PRELIMINARY/FINAL DRAINAGE REPORT

FOR PAINT BRUSH HILLS FILING NO. 14

EL PASO COUNTY, COLORADO

DECEMBER 2020

Prepared for:

The Landhuis Company
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Prepared by:

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Project #10-014
PCD Project # SP206 & SF2024

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FOR PAINT BRUSH HILLS FILING NO. 14

DRAINAGE PLAN STATEMENTS

ENGINEERS STATEMENT

The attached drainage plan and report was prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the County for drainage reports and said report is in conformity with the applicable master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omission on my part in preparing this report.

____
Virgil A. Sanchez, P.E. #37160
For and on Behalf of M&S Civil Consultants, Inc

DEVELOPER'S STATEMENT

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

BY:__________________________________

TITLE:__________________________
DATE:__________________________

ADDRESS: The Landhuis Company
212 N. Wahstach Ave, Suite 301
Colorado Springs, CO 80903

EL PASO COUNTY'S STATEMENT

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

BY:______________________________ DATE:____________________
Jennifer Irvine, P.E.
County Engineer/ECM Administrator

CONDITIONS

PRELIMINARY/FINAL DRAINAGE REPORT
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APPENDIX

PRELIMINARY/FINAL DRAINAGE REPORT
FOR PAINT BRUSH HILLS FILING NO. 14

PURPOSE

This document is intended to serve as the Preliminary and Final Drainage Report for Paint Brush Hills Filing No. 14. The purpose of this document is to identify and analyze the on and offsite drainage patterns and to ensure that post development runoff is routed through the site safely and in a manner that satisfies the requirements set forth by the El Paso County Drainage Criteria Manual. The proposed principal use for the site consists of infrastructure typically associated with single family residential developments. The majority of the site will consist of asphalt, curb, landscaping and an existing storm water quality facility (Pond C) located near the southwest boundary of the site. This document is also intended to show some of Paint Brush Hills Filing No. 14 onsite drainage (of approximately 6.72 acres,) will not adversely affect the capacity of the existing storm water quality facility (Pond D) in the "Preliminary Drainage Report for Paint Brush Hills Filing 13E (PDRPBH-13E) (Pre-Development Grading Plan)", prepared by Classic Consulting Engineers and Surveyors, submitted on February 2018.

GENERAL LOCATION AND DESCRIPTION

Paint Brush Hills Filing No. 14 is located in the northeast quarter of Section 26, Township 12 South, Range 65 West of the 6th P.M. in El Paso County, Colorado. The parcel is bound to the north by existing single family residential Paint Brush Hills Filing No.3 and to the south by existing single family residential Paint Brush Hills Filing No. 12. An existing utility corridor and single family residential subdivision Paint Brush Hills Filing No. 13E, is planned along the east boundary of the site. Along the west property line are two rural and undeveloped parcels. Generally, runoff produced by the site is directed south and southwest to an Extended Detention Basin (EDB) Pond C and subsequently to an existing swale tributary to the Falcon Drainage Basin. The site lies within the Falcon Drainage Basin.

The site consists of 88.631 acres which is presently undeveloped. Vegetation is sparse, consisting of native grasses with no trees onsite. The site has not experienced any overlot grading activities. Existing site terrain generally slopes from north to south at grade rates that vary between 1.0% and 4.0%.

The site is currently platted and zoned "RS-20,000 & RS-6000" for Residential Suburban. The proposed principal use for the site is single family residential. The majority of the lots shall consist of standard setbacks, landscaping and back and/or side lot swales typical for single family housing. An existing detention facility is located at the southwest boundary of the site and is to be upgraded upon development of the proposed Paint Brush Hills Filing No. 14 site.

SOILS

Soils for this project have been delineated by the map in the appendix, as Pring Coarse Sandy Loam (71) and is characterized as Hydrologic Soil Type "B". Soils in the study area are shown as mapped by S.C.S. in the "Soils Survey of El Paso County Area." Vegetation is sparse, consisting of native grasses and weeds.

