C	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 =	5	100	years
Return Period One-Hour Precipitation, P_1 =	1.35	2.61	inches
C_1 =	28.5	28.5	
C_2 =	10.0	10.0	
C_3 =	0.786	0.786	
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 =	0.900	0.950	
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.02**	**0.27**	**cfs**

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

	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	0.896	0.956	
Calculated 5-yr. Runoff Coefficient, C5 =	0.896	0.896	
Overland Flow Velocity, V_O =	0.06	0.08	fps
Gutter Flow Velocity, V_G =	2.62	2.62	fps
Overland Flow Time, t_O =	0.29	0.22	minutes
Gutter Flow Time, t_G =	0.73	0.73	minutes
Calculated Time of Concentration, T_c =	1.02	0.95	minutes
Time of Concentration by Regional Formula, T_c =	10.64	10.64	minutes
Recommended T_c =	5.00	5.00	minutes
Time of Concentration Selected by User, T_c =	**5.00**	**5.00**	**minutes**
Design Rainfall Intensity, I =	4.58	8.85	inch/hr
Calculated Local Peak Flow, Q_p =	0.16	0.34	cfs
Total Design Peak Flow, Q =	**0.18**	**0.61**	**cfs**

NOTE: For the MINOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

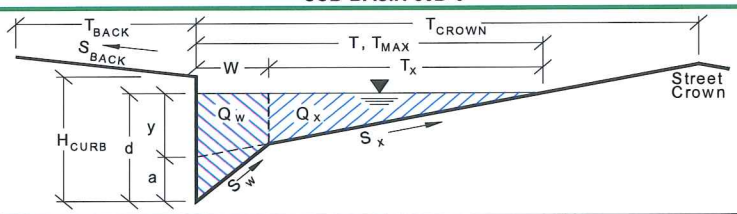
NOTE: For the MAJOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

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

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

Project: Central Park Boulevard

Inlet ID: SUB-BASIN 50B-6



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} =	0.0200	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} =	36.0	ft
Gutter Depression	a =	0.00	inches
Gutter Width	W =	3.00	ft
Street Transverse Slope	S_X =	0.0333	ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0333	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0150	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	4.0	8.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	6.00	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 =	0.0333	0.0333	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	1.60	3.20	inches
Water Depth with a Gutter Depression	d =	1.60	3.20	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	1.0	5.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.975	0.714	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.0	1.7	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	0.9	4.3	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 =**	**0.9**	**6.0**	**cfs**
Flow Velocity Within the Gutter Section	V =	8.3	14.9	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	1.1	4.0	

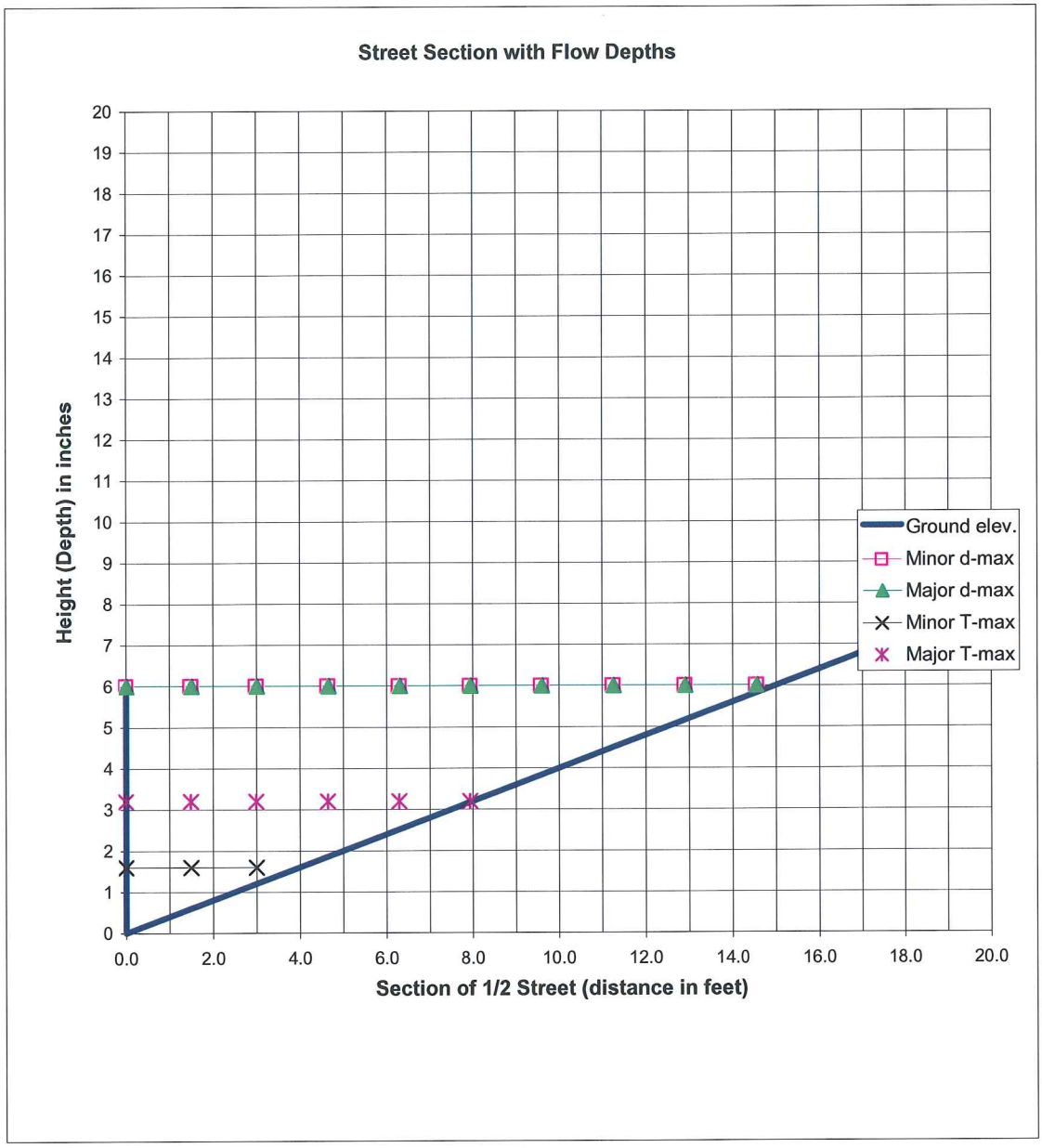
Maximum Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	15.0	15.0	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	12.0	12.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.448	0.448	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	17.8	17.8	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	17.8	17.8	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	14.4	14.4	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**32.2**	**32.2**	**cfs**
Flow Velocity Within the Gutter Section	V =	24.1	24.1	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	12.0	12.0	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d ≥ 6") Storm	R =	0.68	0.68	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**22.1**	**22.1**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.21	5.21	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} =**	**0.9**	**6.0**	**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'

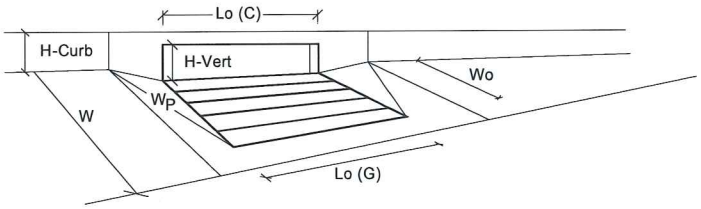


$$Q_x = \frac{0.56}{n} S_x^{5/3} S_L^{1/2} T_x^{8/3} \qquad E_o = \frac{1}{1 + \dfrac{S_w / S_x}{\left[1 + \dfrac{S_w / S_x}{(T/W) - 1}\right]^{8/3} - 1}}$$

$$Q = \frac{Q_x}{1 - E_o}; \; Q_w = Q - Q_x$$

INLET ON A CONTINUOUS GRADE

Project: Central Park Boulevard
Inlet ID: SUB-BASIN 50B-6



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 =	2.00	2.00	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 =**	**0.18**	**0.61**	**cfs**
Water Spread Width	T =	2.2	3.4	ft
Water Depth at Flowline (outside of local depression)	d =	0.9	1.4	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	0.997	
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 =	0.19	0.61	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.08	0.19	sq ft
Street Flow Velocity	V_s =	2.34	3.18	fps
Water Depth for Design Condition	d_{LOCAL} =	1.9	2.4	inches

Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	2.00	2.00	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	1.000	0.997	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =	5.96	5.96	fps
Interception Rate of Frontal Flow	R_f =	1.00	1.00	
Interception Rate of Side Flow	R_x =	0.19	0.12	
Interception Capacity	Q_i =	0.19	0.61	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 =	1.00	1.00	ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =	3.99	3.99	fps
Interception Rate of Frontal Flow	R_f =	1.00	1.00	
Interception Rate of Side Flow	R_x =	0.05	0.03	
Actual Interception Capacity	**Q_a =**	**0.18**	**0.61**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**0.00**	**0.00**	**cfs**

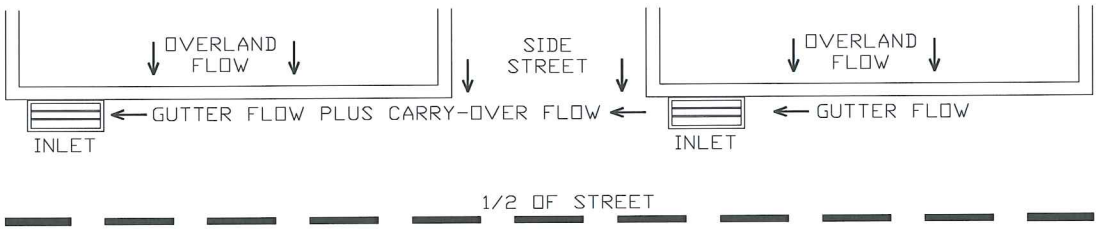
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.19**	**0.61**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.00**	**0.00**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**100.0**	**99.5**	**%**

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

Central Park Boulevard

SUB-BASIN 50B-7

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 =			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 =	0.05	Acres
Percent Imperviousness =	100.00	%
NRCS Soil Type =	C	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 =	5	100	years
Return Period One-Hour Precipitation, P_1 =	1.35	2.61	inches
C_1 =	28.5	28.5	
C_2 =	10.0	10.0	
C_3 =	0.786	0.786	
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 =	0.900	0.950	
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 =	0.896	0.956	
Calculated 5-yr. Runoff Coefficient, C5 =	0.896	0.896	
Overland Flow Velocity, V_O =	0.06	0.08	fps
Gutter Flow Velocity, V_G =	2.21	2.21	fps
Overland Flow Time, t_O =	0.29	0.22	minutes
Gutter Flow Time, t_G =	0.87	0.87	minutes
Calculated Time of Concentration, T_c =	1.15	1.08	minutes
Time of Concentration by Regional Formula, T_c =	10.64	10.64	minutes
Recommended T_c =	5.00	5.00	minutes
Time of Concentration Selected by User, T_c =	**5.00**	**5.00**	**minutes**
Design Rainfall Intensity, I =	4.58	8.85	inch/hr
Calculated Local Peak Flow, Q_p =	0.21	0.42	cfs
Total Design Peak Flow, Q =	**0.21**	**0.42**	**cfs**

NOTE: For the MINOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

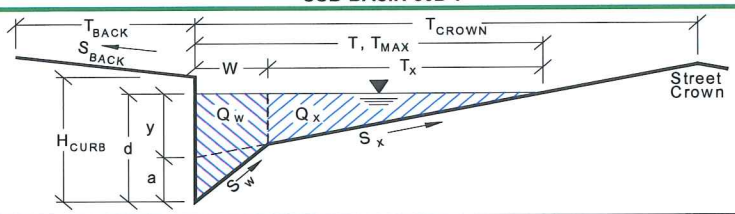
NOTE: For the MAJOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

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

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

Project: Central Park Boulevard

Inlet ID: SUB-BASIN 50B-7



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} =	0.0200	ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0130	
Height of Curb at Gutter Flow Line	H_{CURB} =	4.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	36.0	ft
Gutter Depression	a =	0.00	inches
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.0333	ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0286	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0150	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	4.0	8.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	4.00	4.00	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 =	0.0333	0.0333	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	1.60	3.20	inches
Water Depth with a Gutter Depression	d =	1.60	3.20	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	2.0	6.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.843	0.536	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.1	2.6	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	0.7	3.0	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 =**	**0.9**	**5.6**	**cfs**
Flow Velocity Within the Gutter Section	V =	3.7	6.4	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.5	1.7	

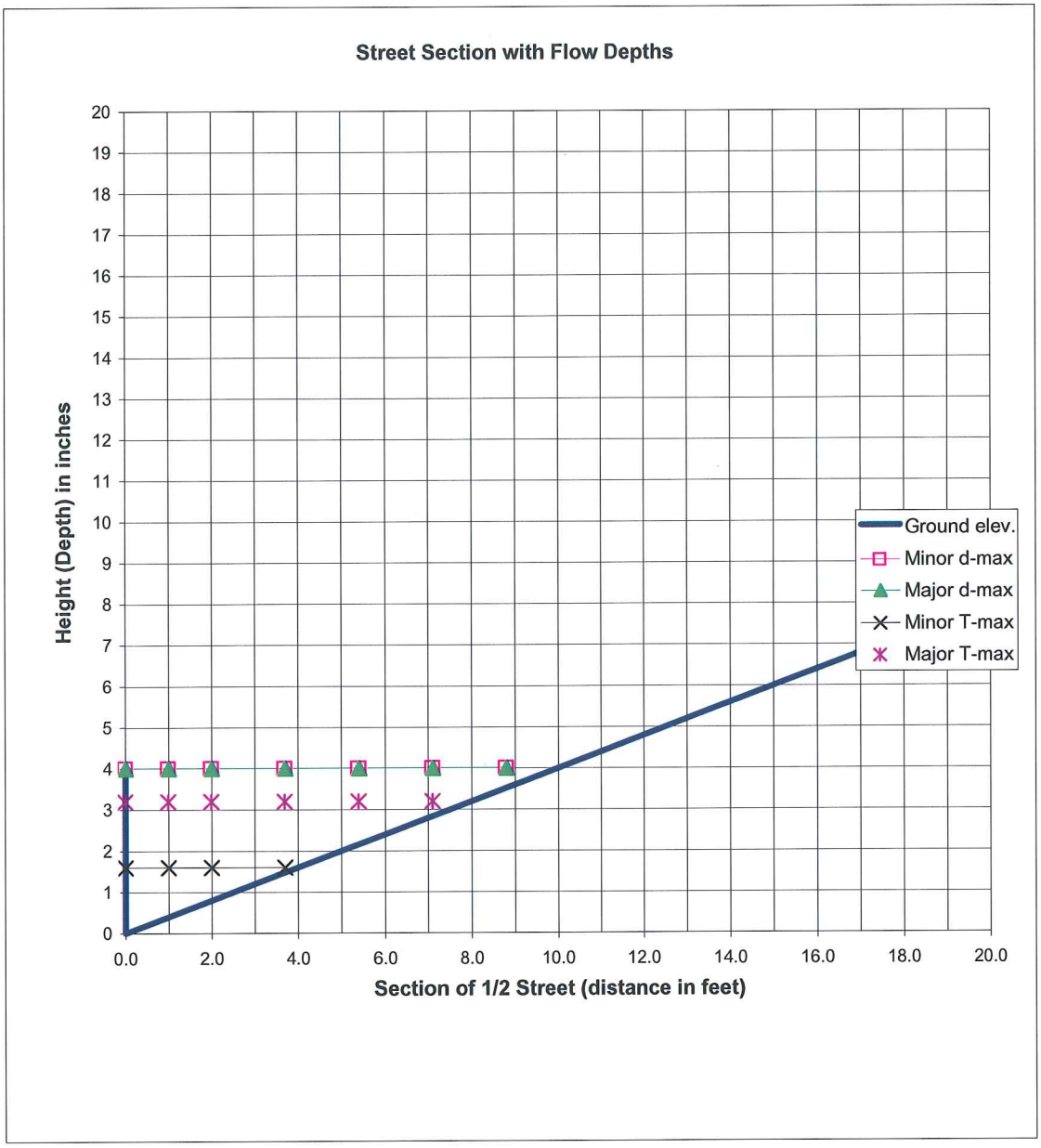
Maximum Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	10.0	10.0	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	8.0	8.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.448	0.448	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	5.6	5.6	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	5.6	5.6	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	4.5	4.5	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**10.1**	**10.1**	**cfs**
Flow Velocity Within the Gutter Section	V =	7.6	7.6	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.5	2.5	
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 =**	**10.1**	**10.1**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	4.00	4.00	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} =**	**0.9**	**5.6**	**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'

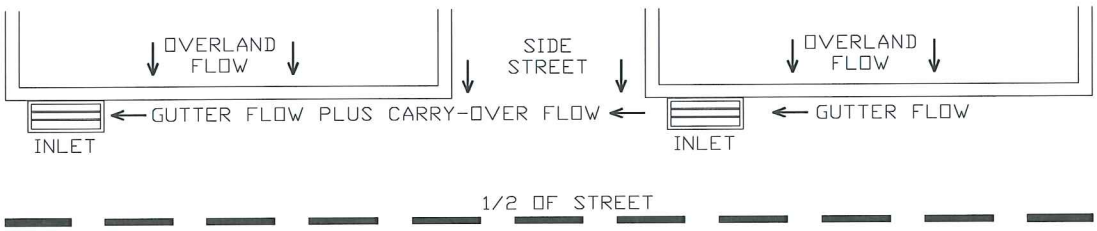


$$Q_x = \frac{0.56}{n} S_x^{5/3} S_L^{1/2} T_x^{8/3} \qquad E_o = \frac{1}{1 + \dfrac{S_w / S_x}{\left[1 + \dfrac{S_w / S_x}{(T/W) - 1}\right]^{8/3} - 1}}$$

$$Q = \frac{Q_x}{1 - E_o}; \; Q_w = Q - Q_x$$

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

Central Park Boulevard
SUB-BASIN 60A-1
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 =			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 =	0.22	Acres
Percent Imperviousness =	100.00	%
NRCS Soil Type =	C	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 =	5	100	years
Return Period One-Hour Precipitation, P_1 =	1.35	2.61	inches
C_1 =	28.5	28.5	
C_2 =	10.0	10.0	
C_3 =	0.786	0.786	
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 =	0.900	0.950	
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.03**	**0.85**	**cfs**

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

	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	0.896	0.956	
Calculated 5-yr. Runoff Coefficient, C5 =	0.896	0.896	
Overland Flow Velocity, V_O =	0.06	0.08	fps
Gutter Flow Velocity, V_G =	2.21	2.21	fps
Overland Flow Time, t_O =	0.29	0.22	minutes
Gutter Flow Time, t_G =	0.87	0.87	minutes
Calculated Time of Concentration, T_c =	1.15	1.08	minutes
Time of Concentration by Regional Formula, T_c =	10.64	10.64	minutes
Recommended T_c =	5.00	5.00	minutes
Time of Concentration Selected by User, T_c =	**5.00**	**5.00**	**minutes**
Design Rainfall Intensity, I =	4.58	8.85	inch/hr
Calculated Local Peak Flow, Q_p =	0.90	1.86	cfs
Total Design Peak Flow, Q =	**0.93**	**2.71**	**cfs**

NOTE: For the MINOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

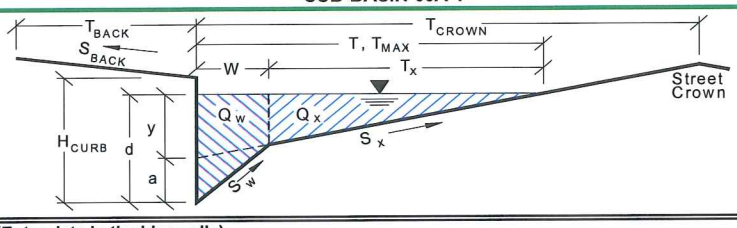
NOTE: For the MAJOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

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

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

Project: Central Park Boulevard

Inlet ID: SUB-BASIN 60A-1



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} =	0.0200	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} =	24.0	ft
Gutter Depression	a =	2.00	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 =	0.0185	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0150	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	8.0	12.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	6.00	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 =	0.1033	0.1033	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	1.92	2.88	inches
Water Depth with a Gutter Depression	d =	3.92	4.88	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	6.0	10.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.722	0.522	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.9	3.5	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	2.3	3.8	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 =**	**3.2**	**7.3**	**cfs**
Flow Velocity Within the Gutter Section	V =	5.2	6.2	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	1.7	2.5	

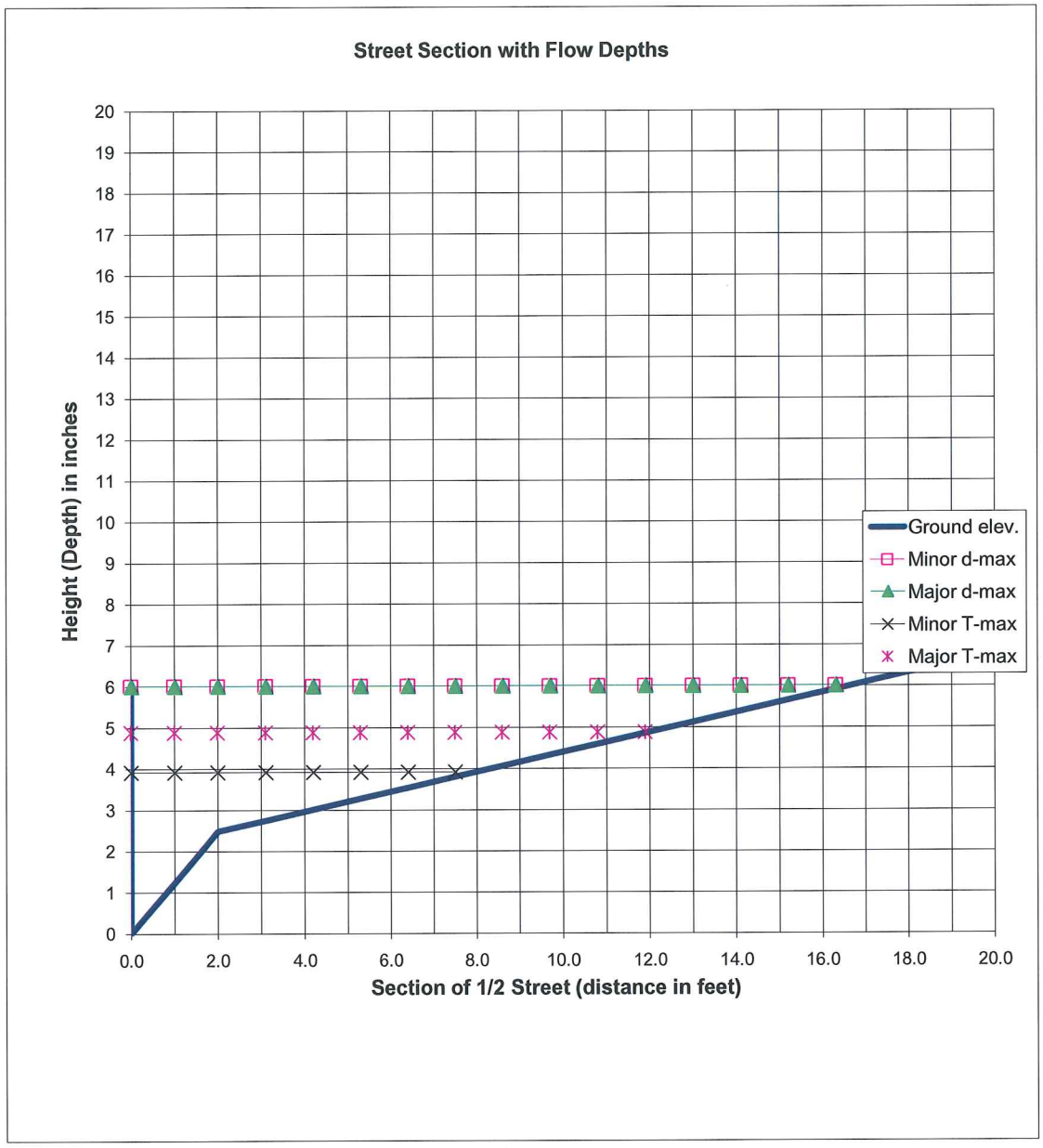
Maximum Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	16.7	16.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	14.7	14.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.378	0.378	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	9.6	9.6	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	9.6	9.6	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	5.9	5.9	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**15.5**	**15.5**	**cfs**
Flow Velocity Within the Gutter Section	V =	7.4	7.4	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	3.7	3.7	
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 =**	**15.5**	**15.5**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	6.00	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} =**	**3.2**	**7.3**	**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'



$$Q_x = \frac{0.56}{n} S_x^{5/3} S_L^{1/2} T_x^{8/3} \qquad E_o = \frac{1}{1 + \dfrac{S_w / S_x}{\left[1 + \dfrac{S_w / S_x}{(T/W) - 1}\right]^{8/3} - 1}}$$

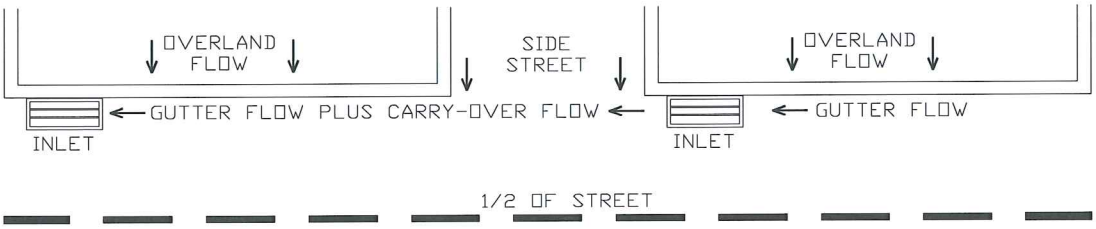
$$Q = \frac{Q_x}{1 - E_o}; \; Q_w = Q - Q_x$$

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

Central Park Boulevard

SUB-BASIN 61A-1

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 =			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 =	0.26	Acres
Percent Imperviousness =	100.00	%
NRCS Soil Type =	C	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 =	5	100	years
Return Period One-Hour Precipitation, P_1 =	1.35	2.61	inches
C_1 =	28.5	28.5	
C_2 =	10.0	10.0	
C_3 =	0.786	0.786	
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 =	0.900	0.950	
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 =	0.896	0.956	
Calculated 5-yr. Runoff Coefficient, C5 =	0.896	0.896	
Overland Flow Velocity, V_O =	0.06	0.08	fps
Gutter Flow Velocity, V_G =	2.21	2.21	fps
Overland Flow Time, t_O =	0.29	0.22	minutes
Gutter Flow Time, t_G =	0.87	0.87	minutes
Calculated Time of Concentration, T_c =	1.15	1.08	minutes
Time of Concentration by Regional Formula, T_c =	10.64	10.64	minutes
Recommended T_c =	5.00	5.00	minutes
Time of Concentration Selected by User, T_c =	**5.00**	**5.00**	**minutes**
Design Rainfall Intensity, I =	4.58	8.85	inch/hr
Calculated Local Peak Flow, Q_p =	1.07	2.20	cfs
Total Design Peak Flow, Q =	**1.07**	**2.20**	**cfs**

NOTE: For the MINOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

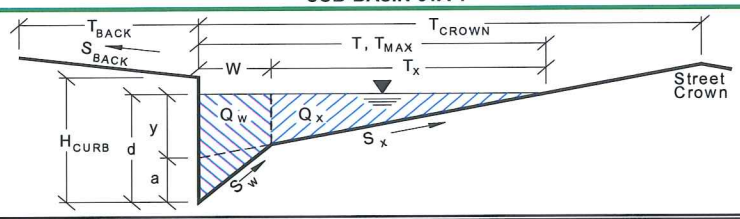
NOTE: For the MAJOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

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

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

Project: Central Park Boulevard

Inlet ID: SUB-BASIN 61A-1



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} =	0.0200	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} =	45.0	ft
Gutter Depression	a =	0.00	inches
Gutter Width	W =	3.00	ft
Street Transverse Slope	S_X =	0.0200	ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0119	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0150	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	12.0	18.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	6.00	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	4.32	inches
Water Depth with a Gutter Depression	d =	2.88	4.32	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	9.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.536	0.385	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	2.1	8.2	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	2.4	5.1	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 =**	**4.5**	**13.4**	**cfs**
Flow Velocity Within the Gutter Section	V =	8.7	11.7	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.1	4.2	

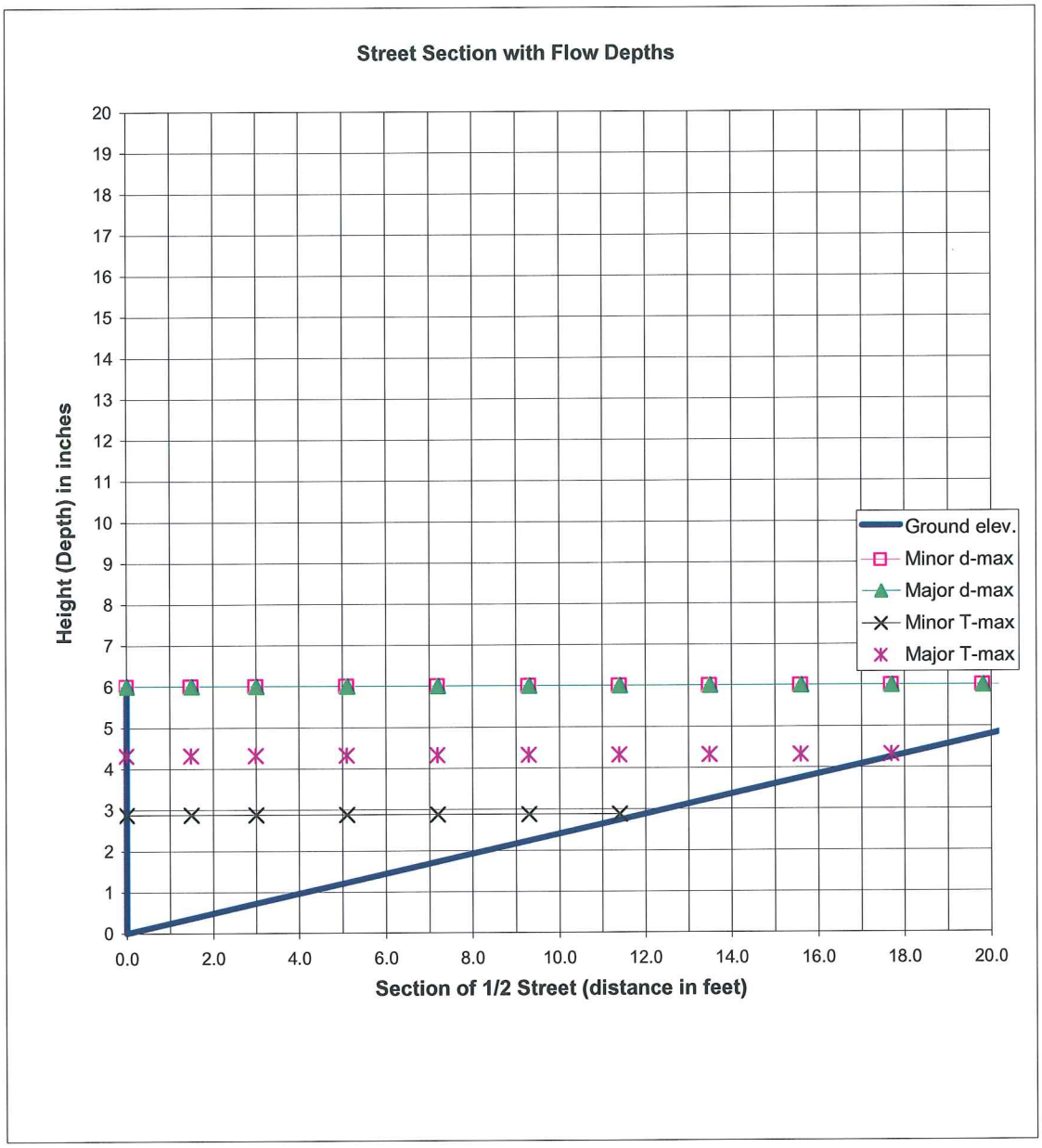
Maximum Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	25.0	25.0	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	22.0	22.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.289	0.289	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	22.8	22.8	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	22.8	22.8	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	9.3	9.3	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**32.1**	**32.1**	**cfs**
Flow Velocity Within the Gutter Section	V =	14.8	14.8	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	7.4	7.4	
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 =**	**32.1**	**32.1**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	6.00	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} =**	**4.5**	**13.4**	**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'

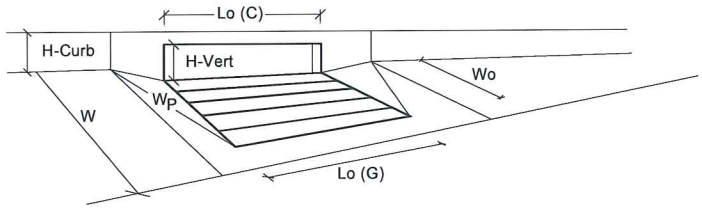


$$Q_x = \frac{0.56}{n} S_x^{5/3} S_L^{1/2} T_x^{8/3} \qquad E_o = \frac{1}{1 + \dfrac{S_w / S_x}{\left[1 + \dfrac{S_w / S_x}{(T/W) - 1}\right]^{8/3} - 1}}$$

$$Q = \frac{Q_x}{1 - E_o}; \; Q_w = Q - Q_x$$

INLET ON A CONTINUOUS GRADE

Project: Central Park Boulevard
Inlet ID: SUB-BASIN 61A-1



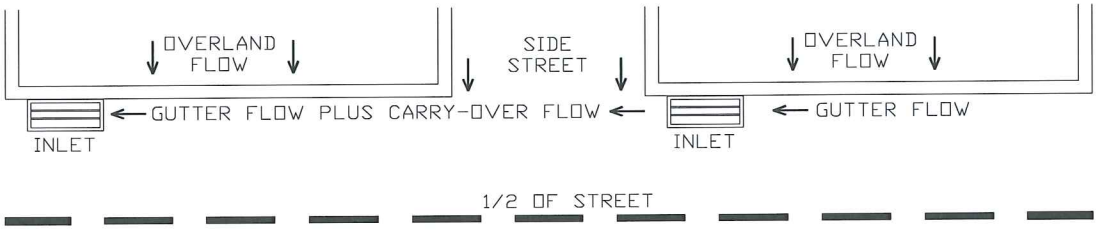
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Directional Cast Vane Grate		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	0.5	0.5	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	2.00	2.00	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**	**2.20**	**cfs**
Water Spread Width	T =	7.0	9.2	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 =	0.776	0.653	
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 =	0.83	1.44	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.49	0.84	sq ft
Street Flow Velocity	V_s =	2.19	2.63	fps
Water Depth for Design Condition	d_{LOCAL} =	2.2	2.7	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	2.00	2.00	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	0.776	0.653	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =	5.96	5.96	fps
Interception Rate of Frontal Flow	R_f =	1.00	1.00	
Interception Rate of Side Flow	R_x =	0.14	0.10	
Interception Capacity	Q_i =	0.67	0.99	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 =	1.00	1.00	ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =	3.99	3.99	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**	**0.95**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	Q_b =	**0.42**	**1.25**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	**0.65**	**0.95**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	**0.42**	**1.25**	**cfs**
Capture Percentage = Q_a/Q_o =	C% =	**60.9**	**43.2**	**%**

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

Central Park Boulevard

SUB-BASIN 61A-2

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 =			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 =	0.25	Acres
Percent Imperviousness =	100.00	%
NRCS Soil Type =	C	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 =	5	100	years
Return Period One-Hour Precipitation, P_1 =	1.35	2.61	inches
C_1 =	28.5	28.5	
C_2 =	10.0	10.0	
C_3 =	0.786	0.786	
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 =	0.900	0.950	
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 =	0.896	0.956	
Calculated 5-yr. Runoff Coefficient, C5 =	0.896	0.896	
Overland Flow Velocity, V_O =	0.06	0.08	fps
Gutter Flow Velocity, V_G =	2.21	2.21	fps
Overland Flow Time, t_O =	0.29	0.22	minutes
Gutter Flow Time, t_G =	0.87	0.87	minutes
Calculated Time of Concentration, T_c =	1.15	1.08	minutes
Time of Concentration by Regional Formula, T_c =	10.64	10.64	minutes
Recommended T_c =	5.00	5.00	minutes
Time of Concentration Selected by User, T_c =	**5.00**	**5.00**	**minutes**
Design Rainfall Intensity, I =	4.58	8.85	inch/hr
Calculated Local Peak Flow, Q_p =	1.03	2.12	cfs
Total Design Peak Flow, Q =	**1.03**	**2.12**	**cfs**

NOTE: For the MINOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

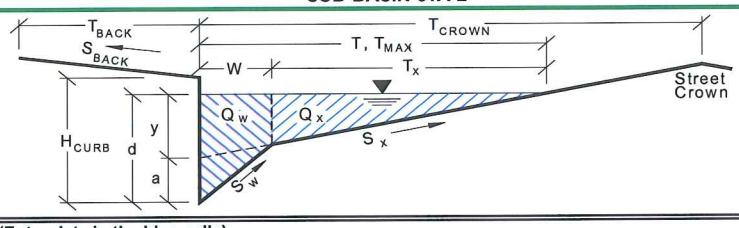
NOTE: For the MAJOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

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

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

Project: Central Park Boulevard

Inlet ID: SUB-BASIN 61A-2



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} =	0.0200	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} =	45.0	ft
Gutter Depression	a =	0.00	inches
Gutter Width	W =	3.00	ft
Street Transverse Slope	S_X =	0.0200	ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0122	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0150	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	12.0	18.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	6.00	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	4.32	inches
Water Depth with a Gutter Depression	d =	2.88	4.32	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	9.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.536	0.385	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	2.1	8.3	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	2.5	5.2	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 =**	**4.6**	**13.5**	**cfs**
Flow Velocity Within the Gutter Section	V =	8.8	11.8	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.1	4.3	

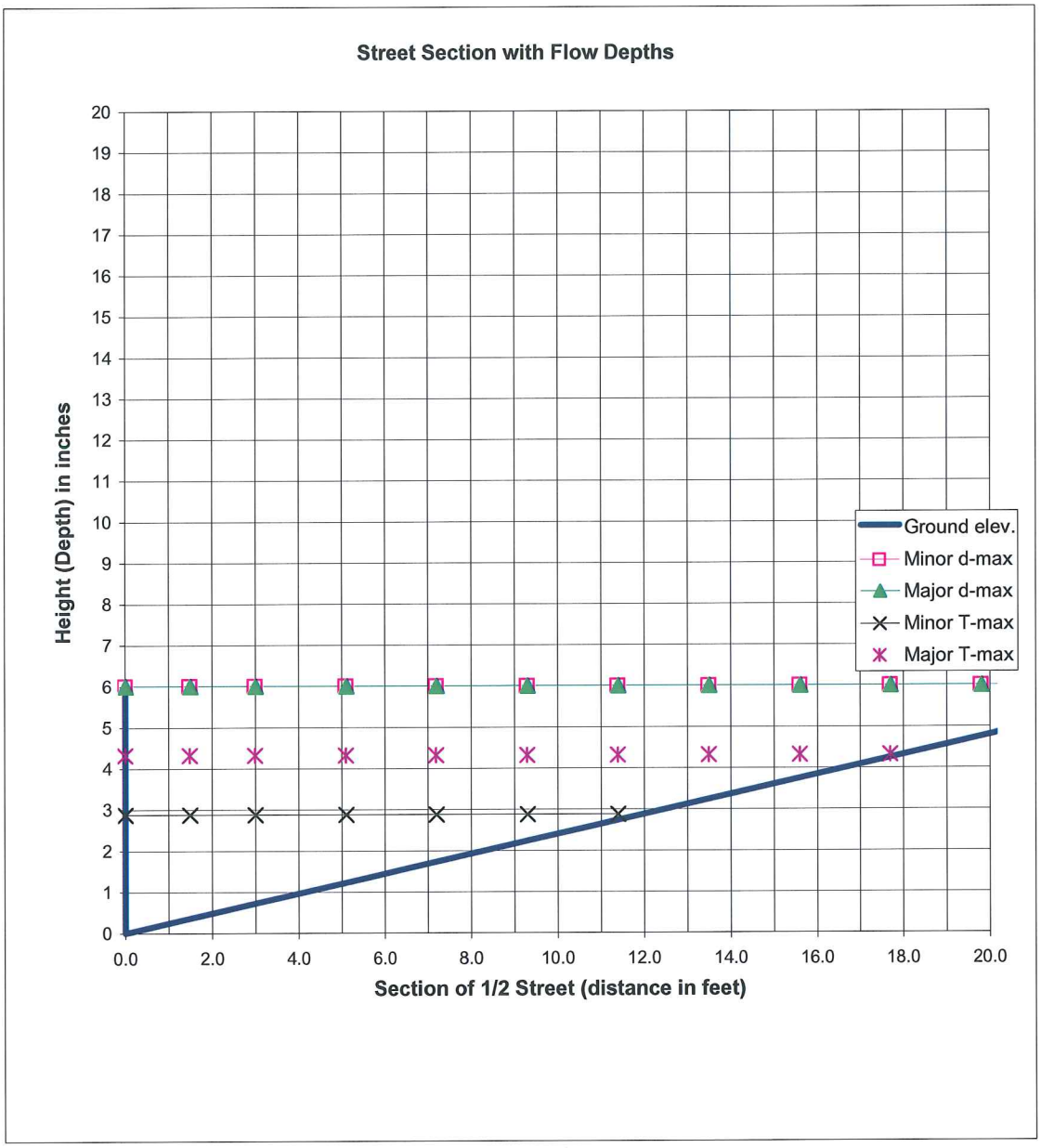
Maximum Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	25.0	25.0	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	22.0	22.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.289	0.289	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	23.1	23.1	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	23.1	23.1	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	9.4	9.4	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**32.5**	**32.5**	**cfs**
Flow Velocity Within the Gutter Section	V =	15.0	15.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	7.5	7.5	
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 =**	**32.5**	**32.5**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	6.00	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} =**	**4.6**	**13.5**	**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'

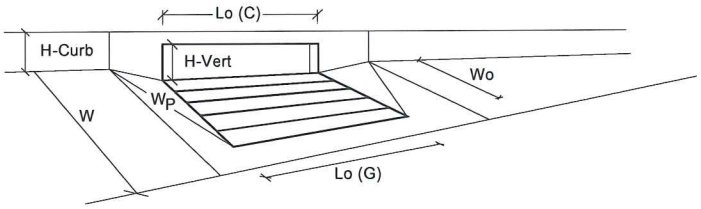


$$Q_x = \frac{0.56}{n} S_x^{5/3} S_L^{1/2} T_x^{8/3} \qquad E_o = \frac{1}{1 + \dfrac{S_w / S_x}{\left[1 + \dfrac{S_w / S_x}{(T/W) - 1}\right]^{8/3} - 1}}$$

$$Q = \frac{Q_x}{1 - E_o}; \; Q_w = Q - Q_x$$

INLET ON A CONTINUOUS GRADE

Project: Central Park Boulevard
Inlet ID: SUB-BASIN 61A-2



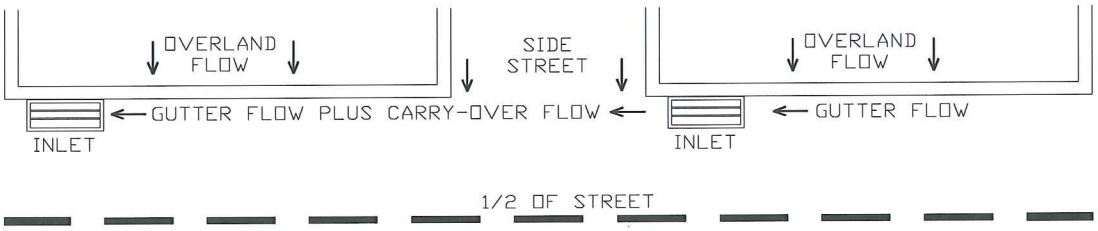
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Directional Cast Vane Grate		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	0.5	0.5	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	2.00	2.00	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**	**2.12**	**cfs**
Water Spread Width	T =	6.9	9.0	ft
Water Depth at Flowline (outside of local depression)	d =	1.6	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 =	0.785	0.662	
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 =	0.81	1.40	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.47	0.81	sq ft
Street Flow Velocity	V_s =	2.19	2.63	fps
Water Depth for Design Condition	d_{LOCAL} =	2.1	2.7	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	2.00	2.00	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	0.785	0.662	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =	5.96	5.96	fps
Interception Rate of Frontal Flow	R_f =	1.00	1.00	
Interception Rate of Side Flow	R_x =	0.14	0.10	
Interception Capacity	Q_i =	0.66	0.98	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 =	1.00	1.00	ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =	3.99	3.99	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 =	**0.64**	**0.94**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	Q_b =	**0.39**	**1.18**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	**0.64**	**0.94**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	**0.39**	**1.18**	**cfs**
Capture Percentage = Q_a/Q_o =	C% =	**62.3**	**44.3**	**%**

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

Central Park Boulevard

SUB-BASIN 61A-3

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 =			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 =	0.28	Acres
Percent Imperviousness =	100.00	%
NRCS Soil Type =	C	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 =	5	100	years
Return Period One-Hour Precipitation, P_1 =	1.35	2.61	inches
C_1 =	28.5	28.5	
C_2 =	10.0	10.0	
C_3 =	0.786	0.786	
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 =	0.900	0.950	
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.42**	**1.25**	**cfs**

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

	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	0.896	0.956	
Calculated 5-yr. Runoff Coefficient, C5 =	0.896	0.896	
Overland Flow Velocity, V_O =	0.06	0.08	fps
Gutter Flow Velocity, V_G =	2.21	2.21	fps
Overland Flow Time, t_O =	0.29	0.22	minutes
Gutter Flow Time, t_G =	0.87	0.87	minutes
Calculated Time of Concentration, T_c =	1.15	1.08	minutes
Time of Concentration by Regional Formula, T_c =	10.64	10.64	minutes
Recommended T_c =	5.00	5.00	minutes
Time of Concentration Selected by User, T_c =	**5.00**	**5.00**	**minutes**
Design Rainfall Intensity, I =	4.58	8.85	inch/hr
Calculated Local Peak Flow, Q_p =	1.15	2.37	cfs
Total Design Peak Flow, Q =	**1.57**	**3.62**	**cfs**

NOTE: For the MINOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

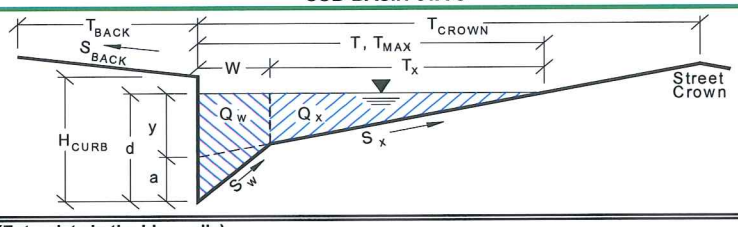
NOTE: For the MAJOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

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

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

Project: Central Park Boulevard

Inlet ID: SUB-BASIN 61A-3



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} =	0.0200	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} =	45.0	ft
Gutter Depression	a =	2.00	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 =	0.0137	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0150	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	12.0	18.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	6.00	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 =	0.1033	0.1033	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	2.88	4.32	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 =	10.0	16.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.522	0.350	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	3.0	10.5	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	3.3	5.6	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 =**	**6.2**	**16.1**	**cfs**
Flow Velocity Within the Gutter Section	V =	5.4	6.6	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.2	3.5	

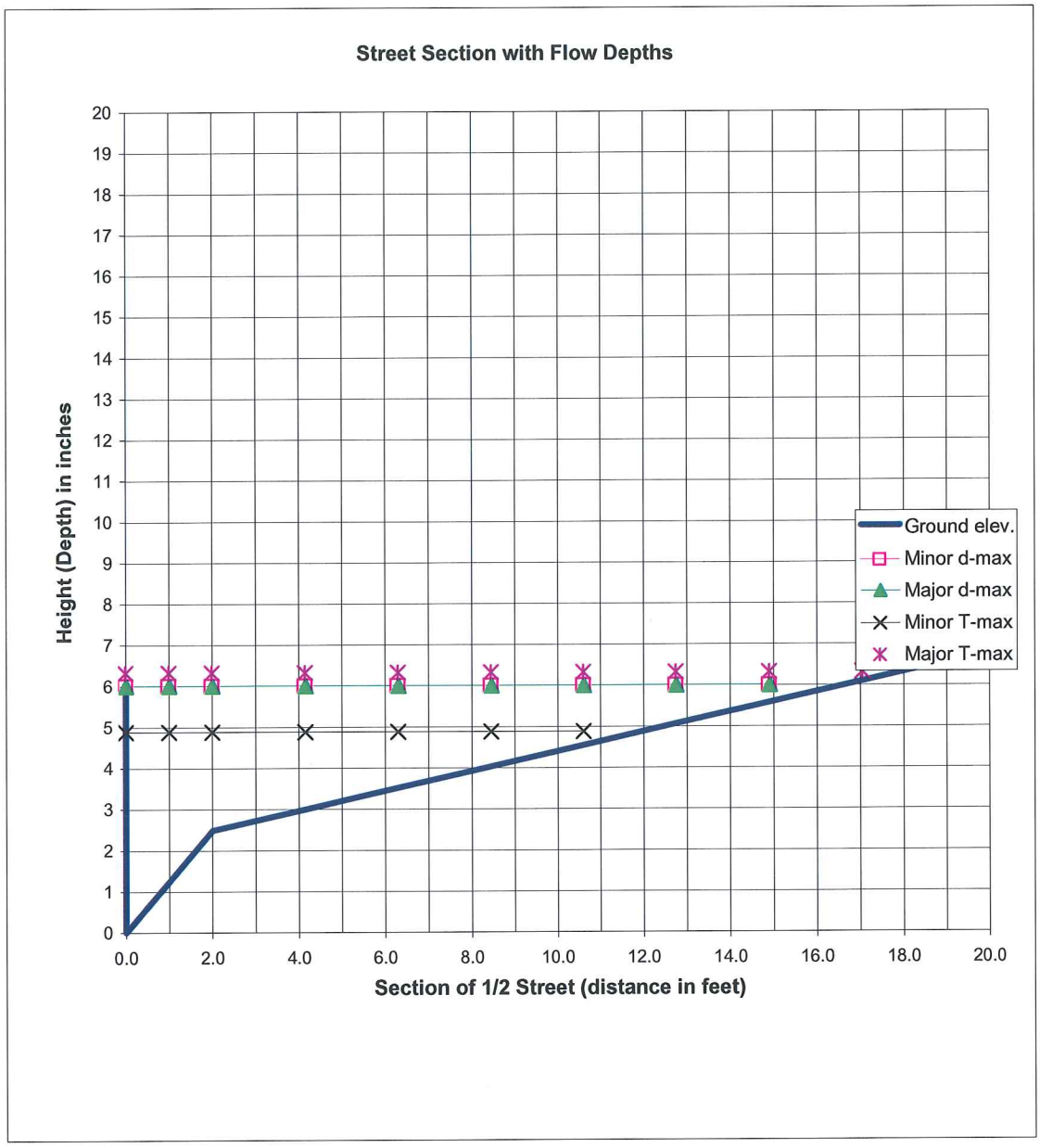
Maximum Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	16.7	16.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	14.7	14.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.378	0.378	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	8.3	8.3	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	8.3	8.3	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	5.1	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 =**	**13.4**	**13.4**	**cfs**
Flow Velocity Within the Gutter Section	V =	6.4	6.4	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	3.2	3.2	
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 =**	**13.4**	**13.4**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	6.00	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} =**	**6.2**	**13.4**	**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'



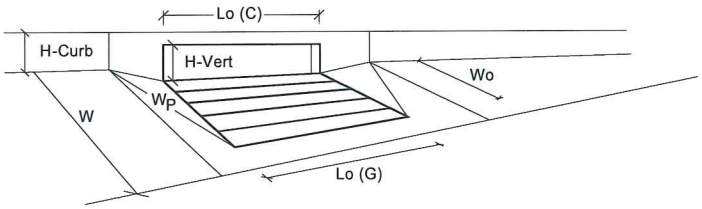
$$Q_x = \frac{0.56}{n} S_x^{5/3} S_L^{1/2} T_x^{8/3}$$

$$E_o = \frac{1}{1 + \dfrac{S_w / S_x}{\left[1 + \dfrac{S_w / S_x}{(T/W) - 1}\right]^{8/3} - 1}}$$

$$Q = \frac{Q_x}{1 - E_o}; \; Q_w = Q - Q_x$$

INLET ON A CONTINUOUS GRADE

Project: Central Park Boulevard
Inlet ID: SUB-BASIN 61A-3



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 =	**1.57**	**3.62**	**cfs**
Water Spread Width	T =	5.6	9.3	ft
Water Depth at Flowline (outside of local depression)	d =	3.4	4.2	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.872	0.651	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.20	1.26	cfs
Discharge within the Gutter Section W	Q_w =	1.37	2.36	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.48	1.02	sq ft
Street Flow Velocity	V_s =	3.25	3.55	fps
Water Depth for Design Condition	d_{LOCAL} =	6.4	7.2	inches

Curb or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.2018	0.1557	ft/ft
Required Length L_T to Have 100% Interception	L_T =	6.50	10.79	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 =	1.55	2.78	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 =	**1.51**	**2.58**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	Q_b =	**0.06**	**1.04**	**cfs**

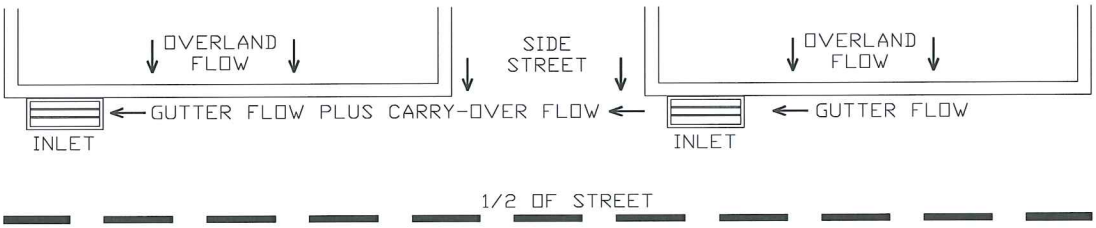
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	**1.51**	**2.58**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	**0.06**	**1.04**	**cfs**
Capture Percentage = Q_a/Q_o =	C% =	**96.0**	**71.4**	**%**

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

Central Park Boulevard

SUB-BASIN 61A-4

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 =			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 =	0.26	Acres
Percent Imperviousness =	100.00	%
NRCS Soil Type =	C	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 =	5	100	years
Return Period One-Hour Precipitation, P_1 =	1.35	2.61	inches
C_1 =	28.5	28.5	
C_2 =	10.0	10.0	
C_3 =	0.786	0.786	
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 =	0.900	0.950	
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.39**	**1.18**	**cfs**

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

	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	0.896	0.956	
Calculated 5-yr. Runoff Coefficient, C5 =	0.896	0.896	
Overland Flow Velocity, V_O =	0.06	0.08	fps
Gutter Flow Velocity, V_G =	2.21	2.21	fps
Overland Flow Time, t_O =	0.29	0.22	minutes
Gutter Flow Time, t_G =	0.87	0.87	minutes
Calculated Time of Concentration, T_c =	1.15	1.08	minutes
Time of Concentration by Regional Formula, T_c =	10.64	10.64	minutes
Recommended T_c =	5.00	5.00	minutes
Time of Concentration Selected by User, T_c =	**5.00**	**5.00**	**minutes**
Design Rainfall Intensity, I =	4.58	8.85	inch/hr
Calculated Local Peak Flow, Q_p =	1.07	2.20	cfs
Total Design Peak Flow, Q =	**1.46**	**3.38**	**cfs**

NOTE: For the MINOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

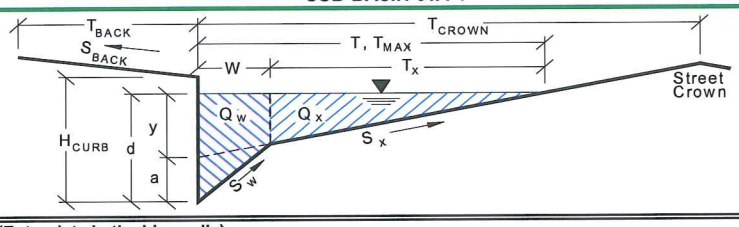
NOTE: For the MAJOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

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

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

Project: Central Park Boulevard

Inlet ID: SUB-BASIN 61A-4



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} =	0.0200	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} =	45.0	ft
Gutter Depression	a =	2.00	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 =	0.0122	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0150	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	12.0	18.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	6.00	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 =	0.1033	0.1033	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	2.88	4.32	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 =	10.0	16.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.522	0.350	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	2.8	9.9	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	3.1	5.3	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 =**	**5.9**	**15.2**	**cfs**
Flow Velocity Within the Gutter Section	V =	5.1	6.3	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.1	3.3	

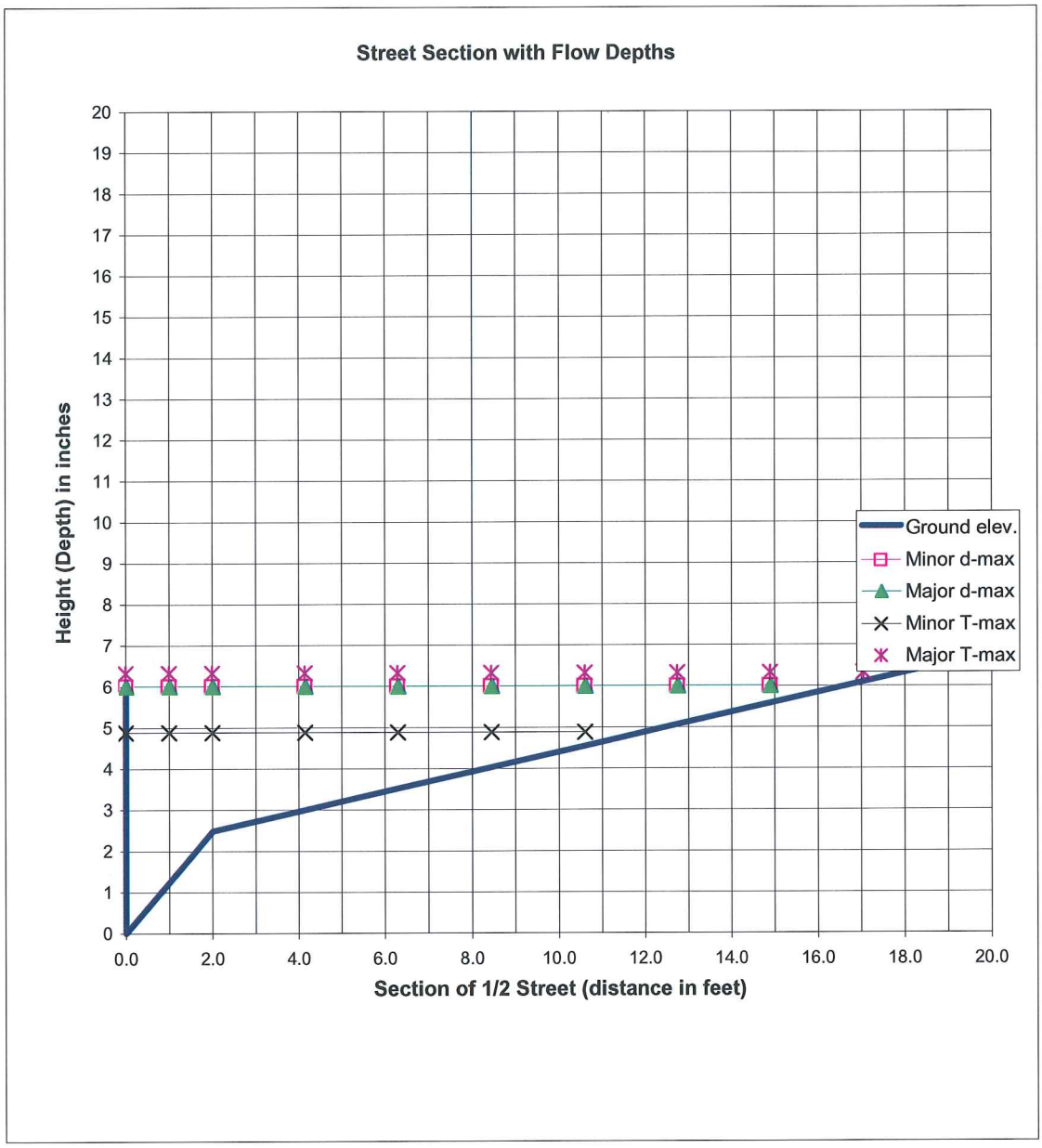
Maximum Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	16.7	16.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	14.7	14.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.378	0.378	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	7.8	7.8	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	7.8	7.8	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	4.8	4.8	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**12.6**	**12.6**	**cfs**
Flow Velocity Within the Gutter Section	V =	6.0	6.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	3.0	3.0	
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 =**	**12.6**	**12.6**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	6.00	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} =**	**5.9**	**12.6**	**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'

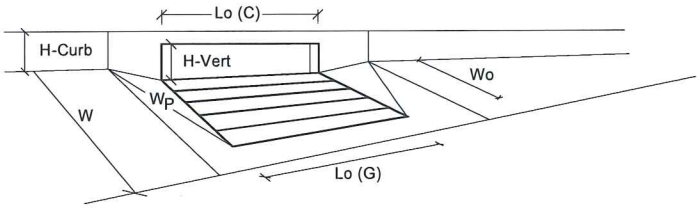


$$Q_x = \frac{0.56}{n} S_x^{5/3} S_L^{1/2} T_x^{8/3} \qquad E_o = \frac{1}{1 + \dfrac{S_w / S_x}{\left[1 + \dfrac{S_w / S_x}{(T/W) - 1}\right]^{8/3} - 1}}$$

$$Q = \frac{Q_x}{1 - E_o}; \; Q_w = Q - Q_x$$

INLET ON A CONTINUOUS GRADE

Project: Central Park Boulevard
Inlet ID: SUB-BASIN 61A-4



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 =	**1.46**	**3.38**	**cfs**
Water Spread Width	T =	5.6	9.2	ft
Water Depth at Flowline (outside of local depression)	d =	3.3	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 =	0.877	0.654	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.18	1.17	cfs
Discharge within the Gutter Section W	Q_w =	1.28	2.21	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.48	1.01	sq ft
Street Flow Velocity	V_s =	3.06	3.34	fps
Water Depth for Design Condition	d_{LOCAL} =	6.3	7.2	inches

Curb or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.2027	0.1562	ft/ft
Required Length L_T to Have 100% Interception	L_T =	6.07	10.10	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 =	1.46	2.71	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 =	**1.43**	**2.53**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	Q_b =	**0.03**	**0.85**	**cfs**

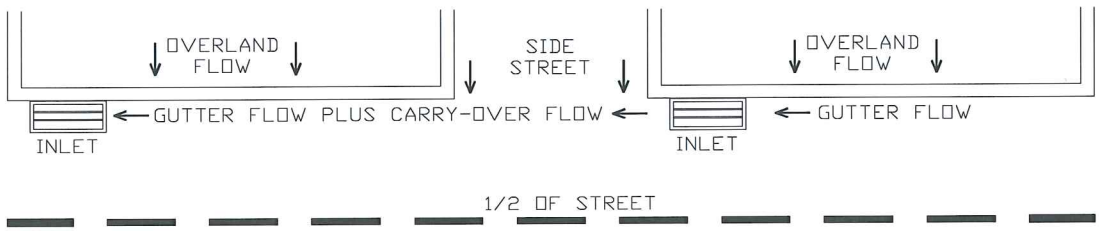
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	**1.43**	**2.53**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	**0.02**	**0.85**	**cfs**
Capture Percentage = Q_a/Q_o =	C% =	**98.3**	**74.8**	**%**

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

Central Park Boulevard

SUB-BASIN 62-1

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 =			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 =	1.59	Acres
Percent Imperviousness =	40.00	%
NRCS Soil Type =	C	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 =	0.0200	30.0
Gutter Flow =	0.0135	700.0

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 =	5	100	years
Return Period One-Hour Precipitation, P_1 =	1.35	2.61	inches
C_1 =	28.5	28.5	
C_2 =	10.0	10.0	
C_3 =	0.786	0.786	
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:

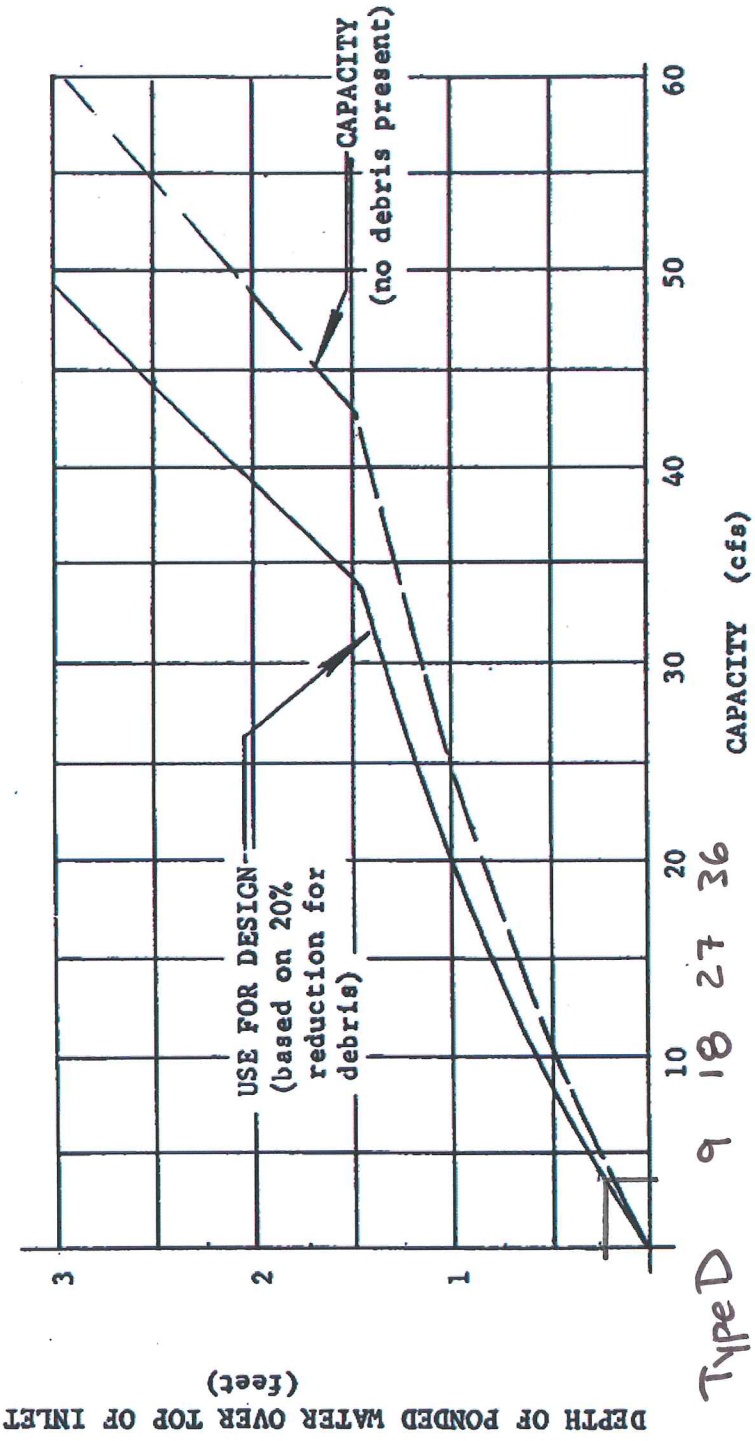
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	0.349	0.583	
Calculated 5-yr. Runoff Coefficient, C5 =	0.349	0.349	
Overland Flow Velocity, V_O =	0.08	0.08	fps
Gutter Flow Velocity, V_G =	2.32	2.32	fps
Overland Flow Time, t_O =	5.91	5.91	minutes
Gutter Flow Time, t_G =	5.02	5.02	minutes
Calculated Time of Concentration, T_c =	10.93	10.93	minutes
Time of Concentration by Regional Formula, T_c =	14.06	14.06	minutes
Recommended T_c =	10.93	10.93	minutes
Time of Concentration Selected by User, T_c =	**10.93**	**10.93**	**minutes**
Design Rainfall Intensity, I =	3.52	6.81	inch/hr
Calculated Local Peak Flow, Q_p =	1.96	6.32	cfs
Total Design Peak Flow, Q =	**1.96**	**6.32**	**cfs**

S62-1

$Q_{100} = 6.32$ cfs

TYPE C MEDIAN INLET CAPACITY - for single grate installations

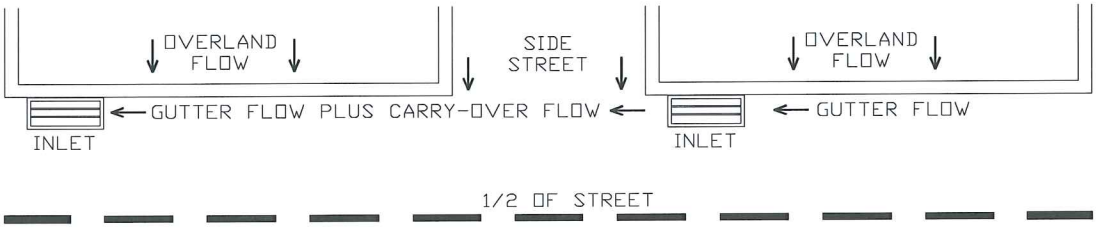
-for two grate installations multiply single grate discharge by 1.8
-for three grate installations multiply single grate discharge by 2.5
-additional capacity reduction is necessary where heavy debris exists



Type D 9 18 27 36

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

Central Park Boulevard
SUB-BASIN 62-2
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 =			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 =	0.44	Acres
Percent Imperviousness =	100.00	%
NRCS Soil Type =	C	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 =	0.0600	45.0
Gutter Flow =	0.0170	410.0

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 =	5	100	years
Return Period One-Hour Precipitation, P_1 =	1.35	2.61	inches
C_1 =	28.5	28.5	
C_2 =	10.0	10.0	
C_3 =	0.786	0.786	
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 =	0.900	0.950	
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 =	0.896	0.956	
Calculated 5-yr. Runoff Coefficient, C5 =	0.896	0.896	
Overland Flow Velocity, V_O =	0.56	0.75	fps
Gutter Flow Velocity, V_G =	2.61	2.61	fps
Overland Flow Time, t_O =	1.34	1.01	minutes
Gutter Flow Time, t_G =	2.62	2.62	minutes
Calculated Time of Concentration, T_c =	3.96	3.63	minutes
Time of Concentration by Regional Formula, T_c =	12.53	12.53	minutes
Recommended T_c =	5.00	5.00	minutes
Time of Concentration Selected by User, T_c =	**5.00**	**5.00**	**minutes**
Design Rainfall Intensity, I =	4.58	8.85	inch/hr
Calculated Local Peak Flow, Q_p =	1.81	3.72	cfs
Total Design Peak Flow, Q =	**1.81**	**3.72**	**cfs**

NOTE: For the MINOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

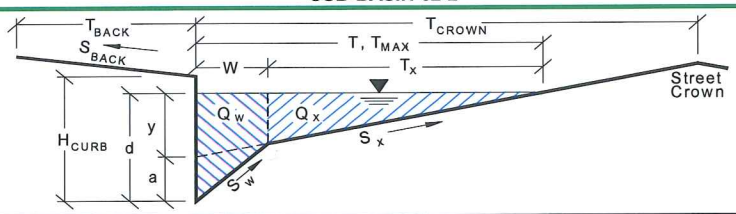
NOTE: For the MAJOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

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

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

Project: Central Park Boulevard

Inlet ID: SUB-BASIN 62-2



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} =	0.0200	ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0130	
Height of Curb at Gutter Flow Line	H_{CURB} =	4.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	28.0	ft
Gutter Depression	a =	0.00	inches
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.0600	ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0171	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0150	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	4.0	8.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	4.00	4.00	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 =	0.0600	0.0600	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	2.88	5.76	inches
Water Depth with a Gutter Depression	d =	2.88	5.76	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	2.0	6.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.843	0.536	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.3	5.3	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	1.5	6.2	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 =**	**1.8**	**11.5**	**cfs**
Flow Velocity Within the Gutter Section	V =	4.2	7.3	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	1.0	3.5	

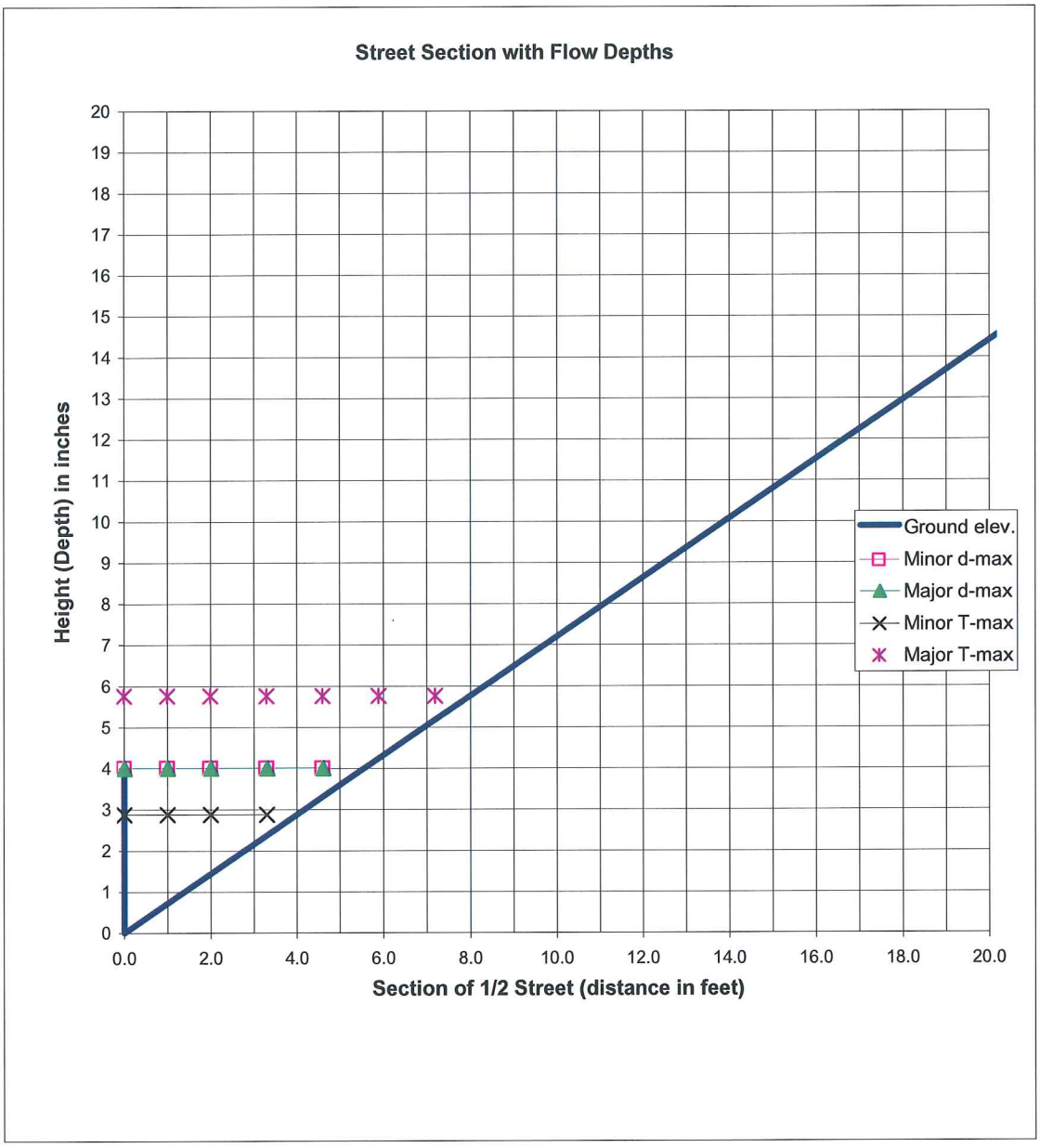
Maximum Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	5.6	5.6	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	3.6	3.6	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.696	0.696	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	1.3	1.3	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	1.3	1.3	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	3.0	3.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**4.3**	**4.3**	**cfs**
Flow Velocity Within the Gutter Section	V =	5.5	5.5	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	1.8	1.8	
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 =**	**4.4**	**4.4**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	4.00	4.00	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} =**	**1.8**	**4.4**	**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'



$$Q_x = \frac{0.56}{n} S_x^{5/3} S_L^{1/2} T_x^{8/3} \qquad E_o = \frac{1}{1 + \dfrac{S_w / S_x}{\left[1 + \dfrac{S_w / S_x}{(T/W) - 1}\right]^{8/3} - 1}}$$

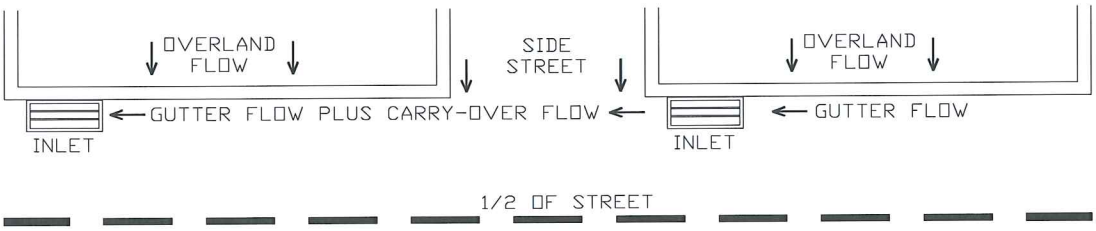
$$Q = \frac{Q_x}{1 - E_o}; \; Q_w = Q - Q_x$$

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

Central Park Boulevard

SUB-BASIN 65A-1

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 =			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 =	0.26	Acres
Percent Imperviousness =	100.00	%
NRCS Soil Type =	C	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 =	5	100	years
Return Period One-Hour Precipitation, P_1 =	1.35	2.61	inches
C_1 =	28.5	28.5	
C_2 =	10.0	10.0	
C_3 =	0.786	0.786	
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 =	0.900	0.950	
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.06**	**1.04**	**cfs**

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

	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	0.896	0.956	
Calculated 5-yr. Runoff Coefficient, C5 =	0.896	0.896	
Overland Flow Velocity, V_O =	0.06	0.08	fps
Gutter Flow Velocity, V_G =	2.21	2.21	fps
Overland Flow Time, t_O =	0.29	0.22	minutes
Gutter Flow Time, t_G =	0.87	0.87	minutes
Calculated Time of Concentration, T_c =	1.15	1.08	minutes
Time of Concentration by Regional Formula, T_c =	10.64	10.64	minutes
Recommended T_c =	5.00	5.00	minutes
Time of Concentration Selected by User, T_c =	**5.00**	**5.00**	**minutes**
Design Rainfall Intensity, I =	4.58	8.85	inch/hr
Calculated Local Peak Flow, Q_p =	1.07	2.20	cfs
Total Design Peak Flow, Q =	**1.13**	**3.24**	**cfs**

NOTE: For the MINOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

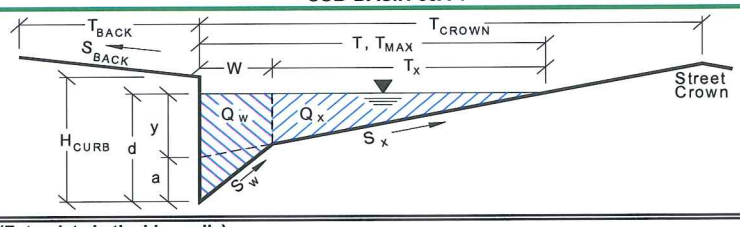
NOTE: For the MAJOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

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

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

Project: Central Park Boulevard

Inlet ID: SUB-BASIN 65A-1



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} =	0.0200	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} =	36.0	ft
Gutter Depression	a =	2.00	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 =	0.0200	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0150	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	8.0	12.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	6.00	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 =	0.1033	0.1033	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	1.92	2.88	inches
Water Depth with a Gutter Depression	d =	3.92	4.88	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	6.0	10.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.722	0.522	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.9	3.6	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	2.4	3.9	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 =**	**3.3**	**7.6**	**cfs**
Flow Velocity Within the Gutter Section	V =	5.4	6.5	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	1.8	2.6	