HYDROLOGIC CALCULATIONS

Hydrologic calculations were performed using the El Paso County and City of Colorado Springs Storm Drainage Design Criteria manual and where applicable the Urban Storm Drainage Criteria Manual. The Rational Method was used to estimate stormwater runoff anticipated from design storms with 5-year and 100-year recurrence intervals.

HYDRAULIC CALCULATIONS

Hydraulic calculations were estimated using the Manning's Formula and the methods described in the El Paso County Storm Drainage Design Criteria manual. The relevant data sheets are included in the appendix of this report.

FLOODPLAIN STATEMENT

No portion of this site is within a designated F.E.M.A. floodplain as determined by the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) Panel No. 08041C0535 G, effective date December 7, 2018. A FIRM Panel is included in the Appendix.

DRAINAGE CRITERIA

This drainage analysis has been prepared in accordance with the current El Paso County Drainage Criteria Manual and where applicable the City of Colorado Springs DCM Volume 1 dated May 2014 effective January 2015. Hydrologic calculations were performed to determine runoff quantities for the 5-yea… d
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Step 4: Consider Need for Industrial and Commercial BMPs

If a new development or significant redevelopment activity is planned for an industrial or commercial site, the need for specialized BMPs must be considered. Two approaches are described in the New Development BMP Factsheets:

- Covering of Storage/Handling Areas
- Spill Containment and Control

Other Specialized BMPs may also be required

FOUR

Step1 … :e) … to … :st
corner of the site will have roof drains directed to the front of the lot.

Step 2 Stabilize Drainageways … tailwater riprap basin w… avoid erosion. Existing … at Design Point 17 (exis… dissipated energy and ve… flows have been restricte… on the downstream drain…

Update to match the four-step listed in ECM Appendix I Section I.7.2

Unresolved. Address Step 4 appropriately, this project is a residential site not an industrial or commercial site. Are specialized BMPs listed above required or being implemented?

Step 3 Provide Water Quality Capture Volume – The existing Pond C will be retrofitted to an Full Spectrum Extended Drainage Basin and will provide WQCV.

Step4 Consider Need for Industrial and Commercial BMP's – This submittal provides a Preliminary Grading and Erosion Control plan. A Final GEC plan with BMP's in place shall be required with a Final Plat and Site Development applications. The proposed project will use silt fence, a vehicle tracking control pad, a concrete washout area, mulching and reseeding to mitigate the potential for erosion across the site.

EXISTING DRAINAGE CONDITIONS

The Paint Brush Hills Filing No. 14 site consists of 88.631 acres and is situated in the Falcon Drainage Basin with Chico Creek as receiving waters. This site was studied as part of the "Master Development Drainage Plan for Falcon Hills Development (MDDP)" prepared by Kiowa Engineering Corporation, approved November 2002. More recently the site was studied in the "Final Drainage Report for Paint

Brush Hills-Phase 2 (Filing No. 13,(FDRPBH-PH2-13))", prepared by Classic Consulting Engineers and Surveyors, rev.June 2008.

Existing Paint Brush Hills Filing No. 14 site and offsite Paint Brush Hills Filing No. 3 is currently undeveloped and the terrain generally slopes from north to southwest at grade rates that vary between 1.0% and 4.0%. Existing natural drainage swales route flows to an existing detention facility (Pond C) constructed as part of the "Paint Brush Hills Filing No. 12", see attached Historic Conditions Drainage Map from FDRPBH-PH2-13 and also refer to "Final Drainage Report for Paint Brush Hill Filing Nos. 10, 11 & 12 (FDRPBH-10,11,12)" prepared by Classic Consulting Engineers and Surveyors, rev. July 2003. See Historic Conditions Drainage Map in Drainage Maps section of this report. Offsite and onsite flows on Paint Brush Hills Filing No.14 are described as follows;

Historic Basin Descriptions

Basin OS-5, 46.1 acres, (Q_5=35 cfs, Q_{100}=79.0 cfs), consists of offsite existing Paint Brush Hills Filing No.3. Filing No.3 is a single family residential development with the average lot size of 3.5 acres. The percent impervious is approximately 11%. The west half of **Basin OS-5**, runoff enters the site as sheet flow. The east half of **Basin OS-5**, runoff is concentrated and enters the site via a natural swale.