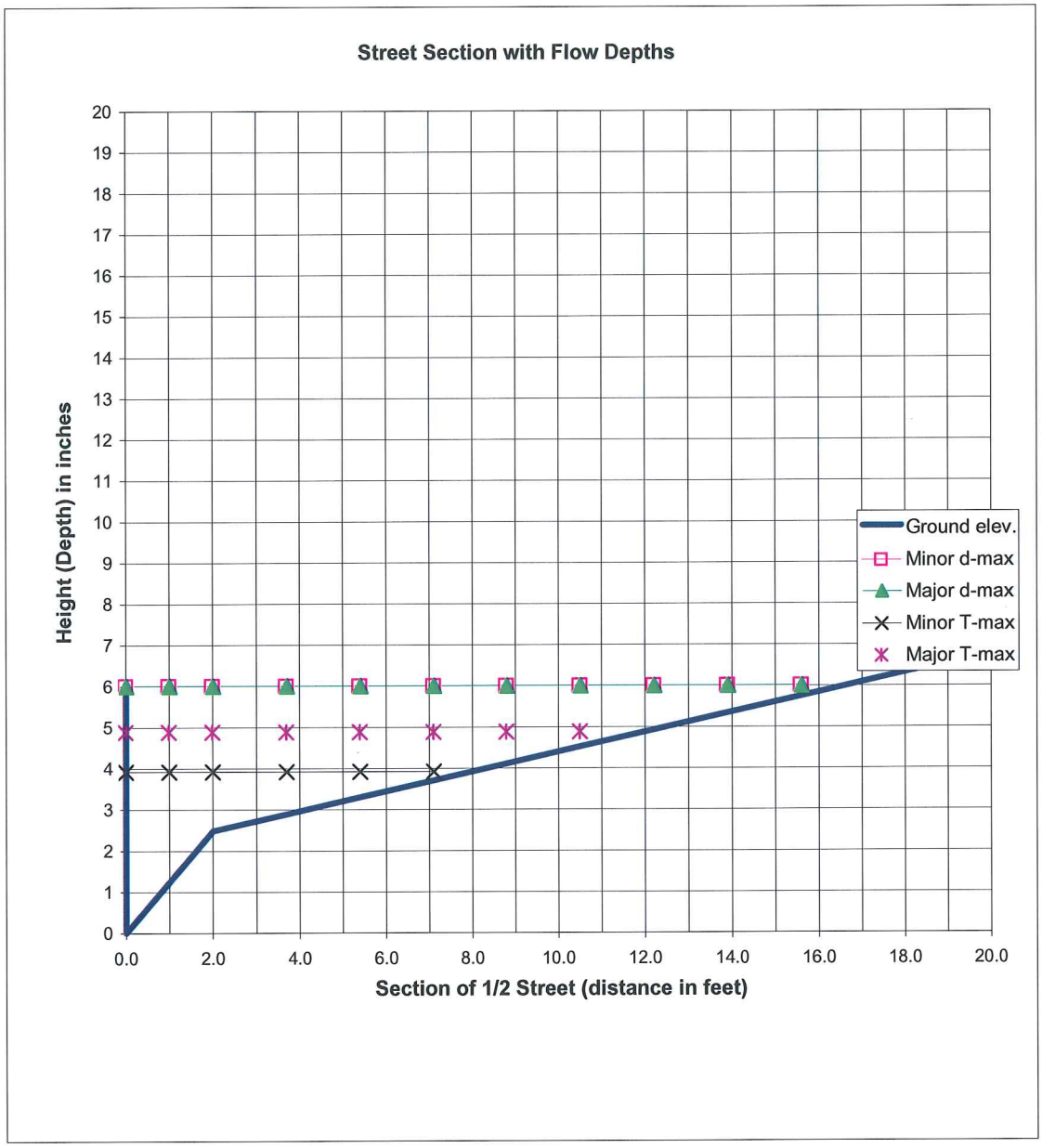
Maximum Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	16.7	16.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	14.7	14.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.378	0.378	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	10.0	10.0	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	10.0	10.0	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	6.1	6.1	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**16.1**	**16.1**	**cfs**
Flow Velocity Within the Gutter Section	V =	7.7	7.7	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	3.8	3.8	
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 =**	**16.1**	**16.1**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	6.00	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} =**	**3.3**	**7.6**	**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'



$$Q_x = \frac{0.56}{n} S_x^{5/3} S_L^{1/2} T_x^{8/3} \qquad E_o = \frac{1}{1 + \dfrac{S_w / S_x}{\left[1 + \dfrac{S_w / S_x}{(T/W) - 1}\right]^{8/3} - 1}}$$

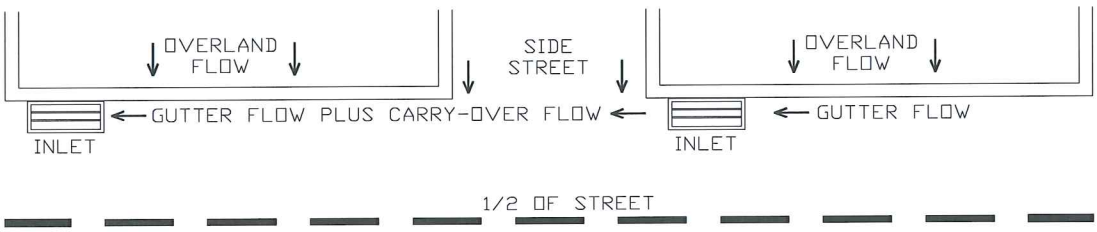
$$Q = \frac{Q_x}{1 - E_o}; \; Q_w = Q - Q_x$$

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

Central Park Boulevard

SUB-BASIN 68-1

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 =			cfs

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

Subcatchment Area =	2.70	Acres
Percent Imperviousness =	70.00	%
NRCS Soil Type =	C	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 =	0.0200	60.0
Gutter Flow =	0.0060	600.0

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

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =	5	100	years
Return Period One-Hour Precipitation, P_1 =	1.35	2.61	inches
C_1 =	28.5	28.5	
C_2 =	10.0	10.0	
C_3 =	0.786	0.786	
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**

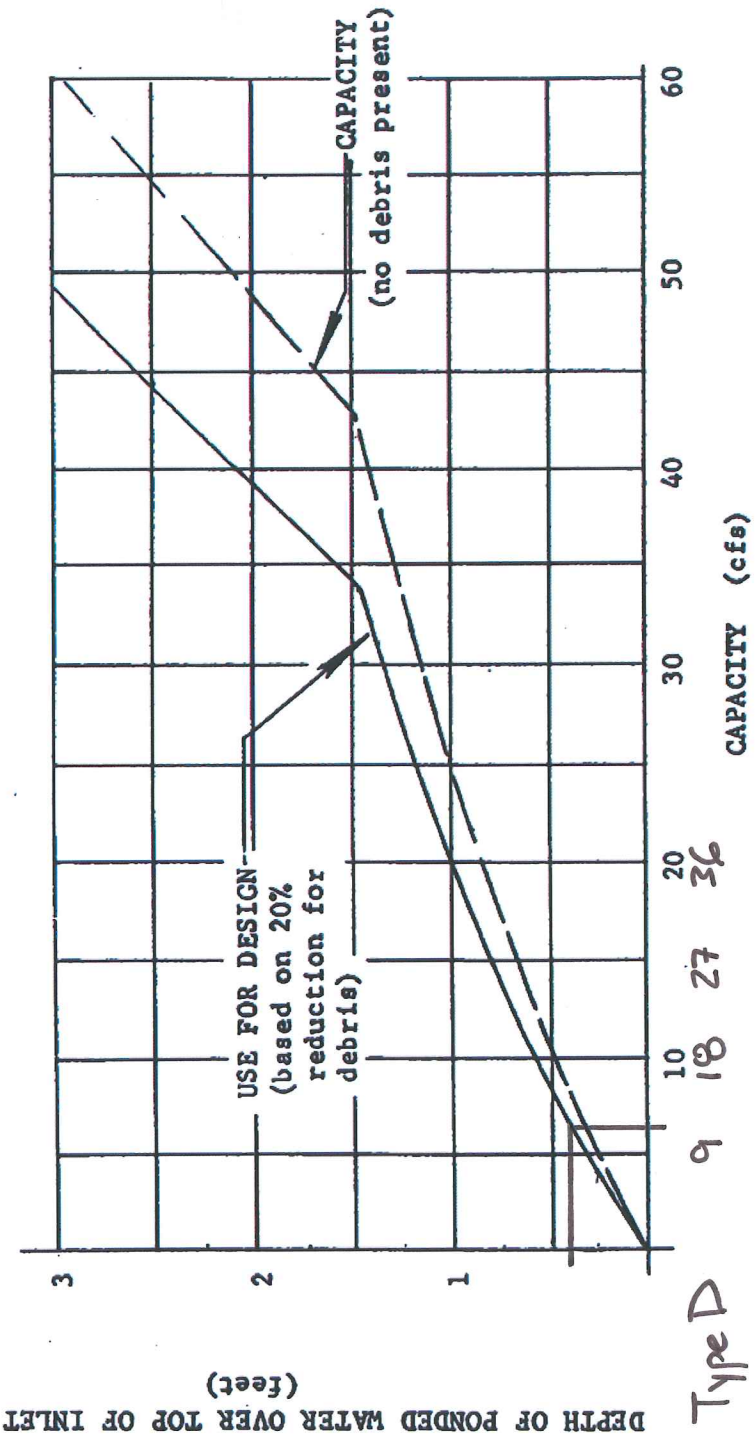
Analysis of Flow Time (Time of Concentration) for a Catchment:

	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	0.531	0.678	
Calculated 5-yr. Runoff Coefficient, C5 =	0.531	0.531	
Overland Flow Velocity, V_O =	0.16	0.16	fps
Gutter Flow Velocity, V_G =	1.55	1.55	fps
Overland Flow Time, t_O =	6.33	6.33	minutes
Gutter Flow Time, t_G =	6.45	6.45	minutes
Calculated Time of Concentration, T_c =	12.79	12.79	minutes
Time of Concentration by Regional Formula, T_c =	13.67	13.67	minutes
Recommended T_c =	12.79	12.79	minutes
Time of Concentration Selected by User, T_c =	**12.79**	**12.79**	**minutes**
Design Rainfall Intensity, I =	3.30	6.37	inch/hr
Calculated Local Peak Flow, Q_p =	4.73	11.67	cfs
Total Design Peak Flow, Q =	**4.73**	**11.67**	**cfs**

Q_{100} = 11.67 cfs

TYPE C MEDIAN INLET CAPACITY - for single grate installations

-for two grate installations multiply single grate discharge by 1.8
-for three grate installations multiply single grate discharge by 2.5
-additional capacity reduction is necessary where heavy debris exists



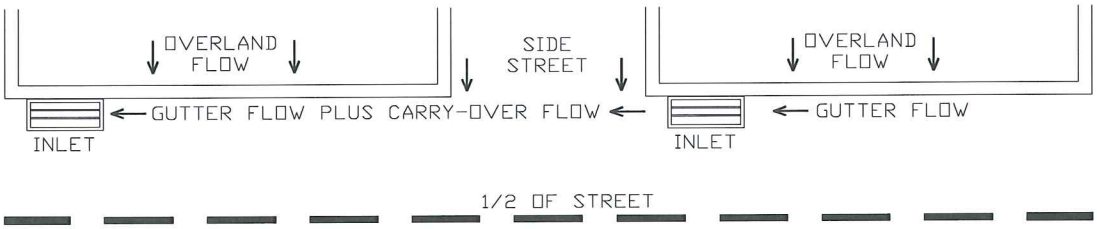
Type D

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

Central Park Boulevard

SUB-BASIN 70-1

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 =			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 =	1.01	Acres
Percent Imperviousness =	60.00	%
NRCS Soil Type =	C	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 =	5	100	years
Return Period One-Hour Precipitation, P_1 =	1.35	2.61	inches
C_1 =	28.5	28.5	
C_2 =	10.0	10.0	
C_3 =	0.786	0.786	
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 =			**cfs**

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

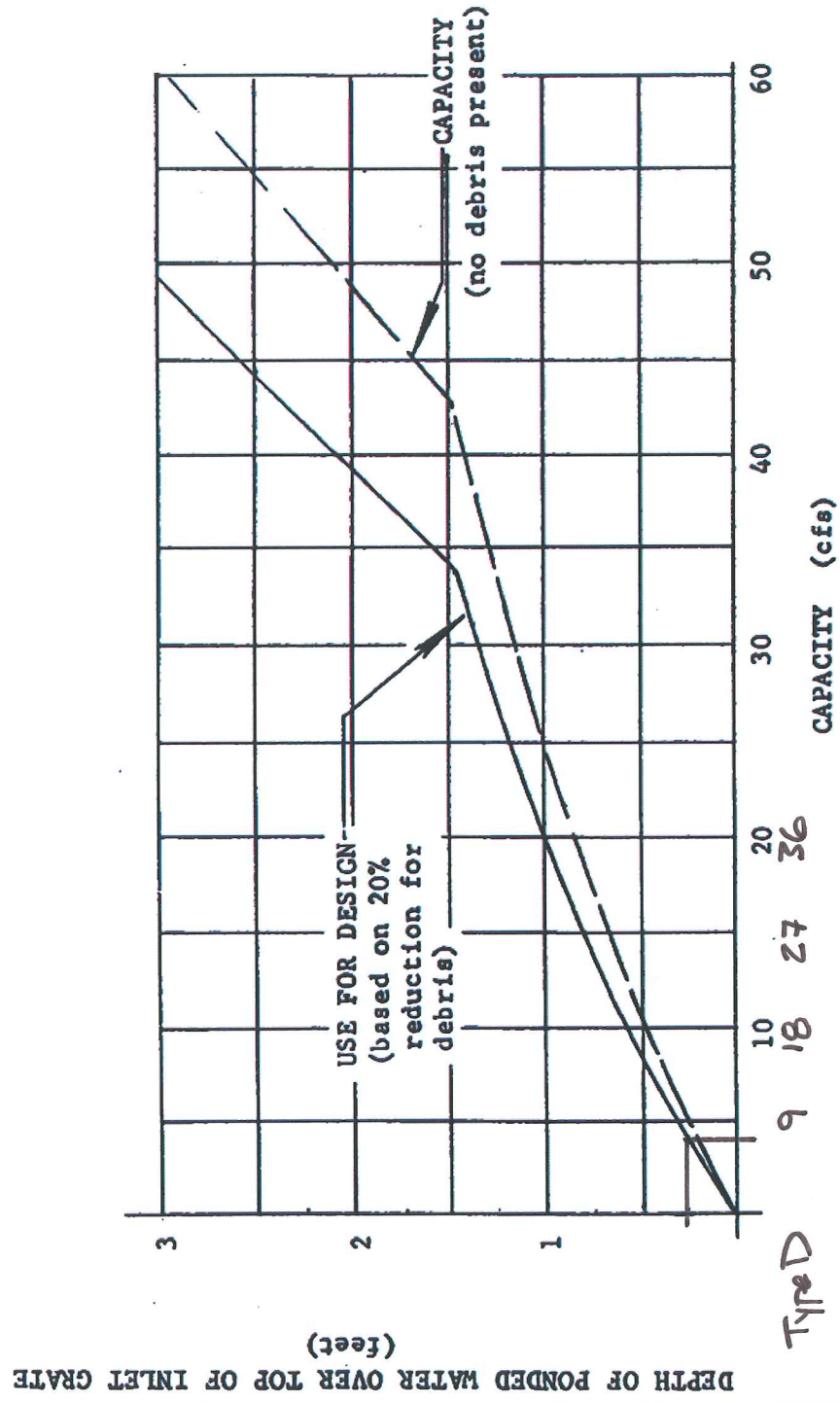
	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	0.457	0.633	
Calculated 5-yr. Runoff Coefficient, C5 =	0.457	0.457	
Overland Flow Velocity, V_O =	0.03	0.03	fps
Gutter Flow Velocity, V_G =	2.21	2.21	fps
Overland Flow Time, t_O =	0.64	0.64	minutes
Gutter Flow Time, t_G =	0.87	0.87	minutes
Calculated Time of Concentration, T_c =	1.51	1.51	minutes
Time of Concentration by Regional Formula, T_c =	10.64	10.64	minutes
Recommended T_c =	5.00	5.00	minutes
Time of Concentration Selected by User, T_c =	**5.00**	**5.00**	**minutes**
Design Rainfall Intensity, I =	4.58	8.85	inch/hr
Calculated Local Peak Flow, Q_p =	2.11	5.66	cfs
Total Design Peak Flow, Q =	**2.11**	**5.66**	**cfs**

S 70-1

$Q_{100} = 5.66$ cfs

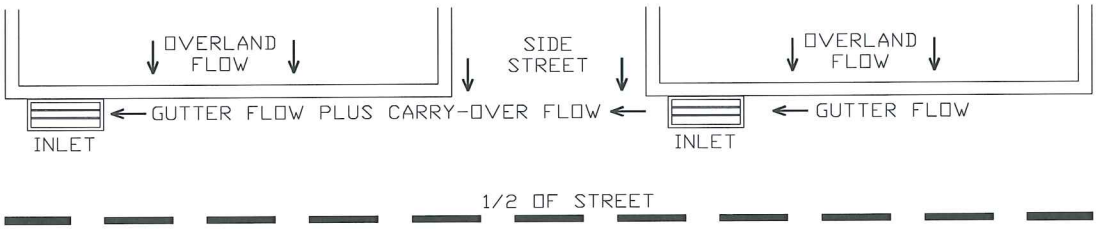
TYPE C MEDIAN INLET CAPACITY - for single grate installations

-for two grate installations multiply single grate discharge by 1.8
-for three grate installations multiply single grate discharge by 2.5
-additional capacity reduction is necessary where heavy debris exists



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

Central Park Boulevard
SUB-BASIN 72-1
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 =			cfs

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

Subcatchment Area =	0.07	Acres
Percent Imperviousness =	100.00	%
NRCS Soil Type =	C	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 =	5	100	years
Return Period One-Hour Precipitation, P_1 =	1.35	2.61	inches
C_1 =	28.5	28.5	
C_2 =	10.0	10.0	
C_3 =	0.786	0.786	
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 =	0.900	0.950	
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 =	0.896	0.956	
Calculated 5-yr. Runoff Coefficient, C5 =	0.896	0.896	
Overland Flow Velocity, V_O =	0.06	0.08	fps
Gutter Flow Velocity, V_G =	2.83	2.83	fps
Overland Flow Time, t_O =	0.29	0.22	minutes
Gutter Flow Time, t_G =	0.06	0.06	minutes
Calculated Time of Concentration, T_c =	0.35	0.27	minutes
Time of Concentration by Regional Formula, T_c =	10.06	10.06	minutes
Recommended T_c =	5.00	5.00	minutes
Time of Concentration Selected by User, T_c =	**5.00**	**5.00**	**minutes**
Design Rainfall Intensity, I =	4.58	8.85	inch/hr
Calculated Local Peak Flow, Q_p =	0.29	0.59	cfs
Total Design Peak Flow, Q =	**0.29**	**0.59**	**cfs**

NOTE: For the MINOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

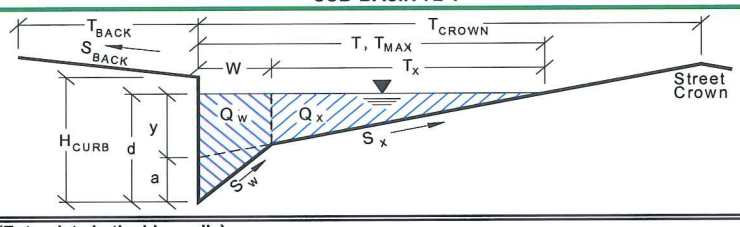
NOTE: For the MAJOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

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

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

Project: Central Park Boulevard

Inlet ID: SUB-BASIN 72-1



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} =	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} =	35.0	ft
Gutter Depression	a =	0.00	inches
Gutter Width	W =	3.50	ft
Street Transverse Slope	S_X =	0.0270	ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0227	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0150	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	4.0	8.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	2.00	2.00	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 =	0.0270	0.0270	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	1.30	2.59	inches
Water Depth with a Gutter Depression	d =	1.30	2.59	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	0.5	4.5	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.996	0.784	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.0	0.8	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	0.5	2.7	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**	**3.5**	**cfs**
Flow Velocity Within the Gutter Section	V =	7.9	14.2	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.9	3.1	

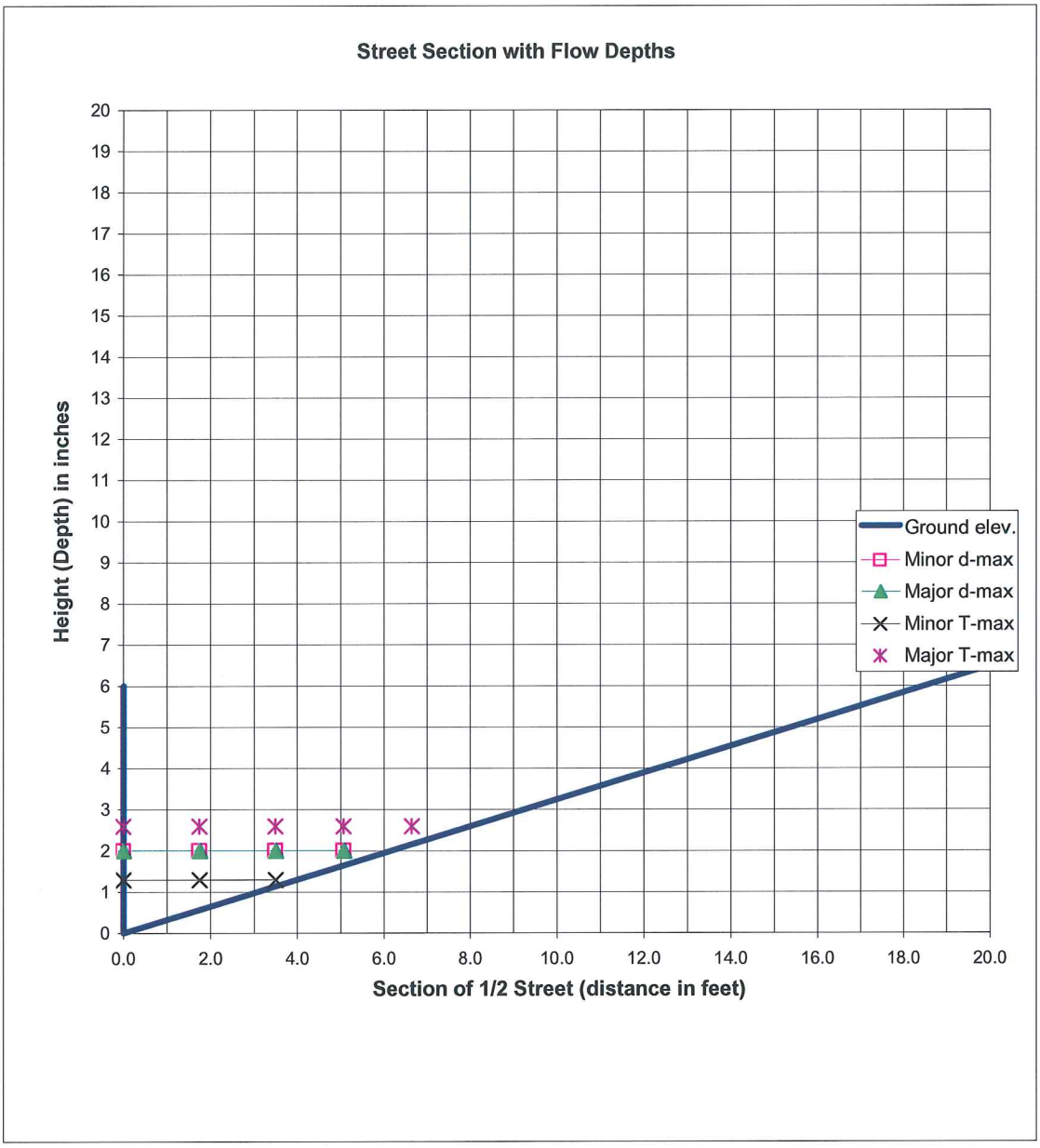
Maximum Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	6.2	6.2	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	2.7	2.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.893	0.893	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	0.2	0.2	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	0.2	0.2	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	1.6	1.6	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**1.8**	**1.8**	**cfs**
Flow Velocity Within the Gutter Section	V =	11.5	11.5	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	1.9	1.9	
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 =**	**1.8**	**1.8**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	2.00	2.00	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} =**	**0.6**	**1.8**	**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'

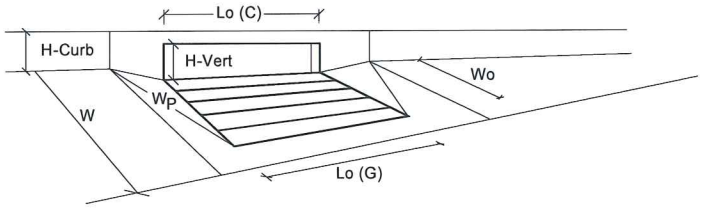


$$Q_x = \frac{0.56}{n} S_x^{5/3} S_L^{1/2} T_x^{8/3} \qquad E_o = \frac{1}{1 + \dfrac{S_w / S_x}{\left[1 + \dfrac{S_w / S_x}{(T/W) - 1}\right]^{8/3} - 1}}$$

$$Q = \frac{Q_x}{1 - E_o}; \; Q_w = Q - Q_x$$

INLET ON A CONTINUOUS GRADE

Project: Central Park Boulevard
Inlet ID: SUB-BASIN 72-1



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} =	0.5	0.5	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 =	2.00	2.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	W_o =	3.50	3.50	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 =**	**0.29**	**0.59**	**cfs**
Water Spread Width	T =	3.2	4.1	ft
Water Depth at Flowline (outside of local depression)	d =	1.0	1.3	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 =	1.000	0.994	
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 =	0.29	0.59	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.13	0.23	sq ft
Street Flow Velocity	V_s =	2.16	2.60	fps
Water Depth for Design Condition	d_{LOCAL} =	1.5	1.8	inches

Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	2.00	2.00	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	1.000	0.994	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =	5.96	5.96	fps
Interception Rate of Frontal Flow	R_f =	1.00	1.00	
Interception Rate of Side Flow	R_x =	0.18	0.14	
Interception Capacity	Q_i =	0.29	0.59	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 =	1.00	1.00	ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =	3.99	3.99	fps
Interception Rate of Frontal Flow	R_f =	1.00	1.00	
Interception Rate of Side Flow	R_x =	0.04	0.03	
Actual Interception Capacity	**Q_a =**	**0.29**	**0.59**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**0.00**	**0.01**	**cfs**

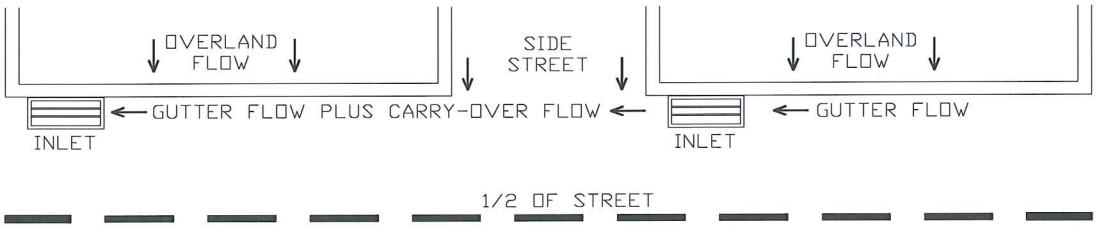
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.29**	**0.59**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.00**	**0.01**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**100.0**	**98.8**	**%**

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

Central Park Boulevard

SUB-BASIN 72-2

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 =			cfs

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

Subcatchment Area =	0.15	Acres
Percent Imperviousness =	100.00	%
NRCS Soil Type =	C	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 =	5	100	years
Return Period One-Hour Precipitation, P_1 =	1.35	2.61	inches
C_1 =	28.5	28.5	
C_2 =	10.0	10.0	
C_3 =	0.786	0.786	
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 =	0.900	0.950	
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 =	0.896	0.956	
Calculated 5-yr. Runoff Coefficient, C5 =	0.896	0.896	
Overland Flow Velocity, V_O =	0.06	0.08	fps
Gutter Flow Velocity, V_G =	2.83	2.83	fps
Overland Flow Time, t_O =	0.29	0.22	minutes
Gutter Flow Time, t_G =	0.06	0.06	minutes
Calculated Time of Concentration, T_c =	0.35	0.27	minutes
Time of Concentration by Regional Formula, T_c =	10.06	10.06	minutes
Recommended T_c =	5.00	5.00	minutes
Time of Concentration Selected by User, T_c =	**5.00**	**5.00**	**minutes**
Design Rainfall Intensity, I =	4.58	8.85	inch/hr
Calculated Local Peak Flow, Q_p =	0.62	1.27	cfs
Total Design Peak Flow, Q =	**0.62**	**1.28**	**cfs**

NOTE: For the MINOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

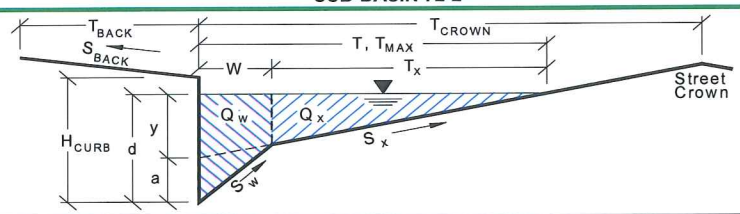
NOTE: For the MAJOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

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

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

Project: Central Park Boulevard

Inlet ID: SUB-BASIN 72-2



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} =	0.0200	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} =	32.0	ft
Gutter Depression	a =	0.00	inches
Gutter Width	W =	3.00	ft
Street Transverse Slope	S_X =	0.0263	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} =	0.0150	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	8.0	12.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	2.00	2.00	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 =	0.0263	0.0263	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	2.52	3.79	inches
Water Depth with a Gutter Depression	d =	2.52	3.79	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	5.0	9.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.714	0.536	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	1.3	6.1	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	3.2	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 =**	**4.4**	**13.1**	**cfs**
Flow Velocity Within the Gutter Section	V =	13.9	19.1	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.9	6.0	

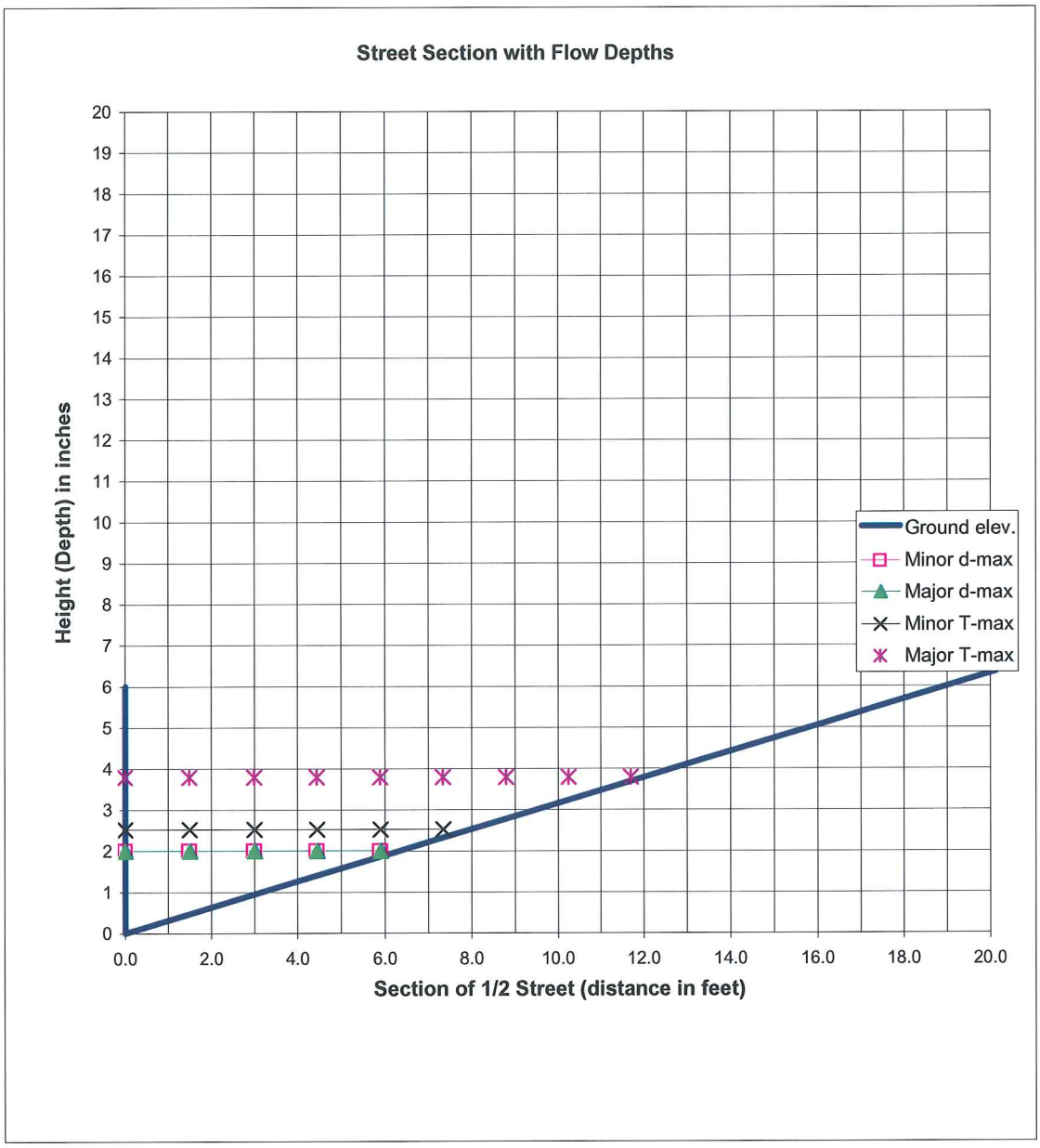
Maximum Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	6.3	6.3	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	3.3	3.3	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.819	0.819	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	0.4	0.4	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	0.4	0.4	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	2.0	2.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**2.4**	**2.4**	**cfs**
Flow Velocity Within the Gutter Section	V =	11.5	11.5	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	1.9	1.9	
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 =**	**2.4**	**2.4**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	2.00	2.00	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} =**	**2.4**	**2.4**	**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'

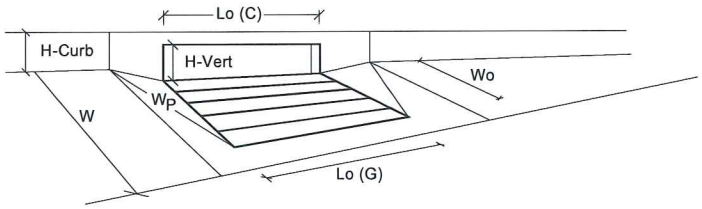


$$Q_x = \frac{0.56}{n} S_x^{5/3} S_L^{1/2} T_x^{8/3} \qquad E_o = \frac{1}{1 + \dfrac{S_w / S_x}{\left[1 + \dfrac{S_w / S_x}{(T/W) - 1}\right]^{8/3} - 1}}$$

$$Q = \frac{Q_x}{1 - E_o}; \; Q_w = Q - Q_x$$

INLET ON A CONTINUOUS GRADE

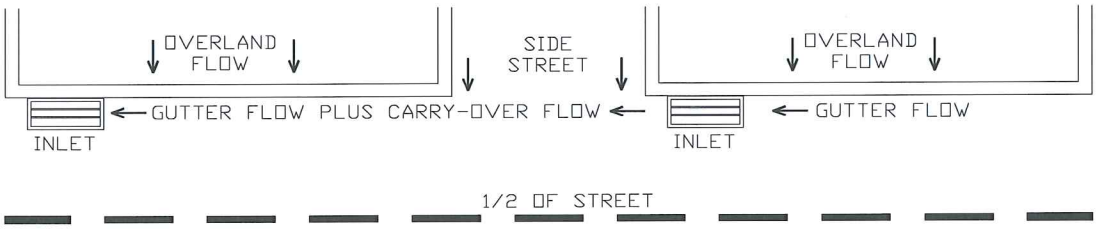
Project: Central Park Boulevard
Inlet ID: SUB-BASIN 72-2



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} =	0.5	0.5	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 =	2.00	2.00	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 =	**0.62**	**1.28**	**cfs**
Water Spread Width	T =	3.8	5.0	ft
Water Depth at Flowline (outside of local depression)	d =	1.2	1.6	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 =	0.983	0.912	
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 =	0.61	1.17	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.19	0.33	sq ft
Street Flow Velocity	V_s =	3.23	3.87	fps
Water Depth for Design Condition	d_{LOCAL} =	1.7	2.1	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	2.00	2.00	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	0.983	0.912	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =	5.96	5.96	fps
Interception Rate of Frontal Flow	R_f =	1.00	1.00	
Interception Rate of Side Flow	R_x =	0.09	0.07	
Interception Capacity	Q_i =	0.60	1.07	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 =	1.00	1.00	ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =	3.99	3.99	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 =	**0.60**	**1.07**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	Q_b =	**0.02**	**0.21**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	**0.60**	**1.07**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	**0.02**	**0.21**	**cfs**
Capture Percentage = Q_a/Q_o =	C% =	**97.4**	**83.5**	**%**

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

Central Park Boulevard
SUB-BASIN 72-3
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 =			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 =	0.04	Acres
Percent Imperviousness =	100.00	%
NRCS Soil Type =	C	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 =	5	100	years
Return Period One-Hour Precipitation, P_1 =	1.35	2.61	inches
C_1 =	28.5	28.5	
C_2 =	10.0	10.0	
C_3 =	0.786	0.786	
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 =	0.900	0.950	
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.02**	**0.21**	**cfs**

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

	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	0.896	0.956	
Calculated 5-yr. Runoff Coefficient, C5 =	0.896	0.896	
Overland Flow Velocity, V_O =	0.06	0.08	fps
Gutter Flow Velocity, V_G =	2.83	2.83	fps
Overland Flow Time, t_O =	0.29	0.22	minutes
Gutter Flow Time, t_G =	0.06	0.06	minutes
Calculated Time of Concentration, T_c =	0.35	0.27	minutes
Time of Concentration by Regional Formula, T_c =	10.06	10.06	minutes
Recommended T_c =	5.00	5.00	minutes
Time of Concentration Selected by User, T_c =	**5.00**	**5.00**	**minutes**
Design Rainfall Intensity, I =	4.58	8.85	inch/hr
Calculated Local Peak Flow, Q_p =	0.16	0.34	cfs
Total Design Peak Flow, Q =	**0.18**	**0.55**	**cfs**

NOTE: For the MINOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

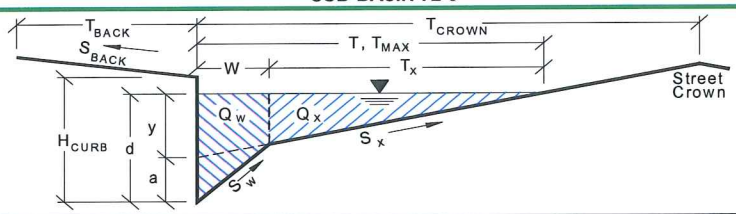
NOTE: For the MAJOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

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

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

Project: Central Park Boulevard

Inlet ID: SUB-BASIN 72-3



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} =	0.0200	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} =	32.0	ft
Gutter Depression	a =	0.00	inches
Gutter Width	W =	3.00	ft
Street Transverse Slope	S_X =	0.0357	ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0435	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0150	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	8.0	12.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	6.00	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 =	0.0357	0.0357	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	3.43	5.14	inches
Water Depth with a Gutter Depression	d =	3.43	5.14	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	5.0	9.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.714	0.536	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	2.2	10.6	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	5.5	12.2	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 =**	**7.7**	**22.7**	**cfs**
Flow Velocity Within the Gutter Section	V =	17.8	24.4	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	5.1	10.4	

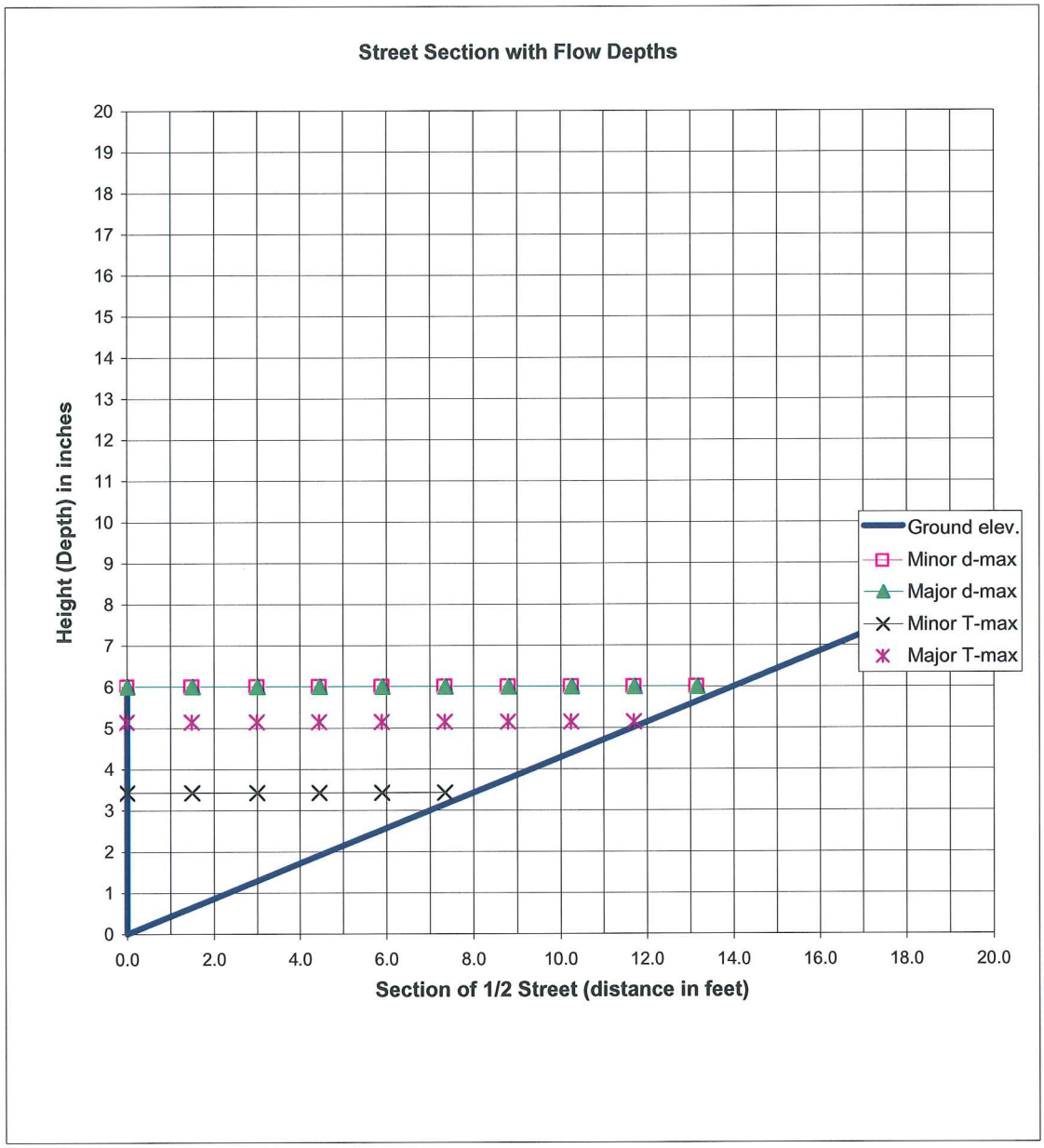
Maximum Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	14.0	14.0	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	11.0	11.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.474	0.474	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	18.1	18.1	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	18.1	18.1	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	16.3	16.3	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**34.3**	**34.3**	**cfs**
Flow Velocity Within the Gutter Section	V =	27.4	27.4	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	13.7	13.7	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d ≥ 6") Storm	R =	0.55	0.55	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**19.0**	**19.0**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	4.81	4.81	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} =**	**7.7**	**19.0**	**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'



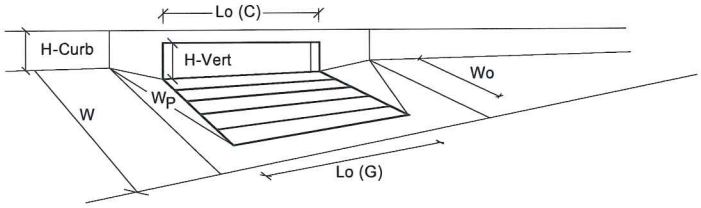
$$Q_x = \frac{0.56}{n} S_x^{5/3} S_L^{1/2} T_x^{8/3}$$

$$Q = \frac{Q_x}{1 - E_o}; \; Q_w = Q - Q_x$$

$$E_o = \frac{1}{1 + \dfrac{S_w / S_x}{\left[1 + \dfrac{S_w / S_x}{(T/W) - 1}\right]^{8/3} - 1}}$$

INLET ON A CONTINUOUS GRADE

Project: Central Park Boulevard
Inlet ID: SUB-BASIN 72-3



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 =	2.00	2.00	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 =	**0.18**	**0.55**	**cfs**
Water Spread Width	T =	2.0	3.0	ft
Water Depth at Flowline (outside of local depression)	d =	0.9	1.3	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 =	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 =	0.19	0.55	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.07	0.16	sq ft
Street Flow Velocity	V_s =	2.64	3.46	fps
Water Depth for Design Condition	d_{LOCAL} =	1.9	2.3	inches

Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	2.00	2.00	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	1.000	1.000	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =	5.96	5.96	fps
Interception Rate of Frontal Flow	R_f =	1.00	1.00	
Interception Rate of Side Flow	R_x =	0.17	0.11	
Interception Capacity	Q_i =	0.19	0.55	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 =	1.00	1.00	ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =	3.99	3.99	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 =	**0.18**	**0.55**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	Q_b =	**0.00**	**0.00**	**cfs**

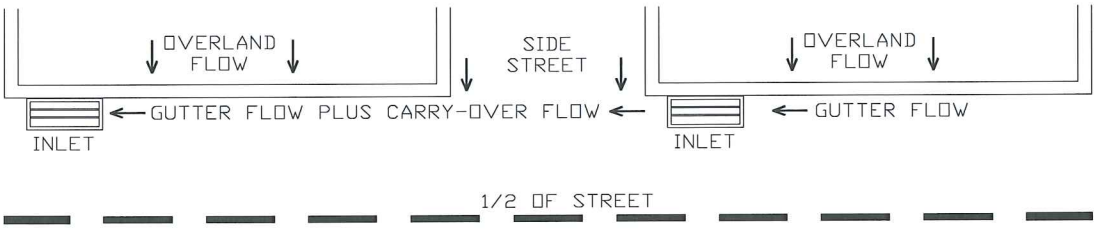
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	**0.19**	**0.55**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	**0.00**	**0.00**	**cfs**
Capture Percentage = Q_a/Q_o =	C% =	**100.0**	**100.0**	**%**

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

Central Park Boulevard

SUB-BASIN 72-4

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 =			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 =	0.05	Acres
Percent Imperviousness =	100.00	%
NRCS Soil Type =	C	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 =	5	100	years
Return Period One-Hour Precipitation, P_1 =	1.35	2.61	inches
C_1 =	28.5	28.5	
C_2 =	10.0	10.0	
C_3 =	0.786	0.786	
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 =	0.900	0.950	
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 =	0.896	0.956	
Calculated 5-yr. Runoff Coefficient, C5 =	0.896	0.896	
Overland Flow Velocity, V_O =	0.06	0.08	fps
Gutter Flow Velocity, V_G =	2.83	2.83	fps
Overland Flow Time, t_O =	0.29	0.22	minutes
Gutter Flow Time, t_G =	0.06	0.06	minutes
Calculated Time of Concentration, T_c =	0.35	0.27	minutes
Time of Concentration by Regional Formula, T_c =	10.06	10.06	minutes
Recommended T_c =	5.00	5.00	minutes
Time of Concentration Selected by User, T_c =	**5.00**	**5.00**	**minutes**
Design Rainfall Intensity, I =	4.58	8.85	inch/hr
Calculated Local Peak Flow, Q_p =	0.21	0.42	cfs
Total Design Peak Flow, Q =	**0.21**	**0.42**	**cfs**

NOTE: For the MINOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

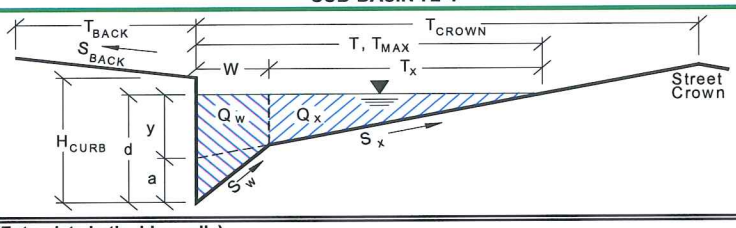
NOTE: For the MAJOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

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

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

Project: Central Park Boulevard

Inlet ID: SUB-BASIN 72-4



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} =	0.0200	ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0130	
Height of Curb at Gutter Flow Line	H_{CURB} =	4.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	30.0	ft
Gutter Depression	a =	0.00	inches
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.0417	ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0417	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0150	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	8.0	12.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	4.00	4.00	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 =	0.0417	0.0417	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	4.00	6.00	inches
Water Depth with a Gutter Depression	d =	4.00	6.00	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	6.0	10.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.536	0.385	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	4.5	17.7	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	5.2	11.1	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 =**	**9.8**	**28.9**	**cfs**
Flow Velocity Within the Gutter Section	V =	9.0	12.1	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	3.0	6.1	

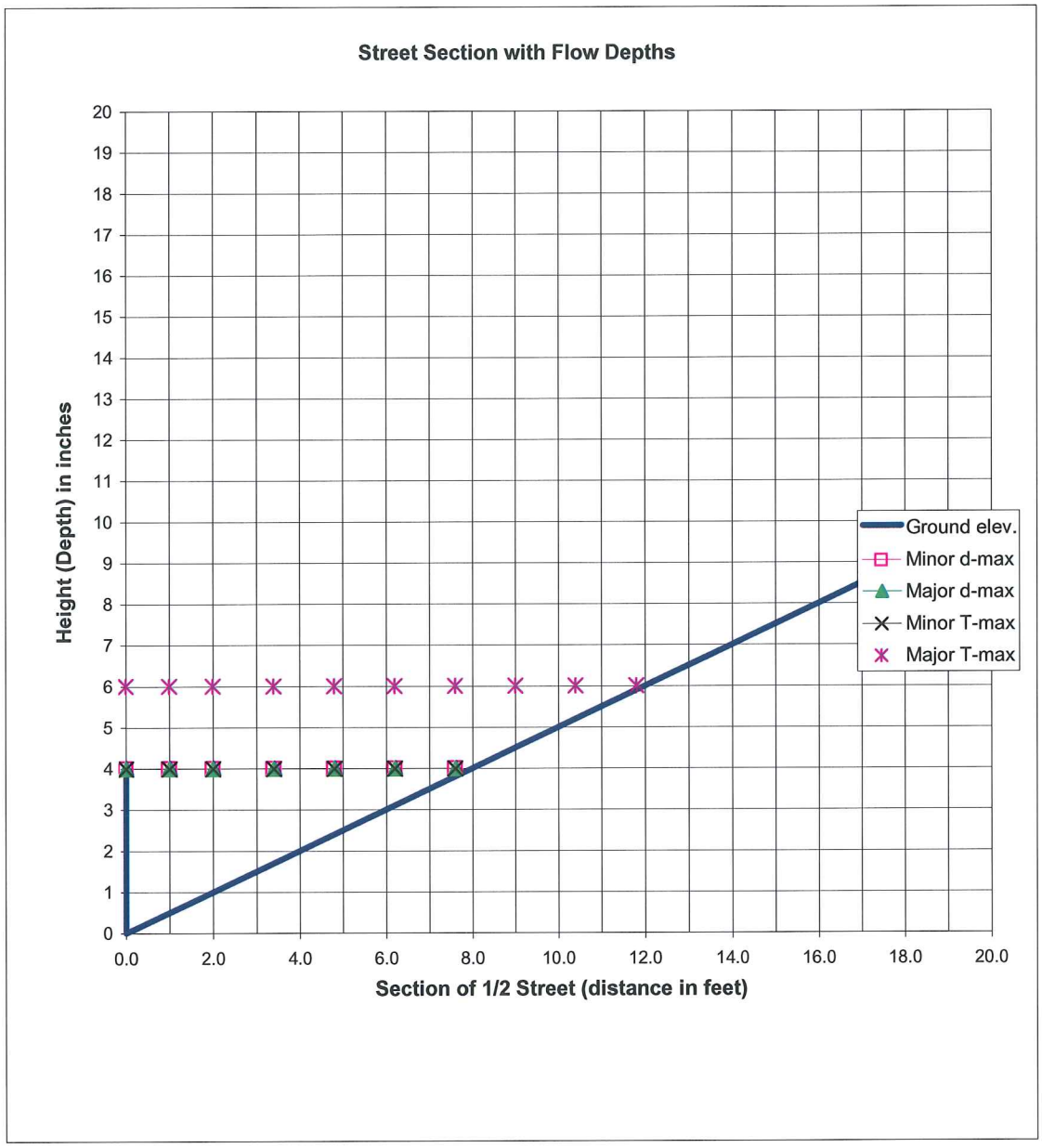
Maximum Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	8.0	8.0	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	6.0	6.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.536	0.536	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	4.5	4.5	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	4.5	4.5	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	5.2	5.2	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**9.8**	**9.8**	**cfs**
Flow Velocity Within the Gutter Section	V =	9.0	9.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	3.0	3.0	
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 =**	**9.8**	**9.8**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	4.00	4.00	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} =**	**9.8**	**9.8**	**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'



$$Q_x = \frac{0.56}{n} S_x^{5/3} S_L^{1/2} T_x^{8/3} \qquad E_o = \frac{1}{1 + \dfrac{S_w / S_x}{\left[1 + \dfrac{S_w / S_x}{(T/W) - 1}\right]^{8/3} - 1}}$$

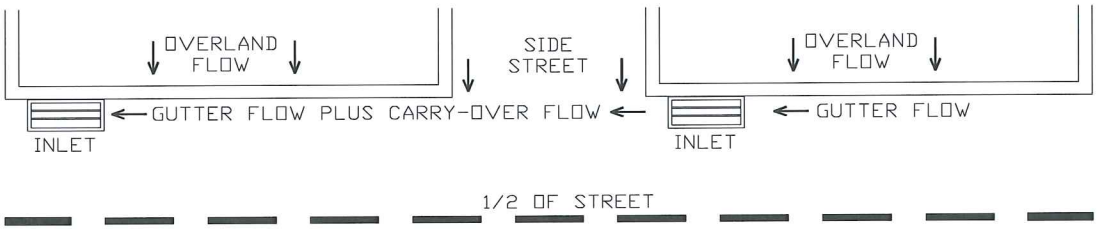
$$Q = \frac{Q_x}{1 - E_o}; \; Q_w = Q - Q_x$$

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

Central Park Boulevard

SUB-BASIN 73-1

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 =			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 =	0.20	Acres
Percent Imperviousness =	40.00	%
NRCS Soil Type =	C	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) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

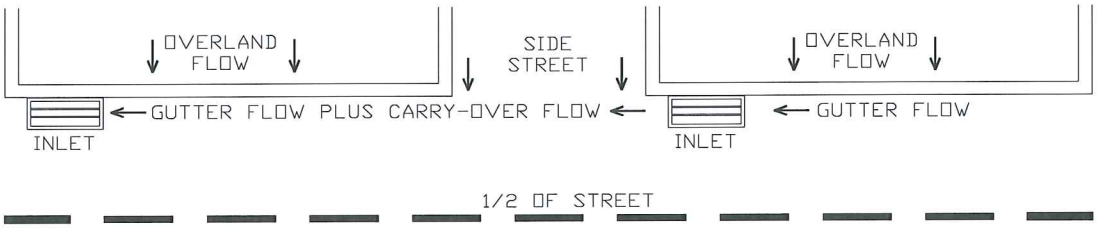
	Minor Storm	Major Storm	
Design Storm Return Period, T_r =	5	100	years
Return Period One-Hour Precipitation, P_1 =	1.35	2.61	inches
C_1 =	28.5	28.5	
C_2 =	10.0	10.0	
C_3 =	0.786	0.786	
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff 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 =	0.349	0.583	
Calculated 5-yr. Runoff Coefficient, C5 =	0.349	0.349	
Overland Flow Velocity, V_O =	0.02	0.02	fps
Gutter Flow Velocity, V_G =	2.21	2.21	fps
Overland Flow Time, t_O =	0.75	0.75	minutes
Gutter Flow Time, t_G =	0.87	0.87	minutes
Calculated Time of Concentration, T_c =	1.62	1.62	minutes
Time of Concentration by Regional Formula, T_c =	10.64	10.64	minutes
Recommended T_c =	5.00	5.00	minutes
Time of Concentration Selected by User, T_c =	**5.00**	**5.00**	**minutes**
Design Rainfall Intensity, I =	4.58	8.85	inch/hr
Calculated Local Peak Flow, Q_p =	0.32	1.03	cfs
Total Design Peak Flow, Q =	**0.32**	**1.03**	**cfs**

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

Central Park Boulevard
SUB-BASIN 75-1
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 =			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 =	0.15	Acres
Percent Imperviousness =	100.00	%
NRCS Soil Type =	C	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 =	5	100	years
Return Period One-Hour Precipitation, P_1 =	1.35	2.61	inches
C_1 =	28.5	28.5	
C_2 =	10.0	10.0	
C_3 =	0.786	0.786	
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 =	0.900	0.950	
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.08**	**0.92**	**cfs**

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

	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	0.896	0.956	
Calculated 5-yr. Runoff Coefficient, C5 =	0.896	0.896	
Overland Flow Velocity, V_O =	0.06	0.08	fps
Gutter Flow Velocity, V_G =	2.21	2.21	fps
Overland Flow Time, t_O =	0.29	0.22	minutes
Gutter Flow Time, t_G =	0.87	0.87	minutes
Calculated Time of Concentration, T_c =	1.15	1.08	minutes
Time of Concentration by Regional Formula, T_c =	10.64	10.64	minutes
Recommended T_c =	5.00	5.00	minutes
Time of Concentration Selected by User, T_c =	**5.00**	**5.00**	**minutes**
Design Rainfall Intensity, I =	4.58	8.85	inch/hr
Calculated Local Peak Flow, Q_p =	0.62	1.27	cfs
Total Design Peak Flow, Q =	**0.70**	**2.19**	**cfs**

NOTE: For the MINOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

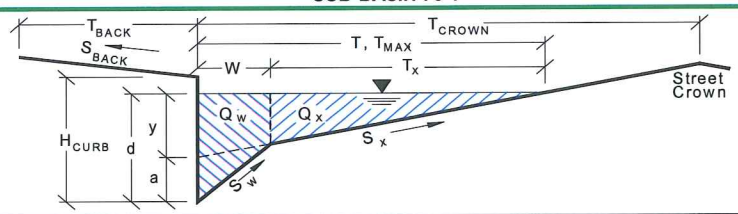
NOTE: For the MAJOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

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

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

Project: Central Park Boulevard

Inlet ID: SUB-BASIN 75-1



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} =	0.0200	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} =	24.0	ft
Gutter Depression	a =	2.00	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 =	0.0140	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0150	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	8.0	12.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	6.00	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 =	0.1033	0.1033	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	1.92	2.88	inches
Water Depth with a Gutter Depression	d =	3.92	4.88	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	6.0	10.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.722	0.522	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.8	3.0	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	2.0	3.3	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 =**	**2.8**	**6.3**	**cfs**
Flow Velocity Within the Gutter Section	V =	4.5	5.4	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	1.5	2.2	

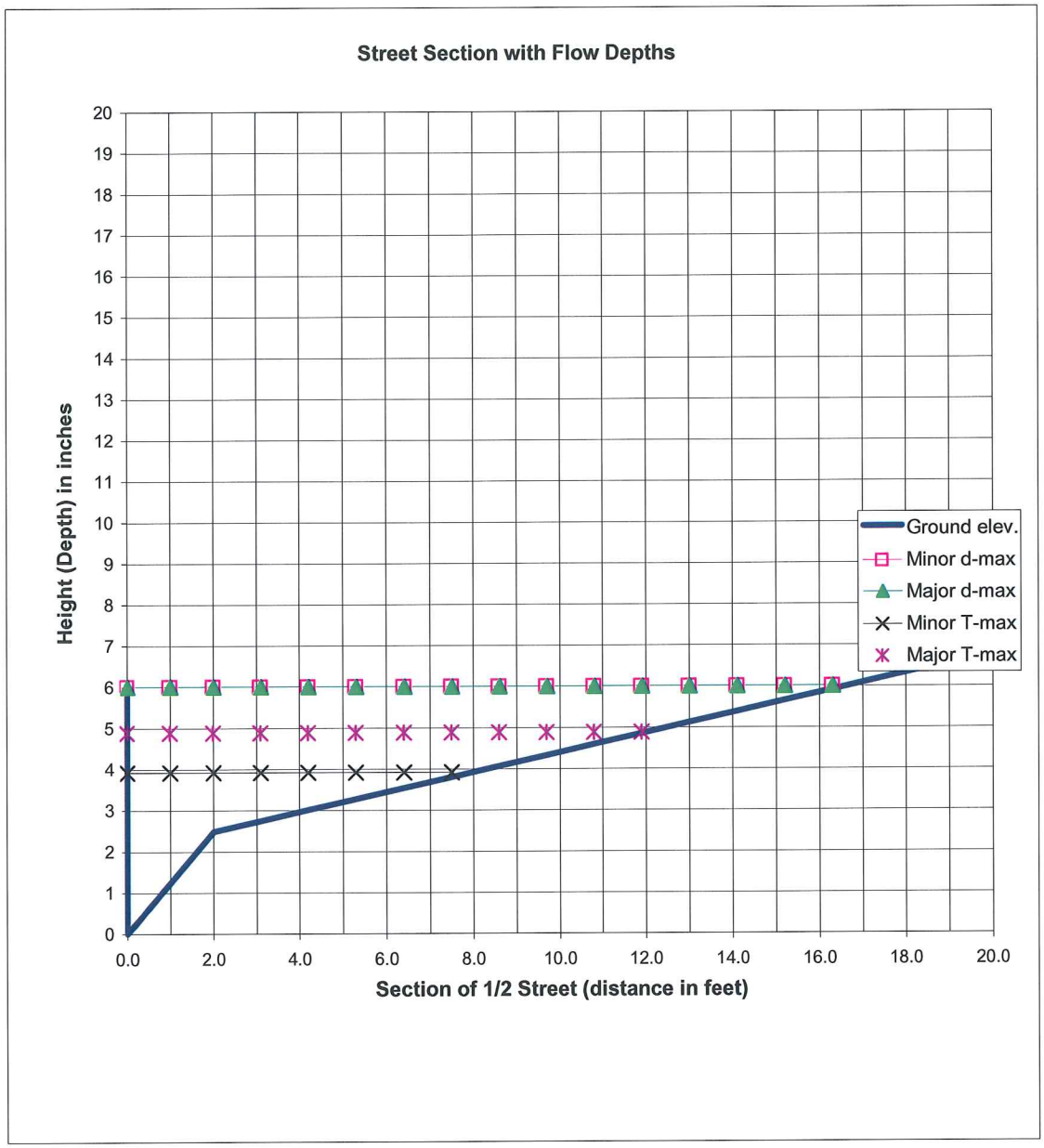
Maximum Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	16.7	16.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	14.7	14.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.378	0.378	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	8.4	8.4	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	8.4	8.4	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	5.1	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 =**	**13.5**	**13.5**	**cfs**
Flow Velocity Within the Gutter Section	V =	6.4	6.4	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	3.2	3.2	
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 =**	**13.5**	**13.5**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	6.00	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} =**	**2.8**	**6.3**	**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'

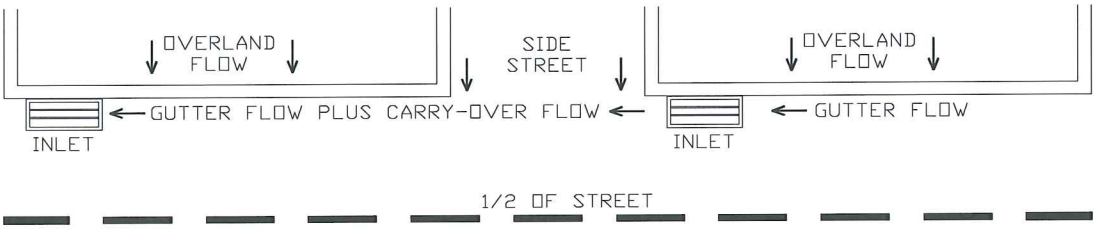


$$Q_x = \frac{0.56}{n} S_x^{5/3} S_L^{1/2} T_x^{8/3} \qquad E_o = \frac{1}{1 + \dfrac{S_w / S_x}{\left[1 + \dfrac{S_w / S_x}{(T/W) - 1}\right]^{8/3} - 1}}$$

$$Q = \frac{Q_x}{1 - E_o}; \; Q_w = Q - Q_x$$

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

Central Park Boulevard
SUB-BASIN 77-1
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 =			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 =	0.22	Acres
Percent Imperviousness =	100.00	%
NRCS Soil Type =	C	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 =	5	100	years
Return Period One-Hour Precipitation, P_1 =	1.35	2.61	inches
C_1 =	28.5	28.5	
C_2 =	10.0	10.0	
C_3 =	0.786	0.786	
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 =	0.900	0.950	
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 =	0.896	0.956	
Calculated 5-yr. Runoff Coefficient, C5 =	0.896	0.896	
Overland Flow Velocity, V_O =	0.06	0.08	fps
Gutter Flow Velocity, V_G =	2.62	2.62	fps
Overland Flow Time, t_O =	0.29	0.22	minutes
Gutter Flow Time, t_G =	0.73	0.73	minutes
Calculated Time of Concentration, T_c =	1.02	0.95	minutes
Time of Concentration by Regional Formula, T_c =	10.64	10.64	minutes
Recommended T_c =	5.00	5.00	minutes
Time of Concentration Selected by User, T_c =	**5.00**	**5.00**	**minutes**
Design Rainfall Intensity, I =	4.58	8.85	inch/hr
Calculated Local Peak Flow, Q_p =	0.90	1.86	cfs
Total Design Peak Flow, Q =	**0.90**	**1.86**	**cfs**

NOTE: For the MINOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

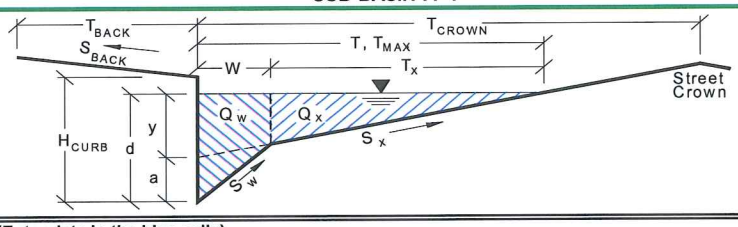
NOTE: For the MAJOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

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

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

Project: Central Park Boulevard

Inlet ID: SUB-BASIN 77-1



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} =	0.0200	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} =	32.0	ft
Gutter Depression	a =	0.00	inches
Gutter Width	W =	3.00	ft
Street Transverse Slope	S_X =	0.0143	ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0222	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0150	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	8.0	12.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	6.00	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 =	0.0143	0.0143	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	1.37	2.06	inches
Water Depth with a Gutter Depression	d =	1.37	2.06	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	5.0	9.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.714	0.536	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.3	1.6	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	0.9	1.9	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 =**	**1.2**	**3.5**	**cfs**
Flow Velocity Within the Gutter Section	V =	6.9	9.5	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.8	1.6	

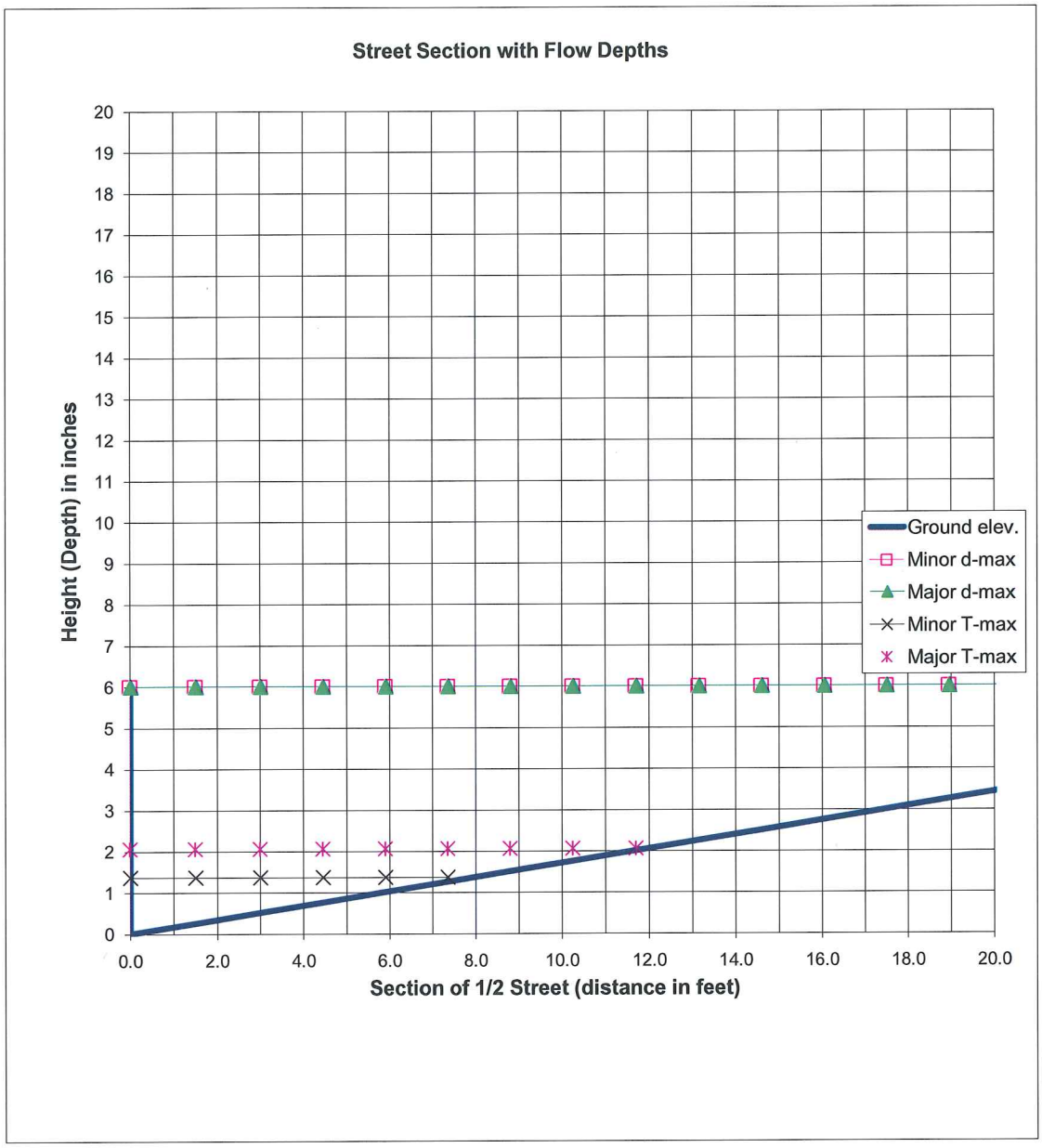
Maximum Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	35.0	35.0	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	32.0	32.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.213	0.213	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	48.2	48.2	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	48.1	48.1	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	13.0	13.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**61.2**	**61.2**	**cfs**
Flow Velocity Within the Gutter Section	V =	20.4	20.4	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	10.2	10.2	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d ≥ 6") Storm	R =	0.95	0.95	
Max Flow Based on Allow. Gutter Depth (Safety Factor Applied)	**Q_d =**	**57.9**	**57.9**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.88	5.88	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.39	0.39	inches

		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	**Q_{allow} =**	**1.2**	**3.5**	**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'

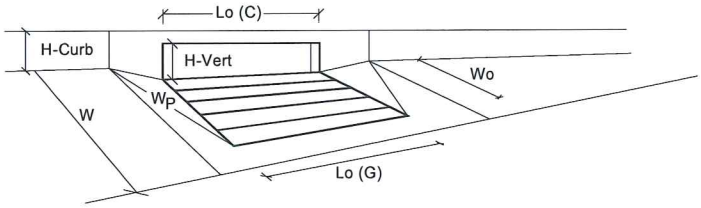


$$Q_x = \frac{0.56}{n} S_x^{5/3} S_L^{1/2} T_x^{8/3} \qquad E_o = \frac{1}{1 + \dfrac{S_w / S_x}{\left[1 + \dfrac{S_w / S_x}{(T/W) - 1}\right]^{8/3} - 1}}$$

$$Q = \frac{Q_x}{1 - E_o}; \; Q_w = Q - Q_x$$

INLET ON A CONTINUOUS GRADE

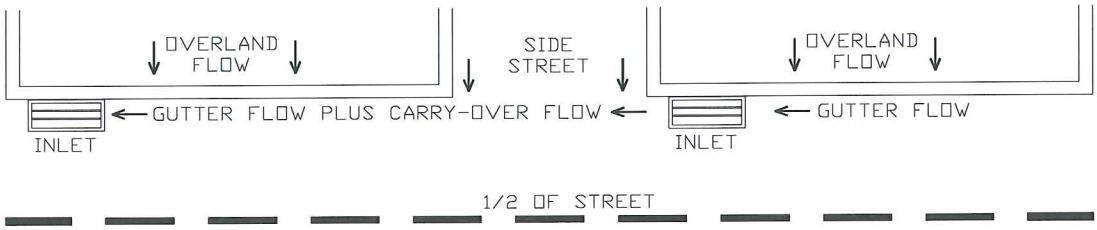
Project: Central Park Boulevard
Inlet ID: SUB-BASIN 77-1



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} =	0.5	0.5	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 =	2.00	2.00	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 =	**0.90**	**1.86**	**cfs**
Water Spread Width	T =	7.2	9.5	ft
Water Depth at Flowline (outside of local depression)	d =	1.2	1.6	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 =	0.762	0.639	
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 =	0.69	1.19	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.37	0.64	sq ft
Street Flow Velocity	V_s =	2.44	2.93	fps
Water Depth for Design Condition	d_{LOCAL} =	1.7	2.1	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	2.00	2.00	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	0.762	0.639	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =	5.96	5.96	fps
Interception Rate of Frontal Flow	R_f =	1.00	1.00	
Interception Rate of Side Flow	R_x =	0.09	0.06	
Interception Capacity	Q_i =	0.54	0.79	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 =	1.00	1.00	ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =	3.99	3.99	fps
Interception Rate of Frontal Flow	R_f =	1.00	1.00	
Interception Rate of Side Flow	R_x =	0.02	0.01	
Actual Interception Capacity	Q_a =	**0.53**	**0.77**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	Q_b =	**0.37**	**1.09**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	**0.53**	**0.77**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	**0.37**	**1.09**	**cfs**
Capture Percentage = Q_a/Q_o =	C% =	**58.7**	**41.3**	**%**

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

Central Park Boulevard
SUB-BASIN 77-2
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 =			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 =	0.11	Acres
Percent Imperviousness =	100.00	%
NRCS Soil Type =	C	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 =	5	100	years
Return Period One-Hour Precipitation, P_1 =	1.35	2.61	inches
C_1 =	28.5	28.5	
C_2 =	10.0	10.0	
C_3 =	0.786	0.786	
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 =	0.900	0.950	
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.37**	**1.09**	**cfs**

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

	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	0.896	0.956	
Calculated 5-yr. Runoff Coefficient, C5 =	0.896	0.896	
Overland Flow Velocity, V_O =	0.06	0.08	fps
Gutter Flow Velocity, V_G =	2.62	2.62	fps
Overland Flow Time, t_O =	0.29	0.22	minutes
Gutter Flow Time, t_G =	0.73	0.73	minutes
Calculated Time of Concentration, T_c =	1.02	0.95	minutes
Time of Concentration by Regional Formula, T_c =	10.64	10.64	minutes
Recommended T_c =	5.00	5.00	minutes
Time of Concentration Selected by User, T_c =	**5.00**	**5.00**	**minutes**
Design Rainfall Intensity, I =	4.58	8.85	inch/hr
Calculated Local Peak Flow, Q_p =	0.45	0.93	cfs
Total Design Peak Flow, Q =	**0.82**	**2.02**	**cfs**

NOTE: For the MINOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

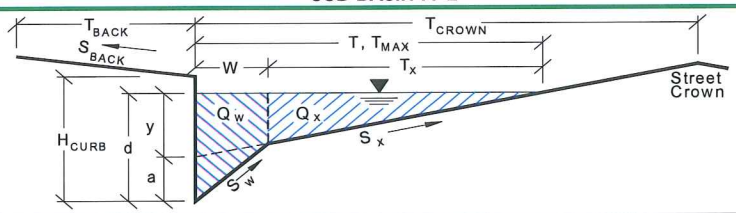
NOTE: For the MAJOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

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

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

Project: Central Park Boulevard

Inlet ID: SUB-BASIN 77-2



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} =	0.0200	ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0130	
Height of Curb at Gutter Flow Line	H_{CURB} =	4.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	32.0	ft
Gutter Depression	a =	0.00	inches
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.0300	ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0286	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0150	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	8.0	12.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	4.00	4.00	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 =	0.0300	0.0300	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	2.88	4.32	inches
Water Depth with a Gutter Depression	d =	2.88	4.32	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	6.0	10.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.536	0.385	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	2.2	8.5	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	2.5	5.3	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 =**	**4.7**	**13.8**	**cfs**
Flow Velocity Within the Gutter Section	V =	6.0	8.1	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	1.4	2.9	

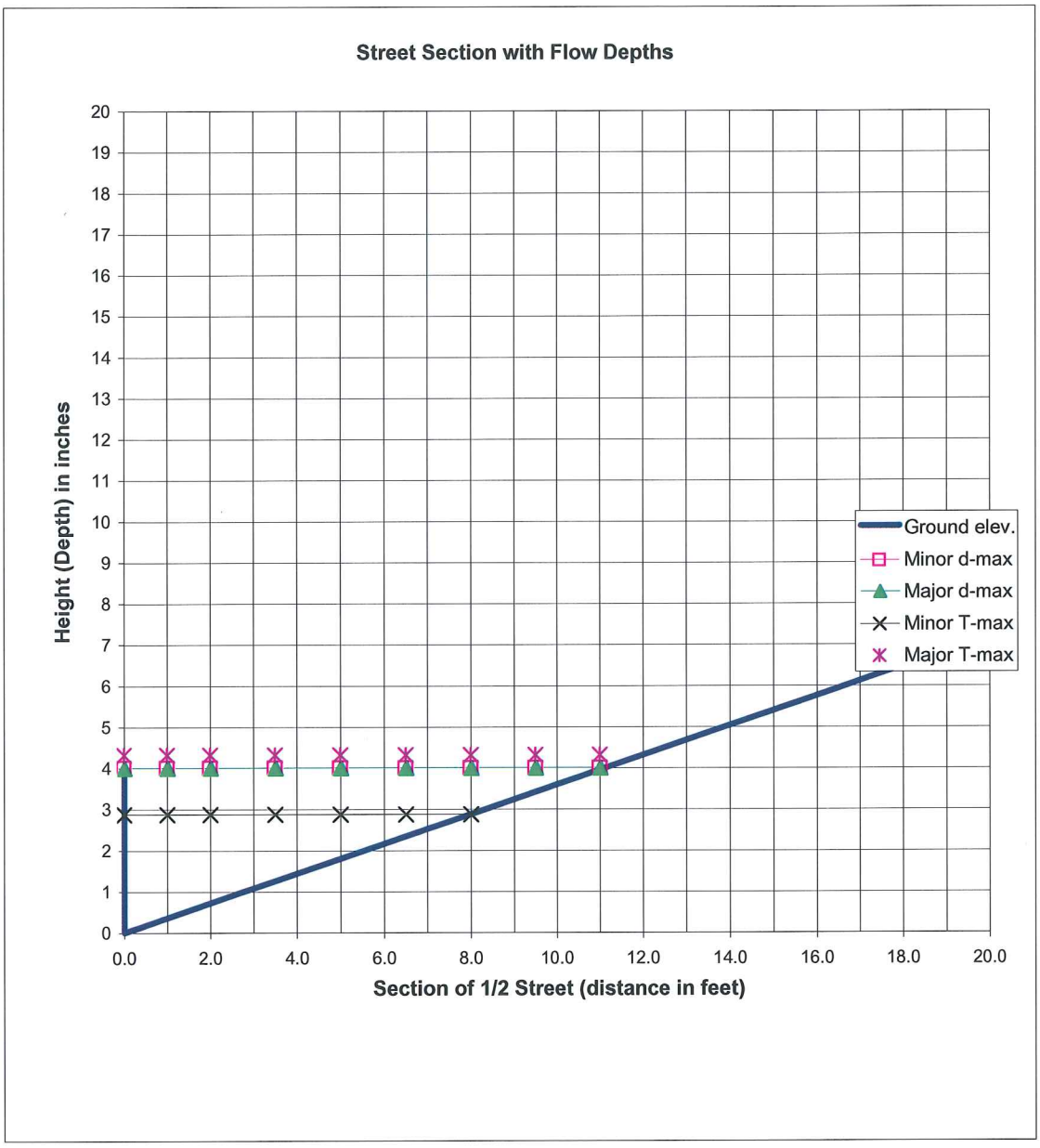
Maximum Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	11.1	11.1	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	9.1	9.1	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.411	0.411	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	6.6	6.6	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	6.6	6.6	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	4.6	4.6	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**11.2**	**11.2**	**cfs**
Flow Velocity Within the Gutter Section	V =	7.6	7.6	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.5	2.5	
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 =**	**11.2**	**11.2**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	4.00	4.00	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} =**	**4.7**	**11.2**	**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'

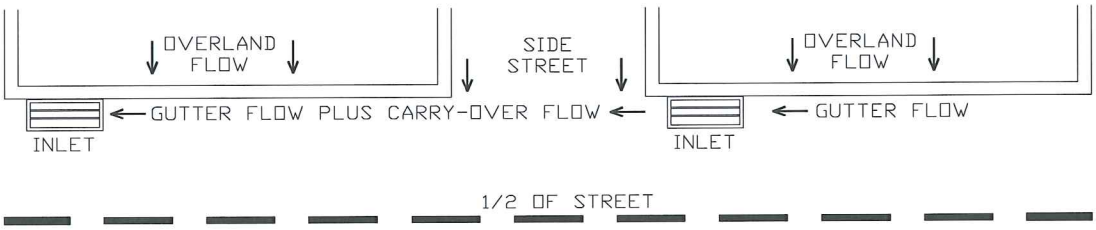


$$Q_x = \frac{0.56}{n} S_x^{5/3} S_L^{1/2} T_x^{8/3} \qquad E_o = \frac{1}{1 + \dfrac{S_w / S_x}{\left[1 + \dfrac{S_w / S_x}{(T/W) - 1}\right]^{8/3} - 1}}$$

$$Q = \frac{Q_x}{1 - E_o}; \; Q_w = Q - Q_x$$

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

Central Park Boulevard
SUB-BASIN 77-3
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 =			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 =	0.07	Acres
Percent Imperviousness =	100.00	%
NRCS Soil Type =	C	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 =	5	100	years
Return Period One-Hour Precipitation, P_1 =	1.35	2.61	inches
C_1 =	28.5	28.5	
C_2 =	10.0	10.0	
C_3 =	0.786	0.786	
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 =	0.900	0.950	
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 =	0.896	0.956	
Calculated 5-yr. Runoff Coefficient, C5 =	0.896	0.896	
Overland Flow Velocity, V_O =	0.06	0.08	fps
Gutter Flow Velocity, V_G =	2.62	2.62	fps
Overland Flow Time, t_O =	0.29	0.22	minutes
Gutter Flow Time, t_G =	0.73	0.73	minutes
Calculated Time of Concentration, T_c =	1.02	0.95	minutes
Time of Concentration by Regional Formula, T_c =	10.64	10.64	minutes
Recommended T_c =	5.00	5.00	minutes
Time of Concentration Selected by User, T_c =	**5.00**	**5.00**	**minutes**
Design Rainfall Intensity, I =	4.58	8.85	inch/hr
Calculated Local Peak Flow, Q_p =	0.29	0.59	cfs
Total Design Peak Flow, Q =	**0.29**	**0.59**	**cfs**

NOTE: For the MINOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

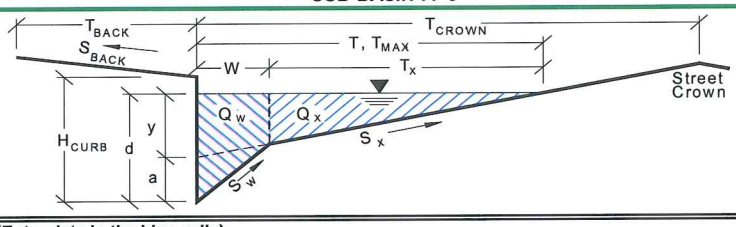
NOTE: For the MAJOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

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

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

Project: Central Park Boulevard

Inlet ID: SUB-BASIN 77-3



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} =	0.0200	ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0130	
Height of Curb at Gutter Flow Line	H_{CURB} =	4.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	32.0	ft
Gutter Depression	a =	0.00	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 =	0.0333	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0150	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	8.0	12.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	4.00	4.00	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 =	1.92	2.88	inches
Water Depth with a Gutter Depression	d =	1.92	2.88	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	6.0	10.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.536	0.385	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	1.2	4.7	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	1.4	2.9	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**	**7.6**	**cfs**
Flow Velocity Within the Gutter Section	V =	4.9	6.6	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.8	1.6	

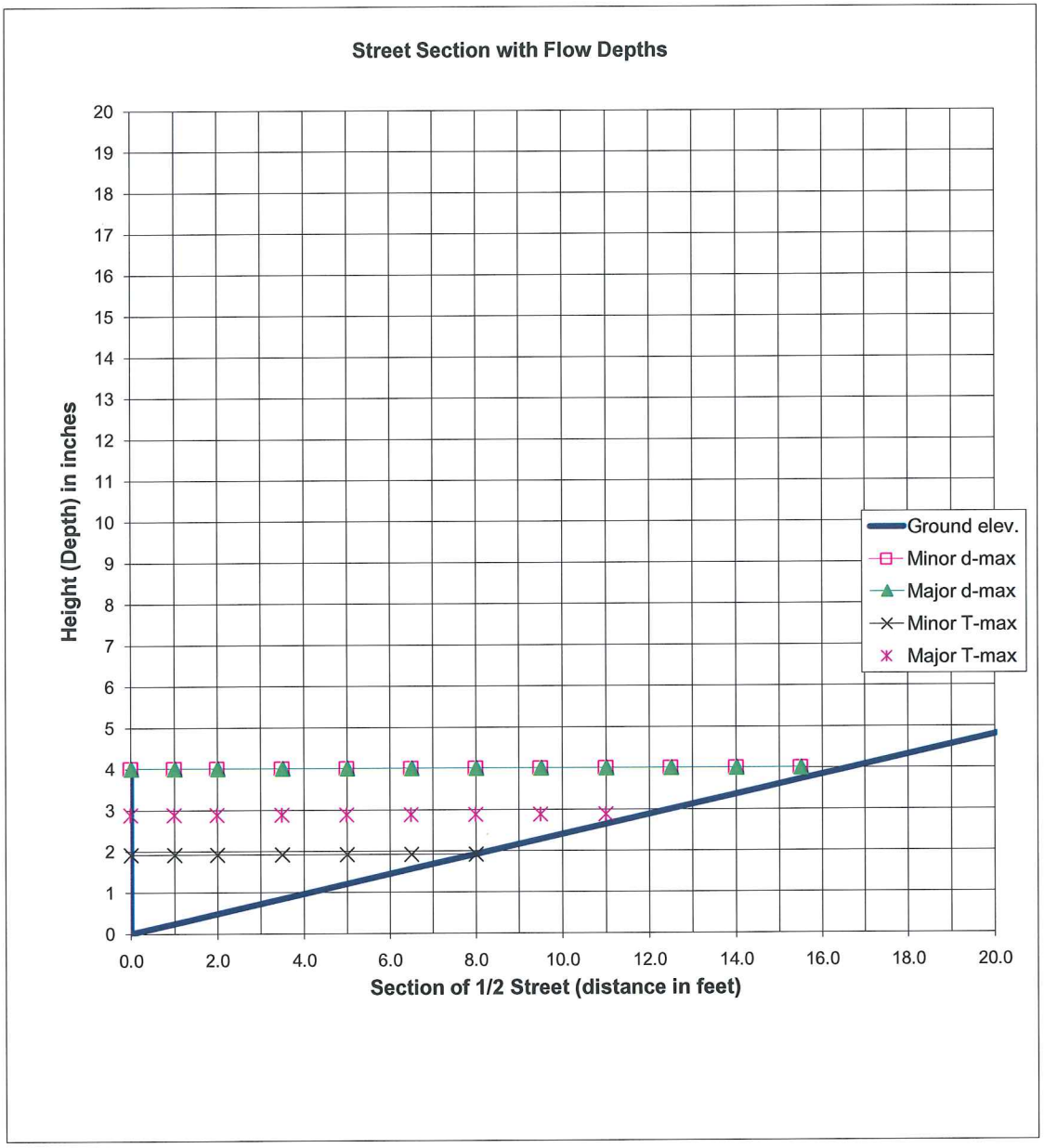
Maximum Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	16.7	16.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	14.7	14.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.289	0.289	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	12.9	12.9	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	12.9	12.9	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	5.3	5.3	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**18.2**	**18.2**	**cfs**
Flow Velocity Within the Gutter Section	V =	8.4	8.4	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.8	2.8	
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 =**	**18.2**	**18.2**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	4.00	4.00	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} =**	**2.6**	**7.6**	**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'



$$Q_x = \frac{0.56}{n} S_x^{5/3} S_L^{1/2} T_x^{8/3} \qquad E_o = \frac{1}{1 + \dfrac{S_w / S_x}{\left[1 + \dfrac{S_w / S_x}{(T/W) - 1}\right]^{8/3} - 1}}$$

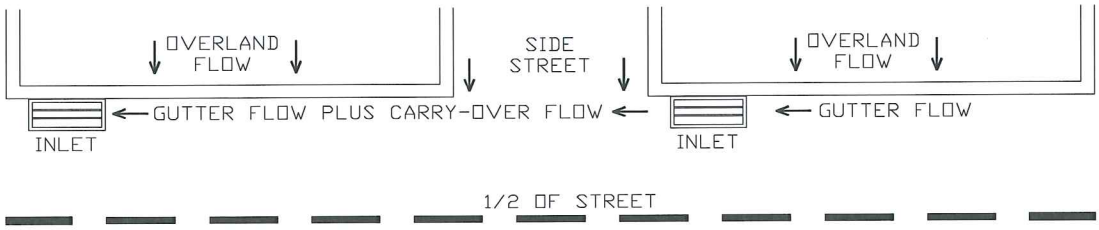
$$Q = \frac{Q_x}{1 - E_o}; \; Q_w = Q - Q_x$$

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

Central Park Boulevard

SUB-BASIN 77-4

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 =			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 =	0.69	Acres
Percent Imperviousness =	70.00	%
NRCS Soil Type =	C	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) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

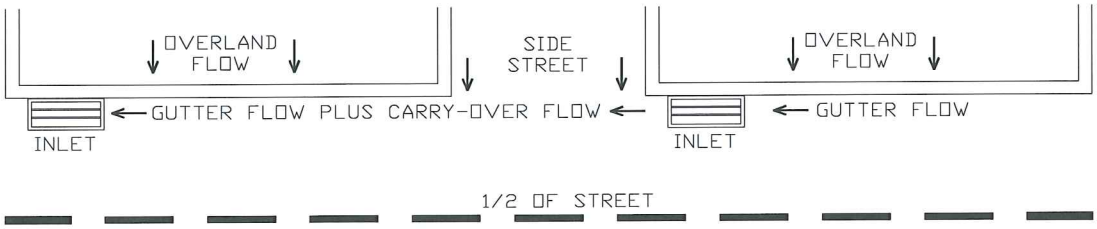
	Minor Storm	Major Storm	
Design Storm Return Period, T_r =	5	100	years
Return Period One-Hour Precipitation, P_1 =	1.35	2.61	inches
C_1 =	28.5	28.5	
C_2 =	10.0	10.0	
C_3 =	0.786	0.786	
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff 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 =	0.531	0.678	
Calculated 5-yr. Runoff Coefficient, C5 =	0.531	0.531	
Overland Flow Velocity, V_O =	0.03	0.03	fps
Gutter Flow Velocity, V_G =	2.21	2.21	fps
Overland Flow Time, t_O =	0.57	0.57	minutes
Gutter Flow Time, t_G =	0.87	0.87	minutes
Calculated Time of Concentration, T_c =	1.44	1.44	minutes
Time of Concentration by Regional Formula, T_c =	10.64	10.64	minutes
Recommended T_c =	5.00	5.00	minutes
Time of Concentration Selected by User, T_c =	**5.00**	**5.00**	**minutes**
Design Rainfall Intensity, I =	4.58	8.85	inch/hr
Calculated Local Peak Flow, Q_p =	1.68	4.14	cfs
Total Design Peak Flow, Q =	**1.68**	**4.14**	**cfs**

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

Central Park Boulevard
SUB-BASIN 78-1
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 =			cfs

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

Subcatchment Area =	0.16	Acres
Percent Imperviousness =	100.00	%
NRCS Soil Type =	C	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 =	5	100	years
Return Period One-Hour Precipitation, P_1 =	1.35	2.61	inches
C_1 =	28.5	28.5	
C_2 =	10.0	10.0	
C_3 =	0.786	0.786	
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 =	0.900	0.950	
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 =	0.896	0.956	
Calculated 5-yr. Runoff Coefficient, C5 =	0.896	0.896	
Overland Flow Velocity, V_O =	0.06	0.08	fps
Gutter Flow Velocity, V_G =	2.62	2.62	fps
Overland Flow Time, t_O =	0.29	0.22	minutes
Gutter Flow Time, t_G =	0.73	0.73	minutes
Calculated Time of Concentration, T_c =	1.02	0.95	minutes
Time of Concentration by Regional Formula, T_c =	10.64	10.64	minutes
Recommended T_c =	5.00	5.00	minutes
Time of Concentration Selected by User, T_c =	**5.00**	**5.00**	**minutes**
Design Rainfall Intensity, I =	4.58	8.85	inch/hr
Calculated Local Peak Flow, Q_p =	0.66	1.35	cfs
Total Design Peak Flow, Q =	**0.66**	**1.35**	**cfs**

NOTE: For the MINOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

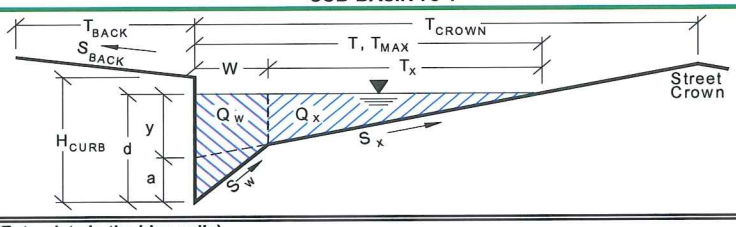
NOTE: For the MAJOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

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

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

Project: Central Park Boulevard

Inlet ID: SUB-BASIN 78-1



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} =	0.0200	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} =	36.0	ft
Gutter Depression	a =	0.00	inches
Gutter Width	W =	3.00	ft
Street Transverse Slope	S_X =	0.0154	ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0130	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0150	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	8.0	12.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	6.00	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 =	0.0154	0.0154	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	1.48	2.22	inches
Water Depth with a Gutter Depression	d =	1.48	2.22	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	5.0	9.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.714	0.536	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.3	1.4	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	0.7	1.6	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 =**	**1.0**	**3.1**	**cfs**
Flow Velocity Within the Gutter Section	V =	5.6	7.6	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.7	1.4	

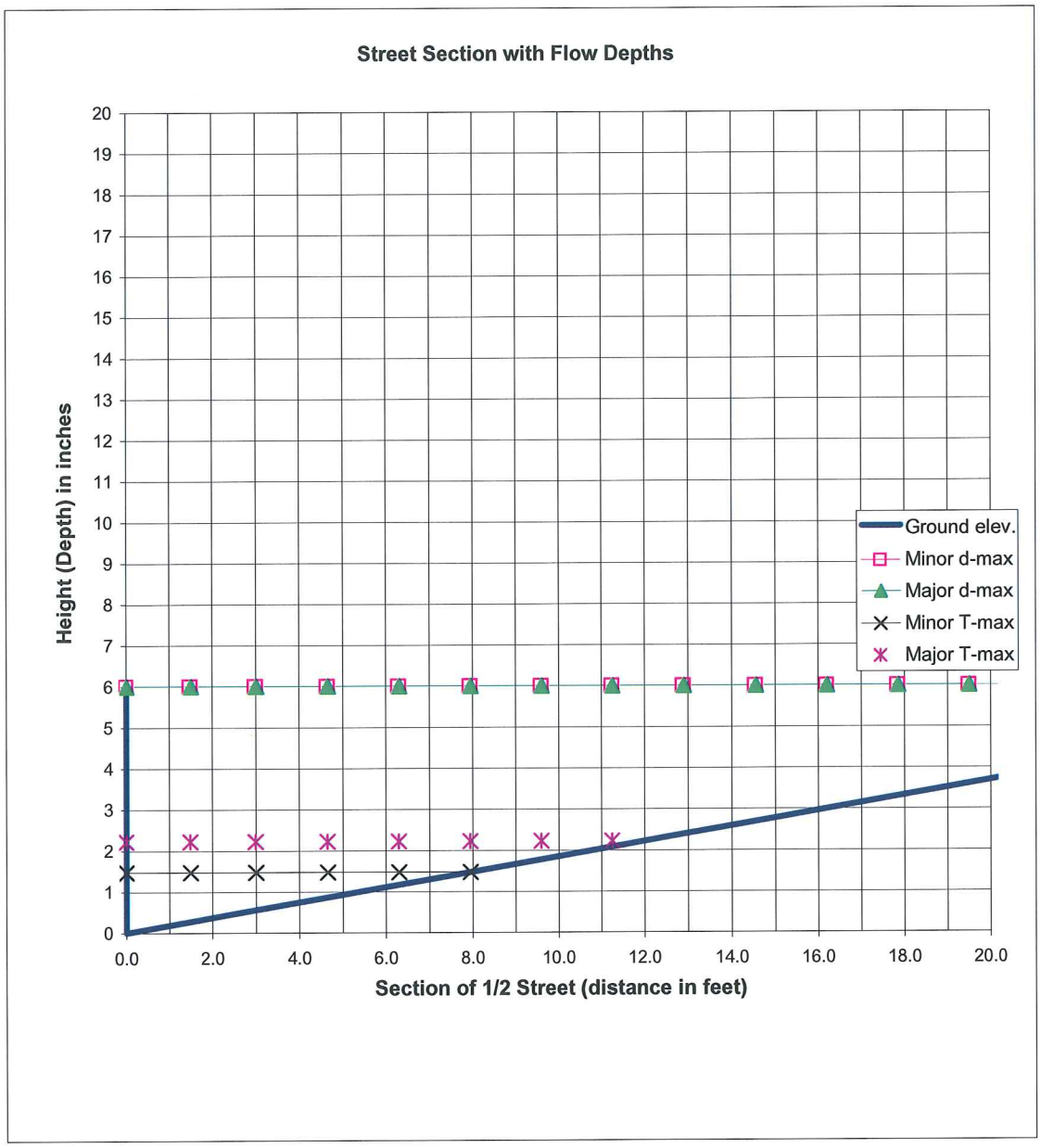
Maximum Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	32.5	32.5	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	29.5	29.5	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.228	0.228	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	33.6	33.6	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	33.6	33.6	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	9.9	9.9	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**43.5**	**43.5**	**cfs**
Flow Velocity Within the Gutter Section	V =	15.6	15.6	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	7.8	7.8	
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 =**	**43.5**	**43.5**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	6.00	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} =**	**1.0**	**3.1**	**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'

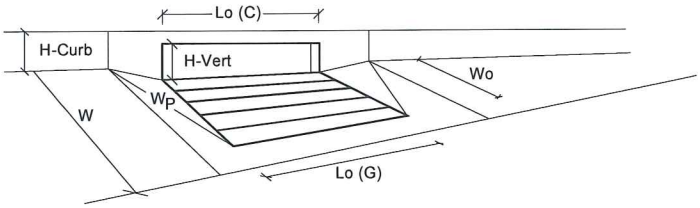


$$Q_x = \frac{0.56}{n} S_x^{5/3} S_L^{1/2} T_x^{8/3} \qquad E_o = \frac{1}{1 + \dfrac{S_w / S_x}{\left[1 + \dfrac{S_w / S_x}{(T/W) - 1}\right]^{8/3} - 1}}$$

$$Q = \frac{Q_x}{1 - E_o}; \; Q_w = Q - Q_x$$

INLET ON A CONTINUOUS GRADE

Project: Central Park Boulevard
Inlet ID: SUB-BASIN 78-1



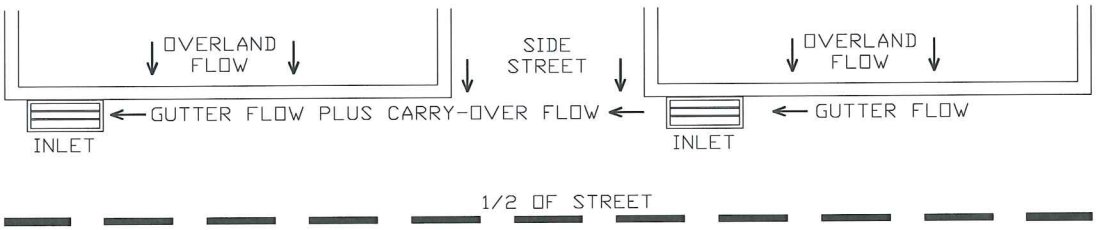
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Directional Cast Vane Grate		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	0.5	0.5	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	2.00	2.00	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 =	**0.66**	**1.35**	**cfs**
Water Spread Width	T =	6.8	8.9	ft
Water Depth at Flowline (outside of local depression)	d =	1.3	1.6	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 =	0.792	0.669	
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 =	0.52	0.91	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.35	0.60	sq ft
Street Flow Velocity	V_s =	1.88	2.25	fps
Water Depth for Design Condition	d_{LOCAL} =	1.7	2.1	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	2.00	2.00	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	0.792	0.669	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =	5.96	5.96	fps
Interception Rate of Frontal Flow	R_f =	1.00	1.00	
Interception Rate of Side Flow	R_x =	0.14	0.11	
Interception Capacity	Q_i =	0.43	0.64	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 =	1.00	1.00	ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =	3.99	3.99	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 =	**0.42**	**0.61**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	Q_b =	**0.24**	**0.74**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	**0.42**	**0.61**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	**0.24**	**0.74**	**cfs**
Capture Percentage = Q_a/Q_o =	C% =	**63.4**	**45.3**	**%**

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

Central Park Boulevard

SUB-BASIN 78-2

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 =			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 =	0.04	Acres
Percent Imperviousness =	100.00	%
NRCS Soil Type =	C	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 =	5	100	years
Return Period One-Hour Precipitation, P_1 =	1.35	2.61	inches
C_1 =	28.5	28.5	
C_2 =	10.0	10.0	
C_3 =	0.786	0.786	
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 =	0.900	0.950	
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.24**	**0.74**	**cfs**

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

	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	0.896	0.956	
Calculated 5-yr. Runoff Coefficient, C5 =	0.896	0.896	
Overland Flow Velocity, V_O =	0.06	0.08	fps
Gutter Flow Velocity, V_G =	2.62	2.62	fps
Overland Flow Time, t_O =	0.29	0.22	minutes
Gutter Flow Time, t_G =	0.73	0.73	minutes
Calculated Time of Concentration, T_c =	1.02	0.95	minutes
Time of Concentration by Regional Formula, T_c =	10.64	10.64	minutes
Recommended T_c =	5.00	5.00	minutes
Time of Concentration Selected by User, T_c =	**5.00**	**5.00**	**minutes**
Design Rainfall Intensity, I =	4.58	8.85	inch/hr
Calculated Local Peak Flow, Q_p =	0.16	0.34	cfs
Total Design Peak Flow, Q =	**0.40**	**1.08**	**cfs**

NOTE: For the MINOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

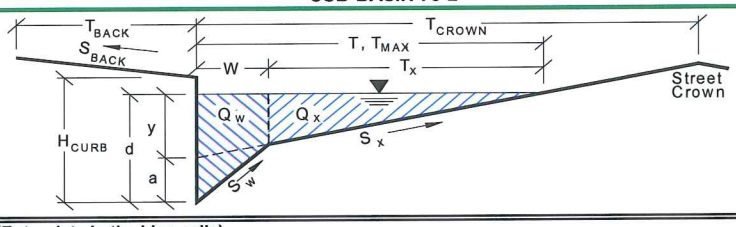
NOTE: For the MAJOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

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

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

Project: Central Park Boulevard

Inlet ID: SUB-BASIN 78-2



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} =	0.0200	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} =	36.0	ft
Gutter Depression	a =	0.00	inches
Gutter Width	W =	3.00	ft
Street Transverse Slope	S_X =	0.0170	ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.0200	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0150	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	8.0	12.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.00	6.00	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 =	0.0170	0.0170	ft/ft
Water Depth without Gutter Depression (Eq. ST-2)	y =	1.63	2.45	inches
Water Depth with a Gutter Depression	d =	1.63	2.45	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	5.0	9.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.714	0.536	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.4	2.1	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	1.1	2.4	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 =**	**1.5**	**4.5**	**cfs**
Flow Velocity Within the Gutter Section	V =	7.4	10.1	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	1.0	2.1	

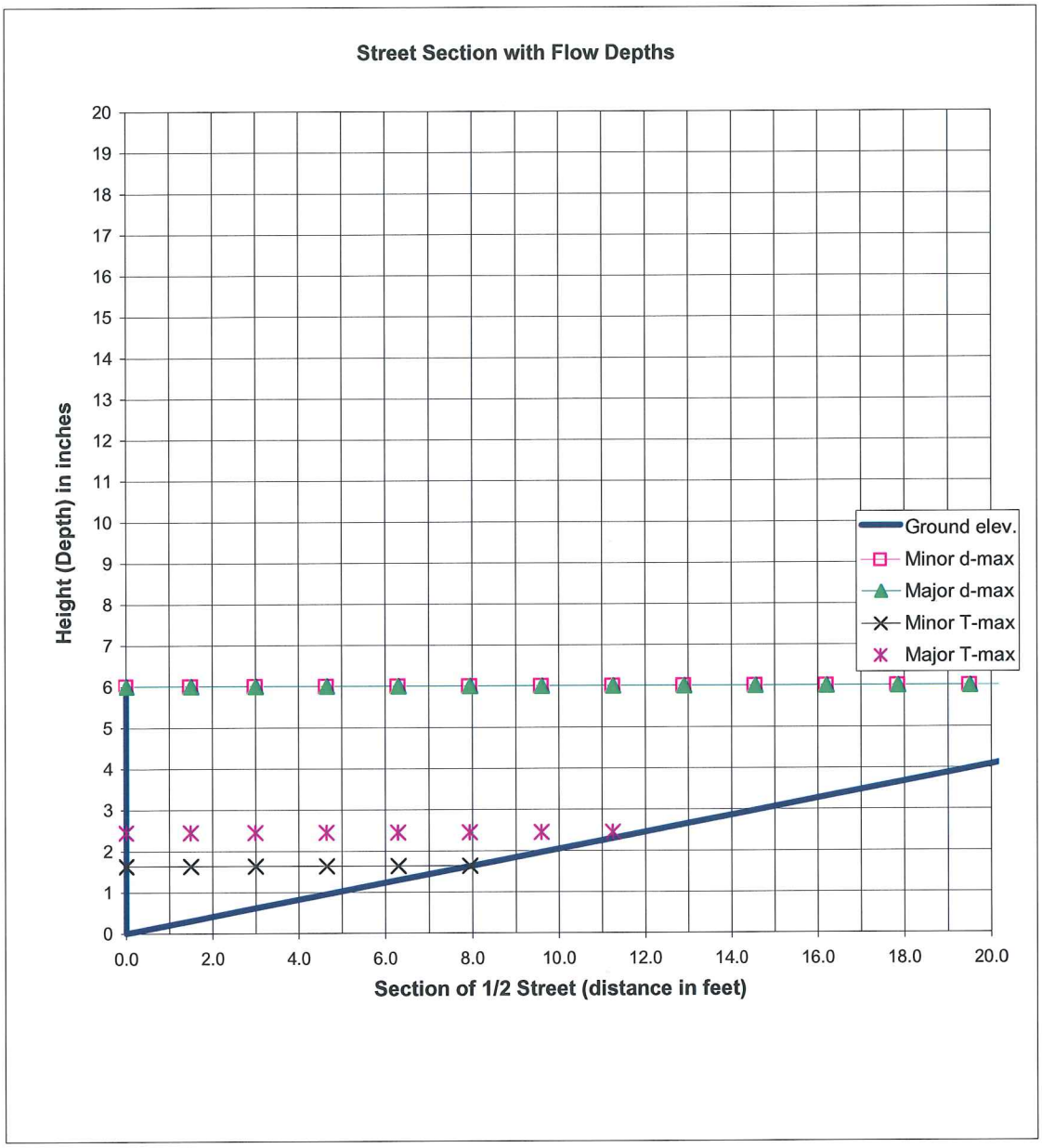
Maximum Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	29.4	29.4	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	26.4	26.4	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.249	0.249	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	36.7	36.7	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	36.7	36.7	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	12.2	12.2	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**48.9**	**48.9**	**cfs**
Flow Velocity Within the Gutter Section	V =	19.3	19.3	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	9.6	9.6	
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 =**	**48.9**	**48.9**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	6.00	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} =**	**1.5**	**4.5**	**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'

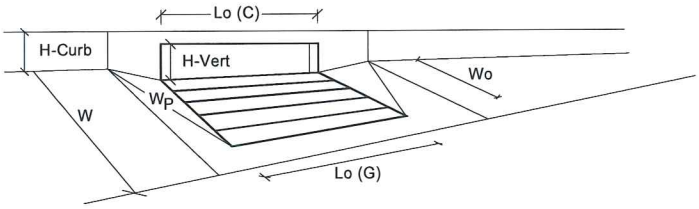


$$Q_x = \frac{0.56}{n} S_x^{5/3} S_L^{1/2} T_x^{8/3} \qquad E_o = \frac{1}{1 + \dfrac{S_w / S_x}{\left[1 + \dfrac{S_w / S_x}{(T/W) - 1}\right]^{8/3} - 1}}$$

$$Q = \frac{Q_x}{1 - E_o}; \; Q_w = Q - Q_x$$

INLET ON A CONTINUOUS GRADE

Project: Central Park Boulevard
Inlet ID: SUB-BASIN 78-2



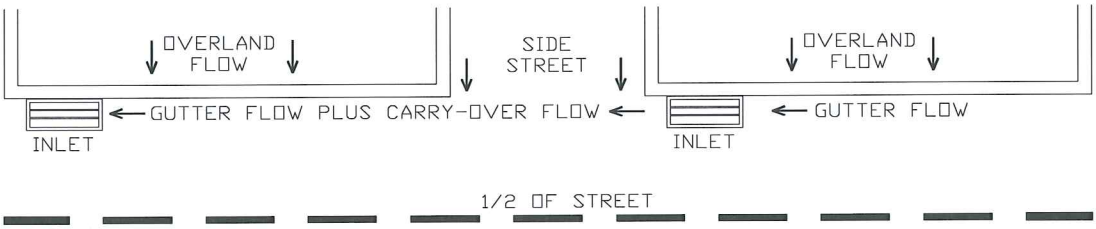
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Directional Cast Vane Grate		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	1.0	1.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	2.00	2.00	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 =	**0.40**	**1.08**	**cfs**
Water Spread Width	T =	4.9	7.1	ft
Water Depth at Flowline (outside of local depression)	d =	1.0	1.4	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.922	0.773	
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 =	0.37	0.83	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.00	0.00	cfs
Street Flow Area	A_s =	0.20	0.42	sq ft
Street Flow Velocity	V_s =	2.01	2.56	fps
Water Depth for Design Condition	d_{LOCAL} =	2.0	2.4	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	2.00	2.00	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	0.922	0.773	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Spash-Over Begins	V_o =	5.96	5.96	fps
Interception Rate of Frontal Flow	R_f =	1.00	1.00	
Interception Rate of Side Flow	R_x =	0.14	0.09	
Interception Capacity	Q_i =	0.35	0.66	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 =	1.00	1.00	ft
Minimum Velocity Where Grate Spash-Over Begins	V_o =	3.99	3.99	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 =	**0.34**	**0.65**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	Q_b =	**0.06**	**0.43**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	**0.34**	**0.65**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	**0.06**	**0.43**	**cfs**
Capture Percentage = Q_a/Q_o =	C% =	**85.3**	**60.2**	**%**

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

Central Park Boulevard

SUB-BASIN 78-3

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 =**			**cfs**

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

Subcatchment Area =	0.06	Acres
Percent Imperviousness =	100.00	%
NRCS Soil Type =	C	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 =	5	100	years
Return Period One-Hour Precipitation, P_1 =	1.35	2.61	inches
C_1 =	28.5	28.5	
C_2 =	10.0	10.0	
C_3 =	0.786	0.786	
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 =	0.900	0.950	
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	**0.06**	**0.43**	**cfs**

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

	Minor Storm	Major Storm	
Calculated Design Storm Runoff Coefficient, C =	0.896	0.956	
Calculated 5-yr. Runoff Coefficient, C5 =	0.896	0.896	
Overland Flow Velocity, V_O =	0.06	0.08	fps
Gutter Flow Velocity, V_G =	2.62	2.62	fps
Overland Flow Time, t_O =	0.29	0.22	minutes
Gutter Flow Time, t_G =	0.73	0.73	minutes
Calculated Time of Concentration, T_c =	1.02	0.95	minutes
Time of Concentration by Regional Formula, T_c =	10.64	10.64	minutes
Recommended T_c =	5.00	5.00	minutes
Time of Concentration Selected by User, T_c =	**5.00**	**5.00**	**minutes**
Design Rainfall Intensity, I =	4.58	8.85	inch/hr
Calculated Local Peak Flow, Q_p =	0.25	0.51	cfs
Total Design Peak Flow, Q =	**0.31**	**0.94**	**cfs**

NOTE: For the MINOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

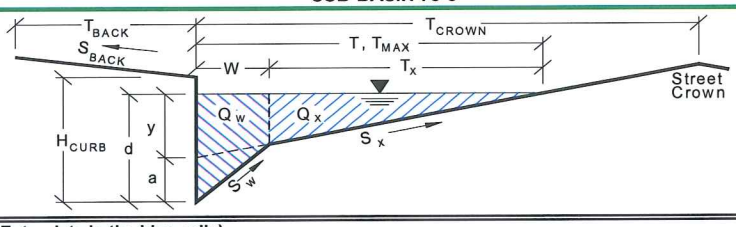
NOTE: For the MAJOR STORM, calculated values for Tc & Qp are based on overide values entered for C and/or C-5.

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

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

Project: Central Park Boulevard

Inlet ID: SUB-BASIN 78-3



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} =	0.0200	ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.0130	
Height of Curb at Gutter Flow Line	H_{CURB} =	4.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	36.0	ft
Gutter Depression	a =	0.00	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 =	0.0222	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.0150	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	8.0	12.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	4.00	4.00	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 =	1.92	2.88	inches
Water Depth with a Gutter Depression	d =	1.92	2.88	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	6.0	10.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.536	0.385	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	1.0	3.8	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	1.1	2.4	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 =**	**2.1**	**6.2**	**cfs**
Flow Velocity Within the Gutter Section	V =	4.0	5.4	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.6	1.3	

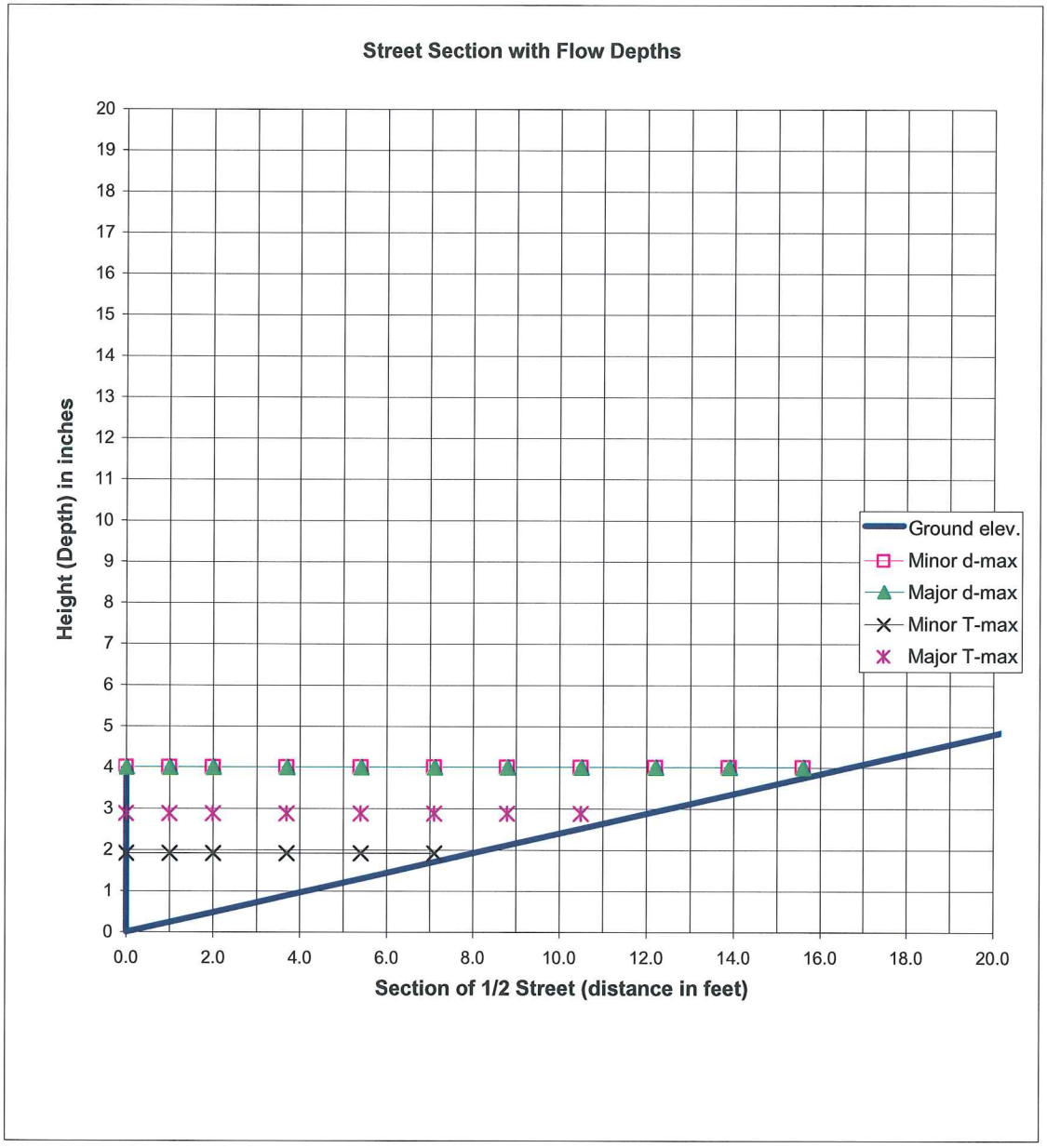
Maximum Gutter Capacity Based on Allowable Gutter Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	16.7	16.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	14.7	14.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.289	0.289	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	10.6	10.6	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	10.6	10.6	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	4.3	4.3	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm	**Q =**	**14.9**	**14.9**	**cfs**
Flow Velocity Within the Gutter Section	V =	6.8	6.8	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.3	2.3	
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 =**	**14.9**	**14.9**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	4.00	4.00	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} =**	**2.1**	**6.2**	**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'



$$Q_x = \frac{0.56}{n} S_x^{5/3} S_L^{1/2} T_x^{8/3}$$

$$E_o = \frac{1}{1 + \dfrac{S_w / S_x}{\left[1 + \dfrac{S_w / S_x}{(T/W) - 1}\right]^{8/3} - 1}}$$

$$Q = \frac{Q_x}{1 - E_o}; \; Q_w = Q - Q_x$$

Central Park Boulevard Interchange with I-70
CDOT Project No.: ES6 C010-103 (17334)
Denver Contract Control No.: CE 93041

Appendix C – Hydraulic Calculations (100-year Event)

CulvertMaster and FlowMaster Printouts

SEMA CONSTRUCTION WILSON & COMPANY

Clean Print
JCH 4-8-10

Worksheet for Pipe P1

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00230	ft/ft
Diameter	3.50	ft
Discharge	21.00	ft³/s

Results

Normal Depth	1.61	ft
Flow Area	4.34	ft²
Wetted Perimeter	5.23	ft
Hydraulic Radius	0.83	ft
Top Width	3.49	ft
Critical Depth	1.40	ft
Percent Full	46.1	%
Critical Slope	0.00379	ft/ft
Velocity	4.84	ft/s
Velocity Head	0.36	ft
Specific Energy	1.98	ft
Froude Number	0.77	
Maximum Discharge	51.90	ft³/s
Discharge Full	48.25	ft³/s
Slope Full	0.00044	ft/ft
Flow Type	SubCritical	

* HGL @ Outlet End
= 5247.50 + 1.61 = 5249.11

* HGL @ Type D Inlet =
5248.10 + .65(0.36) + 1.61 = 5249.95

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	46.14	%
Downstream Velocity	Infinity	ft/s

Trap Channel @ End of P-1

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	0.00300	ft/ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	4.00	ft
Discharge	21.00	ft^3/s

Results

Normal Depth	1.22	ft
Flow Area	10.77	ft^2
Wetted Perimeter	14.02	ft
Hydraulic Radius	0.77	ft
Top Width	13.72	ft
Critical Depth	0.74	ft
Critical Slope	0.02276	ft/ft
Velocity	1.95	ft/s
Velocity Head	0.06	ft
Specific Energy	1.27	ft
Froude Number	0.39	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.22	ft
Critical Depth	0.74	ft
Channel Slope	0.00300	ft/ft

Culvert Calculator Report
Proposed 42" P-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	5,250.60	ft	Headwater Depth/Height	0.58	
Computed Headwater Elev	5,250.54	ft	Discharge	21.00	cfs
Inlet Control HW Elev.	5,250.43	ft	Tailwater Elevation	5,249.95	ft
Outlet Control HW Elev.	5,250.54	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	5,248.50	ft	Downstream Invert	5,248.20	ft
Length	112.00	ft	Constructed Slope	0.002679	ft/ft

Hydraulic Profile					
Profile	M1		Depth, Downstream	1.75	ft
Slope Type	Mild		Normal Depth	1.51	ft
Flow Regime	Subcritical		Critical Depth	1.40	ft
Velocity Downstream	4.37	ft/s	Critical Slope	0.003505	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	3.50	ft
Section Size	42 inch		Rise	3.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	5,250.54	ft	Upstream Velocity Head	0.39	ft
Ke	0.20		Entrance Loss	0.08	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,250.43	ft	Flow Control	Unsubmerged	
Inlet Type	Groove end w/headwall		Area Full	9.6	ft^2
K	0.00180		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	2	
C	0.02920		Equation Form	1	
Y	0.74000				

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Culvert Calculator Report
Proposed 30" P-3

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	5,251.30	ft	Headwater Depth/Height	0.90	
Computed Headwater Elev	5,251.25	ft	Discharge	17.80	cfs
Inlet Control HW Elev.	5,251.07	ft	Tailwater Elevation	5,250.50	ft
Outlet Control HW Elev.	5,251.25	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	5,249.00	ft	Downstream Invert	5,248.60	ft
Length	170.00	ft	Constructed Slope	0.002353	ft/ft

Hydraulic Profile					
Profile	M1		Depth, Downstream	1.90	ft
Slope Type	Mild		Normal Depth	1.85	ft
Flow Regime	Subcritical		Critical Depth	1.43	ft
Velocity Downstream	4.45	ft/s	Critical Slope	0.004860	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.50	ft
Section Size	30 inch		Rise	2.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	5,251.25	ft	Upstream Velocity Head	0.32	ft
Ke	0.20		Entrance Loss	0.06	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,251.07	ft	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	4.9	ft^2
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Minor Basin Storm Sewers P-4 Through P-14 Report

Label	Diameter (ft)	Channel Slope (ft/ft)	Friction Method	Roughness Coefficient	Discharge (ft^3/s)	Normal Depth (ft)	Velocity (ft/s)	Velocity Head (ft)
P-4A	1.50	0.04600	Manning Formula	0.013	1.70	0.28	7.50	0.87
P-4	1.50	0.36160	Manning Formula	0.013	2.20	0.19	16.74	4.36
P-5A	1.50	0.03250	Manning Formula	0.013	1.40	0.28	6.27	0.61
P-5	1.50	0.35600	Manning Formula	0.013	2.00	0.18	16.13	4.04
P-6	1.50	0.01000	Manning Formula	0.013	5.70	0.79	6.07	0.57
P-7	1.50	0.16900	Manning Formula	0.013	6.50	0.39	17.60	4.81
P-8	1.50	0.01000	Manning Formula	0.013	2.20	0.47	4.70	0.34
P-9	1.50	0.02400	Manning Formula	0.013	2.10	0.36	6.34	0.62
P-10	1.50	0.01000	Manning Formula	0.013	1.10	0.33	3.85	0.23
P-11	1.50	0.01000	Manning Formula	0.013	1.00	0.31	3.75	0.22
P-12	1.50	0.01100	Manning Formula	0.013	1.90	0.42	4.67	0.34
P-13	1.50	0.01000	Manning Formula	0.013	2.60	0.51	4.93	0.38
P-14	1.50	0.18500	Manning Formula	0.013	7.00	0.40	18.56	5.35

18" Diameter RCP

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.20000	ft/ft
Diameter	1.50	ft
Discharge	6.30	ft^3/s

Results

Normal Depth	0.37	ft
Flow Area	0.34	ft^2
Wetted Perimeter	1.56	ft
Hydraulic Radius	0.22	ft
Top Width	1.29	ft
Critical Depth	0.97	ft
Percent Full	24.7	%
Critical Slope	0.00637	ft/ft
Velocity	18.51	ft/s
Velocity Head	5.33	ft
Specific Energy	5.70	ft
Froude Number	6.36	
Maximum Discharge	50.53	ft^3/s
Discharge Full	46.97	ft^3/s
Slope Full	0.00360	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	24.74	%
Downstream Velocity	Infinity	ft/s

Culvert Calculator Report
Proposed 24" P-15

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	5,268.00	ft	Headwater Depth/Height	0.43	
Computed Headwater Elev	5,264.87	ft	Discharge	3.00	cfs
Inlet Control HW Elev.	5,264.74	ft	Tailwater Elevation	5,254.00	ft
Outlet Control HW Elev.	5,264.87	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	5,264.00	ft	Downstream Invert	5,253.10	ft
Length	123.00	ft	Constructed Slope	0.088618	ft/ft

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.90	ft
Slope Type	Steep		Normal Depth	0.29	ft
Flow Regime	N/A		Critical Depth	0.60	ft
Velocity Downstream	2.19	ft/s	Critical Slope	0.004456	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	5,264.87	ft	Upstream Velocity Head	0.22	ft
Ke	0.20		Entrance Loss	0.04	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,264.74	ft	Flow Control	Unsubmerged	
Inlet Type	Groove end projecting		Area Full	3.1	ft^2
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

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Culvert Calculator Report
48" Ramp - F P-16

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	5,266.60	ft	Headwater Depth/Height	1.14	
Computed Headwater Elev	5,266.32	ft	Discharge	88.00	cfs
Inlet Control HW Elev.	5,266.32	ft	Tailwater Elevation	5,260.00	ft
Outlet Control HW Elev.	5,266.18	ft	Control Type	Inlet Control	

Grades					
Upstream Invert	5,261.75	ft	Downstream Invert	5,256.60	ft
Length	147.00	ft	Constructed Slope	0.035034	ft/ft

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	1.68	ft
Slope Type	Steep		Normal Depth	1.57	ft
Flow Regime	N/A		Critical Depth	2.84	ft
Velocity Downstream	17.59	ft/s	Critical Slope	0.005143	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	4.00	ft
Section Size	48 inch		Rise	4.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	5,266.18	ft	Upstream Velocity Head	1.32	ft
Ke	0.20		Entrance Loss	0.26	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,266.32	ft	Flow Control	Transition	
Inlet Type	Square edge w/headwall		Area Full	12.6	ft^2
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

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Culvert Calculator Report
Proposed 36" P-17

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	5,255.00	ft	Headwater Depth/Height	1.21	
Computed Headwater Elev	5,254.63	ft	Discharge	44.00	cfs
Inlet Control HW Elev.	5,254.56	ft	Tailwater Elevation	5,252.00	ft
Outlet Control HW Elev.	5,254.63	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	5,251.00	ft	Downstream Invert	5,250.00	ft
Length	222.00	ft	Constructed Slope	0.004505	ft/ft

Hydraulic Profile					
Profile	M2		Depth, Downstream	2.16	ft
Slope Type	Mild		Normal Depth	2.41	ft
Flow Regime	Subcritical		Critical Depth	2.16	ft
Velocity Downstream	8.07	ft/s	Critical Slope	0.005769	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	5,254.63	ft	Upstream Velocity Head	0.81	ft
Ke	0.50		Entrance Loss	0.41	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,254.56	ft	Flow Control	N/A	
Inlet Type	Square edge w/headwall		Area Full	7.1	ft^2
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

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Culvert Calculator Report
36" Ramp - E - P-18

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	5,260.10	ft	Headwater Depth/Height	1.04	
Computed Headwater Elev	5,258.72	ft	Discharge	39.00	cfs
Inlet Control HW Elev.	5,258.49	ft	Tailwater Elevation	5,251.00	ft
Outlet Control HW Elev.	5,258.72	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	5,255.60	ft	Downstream Invert	5,249.50	ft
Length	88.00	ft	Constructed Slope	0.069318	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.03	ft
Slope Type	Steep		Normal Depth	0.96	ft
Flow Regime	Supercritical		Critical Depth	2.03	ft
Velocity Downstream	18.08	ft/s	Critical Slope	0.005319	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	5,258.72	ft	Upstream Velocity Head	0.91	ft
Ke	0.20		Entrance Loss	0.18	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,258.49	ft	Flow Control	Unsubmerged	
Inlet Type	Groove end w/headwall		Area Full	7.1	ft^2
K	0.00180		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	2	
C	0.02920		Equation Form	1	
Y	0.74000				

Culvert Calculator Report
Proposed 30" P-19

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	5,249.00	ft	Headwater Depth/Height	0.86	
Computed Headwater Elev	5,246.15	ft	Discharge	18.00	cfs
Inlet Control HW Elev.	5,246.03	ft	Tailwater Elevation	5,244.00	ft
Outlet Control HW Elev.	5,246.15	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	5,244.00	ft	Downstream Invert	5,239.90	ft
Length	96.00	ft	Constructed Slope	0.042708	ft/ft

Hydraulic Profile					
Profile	CompositePressureProfileS1S2		Depth, Downstream	4.10	ft
Slope Type	N/A		Normal Depth	0.78	ft
Flow Regime	N/A		Critical Depth	1.44	ft
Velocity Downstream	3.67	ft/s	Critical Slope	0.004879	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.50	ft
Section Size	30 inch		Rise	2.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	5,246.15	ft	Upstream Velocity Head	0.59	ft
Ke	0.20		Entrance Loss	0.12	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,246.03	ft	Flow Control	Unsubmerged	
Inlet Type	Groove end projecting		Area Full	4.9	ft^2
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

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MANNINGS n = 0.013

Central Park Boulevard Storm Sewer

Pipes P20 , P21 and ~~P23~~ P22

HGL CALCULATION

4/2/2010 13:07

STATION	PIPE SIZE (inches)	PEAK RATE (cfs)	AREA (sf)	VELOCITY (fps)	CONV. K	FRICTION SLOPE (ft/ft)	JUNCTION DATA LENGTH (ft)	JUNCTION DATA LATERAL SIZE (inches)	JUNCTION DATA LATERAL ANGLE (degrees)	FRICTION LOSS (ft)	MANHOLE LOSS K	MANHOLE LOSS (ft)	ENTRANCE LOSS K	ENTRANCE LOSS (ft)	TOTAL LOSS (ft)	ENERGY GRADE LINE (elevation)	VELOCITY HEAD (ft)	HYDRAULIC GRADE LINE (elevation)
Outlet	54	79																
Outlet	54	79	15.896	4.97	1966	0.00162	0.00			0.00					0.00	5245.00	0.38	5244.62
Type D Inlet	54	79	15.896	4.97	1966	0.00162	199.00			0.32		0.00			0.32	5245.32	0.38	5244.94
Type D Inlet	54	79	15.896	4.97	1966	0.00162	0.00	NA		0.00	0.65	0.25			0.25	5245.57	0.38	5245.19
MH.	54	79	15.896	4.97	1966	0.00162	285.00			0.46		0.00			0.46	5246.03	0.38	5245.65
MH.	54	79	15.896	4.97	1966	0.00162	0.00			0.00	0.45	0.17			0.17	5246.20	0.38	5245.82
Inlet End	54	79	15.896	4.97	1966	0.00162	628.00			1.01		0.00			1.01	5247.22	0.38	5246.83
Inlet End	54	79	15.896	4.97	1966	0.00162	0.00			0.00		0.00	0.50	0.19	0.19	5247.41	0.00	5247.41

Culvert Calculator Report
Proposed 24" RCP Under Ramp A, P23

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	5,251.35	ft	Headwater Depth/Height	1.91	
Computed Headwater Elev	5,251.32	ft	Discharge	14.50	cfs
Inlet Control HW Elev.	5,250.60	ft	Tailwater Elevation	5,250.60	ft
Outlet Control HW Elev.	5,251.32	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	5,247.50	ft	Downstream Invert	5,247.00	ft
Length	86.00	ft	Constructed Slope	0.005814	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	3.60	ft
Slope Type	N/A		Normal Depth	1.36	ft
Flow Regime	N/A		Critical Depth	1.37	ft
Velocity Downstream	4.62	ft/s	Critical Slope	0.005715	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	5,251.32	ft	Upstream Velocity Head	0.33	ft
Ke	0.20		Entrance Loss	0.06	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,250.60	ft	Flow Control	Unsubmerged	
Inlet Type	Groove end w/headwall		Area Full	3.1	ft^2
K	0.00180		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	2	
C	0.02920		Equation Form	1	
Y	0.74000				

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Worksheet for Pipe P-24

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Slope

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00193	ft/ft
Normal Depth	2.50	ft
Diameter	2.50	ft
Discharge	18.00	ft³/s

Results

Channel Slope	0.00193	ft/ft
Normal Depth	2.50	ft
Flow Area	4.91	ft²
Wetted Perimeter	7.85	ft
Hydraulic Radius	0.63	ft
Top Width	0.00	ft
Critical Depth	1.44	ft
Percent Full	100.0	%
Critical Slope	0.00488	ft/ft
Velocity	3.67	ft/s
Velocity Head	0.21	ft
Specific Energy	2.71	ft
Froude Number	0.00	
Maximum Discharge	19.36	ft³/s
Discharge Full	18.00	ft³/s
Slope Full	0.00193	ft/ft
Flow Type	SubCritical	

100 YR WS @ Outlet End
Per SWMM = 5247.62
HGL @ Type D Inlet @
6142+21.5, 59.3 LT (Ramp C)
= 5247.62 + 111(0.00193) +
0.21(0.50) = 5247.94

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%

Minor Basin Storm Sewers P-25 Through P-26A Report

Label	Diameter (ft)	Channel Slope (ft/ft)	Friction Method	Roughness Coefficient	Discharge (ft^3/s)	Normal Depth (ft)	Velocity (ft/s)	Velocity Head (ft)
P-25	1.50	0.21100	Manning Formula	0.013	0.80	0.13	10.22	1.62
P-26	1.50	0.36100	Manning Formula	0.013	1.26	0.15	14.13	3.10
P-26A	1.50	0.01500	Manning Formula	0.013	0.60	0.22	3.72	0.21

18" Diameter RCP

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.20000	ft/ft
Diameter	1.50	ft
Discharge	6.30	ft^3/s

Results

Normal Depth	0.37	ft
Flow Area	0.34	ft^2
Wetted Perimeter	1.56	ft
Hydraulic Radius	0.22	ft
Top Width	1.29	ft
Critical Depth	0.97	ft
Percent Full	24.7	%
Critical Slope	0.00637	ft/ft
Velocity	18.51	ft/s
Velocity Head	5.33	ft
Specific Energy	5.70	ft
Froude Number	6.36	
Maximum Discharge	50.53	ft^3/s
Discharge Full	46.97	ft^3/s
Slope Full	0.00360	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	24.74	%
Downstream Velocity	Infinity	ft/s

Culvert Calculator Report
Proposed 54" South WQ Pond Outlet P-27

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	5,245.00	ft	Headwater Depth/Height	1.81	
Computed Headwater Eleva	5,244.65	ft	Discharge	85.00	cfs
Inlet Control HW Elev.	5,243.76	ft	Tailwater Elevation	5,243.76	ft
Outlet Control HW Elev.	5,244.65	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	5,236.50	ft	Downstream Invert	5,236.25	ft
Length	121.00	ft	Constructed Slope	0.002066	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	7.51	ft
Slope Type	N/A		Normal Depth	3.50	ft
Flow Regime	N/A		Critical Depth	2.70	ft
Velocity Downstream	5.34	ft/s	Critical Slope	0.004136	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	4.50	ft
Section Size	54 inch		Rise	4.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	5,244.65	ft	Upstream Velocity Head	0.44	ft
Ke	0.50		Entrance Loss	0.22	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,243.76	ft	Flow Control	N/A	
Inlet Type	Square edge w/headwall		Area Full	15.9	ft2
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

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Culvert Calculator Report
Proposed 24" P-29

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	5,233.50	ft	Headwater Depth/Height	1.03	
Computed Headwater Elev	5,231.57	ft	Discharge	14.00	cfs
Inlet Control HW Elev.	5,231.48	ft	Tailwater Elevation	5,227.10	ft
Outlet Control HW Elev.	5,231.57	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	5,229.50	ft	Downstream Invert	5,222.00	ft
Length	125.00	ft	Constructed Slope	0.060000	ft/ft

Hydraulic Profile					
Profile	CompositePressureProfileS1S2		Depth, Downstream	5.10	ft
Slope Type	N/A		Normal Depth	0.69	ft
Flow Regime	N/A		Critical Depth	1.35	ft
Velocity Downstream	4.46	ft/s	Critical Slope	0.006053	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	5,231.57	ft	Upstream Velocity Head	0.60	ft
Ke	0.20		Entrance Loss	0.12	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,231.48	ft	Flow Control	Unsubmerged	
Inlet Type	Groove end projecting		Area Full	3.1	ft^2
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Calculator Report
Proposed 36" P-31

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	5,257.00	ft	Headwater Depth/Height	0.30	
Computed Headwater Elev	5,255.00	ft	Discharge	4.10	cfs
Inlet Control HW Elev.	5,254.81	ft	Tailwater Elevation	5,247.60	ft
Outlet Control HW Elev.	5,255.00	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	5,254.10	ft	Downstream Invert	5,243.00	ft
Length	118.00	ft	Constructed Slope	0.094068	ft/ft

Hydraulic Profile					
Profile	CompositePressureProfileS1S2		Depth, Downstream	4.60	ft
Slope Type	N/A		Normal Depth	0.29	ft
Flow Regime	N/A		Critical Depth	0.63	ft
Velocity Downstream	0.58	ft/s	Critical Slope	0.003984	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	5,255.00	ft	Upstream Velocity Head	0.22	ft
Ke	0.20		Entrance Loss	0.04	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,254.81	ft	Flow Control	Unsubmerged	
Inlet Type	Groove end w/headwall		Area Full	7.1	ft^2
K	0.00180		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	2	
C	0.02920		Equation Form	1	
Y	0.74000				

Culvert Calculator Report
Existing 36" CMP N WQ Pond Outlet Pipe D194 to D196, EX-P1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	5,242.00	ft	Headwater Depth/Height	0.87	
Computed Headwater Elev	5,241.10	ft	Discharge	15.00	cfs
Inlet Control HW Elev.	5,240.23	ft	Tailwater Elevation	5,239.00	ft
Outlet Control HW Elev.	5,241.10	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	5,238.50	ft	Downstream Invert	5,238.00	ft
Length	280.00	ft	Constructed Slope	0.000000	ft/ft

Hydraulic Profile					
Profile	H2		Depth, Downstream	1.24	ft
Slope Type	Horizontal		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	1.24	ft
Velocity Downstream	5.47	ft/s	Critical Slope	0.013671	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	5,241.10	ft	Upstream Velocity Head	0.09	ft
Ke	0.50		Entrance Loss	0.05	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,240.23	ft	Flow Control	N/A	
Inlet Type	Headwall		Area Full	7.1	ft^2
K	0.00780		HDS 5 Chart	2	
M	2.00000		HDS 5 Scale	1	
C	0.03790		Equation Form	1	
Y	0.69000				

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Culvert Calculator Report
Existing 18" RCP Under I-70, EX-P2, D-140 to D142, Proposed Condition

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	5,250.70	ft	Headwater Depth/Height	2.40	
Computed Headwater Elev:	5,250.59	ft	Discharge	11.50	cfs
Inlet Control HW Elev.	5,249.27	ft	Tailwater Elevation	5,247.94	ft
Outlet Control HW Elev.	5,250.59	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	5,247.00	ft	Downstream Invert	5,246.50	ft
Length	160.00	ft	Constructed Slope	0.003125	ft/ft

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	1.44	ft
Slope Type	Mild		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	1.29	ft
Velocity Downstream	6.60	ft/s	Critical Slope	0.011064	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.50	ft
Section Size	18 inch		Rise	1.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	5,250.59	ft	Upstream Velocity Head	0.66	ft
Ke	0.10		Entrance Loss	0.07	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,249.27	ft	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	1.8	ft^2
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

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Culvert Calculator Report

Existing 18" RCP Under I-70, EX-P2, D-140 to D142, Existing Condition

Solve For: Discharge

OVERFLOW TO DITCH

+32 = 47cfs = Q100 @ A.P. D121

Culvert Summary

Allowable HW Elevation	5,252.55 ft	Headwater Depth/Height	3.70
Computed Headwater Elev	5,252.55 ft	Discharge	14.82 cfs
Inlet Control HW Elev.	5,249.95 ft	Tailwater Elevation	5,248.15 ft
Outlet Control HW Elev.	5,252.55 ft	Control Type	Outlet Control

Grades

Upstream Invert	5,247.00 ft	Downstream Invert	5,246.50 ft
Length	155.00 ft	Constructed Slope	0.003226 ft/ft

Hydraulic Profile

Profile	PressureProfile	Depth, Downstream	1.65 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	1.40 ft
Velocity Downstream	8.39 ft/s	Critical Slope	0.017218 ft/ft

Section

Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	1.50 ft
Section Size	18 inch	Rise	1.50 ft
Number Sections	1		

Outlet Control Properties

Outlet Control HW Elev.	5,252.55 ft	Upstream Velocity Head	1.09 ft
Ke	0.20	Entrance Loss	0.22 ft

Inlet Control Properties

Inlet Control HW Elev.	5,249.95 ft	Flow Control	Submerged
Inlet Type	Beveled ring, 33.7° bevels	Area Full	1.8 ft²
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	B
C	0.02430	Equation Form	1
Y	0.83000		

Existing Ditch Overflow Point @ Inlet End of Ex P-2, AP D140

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.034	
Channel Slope	0.00220	ft/ft
Normal Depth	1.55	ft
Left Side Slope	6.00	ft/ft (H:V)
Right Side Slope	6.00	ft/ft (H:V)
Bottom Width	2.00	ft

Results

Discharge	31.96	ft^3/s
Flow Area	17.52	ft^2
Wetted Perimeter	20.86	ft
Hydraulic Radius	0.84	ft
Top Width	20.60	ft
Critical Depth	0.97	ft
Critical Slope	0.02082	ft/ft
Velocity	1.82	ft/s
Velocity Head	0.05	ft
Specific Energy	1.60	ft
Froude Number	0.35	
Flow Type	Subcritical	

Use Peak Q100 @ A.P. D121 TO APPROXIMATE EXISTING FLOW TO EXIST. 18" CULVERT EX-P2
Total Q100 = 47cfs
Flow Through EX-P2 = 15 cfs
47 − 15 = 32 cfs

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.55	ft
Critical Depth	0.97	ft
Channel Slope	0.00220	ft/ft

Culvert Calculator Report
Existing 30" RCP Crossing I-70 above P17 EX-P3 Proposed Condition

Solve For: Discharge

Culvert Summary					
Allowable HW Elevation	5,258.60	ft	Headwater Depth/Height	2.00	
Computed Headwater Elev	5,258.60	ft	Discharge	43.66	cfs
Inlet Control HW Elev.	5,257.75	ft	Tailwater Elevation	5,254.63	ft
Outlet Control HW Elev.	5,258.60	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	5,253.60	ft	Downstream Invert	5,252.50	ft
Length	200.00	ft	Constructed Slope	0.005500	ft/ft

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	2.20	ft
Slope Type	Mild		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	2.20	ft
Velocity Downstream	9.54	ft/s	Critical Slope	0.010188	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.50	ft
Section Size	30 inch		Rise	2.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	5,258.60	ft	Upstream Velocity Head	1.23	ft
Ke	0.20		Entrance Loss	0.25	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,257.75	ft	Flow Control	Submerged	
Inlet Type	Groove end w/headwall		Area Full	4.9	ft^2
K	0.00180		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	2	
C	0.02920		Equation Form	1	
Y	0.74000				

Worksheet for Proposed Broad Crested Weir @AP D-118 @ Inlet of EX-P3

Project Description

Solve For	Headwater Elevation

Input Data

Discharge		44.00	ft^3/s
Crest Elevation		5257.50	ft
Tailwater Elevation		5258.50	ft
Crest Surface Type	Gravel		
Crest Breadth		6.00	ft
Crest Length		14.00	ft (average)

Results

Headwater Elevation	5258.62	ft
Headwater Height Above Crest	1.12	ft
Tailwater Height Above Crest	1.00	ft
Weir Coefficient	2.98	US
Submergence Factor	0.89	
Adjusted Weir Coefficient	2.65	US
Flow Area	15.71	ft^2
Velocity	2.80	ft/s
Wetted Perimeter	16.24	ft
Top Width	14.00	ft

Culvert Calculator Report

Existing 30" RCP Crossing I-70 above P17 EX-P3 Existing Condition

EX-P3

Solve For: Discharge

Culvert Summary

Allowable HW Elevation	5,257.10 ft	Headwater Depth/Height	1.40
Computed Headwater Elev	5,257.10 ft	Discharge	35.13 cfs = 88-53 (overfow to Ditch)
Inlet Control HW Elev.	5,256.94 ft	Tailwater Elevation	5,254.00 ft
Outlet Control HW Elev.	5,257.10 ft	Control Type	Outlet Control

Grades

Upstream Invert	5,253.60 ft	Downstream Invert	5,252.50 ft
Length	205.00 ft	Constructed Slope	0.005366 ft/ft

Hydraulic Profile

Profile	CompositeM2PressureProfile	Depth, Downstream	2.01 ft
Slope Type	Mild	Normal Depth	N/A ft
Flow Regime	Subcritical	Critical Depth	2.01 ft
Velocity Downstream	8.29 ft/s	Critical Slope	0.007503 ft/ft

Section

Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	2.50 ft
Section Size	30 inch	Rise	2.50 ft
Number Sections	1		

Outlet Control Properties

Outlet Control HW Elev.	5,257.10 ft	Upstream Velocity Head	0.80 ft
Ke	0.20	Entrance Loss	0.16 ft

Inlet Control Properties

Inlet Control HW Elev.	5,256.94 ft	Flow Control	Submerged
Inlet Type	Groove end w/headwall	Area Full	4.9 ft²
K	0.00180	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	2
C	0.02920	Equation Form	1
Y	0.74000		

Worksheet for Existing Ditch Overflow Point @ Inlet End of Ex P-3, AP

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.034	
Channel Slope	0.00600	ft/ft
Left Side Slope	20.00	ft/ft (H:V)
Right Side Slope	11.00	ft/ft (H:V)
Bottom Width	2.00	ft
Discharge	88-35(culvert flow)=53.00	ft³/s

Results

Normal Depth	1.13	ft + 5256.0 = 5257.1
Flow Area	22.12	ft²
Wetted Perimeter	37.17	ft
Hydraulic Radius	0.60	ft
Top Width	37.09	ft
Critical Depth	0.88	ft
Critical Slope	0.02175	ft/ft
Velocity	2.40	ft/s
Velocity Head	0.09	ft
Specific Energy	1.22	ft
Froude Number	0.55	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.13	ft
Critical Depth	0.88	ft
Channel Slope	0.00600	ft/ft

Culvert Calculator Report
Existing 54" RCP Under CPB D155 to D158, EX-P4

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	5,250.40	ft	Headwater Depth/Height	0.81	
Computed Headwater Elev	5,250.24	ft	Discharge	71.00	cfs
Inlet Control HW Elev.	5,250.08	ft	Tailwater Elevation	5,247.94	ft
Outlet Control HW Elev.	5,250.24	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	5,246.60	ft	Downstream Invert	5,244.30	ft
Length	650.00	ft	Constructed Slope	0.003538	ft/ft

Hydraulic Profile					
Profile	M1		Depth, Downstream	3.64	ft
Slope Type	Mild		Normal Depth	2.53	ft
Flow Regime	Subcritical		Critical Depth	2.46	ft
Velocity Downstream	5.15	ft/s	Critical Slope	0.003886	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	4.50	ft
Section Size	54 inch		Rise	4.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	5,250.24	ft	Upstream Velocity Head	0.92	ft
Ke	0.20		Entrance Loss	0.18	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,250.08	ft	Flow Control	Unsubmerged	
Inlet Type	Groove end w/headwall		Area Full	15.9	ft^2
K	0.00180		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	2	
C	0.02920		Equation Form	1	
Y	0.74000				

Worksheet for Trap Channel NW Pond D137 to P-3 Along Ramp A

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.034	
Channel Slope	0.00150	ft/ft
Normal Depth	1.20	ft
Left Side Slope	3.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	5.50	ft

Results

Discharge	17.22	ft^3/s
Flow Area	11.64	ft^2
Wetted Perimeter	14.24	ft
Hydraulic Radius	0.82	ft
Top Width	13.90	ft
Critical Depth	0.59	ft
Critical Slope	0.02228	ft/ft
Velocity	1.48	ft/s
Velocity Head	0.03	ft
Specific Energy	1.23	ft
Froude Number	0.29	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.20	ft
Critical Depth	0.59	ft
Channel Slope	0.00150	ft/ft

Worksheet for Generic Trapazoidal Channel (Roadside Ditch)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	0.00300	ft/ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	4.00	ft
Discharge	25.00	ft^3/s

Results

Normal Depth	1.32	ft
Flow Area	12.24	ft^2
Wetted Perimeter	14.88	ft
Hydraulic Radius	0.82	ft
Top Width	14.56	ft
Critical Depth	0.81	ft
Critical Slope	0.02220	ft/ft
Velocity	2.04	ft/s
Velocity Head	0.06	ft
Specific Energy	1.38	ft
Froude Number	0.39	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.32	ft
Critical Depth	0.81	ft
Channel Slope	0.00300	ft/ft

Rating Curve for Generic Trapazoidal Channel (Roadside Ditch)

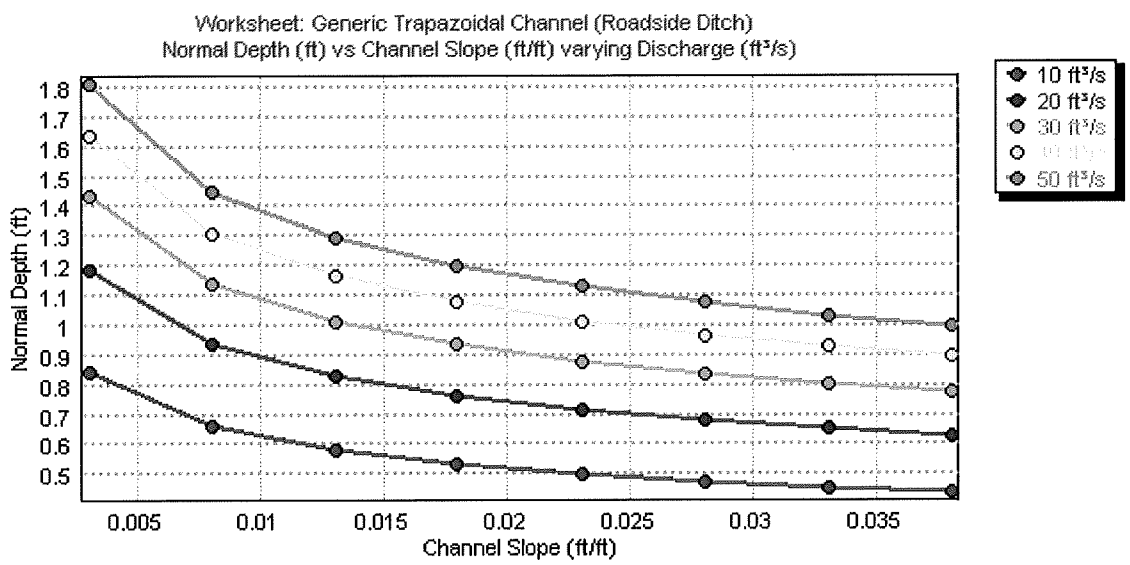
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	0.00300	ft/ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	4.00	ft
Discharge	25.00	ft^3/s

Rating Curve Plot



Rating Curve for Generic Trapazoidal Channel (Roadside Ditch)

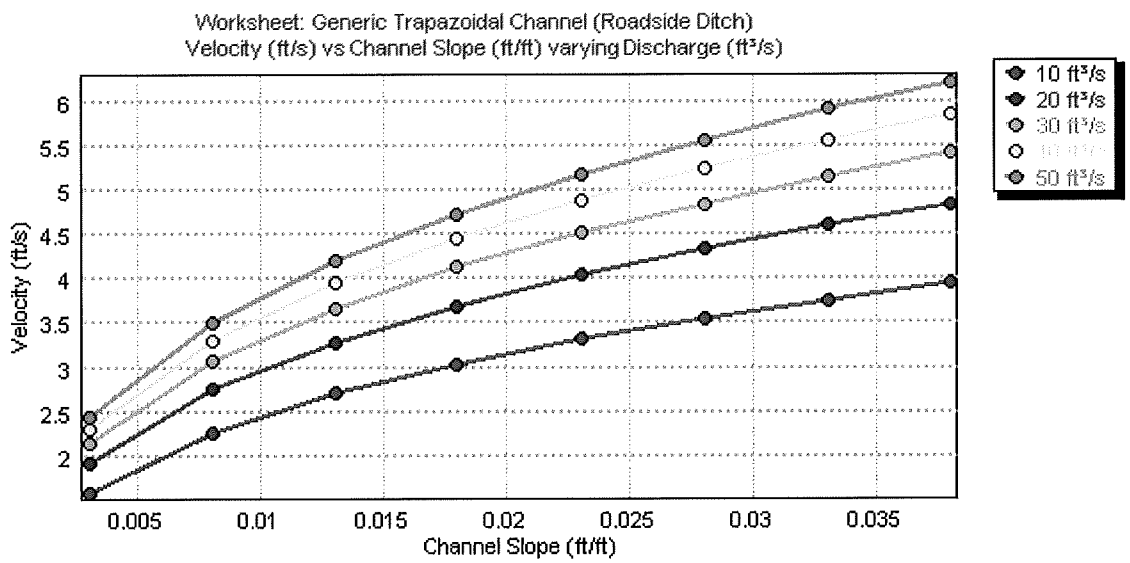
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

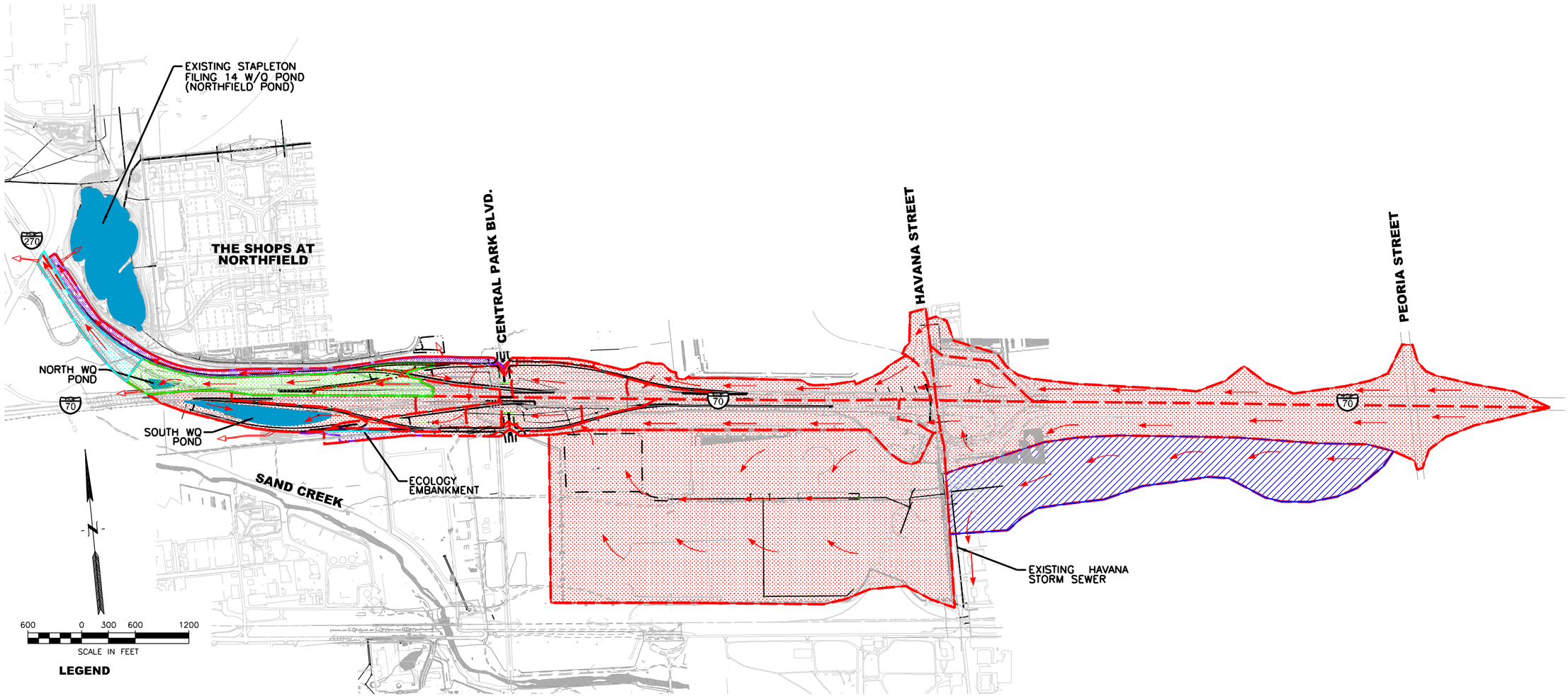
Roughness Coefficient	0.035	
Channel Slope	0.00300	ft/ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	4.00	ft
Discharge	25.00	ft^3/s

Rating Curve Plot



Appendix D – Water Quality

Permanent Water Quality Treatment Map
Water Quality Pond Watershed Summary
Water Quality Pond Calculation Sheets



LEGEND

- GENERAL FLOW DIRECTION
- WATER QUALITY FLOW DRAINS TO HAVANA STORM SEWER (NOT APART OF THE PROJECT AREA)
- RUNOFF FROM THIS AREA TREATED IN THE EXISTING STAPLETON FILING 14 DETENTION W/Q POND (10.21 AC.)
- RUNOFF FROM THIS AREA TREATED IN THE PROPOSED NORTH W/Q POND (19.32 AC.)
- RUNOFF FROM THIS AREA TREATED IN THE PROPOSED SOUTH W/Q POND (422.5 AC.)
- RUNOFF FROM THIS AREA TREATED IN LINEAR ECOLOGY EMBANKMENT ALONG RAMP SHOULDER

JCHolste 10:08:27 AM 5/28/2010 c:\pwworking\wilson_projects\jcholste\dms00313\CE93041_DRN_HYDMAP.dgn

Sheet Revisions

Number	Date:	Comments	Init.
A	02/12/10	PRELIMINARY DESIGN (FIR) PACKAGE	VSF
B	04/09/10	FOR - EARLY GRADING, DRAINAGE & UTILITY PACKAGE	VSF
1	06/03/10	RFC - EARLY GRADING, DRAINAGE & UTILITY PACKAGE	VSF
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CENTRAL PARK BLVD.
INTERCHANGE WITH I-70

SEMA CONSTRUCTION WILSON & COMPANY

PERMANENT WATER QUALITY BMPS
WATERSHED AREA MAP

Designer: VSF	Date: 05/10	Check: JCH	Date: 05/10	Structure Numbers	.
Detailer: DLM	Date: 05/10	Check: JCH	Date: 05/10		.

Project No.	CE 93041
Sheet Subset	DRAINAGE
Sheet Number	DMP005

FOR Water Quality Calc Package

Central Park Blvd.
Waterquality Pond Watershed Summary
3/29/2010

Clean Print
TDS 4.8.10

South WQ Pond

Basin ID	Basin Area (ac)	Percent Impervious	Basin Impervious Area (ac)	% Imp.
10	36.75	65.00	23.89	
11	9.51	40.00	3.80	
20	64.42	65.00	41.87	
21	2.95	49.00	1.45	
40	18.63	30.00	5.59	
41	3.92	15.00	0.59	
42	3.09	70.00	2.16	
43	1.18	35.00	0.41	
50a	10.28	30.00	3.08	
50b	5.93	45.00	2.67	
53	2.13	55.00	1.17	
60	30.51	35.00	10.68	
61a	7.19	50.00	3.60	
61b	2.38	25.00	0.60	
62	13.13	45.00	5.91	
63	2.79	52.00	1.45	
65a	1.75	49.00	0.86	
66	7.21	48.00	3.46	
68	2.70	73.00	1.97	
77	1.31	40.00	0.52	
78	3.96	30.00	1.19	
Sub-total	231.72		116.92	0.50
30	190.76	55.00	104.92	
Total	422.48		221.83	0.53
			MDCIA LEVEL II REDUCTION	0.42

North WQ Pond

Basin ID	Basin Area (ac)	Percent Impervious	Basin Impervious Area (ac)	% Imp.
70	4.56	45.00	2.05	
72	13.52	30.00	4.06	
73	1.24	45.00	0.56	
Total	19.32		6.67	0.35
			MDCIA LEVEL II REDUCTION	0.22

Central Park Blvd.
Waterquality Pond Watershed Summary
3/29/2010

Stapleton 14 WQ Forebay

Basin ID	Basin Area (ac)	Percent Impervious	Basin Impervious Area (ac)	% Imp.
74	6.76	40.0	2.70	
75	3.45	25.0	0.86	
Total	10.21		3.57	0.35
			MDCIA LEVEL II REDUCTION	0.24

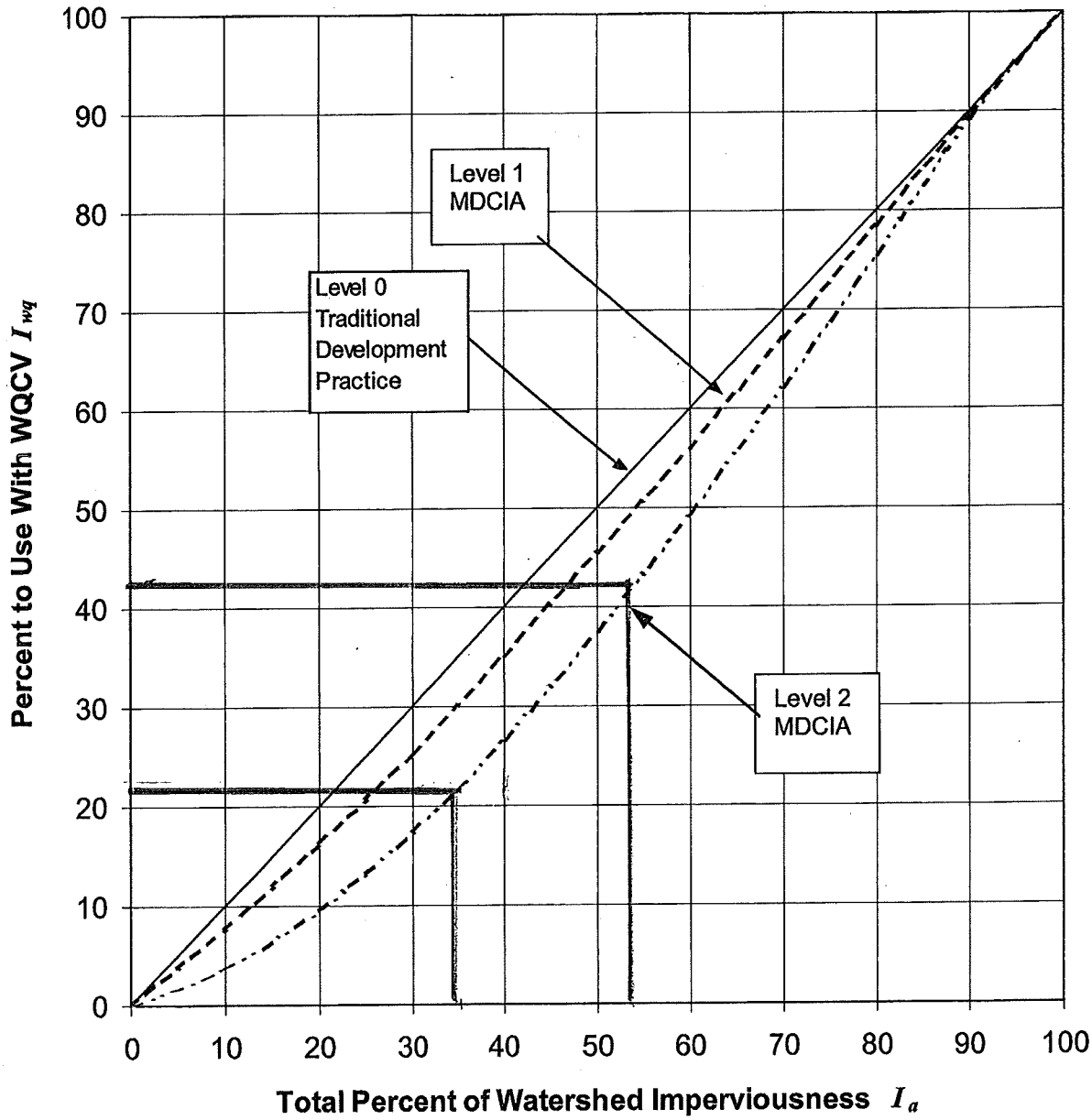


Figure ND-1—Imperviousness Adjustments for Level 1 and 2 of MDCIA

South WQ Pond: Calculated Imp=53%, Level 2 MDCIA Imp = 42%
North WQ Pond: Calculated Imp=35%, Level 2 MDCIA Imp = 22%
Runoff to Stapleton 14 Pond: Imp=35%, Level 2 MDCIA Imp=22%

Design Procedure Form: Extended Detention Basin (EDB) - Sedimentation Facility

Designer:	**D. Moffett**
Company:	**Wilson & Company**
Date:	**May 27, 2010**
Project:	**Central Park Boulevard**
Location:	**South Water Quality Pond**

1. Basin Storage Volume	
A) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)	I_a = 42.00 % i = 0.42
B) Contributing Watershed Area (Area)	Area = 422.480 acres
C) Water Quality Capture Volume (WQCV) ($WQCV = 1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i)$)	WQCV = 0.19 watershed inches
D) Design Volume: Vol = (WQCV / 12) * Area * 1.2	Vol = 7.8203 acre-feet
2. Outlet Works	
A) Outlet Type (Check One)	X Orifice Plate Perforated Riser Pipe Other:
B) Depth at Outlet Above Lowest Perforation (H)	H = 4.91 feet
C) Recommended Maximum Outlet Area per Row, (A_o)	A_o = 10.4 square inches
D) Perforation Dimensions: i) Circular Perforation Diameter or ii) Width of 2" High Rectangular Perforations	 D = inches W = 5.20 inches
E) Number of Columns (nc, See Table 6a-1 For Maximum)	nc = 1 number
F) Actual Design Outlet Area per Row (A_o)	A_o = 10.4 square inches
G) Number of Rows (nr)	nr = 15 number
H) Total Outlet Area (A_{ot})	A_{ot} = 153.3 square inches
3. Trash Rack	
A) Needed Open Area: A_t = 0.5 * (Figure 7 Value) * A_{ot}	A_t = 4,607 square inches
B) Type of Outlet Opening (Check One)	≤ 2" Diameter **Round** X 2" High **Rectangular** Other:
C) For 2", or Smaller, **Round Opening** (Ref.: Figure 6a):	
i) Width of Trash Rack and Concrete Opening (W_{conc}) from Table 6a-1	W_{conc} = inches
ii) Height of Trash Rack Screen (H_{TR})	H_{TR} = inches

Design Procedure Form: Extended Detention Basin (EDB) - Sedimentation Facility

Designer:	**D. Moffett**
Company:	**Wilson & Company**
Date:	**May 27, 2010**
Project:	**Central Park Boulevard**
Location:	**South Water Quality Pond**

iii) Type of Screen (Based on Depth H), Describe if "Other"	____ S.S. #93 VEE Wire (US Filter) ____ Other: ____
iv) Screen Opening Slot Dimension, Describe if "Other"	____ 0.139" (US Filter) ____ Other: ____
v) Spacing of Support Rod (O.C.) Type and Size of Support Rod (Ref.: Table 6a-2)	____ inches
vi) Type and Size of Holding Frame (Ref.: Table 6a-2)	
D) For 2" High **Rectangular Opening** (Refer to Figure 6b):	
I) Width of Rectangular Opening (W)	W = 5.20 inches
ii) Width of Perforated Plate Opening (W_{conc} = W + 12")	W_{conc} = 17.20 inches
iii) Width of Trashrack Opening ($W_{opening}$) from Table 6b-1	$W_{opening}$ = 78.0 inches
iv) Height of Trash Rack Screen (H_{TR})	H_{TR} = 89 inches
v) Type of Screen (based on depth H) (Describe if "Other")	X Klemp™ KPP Series Aluminum ____ Other: ____
vi) Cross-bar Spacing (Based on Table 6b-1, Klemp™ KPP Grating). Describe if "Other"	4.00 inches ____ Other: ____
vii) Minimum Bearing Bar Size (Klemp™ Series, Table 6b-2) (Based on depth of WQCV surcharge)	**2.00 in. x 3/16 in.**
4. Detention Basin length to width ratio	____ (L/W)
5 Pre-sedimentation Forebay Basin - Enter design values	
A) Volume (3% to 5% of Design Volume from 1D) (3% - 5% of Design Volume (0.2346 - 0.391 acre-feet.)	0.2350 acre-feet
B) Surface Area	0.141 acres
C) Connector Pipe Diameter (Size to drain this volume in 5-minutes under inlet control)	12 inches
D) Paved/Hard Bottom and Sides	**YES** yes/no

Design Procedure Form: Extended Detention Basin (EDB) - Sedimentation Facility

Designer: D. Moffett
Company: Wilson & Company
Date: May 27, 2010
Project: Central Park Boulevard
Location: South Water Quality Pond

6. Two-Stage Design - See Figure EDB-1	
A) Top Stage (Depth D_{WQ} = 2' Minimum) Top Stage Storage: no less than 96.5% of Design Volume (7.5462 acre-feet.)	D_{WQ} = 4.91 feet Storage= 7.8200 acre-feet
B) Bottom Stage Depth (D_{BS} = 0.33' Minimum Below Trickle Channel Invert) Bottom Stage Storage: no less than 0.5% of Design Volume (0.0391 acre-feet.) Storage = A * Depth Above WS To Bottom Of Top Stage	D_{BS} = 0.67 feet Storage= 0.0400 acre-feet Surf. Area= 0.060 acres
C) Micro Pool (Minimum Depth = the Larger of 0.50 * Top Stage Depth (2.46 ') or 2.5 '	Depth= 2.00 feet
NOTE: Micro Pool Depth in cell L139 is smaller than recommended. D) Total Volume: Vol_{tot} = Storage from 5A + 6A + 6B (Must be > Design Volume in 1D, or 7.8203 acre-feet.)	Vol_{tot} = 8.0950 acre-feet
7. Basin Side Slopes (Z, horizontal distance per unit vertical) Minimum Z = 4, Flatter Preferred	Z = 4.00 (horizontal/vertical)
8. Dam Embankment Side Slopes (Z, horizontal distance) per unit vertical) Minimum Z = 3, Flatter Preferred	Z = 3.00 (horizontal/vertical)
9. Vegetation (Check the method or describe "Other")	X Native Grass Irrigated Turf Grass Other:

Notes:

CENTRAL PARK BOULEVARD
FINAL DRAINAGE REPORT
(Pond Volume Calculation)

South WQ Pond

Elevation	SF	CF	Storage AF	Storage Sum
5236.5	2,239.96			0
5237	2,720.89	1,240.21	0.03	0.03
5238	8,578.40	5,649.65	0.13	0.16
5239	62,559.50	35,568.95	0.82	0.97
5240	120,419.50	91,489.50	2.10	3.08
5241	156,931.70	138,675.60	3.18	6.26
5242	175,507.40	166,219.55	3.82	10.07
5243	196,204.50	185,855.95	4.27	14.34
5244	213,571.30	204,887.90	4.70	19.04
5245	229,263.30	221,417.30	5.08	24.13

Total = 1,051,005 CF

Total = 24.13 Ac-ft

At Elevation 5241.41, the Storage is 7.82 Ac-ft.
#N/A

Calculated by: DLM
Date: 5/27/2010
Checked by: 2/SF

CENTRAL PARK BOULEVARD
FINAL DRAINAGE REPORT
(Pond Volume Calculation)

South WQ Pond FB

Elevation	SF	CF	Storage AF	Storage Sum
5239.8	0.00			0
5240	3,744.00	374.40	0.01	0.01
5241	4,913.00	4,328.50	0.10	0.11
5242	6,158.00	5,535.50	0.13	0.24

Total = 10,238 CF

Total = 0.24 Ac-ft

#NUM!
#N/A

Calculated by: DLM
Date: 5/27/2010
Checked by: DSF

CENTRAL PARK BOULEVARD
FINAL DRAINAGE REPORT
(Pond Volume Calculation)

South WQ Pond MP

Elevation	SF	CF	Storage AF	Storage Sum
5234.5	946.00			0
5235	1,061.00	501.75	0.01	0.01
5236	1,181.00	1,121.00	0.03	0.04
5236.5	2,240.00	855.25	0.02	0.06

Total = 2,478 CF

Total = 0.06 Ac-ft

#NUM!
#N/A

Calculated by: DLM
Date: 5/27/2010
Checked by: VGF

CENTRAL PARK BOULEVARD
FINAL DRAINAGE REPORT
(Pond Volume Calculation)

S. WQ Pond MP SC

			Storage	
Elevation	SF	CF	AF	Sum
5236.5	2,231.22			0
5237	2,707.69	1,234.73	0.03	0.03
5237.17	2,879.68	474.93	0.01	0.04

Total = 1,710 CF

Total = 0.04 Ac-ft

#NUM!
#N/A

Calculated by: DLM
Date: 5/27/2010
Checked by: DSF

FROM: Central Park Boulevard

TO:

WILSON & COMPANY

DATE:

FILE:

SUBJECT: South W.Q. Pond

Forebay Outlet Works

3% min Total WQCV 0.03 x 7.81 = 10,206 CF

Total Forebay Volume = 10,206 CF = 0.234 Ac-Ft

CDOT Req'd Drain Time = 45 mins

Q_{AVG} = 10,206 cf / (45 mins x 60 sec) = 3.78 l/s

$Q = C_D A \sqrt{2 \cdot g \cdot h}$

$3.78 = 0.6 (A) \sqrt{2 \cdot (32.2) h}$ h = Avg depth

Solve for A 2.2'/2 = 1.1'

A = 0.75

$\pi r^2 = A$

$r = \sqrt{\frac{0.75}{\pi}} = 0.48 = 0.5$ 6"

D = 2xr = 2x 0.5 = 1.0 → Use a min of 12"

Low flow channel

per UDFCD criteria → size low flow channel for 2x discharge. (3.78 x 2) = 7.56 ≈ 7.6 CFS

See Attached Flowmaster Output "S WQ Pond - Low flow channel"

HIGHER Relationships

SHARED OWNERSHIP • COLLABORATION • INTEGRITY • DISCIPLINE • SOLUTIONS

S WQ Pond - Low Flow Channel

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00650	ft/ft
Bottom Width	6.00	ft
Discharge	7.60	ft^3/s

Results

Normal Depth	0.32	ft
Flow Area	1.90	ft^2
Wetted Perimeter	6.63	ft
Hydraulic Radius	0.29	ft
Top Width	6.00	ft
Critical Depth	0.37	ft
Critical Slope	0.00401	ft/ft
Velocity	4.00	ft/s
Velocity Head	0.25	ft
Specific Energy	0.57	ft
Froude Number	1.25	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.32	ft
Critical Depth	0.37	ft
Channel Slope	0.00650	ft/ft
Critical Slope	0.00401	ft/ft

Design Procedure Form: Extended Detention Basin (EDB) - Sedimentation Facility

Designer:	**D. Moffett**
Company:	**Wilson & Company**
Date:	**May 27, 2010**
Project:	**Central Park Boulevard**
Location:	**North Water Quality Pond**

1. Basin Storage Volume	
A) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)	I_a = 22.00 % i = 0.22
B) Contributing Watershed Area (Area)	Area = 19.320 acres
C) Water Quality Capture Volume (WQCV) ($WQCV = 1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i)$)	WQCV = 0.12 watershed inches
D) Design Volume: Vol = (WQCV / 12) * Area * 1.2	Vol = 0.2390 acre-feet
2. Outlet Works	
A) Outlet Type (Check One)	X Orifice Plate Perforated Riser Pipe Other:
B) Depth at Outlet Above Lowest Perforation (H)	H = 1.39 feet
C) Recommended Maximum Outlet Area per Row, (A_o)	A_o = 0.9 square inches
D) Perforation Dimensions: i) Circular Perforation Diameter or ii) Width of 2" High Rectangular Perforations	 D = 1.000 inches W = inches
E) Number of Columns (nc, See Table 6a-1 For Maximum)	nc = 1 number
F) Actual Design Outlet Area per Row (A_o)	A_o = 0.8 square inches
G) Number of Rows (nr)	nr = 4 number
H) Total Outlet Area (A_{ot})	A_{ot} = 3.3 square inches
3. Trash Rack	
A) Needed Open Area: A_t = 0.5 * (Figure 7 Value) * A_{ot}	A_t = 112 square inches
B) Type of Outlet Opening (Check One)	X ≤ 2" Diameter **Round** 2" High **Rectangular** Other:
C) For 2", or Smaller, **Round Opening** (Ref.: Figure 6a):	
i) Width of Trash Rack and Concrete Opening (W_{conc}) from Table 6a-1	W_{conc} = 6 inches
ii) Height of Trash Rack Screen (H_{TR})	H_{TR} = 47 inches

Clean print
JCH
5-28-10

Design Procedure Form: Extended Detention Basin (EDB) - Sedimentation Facility

Designer:	**D. Moffett**
Company:	**Wilson & Company**
Date:	**May 27, 2010**
Project:	**Central Park Boulevard**
Location:	**North Water Quality Pond**

iii) Type of Screen (Based on Depth H), Describe if "Other"	x S.S. #93 VEE Wire (US Filter) Other:
iv) Screen Opening Slot Dimension, Describe if "Other"	X 0.139" (US Filter) Other:
v) Spacing of Support Rod (O.C.)	0.75 inches
Type and Size of Support Rod (Ref.: Table 6a-2)	**#156 VEE**
vi) Type and Size of Holding Frame (Ref.: Table 6a-2)	**3/8 in. x 1.0 in. flat bar**
D) For 2" High **Rectangular Opening** (Refer to Figure 6b):	
I) Width of Rectangular Opening (W)	W = inches
ii) Width of Perforated Plate Opening (W_{conc} = W + 12")	W_{conc} = inches
iii) Width of Trashrack Opening ($W_{opening}$) from Table 6b-1	$W_{opening}$ = inches
iv) Height of Trash Rack Screen (H_{TR})	H_{TR} = inches
v) Type of Screen (based on depth H) (Describe if "Other")	Klemp™ KPP Series Aluminum Other:
vi) Cross-bar Spacing (Based on Table 6b-1, Klemp™ KPP Grating). Describe if "Other"	inches Other:
vii) Minimum Bearing Bar Size (Klemp™ Series, Table 6b-2) (Based on depth of WQCV surcharge)	
4. Detention Basin length to width ratio	6.00 (L/W)
5 Pre-sedimentation Forebay Basin - Enter design values	
A) Volume (3% to 5% of Design Volume from 1D) (3% - 5% of Design Volume (0.0072 - 0.012 acre-feet.)	no acre-feet
B) Surface Area	no acres
C) Connector Pipe Diameter (Size to drain this volume in 5-minutes under inlet control)	none inches
D) Paved/Hard Bottom and Sides	**no** yes/no

Design Procedure Form: Extended Detention Basin (EDB) - Sedimentation Facility

Designer: D. Moffett
Company: Wilson & Company
Date: May 27, 2010
Project: Central Park Boulevard
Location: North Water Quality Pond

6. Two-Stage Design - See Figure EDB-1	
A) Top Stage (Depth D_{WQ} = 2' Minimum) NOTE: #VALUE!	D_{WQ} = 1.39 feet Storage= 0.2400 acre-feet
B) Bottom Stage Depth (D_{BS} = 0.33' Minimum Below Trickle Channel Invert) Bottom Stage Storage: no less than 0.5% of Design Volume (0.0012 acre-feet.) Storage = A * Depth Above WS To Bottom Of Top Stage	D_{BS} = 0.10 feet Storage= 0.0012 acre-feet Surf. Area= 0.012 acres
C) Micro Pool (Minimum Depth = the Larger of 0.50 * Top Stage Depth (0.7 ') or 2.5 '	Depth= 2.00 feet
D) Total Volume: Vol_{tot} = Storage from 5A + 6A + 6B (Must be > Design Volume in 1D, or 0.239 acre-feet.)	Vol_{tot} = acre-feet
7. Basin Side Slopes (Z, horizontal distance per unit vertical) Minimum Z = 4, Flatter Preferred	Z = 4.00 (horizontal/vertical)
8. Dam Embankment Side Slopes (Z, horizontal distance) per unit vertical) Minimum Z = 3, Flatter Preferred	Z = 3.00 (horizontal/vertical)
9. Vegetation (Check the method or describe "Other")	X Native Grass Irrigated Turf Grass Other:

Notes:

CENTRAL PARK BOULEVARD
FINAL DRAINAGE REPORT
(Pond Volume Calculation)

North WQ Pond

			Storage	
Elevation	SF	CF	AF	Sum
5238.5	631.00			0
5239	1,964.00	648.75	0.01	0.01
5240	20,140.00	11,052.00	0.25	0.27
5241	90,368.00	55,254.00	1.27	1.54
5242	141,065.00	115,716.50	2.66	4.19

Total = 182,671 CF

Total = 4.19 Ac-ft

At Elevation 5239.89, the Storage is 0.24 Ac-ft.
#N/A

Calculated by: JCH
Date: 5/27/2010
Checked by: JSF

CENTRAL PARK BOULEVARD
FINAL DRAINAGE REPORT
(Pond Volume Calculation)

North WQ Pond MP

Elevation	SF	CF	Storage AF	Storage Sum
5236.5	148.00			0
5237	186.00	83.50	0.00	0.00
5238	464.00	325.00	0.01	0.01
5238.5	631.00	273.75	0.01	0.02

Total = 682 CF

Total = 0.02 Ac-ft

#NUM!
#N/A

Calculated by: JCH
Date: 5/27/2010
Checked by: JSF

Design Procedure Form: Extended Detention Basin (EDB) - Sedimentation Facility

Designer: D. Moffett
Company: Wilson & Company
Date: April 3, 2010
Project: Central Park Boulevard
Location: Stapleton No. 14 WQ Pond (Forebay Design Only)

1. Basin Storage Volume	
A) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)	I_a = 24.00 % i = 0.24
B) Contributing Watershed Area (Area)	Area = 10.210 acres
C) Water Quality Capture Volume (WQCV) ($WQCV = 1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i)$)	WQCV = 0.13 watershed inches
D) Design Volume: Vol = (WQCV / 12) * Area * 1.2	Vol = 0.1340 acre-feet
2. Outlet Works	
A) Outlet Type (Check One)	____ Orifice Plate ____ Perforated Riser Pipe X Other: Forebay Design Only
B) Depth at Outlet Above Lowest Perforation (H)	H = 0.00 feet
C) Recommended Maximum Outlet Area per Row, (A_o)	A_o = 1.5 square inches
D) Perforation Dimensions: i) Circular Perforation Diameter or ii) Width of 2" High Rectangular Perforations	D = 1.375 inches W = ____ inches
E) Number of Columns (nc, See Table 6a-1 For Maximum)	nc = 1 number
F) Actual Design Outlet Area per Row (A_o)	A_o = 1.5 square inches
G) Number of Rows (nr)	nr = 0 number
H) Total Outlet Area (A_{ot})	A_{ot} = 0.0 square inches
3. Trash Rack	
A) Needed Open Area: A_t = 0.5 * (Figure 7 Value) * A_{ot}	A_t = 0 square inches
B) Type of Outlet Opening (Check One)	X ≤ 2" Diameter **Round** ____ 2" High **Rectangular** ____ Other:
C) For 2", or Smaller, **Round Opening** (Ref.: Figure 6a):	
i) Width of Trash Rack and Concrete Opening (W_{conc}) from Table 6a-1	W_{conc} = 0 inches
ii) Height of Trash Rack Screen (H_{TR})	H_{TR} = 88 inches

Design Procedure Form: Extended Detention Basin (EDB) - Sedimentation Facility

Designer:	**D. Moffett**
Company:	**Wilson & Company**
Date:	**April 3, 2010**
Project:	**Central Park Boulevard**
Location:	**Stapleton No. 14 WQ Pond (Forebay Design Only)**

iii) Type of Screen (Based on Depth H), Describe if "Other"	S.S. #93 VEE Wire (US Filter) Other:
iv) Screen Opening Slot Dimension, Describe if "Other"	0.139" (US Filter) Other:
v) Spacing of Support Rod (O.C.) Type and Size of Support Rod (Ref.: Table 6a-2)	inches
vi) Type and Size of Holding Frame (Ref.: Table 6a-2)	
D) For 2" High **Rectangular Opening** (Refer to Figure 6b):	
i) Width of Rectangular Opening (W)	W = inches
ii) Width of Perforated Plate Opening (W_{conc} = W + 12")	W_{conc} = inches
iii) Width of Trashrack Opening ($W_{opening}$) from Table 6b-1	$W_{opening}$ = inches
iv) Height of Trash Rack Screen (H_{TR})	H_{TR} = inches
v) Type of Screen (based on depth H) (Describe if "Other")	Klemp™ KPP Series Aluminum Other:
vi) Cross-bar Spacing (Based on Table 6b-1, Klemp™ KPP Grating). Describe if "Other"	inches Other:
vii) Minimum Bearing Bar Size (Klemp™ Series, Table 6b-2) (Based on depth of WQCV surcharge)	
4. Detention Basin length to width ratio	(L/W)
5 Pre-sedimentation Forebay Basin - Enter design values	
A) Volume (3% to 5% of Design Volume from 1D) (3% - 5% of Design Volume (0.004 - 0.0067 acre-feet.)	0.0040 acre-feet
B) Surface Area	0.141 acres
C) Connector Pipe Diameter (Size to drain this volume in 5-minutes under inlet control)	8 inches
D) Paved/Hard Bottom and Sides	YES yes/no

FROM: Central Park Blvd.

TO: Stapleton 14 Forebay Outlet

WILSON & COMPANY

DATE: JCH

FILE:

SUBJECT: Total Forebay Volume = 375 ft^3

Req'd drain time = 5 min (CCD)

$Q_{ave} = 375\ ft^3 / 5\ min(60\ sec/min) = 1.25\ cfs$

$Q = C_D A \sqrt{2 \cdot g \cdot h}$

$1.25 = 0.6 (A) \sqrt{2(32.2)0.75}$

h = ave depth

$h = 1.5'/2 = 0.75'$

Solve for A

$A = 0.30$

$\pi r^2 = A = 0.30$

$r = 0.31\ ft$

$D = 2 \times r = 2 \times 0.31 = 0.62 \rightarrow$ Use min 8"

HIGHER Relationships

SHARED OWNERSHIP • COLLABORATION • INTEGRITY • DISCIPLINE • SOLUTIONS

CENTRAL PARK BOULEVARD
FINAL DRAINAGE REPORT
(Pond Volume Calculation)

Stapleton 14 WQ FB

			Storage	
Elevation	SF	CF	AF	Sum
5221.5	0.00			0
5222	221.24	55.31	0.00	0.00
5222.5	316.80	134.51	0.00	0.00
5223	422.95	184.94	0.00	0.01

Total = 375 CF

Total = 0.01 Ac-ft

#NUM!
#N/A

Calculated by: DLM
Date: 5/27/2010
Checked by: VSF

Central Park Boulevard Interchange with I-70
CDOT Project No.: ES6 C010-103 (17334)
Denver Contract Control No.: CE 93041

Appendix E –Floodplain

FIRM Maps
Drainage Plans Showing Floodplain Boundaries
Copy of CLOMR

SEMA CONSTRUCTION WILSON & COMPANY

NOTES TO USERS

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

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

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

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

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

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

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

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

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

Base map information shown on this FIRM was provided in digital format by the City and County of Denver, Department of Public Works Geographic Information Systems (GIS) Division.

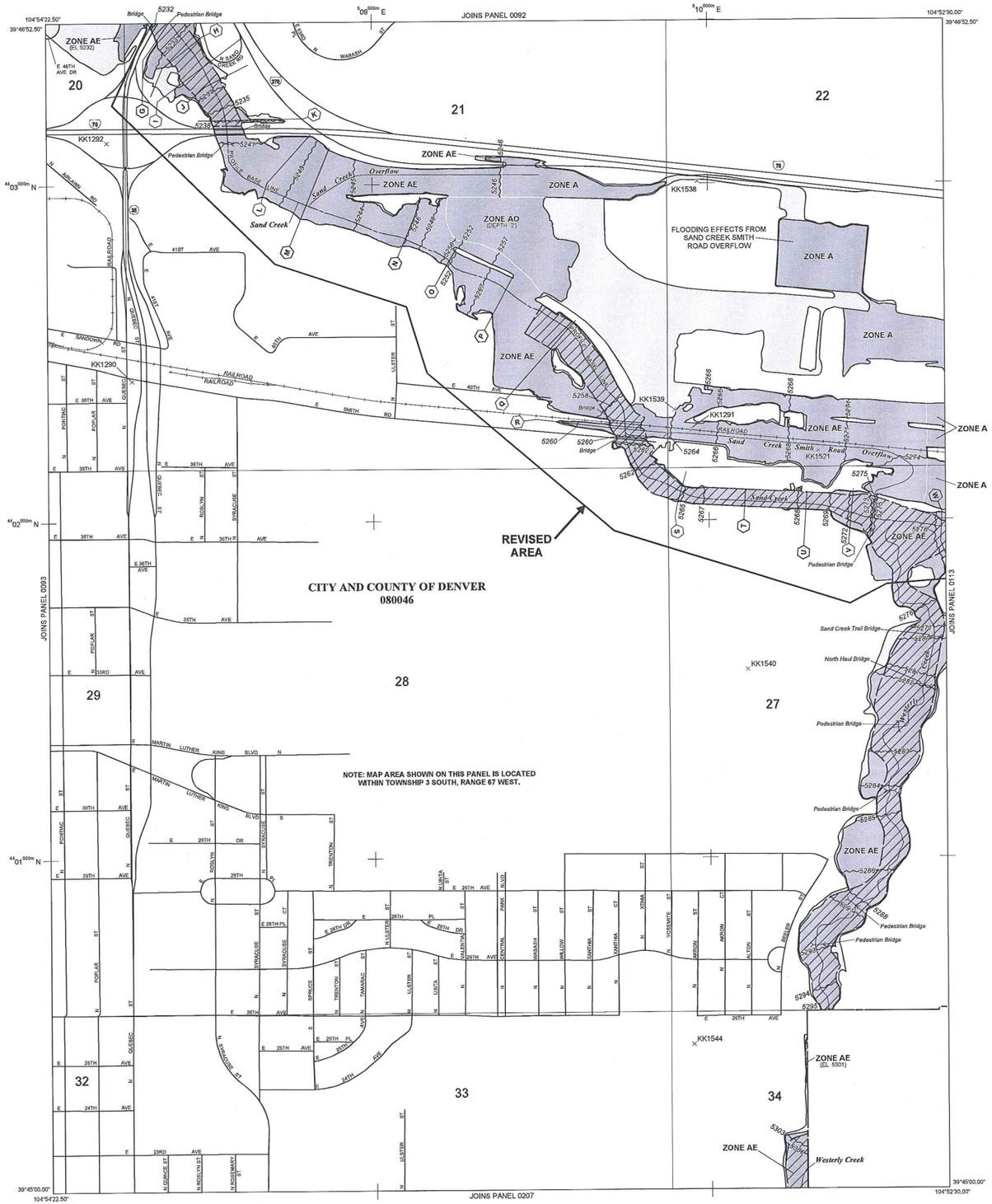
This map reflects more detailed and up- to- date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables *in the Flood Insurance Study report (which contains authoritative hydraulic data)* may reflect stream channel distances that differ from what is shown on this map.

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

Please refer to the separately printed **Map Index** for an overview map showing the layout of map panels for this jurisdiction.

Contact the **FEMA Map Service Center** at 1- 800- 358- 9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, *a Flood Insurance Study report,* and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1- 800- 358- 9620 and its website at http://www.msc.fema.gov/.

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



LEGEND

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

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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

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

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A — A	Cross section line
23 - - - - - 23	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
4275000mN	1000-meter Universal Transverse Mercator grid ticks, zone 13
6000000 M	5000-foot grid ticks: New York State Plane coordinate system, east zone (FIPSZONE 3101), Transverse Mercator
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORY
Department Of Public Works, 201 West Colfax Avenue, Denver, Colorado 80202 (Maps available for reference only, not for distribution.)

INITIAL NFIP MAP DATE
April 15, 1977
FLOOD HAZARD BOUNDARY MAP REVISIONS

FLOOD INSURANCE RATE MAP EFFECTIVE
April 15, 1986
FLOOD INSURANCE RATE MAP REVISIONS

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

MAP SCALE 1" = 500'

250 0 500 1000 FEET

150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0094G

FIRM
FLOOD INSURANCE RATE MAP

CITY AND COUNTY OF
DENVER, COLORADO

PANEL 94 OF 300
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
DENVER, CITY AND COUNTY OF	080046	0094	G

REVISED TO REFLECT LOMR EFFECTIVE: February 12, 2010

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
0800460094G

EFFECTIVE DATE
NOVEMBER 17, 2005

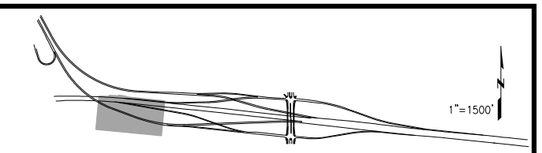
Federal Emergency Management Agency

Know what's below. Call before you dig.

LEGEND

NOT FOR CONSTRUCTION

PT	STATION	OFFSET	ELEVATION	RADIUS
R1	6118+91.7 (RAMP C)	28.0' LT	5249.14	
R2	6119+44.2 (RAMP C)	28.0' LT	5248.73	



SOUTH WQ POND ACCESS ROAD STAKING SUMMARY TABLE

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Sheet Revisions

Number	Date:	Comments	Init.
A	02/12/10	PRELIMINARY DESIGN (FIR) PACKAGE	VSF
B	04/09/10	FOR - EARLY GRADING, DRAINAGE & UTILITY PACKAGE	VSF
1	06/03/10	RFC - EARLY GRADING, DRAINAGE & UTILITY PACKAGE	VSF
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CENTRAL PARK BLVD.
INTERCHANGE WITH I-70

SEMA CONSTRUCTORS WILSON & COMPANY

DRAINAGE PLAN
SOUTH I-70

Designer: DLM	Date: 05/10	Check: VSF	Date: 05/10	Structure Numbers	.
Detailer: JCH	Date: 05/10	Check: VSF	Date: 05/10		.

Project No.	CE 93041
Sheet Subset	DRAINAGE PLAN
Sheet Number	DPL009

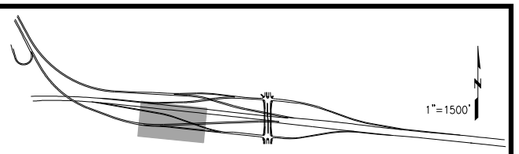
Know what's below. Call before you dig.

PT	STATION	OFFSET	ELEVATION	RADIUS
R3	6121+33.7 (RAMP C)	56.1' LT	5243.19	
R4	6123+32.2 (RAMP C)	68.8' LT	5242.27	
R5	6124+33.5 (RAMP C)	74.6' LT	5242.98	
R6	6126+27.8 (RAMP C)	88.5' LT	5245.01	
R7	6127+01.0 (RAMP C)	97.1' LT	5246.34	
R8	6127+15.8 (RAMP C)	102.3' LT	5246.70	
R9	6127+58.2 (RAMP C)	129.4' LT	5246.67	

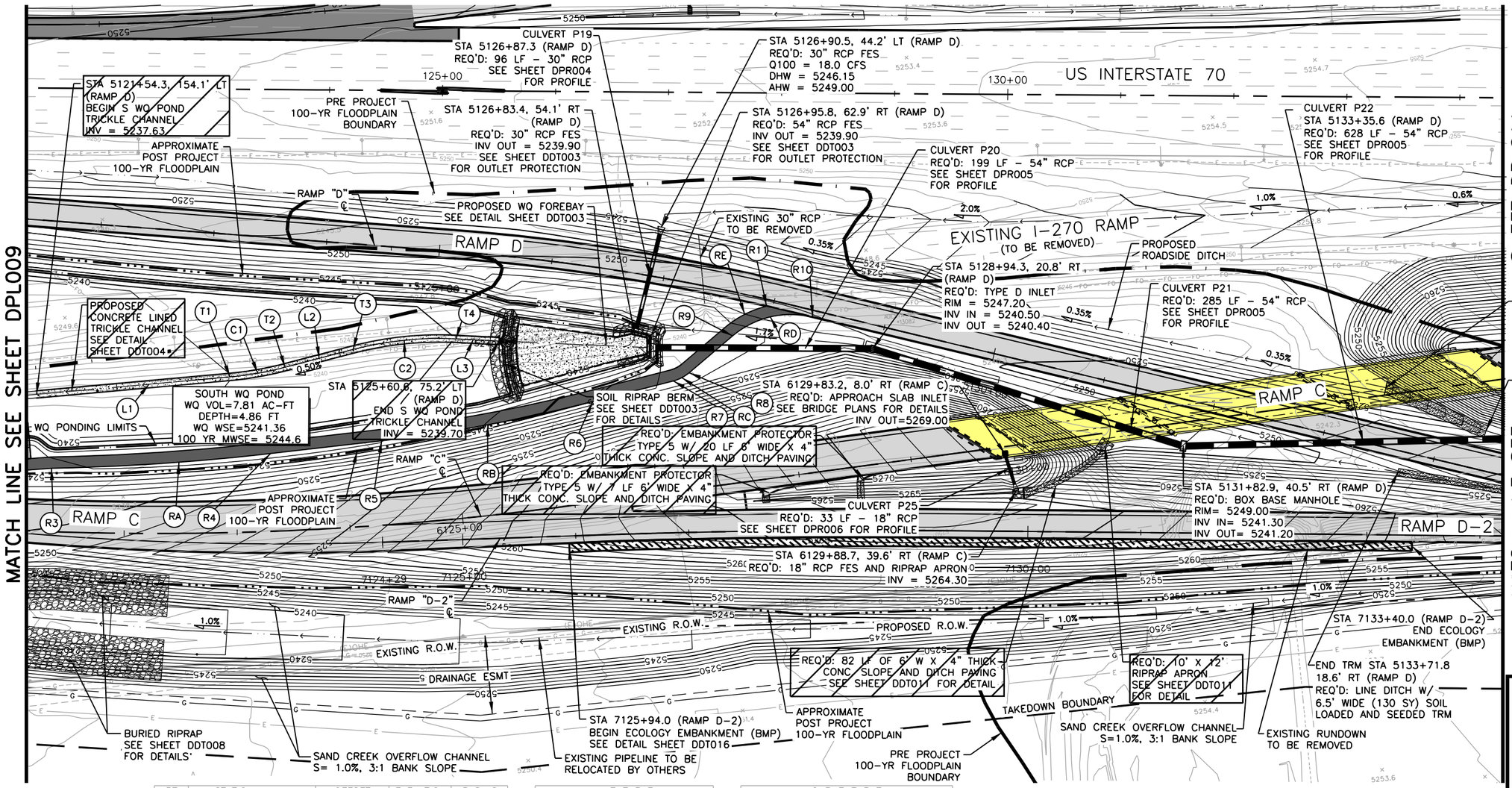
PT	STATION	OFFSET	ELEVATION	RADIUS
R10	6128+30.7 (RAMP C)	136.4' LT	5248.95	
R11	6127+91.6 (RAMP C)	151.5' LT	5248.83	
RA				2010.0'
RB				1398.0'
RC				35.0'
RD				80.0'
RE				91.0'

LEGEND

NOT FOR CONSTRUCTION



SOUTH WQ POND ACCESS ROAD STAKING SUMMARY TABLE



PT	STATION	OFFSET	ELEVATION	RADIUS
T1	5123+23.9 (RAMP D)	125.6' LT	5238.49	
T2	5123+71.8 (RAMP D)	113.4' LT	5238.74	
T3	5124+30.7 (RAMP D)	93.1' LT	5239.05	
T4	5125+21.1 (RAMP D)	76.8' LT	5239.51	

LINE TABLE

LINE	LENGTH	BEARING
L1	171.92	S89°36'07"E
L2	62.34'	N80°56'48"E
L3	38.02'	S81°31'42"E

CURVE TABLE

CURVE	LENGTH	RADIUS	DELTA
C1	49.49'	300.00'	9°27'06"
C2	91.76'	300.00'	17°31'31"

SOUTH WQ POND TRICKLE CHANNEL STAKING SUMMARY TABLE

Sheet Revisions

Number	Date:	Comments	Init.
A	02/12/10	PRELIMINARY DESIGN (FIR) PACKAGE	VSF
B	04/09/10	FOR - EARLY GRADING, DRAINAGE & UTILITY PACKAGE	VSF
1	06/03/10	RFC - EARLY GRADING, DRAINAGE & UTILITY PACKAGE	VSF
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CENTRAL PARK BLVD.
INTERCHANGE WITH I-70

SEMA CONSTRUCTION · WILSON & COMPANY

DRAINAGE PLAN
SOUTH I-70

Designer: DLM	Date: 05/10	Check: VSF	Date: 05/10	Structure Numbers	.
Detailer: JCH	Date: 05/10	Check: VSF	Date: 05/10		.

Project No.	CE 93041
Sheet Subset	DRAINAGE PLAN
Sheet Number	DPL010

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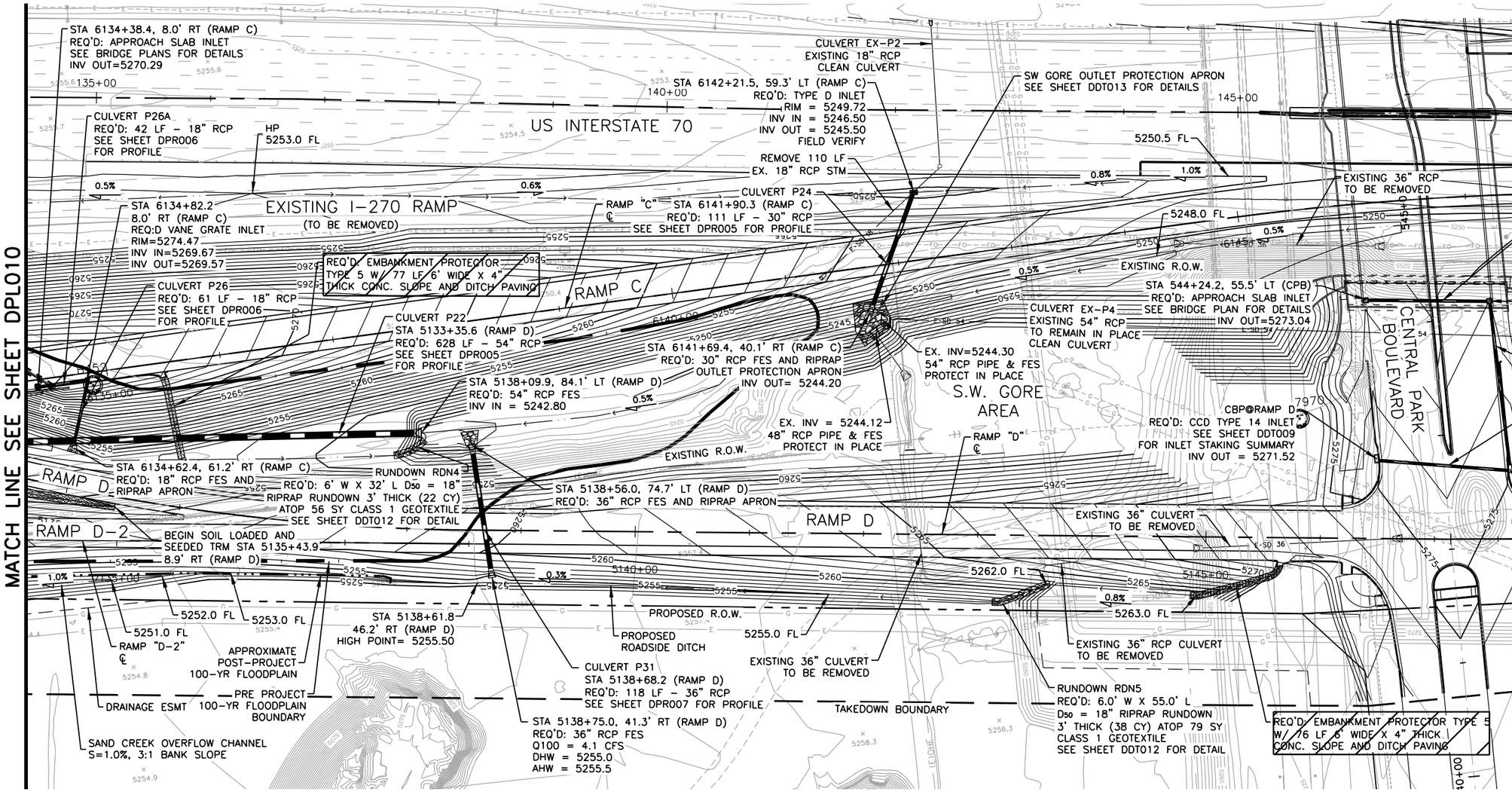
Know what's below. Call before you dig.

LEGEND

NOT FOR CONSTRUCTION

1"=1500'



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Number	Date:	Comments	Init.
A	02/12/10	PRELIMINARY DESIGN (FIR) PACKAGE	VSF
B	04/09/10	FOR - EARLY GRADING, DRAINAGE & UTILITY PACKAGE	VSF
1	06/03/10	RFC - EARLY GRADING, DRAINAGE & UTILITY PACKAGE	VSF
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CENTRAL PARK BLVD.
INTERCHANGE WITH I-70

SEMA CONSTRUCTION WILSON & COMPANY

DRAINAGE PLAN
SOUTH I-70

Designer: DLM	Date: 05/10	Check: VSF	Date: 05/10	Structure Numbers	.
Detailer: JCH	Date: 05/10	Check: VSF	Date: 05/10		.

Project No.	CE 93041
Sheet Subset	DRAINAGE PLAN
Sheet Number	DPL011

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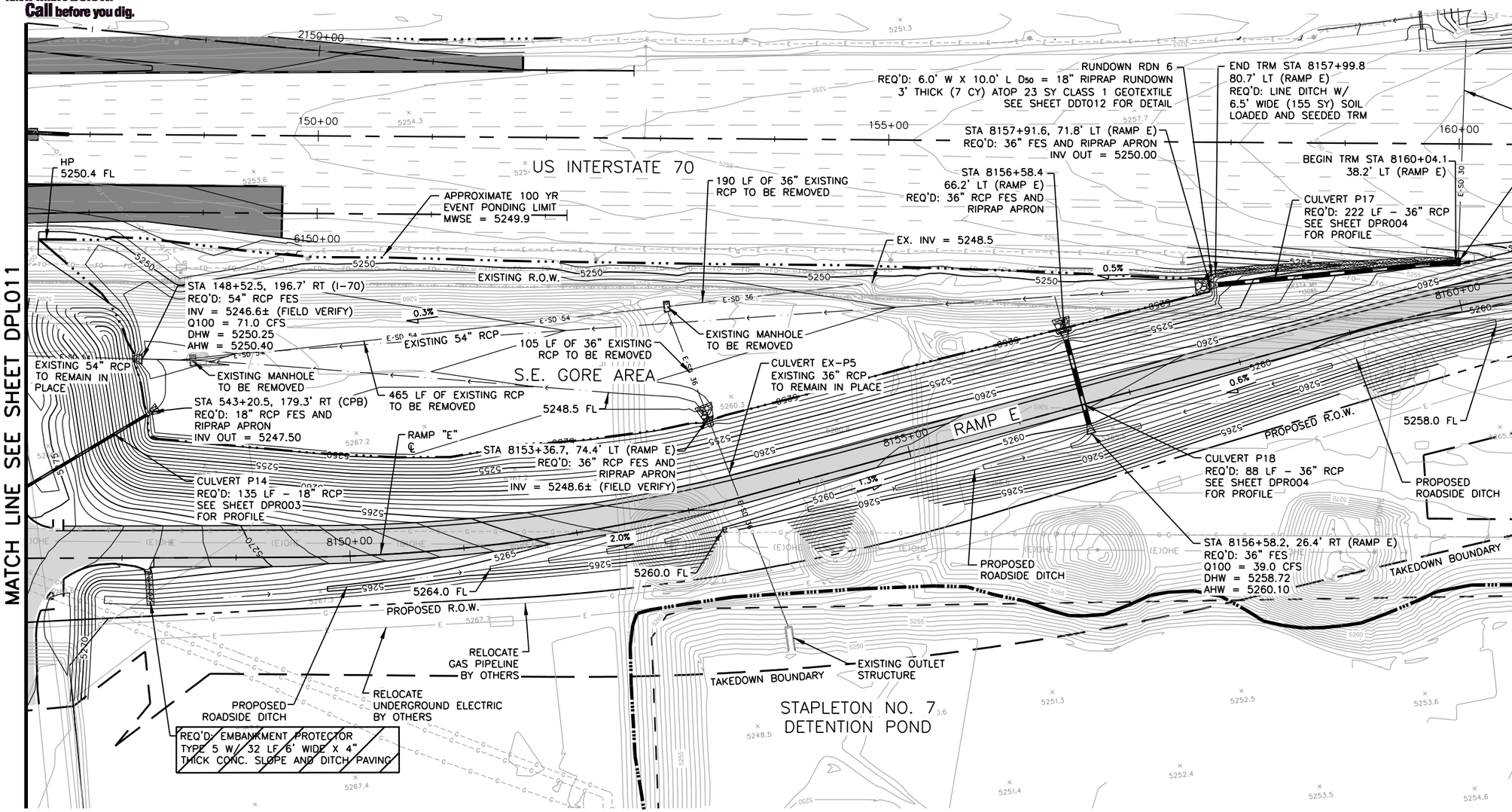
LEGEND

NOT FOR CONSTRUCTION



Sheet Revisions

Number	Date:	Comments	Init.
A	02/12/10	PRELIMINARY DESIGN (FIR) PACKAGE	VSF
B	04/09/10	FOR - EARLY GRADING, DRAINAGE & UTILITY PACKAGE	VSF
1	06/03/10	RFC - EARLY GRADING, DRAINAGE & UTILITY PACKAGE	VSF
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CENTRAL PARK BLVD.
INTERCHANGE WITH I-70

SEMA CONSTRUCTION WILSON & COMPANY

DRAINAGE PLAN
SOUTH I-70

Designer: DLM	Date: 05/10	Check: VSF	Date: 05/10	Structure Numbers	.
Detailer: JCH	Date: 05/10	Check: VSF	Date: 05/10		.

Project No.	CE 93041
Sheet Subset	DRAINAGE PLAN
Sheet Number	DPL012

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Federal Emergency Management Agency

Washington, D.C. 20472

February 26, 2010

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

IN REPLY REFER TO:
Case No.: 10-08-0069R

The Honorable John W. Hickenlooper
Mayor, City and County of Denver
1437 Bannock Street, Suite 350
Denver, CO 80202

Community: City and County of Denver, CO
Community No.: 080046

104

Dear Mayor Hickenlooper:

This responds to a request that the Department of Homeland Security's Federal Emergency Management Agency (FEMA) comment on the effects that a proposed project would have on the effective Flood Insurance Rate Map (FIRM) and Flood Insurance Study (FIS) report for the City and County of Denver, Colorado, in accordance with Part 65 of the National Flood Insurance Program (NFIP) regulations. In a letter dated October 27, 2009, Mr. Justin J.T. Olson, Project Manager, P.E., Vision Land Consultants, Inc. requested that FEMA evaluate the effects that proposed channel modifications along Sand Creek Overflow, associated with the I-70 Interchange at Central Park Boulevard project, would have on the flood hazard information shown on the effective FIRM from just upstream of the confluence with Sand Creek to approximately 2,300 feet upstream. The proposed modifications will include channel modifications along Sand Creek Overflow associated with the embankment for ramp construction for the Center Park Boulevard interchange at I-70.

All data required to complete our review of this request for a Conditional Letter of Map Revision (CLOMR) were submitted with letters from Mr. Olson.

The area along Sand Creek from approximately 130 feet downstream of Quebec Street to approximately 350 feet upstream of Havana Street was revised by a Letter of Map Revision (LOMR) that became effective on February 12, 2010 (Case No. 09-08-512P). The February 12 LOMR revised effective FIRM Panels 0800460092G, 0800460094G, 0800460111G, and 0800460113G for the City and County of Denver to show the effects of the Stapleton Redevelopment area along Sand Creek. The HEC-RAS hydraulic computer model for the February 12 LOMR incorporated the construction of two pedestrian bridges, various channel improvements, and modifications resulting from the removal of runway piers and bridge decks along Sand Creek.

We reviewed the submitted data and the data used to prepare the February 12 LOMR and determined that the proposed project meets the minimum floodplain management criteria of the NFIP. The submitted duplicate effective HEC-RAS hydraulic computer model, dated October 23, 2009, based on the February 12 LOMR, was used as the base conditions model in our review of the proposed conditions model for this CLOMR request. We believe that, if the proposed project is constructed as shown on the drawings entitled "Drainage Plan South I-70, Sheets 89, 90 and 91," prepared by Vision Land Consultants, Inc., dated August 14, 2009, and the data listed below are received, the floodplain boundaries of the base (1-percent-annual-chance) flood and the 0.2-percent-annual-chance flood will be delineated as shown on the drawing entitled "Sand Creek CLOMR Request Topographic Workmap," also prepared by Vision Land Consultants, Inc., dated December 10, 2009.

The Base Flood Elevations (BFEs) computed in the duplicate effective model match the effective BFEs for Sand Creek Overflow, as computed for the February 12 LOMR.

The proposed conditions model incorporated the proposed project into the duplicate effective model. As a result of the proposed project, the BFEs for Sand Creek Overflow will increase in some areas and decrease in other areas compared to the duplicate effective BFEs. The maximum increase in BFE, 3.5 feet, will occur approximately 1,990 feet upstream of the confluence with Sand Creek. The maximum decrease in BFE, 0.3 foot, will occur approximately 1,030 feet upstream of the confluence with Sand Creek.

As a result of the proposed project, the width of the Special Flood Hazard Area (SFHA), the area subject to inundation by the base flood, will increase in some areas and decrease in other areas compared to the effective SFHA width. The maximum increase in SFHA width, approximately 50 feet, will occur approximately 1,200 feet upstream of the confluence with Sand Creek. The maximum decrease in SFHA width, approximately 340 feet, will occur approximately 2,200 feet upstream of the confluence with Sand Creek.

Upon completion of the project, your community may submit the data listed below and request that we make a final determination on revising the effective FIRM and FIS report.

- With this request, your community has complied with all requirements of Paragraph 65.12(a) of the NFIP regulations. Compliance with Paragraph 65.12(b) also is necessary before FEMA can issue a LOMR when a community proposes to permit encroachments into the effective floodplain that will cause increases in BFE in excess of those permitted under Paragraph 60.3(c)(10). Please provide evidence that your community has, prior to approval of the proposed encroachment, adopted floodplain management ordinances that incorporate the increased BFEs and revised floodplain boundary delineations to reflect post-project conditions, as stated in Paragraph 65.12(b).

- Detailed application and certification forms, which were used in processing this request, must be used for requesting final revisions to the maps. Therefore, when the map revision request for the area covered by this letter is submitted, Form 1, entitled "Overview & Concurrence Form," must be included. (A copy of this form is enclosed.)

- The detailed application and certification forms listed below may be required if "as-built" conditions differ from the preliminary plans. If required, please submit new forms (copies of which are enclosed) or annotated copies of the previously submitted forms showing the revised information.

  Form 2, entitled "Riverine Hydrology & Hydraulics Form"

  Form 3, entitled "Riverine Structures Form"

  Hydraulic analyses for "as-built" conditions of the base flood and the floods having a 10-percent, 2-percent, and 0.2-percent-annual-chance, together with a topographic work map showing the revised floodplain boundaries, must be submitted with Form 2.

- Effective January 13, 2010, FEMA revised the fee schedule for reviewing and processing requests for conditional and final modifications to published flood information and maps. In accordance with this schedule, the current fee for this map revision request is $5,000 and must be received before we can begin processing the request. Please note, however, that the fee schedule is subject to change, and requesters are required to submit the fee in effect at the time of the submittal. Payment of this fee shall be made in the form of a check or money order, made

payable in U.S. funds to the National Flood Insurance Program, or by credit card. The payment must be forwarded to the following address:

FEMA Fee Administrator
LOMC Clearinghouse
6730 Santa Barbara Court
Elkridge, MD 21075

- "As-built" plans, certified by a registered professional engineer, of all proposed project elements
- Community acknowledgment of the map revision request
- Evidence of notification of all property owners who will be affected by any increases in width and/or shifting of the base floodplain and/or increases in the BFEs.

After receiving appropriate documentation to show that the project has been completed, FEMA will initiate a revision to the FIRM and FIS report. Because the BFEs would change as a result of the project, a 90-day appeal period would be initiated, during which community officials and interested persons may appeal the revised BFEs based on scientific or technical data.

The basis of this CLOMR is, in whole or in part, a channel-modification project. NFIP regulations, as cited in Paragraph 60.3(b)(7), require that communities assure that the flood-carrying capacity within the altered or relocated portion of any watercourse is maintained. This provision is incorporated into your community's existing floodplain management regulations. Consequently, the ultimate responsibility for maintenance of the modified channel rests with your community.

This CLOMR is based on minimum floodplain management criteria established under the NFIP. Your community is responsible for approving all floodplain development and for ensuring all necessary permits required by Federal or State law have been received. State, county, and community officials, based on knowledge of local conditions and in the interest of safety, may set higher standards for construction in the SFHA. If the State, county, or community has adopted more restrictive or comprehensive floodplain management criteria, these take precedence over the minimum NFIP criteria.

If you have any questions regarding floodplain management regulations for your community or the NFIP in general, please contact the Consultation Coordination Officer (CCO) for your community. Information on the CCO for your community may be obtained by calling the Director, Mitigation Division of FEMA in Denver, Colorado, at (303) 235-4830.

If you have any questions regarding this CLOMR, please call our Map Assistance Center, toll free, at 1-877-FEMA MAP (1-877-336-2627).

Sincerely,

David N. Bascom

David N. Bascom, CFM, Program Specialist
Engineering Management Branch
Mitigation Directorate

For: Kevin C. Long, Acting Chief
Engineering Management Branch
Mitigation Directorate

Enclosures

cc: Mr. Frank Kemme, P.E., CFM
Floodplain Manager
Development Engineering Services
City and County of Denver

Mr. Roger Mutz, P.E.
Capital Projects Management
City and County of Denver

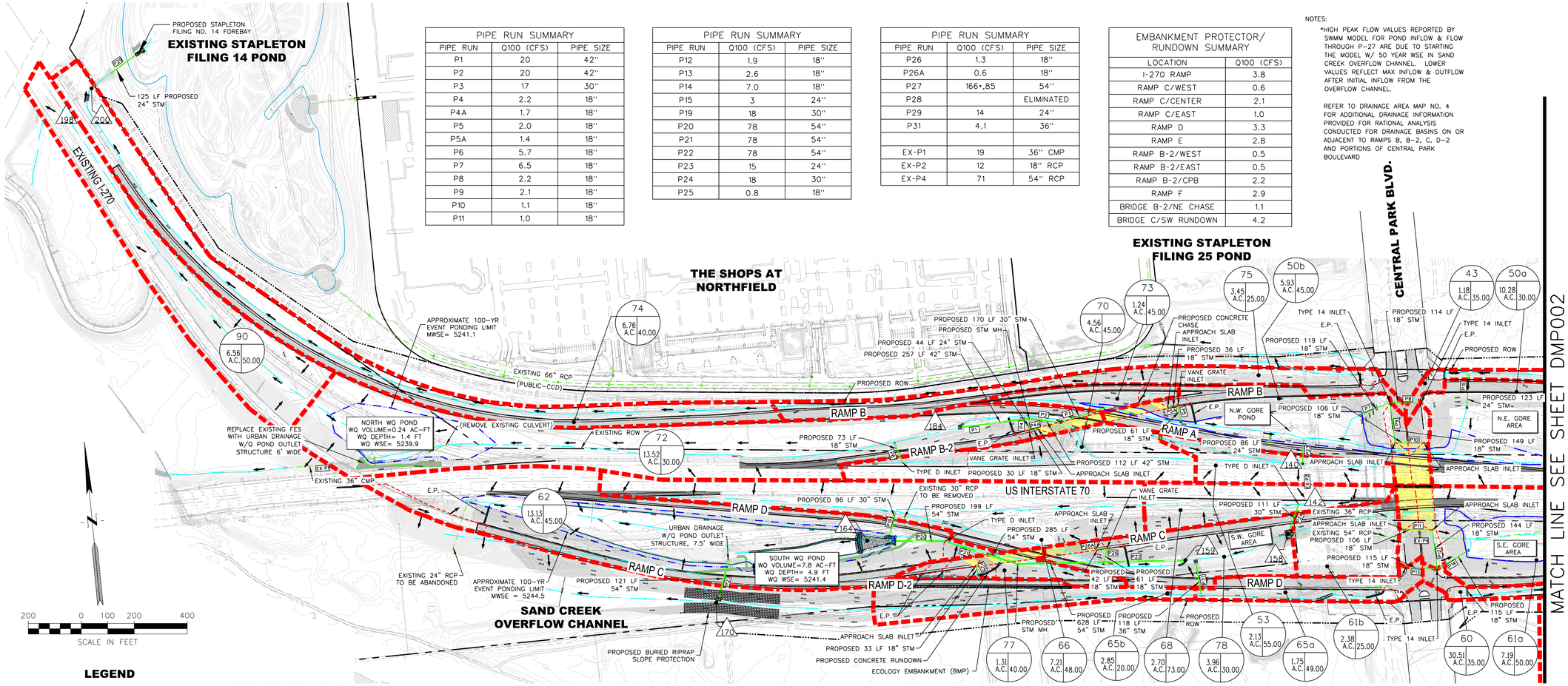
Mr. Bill DeGroot, P.E.
Manager, Floodplain Management Program
Urban Drainage and Flood Control District

Mr. Justin J.T. Olson, P.E.
Project Manager
Vision Land Consultants, Inc.

Central Park Boulevard Interchange with I-70
CDOT Project No.: ES6 C010-103 (17334)
Denver Contract Control No.: CE 93041

Appendix F – Drainage Maps

DMP001
DMP002
DMP003
DMP004



PIPE RUN SUMMARY		
PIPE RUN	Q100 (CFS)	PIPE SIZE
P1	20	42"
P2	20	42"
P3	17	30"
P4	2.2	18"
P4A	1.7	18"
P5	2.0	18"
P5A	1.4	18"
P6	5.7	18"
P7	6.5	18"
P8	2.2	18"
P9	2.1	18"
P10	1.1	18"
P11	1.0	18"

PIPE RUN SUMMARY		
PIPE RUN	Q100 (CFS)	PIPE SIZE
P12	1.9	18"
P13	2.6	18"
P14	7.0	18"
P15	3	24"
P19	18	30"
P20	78	54"
P21	78	54"
P22	78	54"
P23	15	24"
P24	18	30"
P25	0.8	18"

PIPE RUN SUMMARY		
PIPE RUN	Q100 (CFS)	PIPE SIZE
P26	1.3	18"
P26A	0.6	18"
P27	166*.85	54"
P28		ELIMINATED
P29	14	24"
P31	4.1	36"
EX-P1	19	36" CMP
EX-P2	12	18" RCP
EX-P4	71	54" RCP

EMBANKMENT PROTECTOR/ RUNDOWN SUMMARY	
LOCATION	Q100 (CFS)
I-270 RAMP	3.8
RAMP C/WEST	0.6
RAMP C/CENTER	2.1
RAMP C/EAST	1.0
RAMP D	3.3
RAMP E	2.8
RAMP B-2/WEST	0.5
RAMP B-2/EAST	0.5
RAMP B-2/CPB	2.2
RAMP F	2.9
BRIDGE B-2/NE CHASE	1.1
BRIDGE C/SW RUNDOWN	4.2

NOTES:

*HIGH PEAK FLOW VALUES REPORTED BY SWMM MODEL FOR POND INFLOW & FLOW THROUGH P-27 ARE DUE TO STARTING THE MODEL W/ 50 YEAR WSE IN SAND CREEK OVERFLOW CHANNEL. LOWER VALUES REFLECT MAX INFLOW & OUTFLOW AFTER INITIAL INFLOW FROM THE OVERFLOW CHANNEL.

REFER TO DRAINAGE AREA MAP NO. 4 FOR ADDITIONAL DRAINAGE INFORMATION PROVIDED FOR RATIONAL ANALYSIS CONDUCTED FOR DRAINAGE BASINS ON OR ADJACENT TO RAMPS B, B-2, C, D-2 AND PORTIONS OF CENTRAL PARK BOULEVARD

LEGEND

- PROPOSED STORM SEWER
- SWALE
- BASIN BOUNDARY(SWMM)
- BASIN BOUNDARY (RATIONAL METHOD)
- 5250 EXISTING CONTOUR
- 5250 PROPOSED CONTOUR
- APPROXIMATE LIMIT OF 100 YEAR ON-SITE PONDING
- BASIN NAME, BASIN AREA, PERCENT IMPERVIOUS — BASIN BUBBLE
- XX — SWMM ROUTING ELEMENT ID (CONDUIT)
- X — DESIGN POINT
- E.P. — EMBANKMENT PROTECTOR

BASIN RUNOFF SUMMARY	
BASIN	Q100 (CFS)
43	3
50a	18
50b	21
53	9
60	39
61a	22
61b	6
62	48
65a	4
65b	3
66	18

BASIN RUNOFF SUMMARY	
BASIN	Q100 (CFS)
68	11
70	13
72	14
73	3
74	7
75	8
77	4
78	11
90	12

DESIGN POINT SUMMARY	
DESIGN POINT	Q100 (CFS)
158	83
159	82
164	94
170	150*.78
184	20
198	12
200	14

DESIGN POINT SUMMARY	
DESIGN POINT	Q100 (CFS)
N. WQ POND	30
S. WQ POND	158*.94
N.W. GORE POND	52
N.E. GORE POND	56
S.E. GORE POND	112

Sheet Revisions

Number	Date:	Comments	Init.
A	02/12/10	PRELIMINARY DESIGN (FIR) PACKAGE	VSF
B	04/09/10	FOR - EARLY GRADING, DRAINAGE & UTILITY PACKAGE	VSF
1	06/03/10	RFC - EARLY GRADING, DRAINAGE & UTILITY PACKAGE	VSF
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CENTRAL PARK BLVD.
INTERCHANGE WITH I-70

SEMA CONSULTANTS · WILSON & COMPANY

DRAINAGE AREA MAP NO. 1

Designer: VSF	Date: 05/10	Check: JCH	Date: 05/10	Structure Numbers	.
Detailer: JML	Date: 05/10	Check: JCH	Date: 05/10		.

Project No.	CE 93041
Sheet Subset	DRAINAGE
Sheet Number	DMP001

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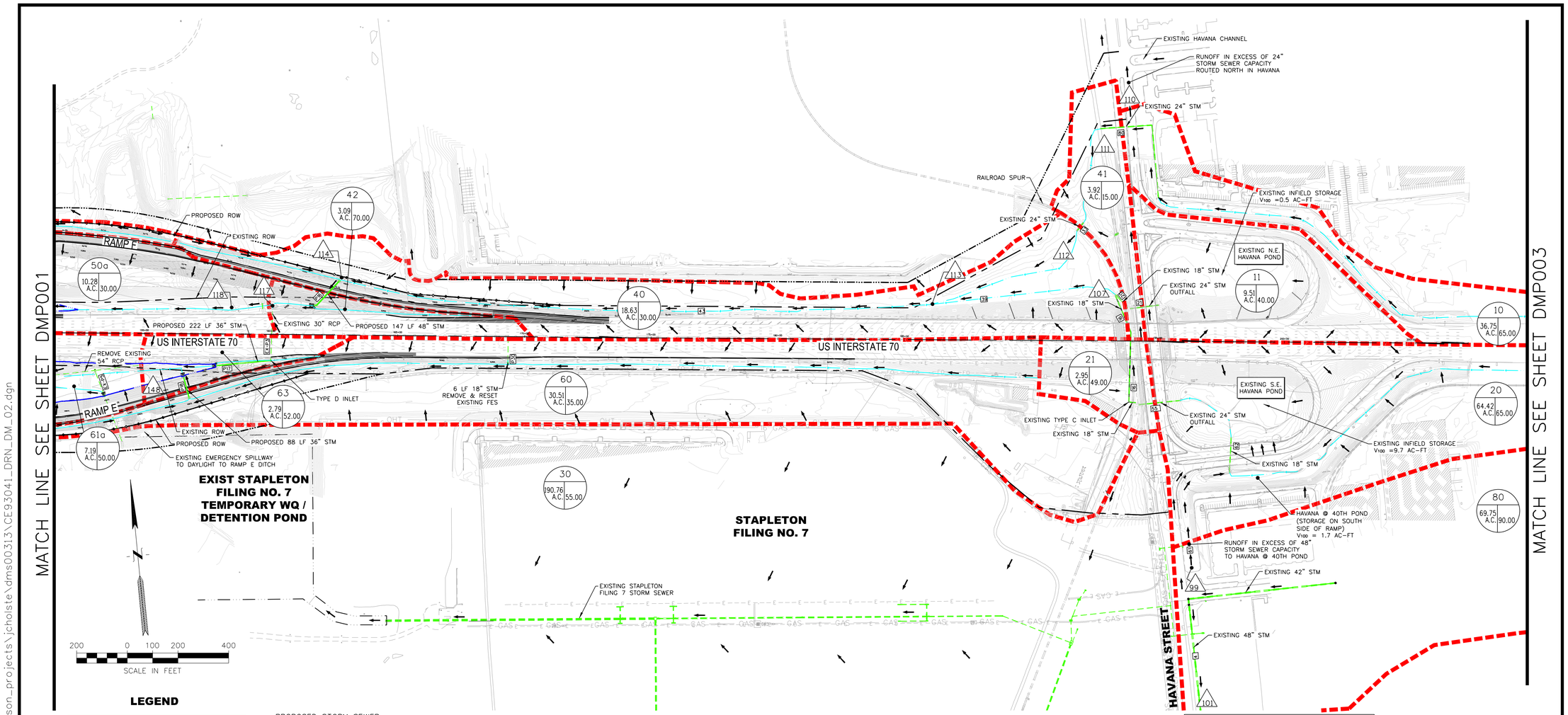

LEGEND

- PROPOSED STORM SEWER
- SWALE
- BASIN BOUNDARY(SWMM)
- BASIN BOUNDARY (RATIONAL METHOD)
- 5250 EXISTING CONTOUR
- 5250 PROPOSED CONTOUR
- APPROXIMATE LIMIT OF 100 YEAR ON-SITE PONDING
- BASIN NAME, BASIN AREA, PERCENT IMPERVIOUS — BASIN BUBBLE
- XX — SWMM ROUTING ELEMENT ID (CONDUIT)
- X — DESIGN POINT
- E.P. — EMBANKMENT PROTECTOR

BASIN RUNOFF SUMMARY	
BASIN	Q100 (CFS)
10	69
11	37
20	149
21	11
30	630
40	20
41	6

BASIN RUNOFF SUMMARY	
BASIN	Q100 (CFS)
42	11
50a	18
60	39
61a	22
63	8
80	250

DESIGN POINT SUMMARY	
DESIGN POINT	Q100 (CFS)
99	250
101	104
107	55
110	48
111	28
112	28

DESIGN POINT SUMMARY	
DESIGN POINT	Q100 (CFS)
113	81
114	90
117	90
118	46
148	85

PIPE RUN SUMMARY		
PIPE RUN	Q100 (CFS)	PIPE SIZE
P16	88	48"
P17	44	36"
P18	39	36"
EX-P3	44	30"
EX-P5	18	36"

OFFSITE SWMM ROUTING ELEMENT SUMMARY	
ELEMENT	Q100 (CFS)
4	104
16	7
20	6
21	22
33	28
39	55
43	79
55	34
61	147
62	13
80	22

Sheet Revisions

Number	Date:	Comments	Init.
A	02/12/10	PRELIMINARY DESIGN (FIR) PACKAGE	VSF
B	04/09/10	FDR - EARLY GRADING, DRAINAGE & UTILITY PACKAGE	VSF
1	06/03/10	RFC - EARLY GRADING, DRAINAGE & UTILITY PACKAGE	VSF
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CENTRAL PARK BLVD.
INTERCHANGE WITH I-70

SEMA WILSON & COMPANY

DRAINAGE AREA MAP NO. 2

Designer: VSF	Date: 05/10	Check: JCH	Date: 05/10	Structure Numbers	.
Detailer: JML	Date: 05/10	Check: JCH	Date: 05/10		.

Project No.	CE 93041
Sheet Subset	DRAINAGE
Sheet Number	DMP002

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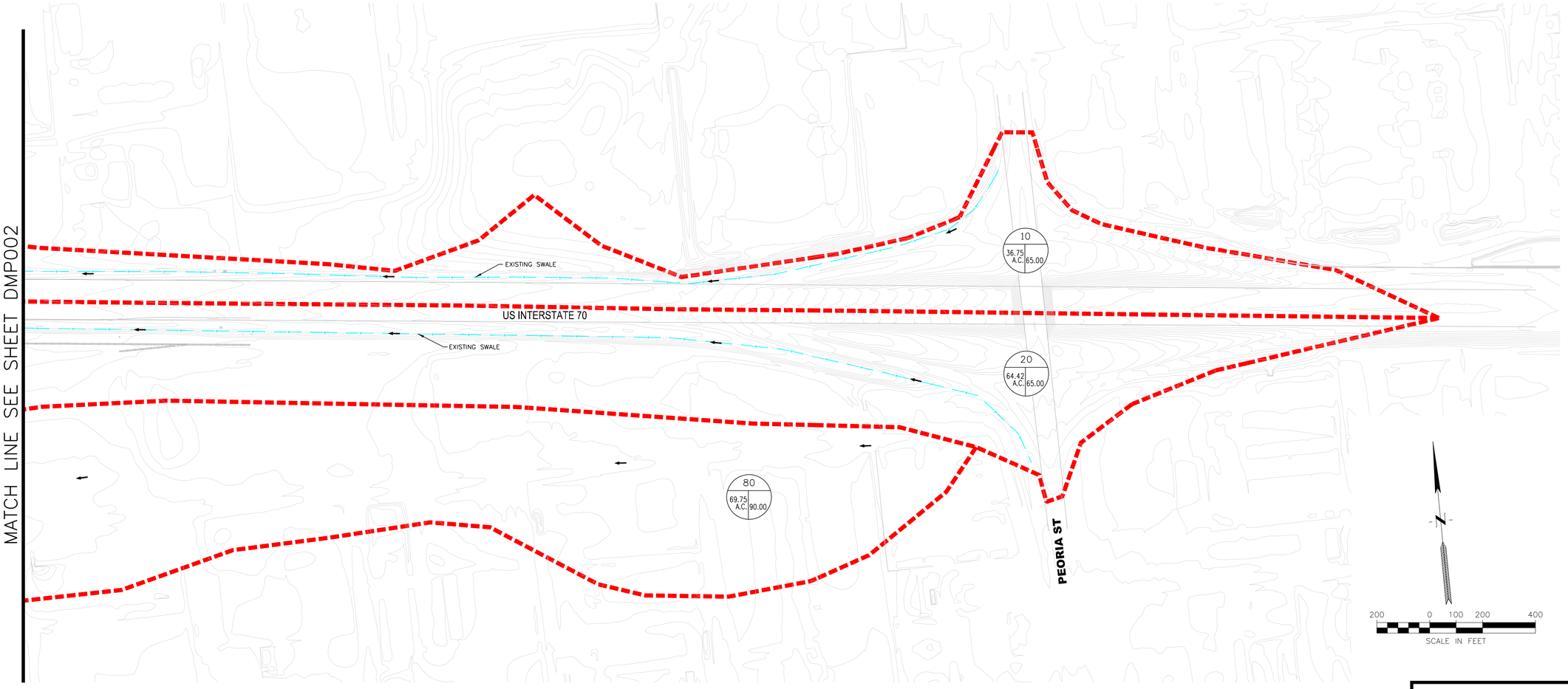

LEGEND

PROPOSED STORM SEWER

SWALE

BASIN BOUNDARY(SWMM)

5250 EXISTING CONTOUR

5250 PROPOSED CONTOUR

BASIN NAME — XX

BASIN AREA — X AC. X — PERCENT IMPERVIOUS

BASIN BUBBLE

BASIN RUNOFF SUMMARY	
BASIN	Q100 (CFS)
10	69
20	149
80	250

PRELIMINARY
NOT FOR CONSTRUCTION

Sheet Revisions

Number	Date:	Comments	Init.
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CENTRAL PARK BLVD.
INTERCHANGE WITH I-70

DRAINAGE AREA MAP NO.3
(OFFSITE AREA)

Designer: VSF	Date: 04/10	Check: JCH	Date: 04/10	Structure Numbers	.
Detailer: JML	Date: 04/10	Check: JCH	Date: 04/10		.

Project No.	CE 93041
Sheet Subset	DRAINAGE
Sheet Number	DMP003

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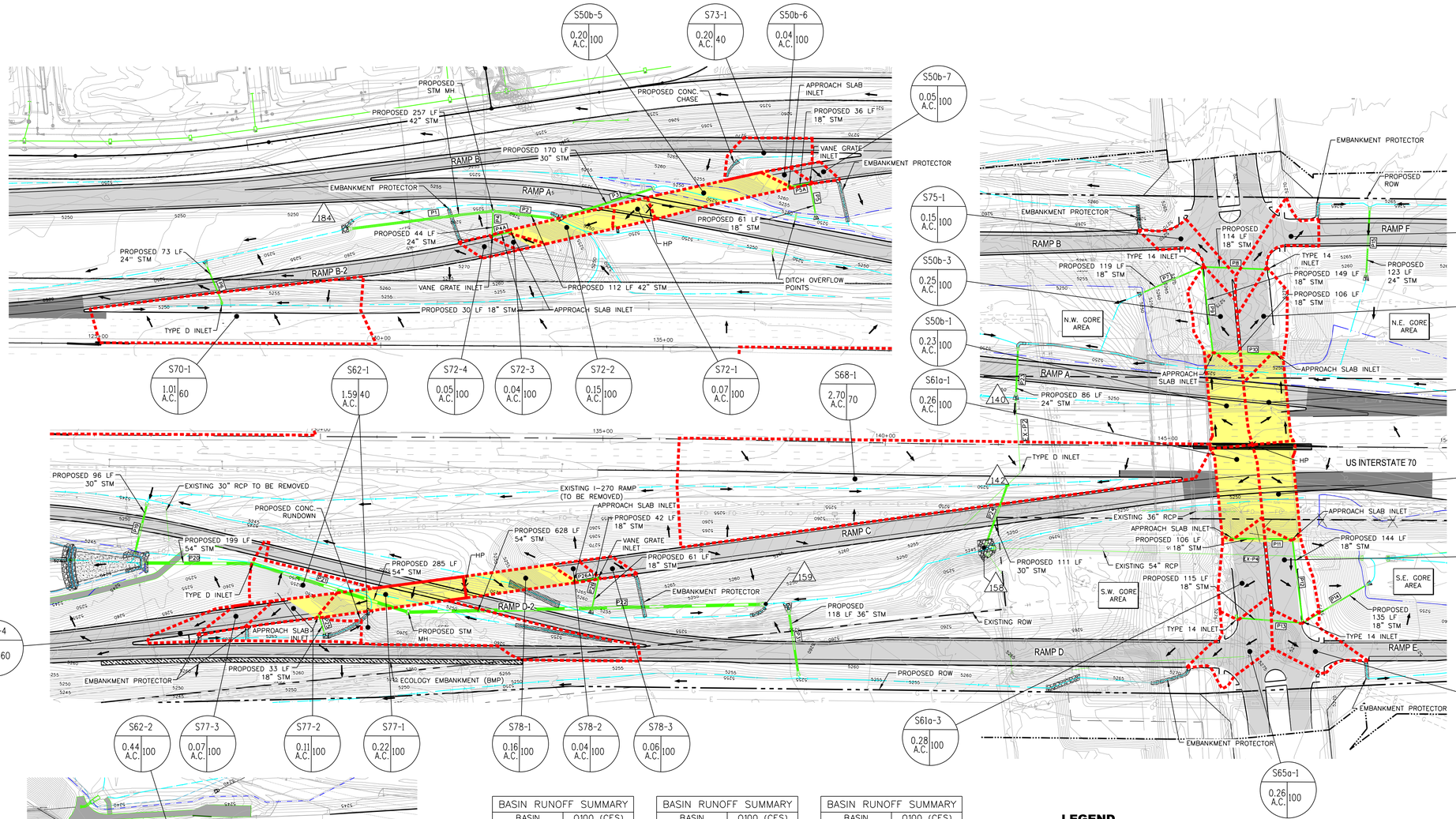

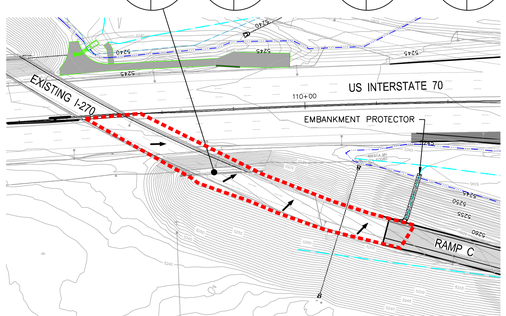

BASIN RUNOFF SUMMARY	
BASIN	Q100 (CFS)
S43-1	1.9
S50b-1	2.0
S50b-2	2.1
S50b-3	2.2
S50b-4	2.3
S50b-5	1.7
S50b-6	0.4
S50b-7	0.5
S60a-1	1.9
S61a-1	2.2
S61a-2	2.2

BASIN RUNOFF SUMMARY	
BASIN	Q100 (CFS)
S61a-3	2.4
S61a-4	2.2
S62-1	6.4
S62-2	3.8
S65a-1	2.2
S68-1	11.7
S70-1	5.7
S72-1	0.6
S72-2	1.3
S72-3	0.4
S72-4	0.5

BASIN RUNOFF SUMMARY	
BASIN	Q100 (CFS)
S73-1	1.1
S75-1	1.3
S77-1	1.9
S77-2	1.0
S77-3	0.6
S77-4	3.9
S78-1	1.4
S78-2	0.4
S78-3	0.6

LEGEND

- PROPOSED STORM SEWER
- SWALE
- SUB-BASIN BOUNDARY (RATIONAL METHOD)
- EXISTING CONTOUR
- PROPOSED CONTOUR
- APPROXIMATE LIMIT OF 100 YEAR ON-SITE PONDING
- BASIN NAME, BASIN AREA, PERCENT IMPERVIOUS — BASIN BUBBLE
- SWMM ROUTING
- ELEMENT ID (CONDUIT)
- DESIGN POINT

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Sheet Revisions

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1	06/03/10	RFC - EARLY GRADING, DRAINAGE & UTILITY PACKAGE	VSF
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CENTRAL PARK BLVD.
INTERCHANGE WITH I-70

SEMA CORPORATION · WILSON & COMPANY

DRAINAGE AREA MAP NO. 4 (SUB-BASINS)

Designer: VSF	Date: 05/10	Check: JCH	Date: 05/10	Structure Numbers	.
Detailer: JML	Date: 05/10	Check: JCH	Date: 05/10		.

Project No.	CE 93041
Sheet Subset	DRAINAGE
Sheet Number	DMP004