Basin H-1, 92.3 acres, (Q_5=42.0 cfs, Q_{100}=108.0 cfs), consists of undeveloped Paint Brush Hills Filing No.14. The terrain generally slopes from north to southwest at grade rates that vary between 1.0% and 4.0%. Existing natural drainage swales route flows to an existing detention facility (Pond C). Historic cumulative flows, from **Basin OS-5** and **Basin H-1** are Q_5=68.0 cfs, Q_{100}=169.0 cfs. Runoff is released via an existing 48" RCP pipe to an existing swale.

Basin H-5, 55.6 acres, (Q_5=32.0 cfs, Q_{100}=80.0 cfs), consists of undeveloped Paint Brush Hills Filing No.13E. The terrain generally slopes from north to southwest at grade rates that vary between 1.0% and 4.0%. Existing natural drainage swales route flows to the south end of the basin. Approximately 6.0 acres of undeveloped Paint Brush Hills Filing No. 14 is located at the northeast corner of **Basin H-5**. Historic flows, from **Basin H-5** are Q_5=32.0 cfs, Q_{100}=80.0 cfs. Runoff is released via a pair of existing 36" RCP culverts located under existing Londonderry Drive and outfall to an existing swale.

PROPOSED DRAINAGE CHARACTERISTICS

General Concept Drainage Discussion

The following is a description of the offsite and onsite basins, offsite flows and the overall proposed drainage characteristics for the development of Paint Brush Hill Filing No. 14. These calculations have been provided to show that what is proposed will be adequate to convey flows when development occurs. Offsite **Basin ***OS-5** has been divided into 3 sub-basins as they pertain to the onsite proposed drainage characteristics. The following **Basin** description, **Design Points (DP)** and **Pipe Runs (PR)** were determined using the Rational Method since each individual basin is less than 100 acres and the combined acreage at any DP are also less than 130 acres. See drainage map in appendix for proposed conditions. This method offers a conservative approach to sizing swales and storm drains. Development of this site will not adversely affect the surrounding development and is compliance with the M.D.D.P. approved for this site.

The * before a basin, design point and pipe run callout denotes previously studied in the "Final Drainage Report for Paint Brush Hills Filing 13E (FDRPBH-13E)", prepared by Classic Consulting Engineers and Surveyors, submitted on September 2018. The ** before a basin callout denotes a revision to PDRPBH-13E. The *** before a basin callout denotes previously studied in the "Final Drainage Report for Paint Brush Hills-Phase 2 (Filing No. 13,(FDRPBH-PH2-13))", prepared by Classic Consulting Engineers and

Surveyors, submitted on rev. June 2008, specifically Basin ***OS-5. The # before a pipe run callout denotes, to be constructed with the Paint Brush Hills Filing No. 13E Street and Storm Sewer plans but the flows (slightly higher) have been adjusted by this report the Preliminary/Final Drainage Report for Paint Brush Hills Filing No. 14" prepared by MS Civil Consultants, dated December 2020.

Detailed Drainage Discussion

Update Basin A per Parks comments and discussion with the design engineer on 2/24/11 this area will be redesigned.

Basins Tributary to Detention Pon

Basin OS5C, 29.0 acres, (Q_5=25.5 cfs, Q_{100}=57.0 cfs), consist of existing developed 3.5-acre properties and streets. Runoff produced by the offsite area, are routed via existing roadside swales to a larger natural swale which carries flows south towards the north boundary of the subject site.

Basin A, 0.5 acres, (Q_5=0.4 cfs, Q_{100}=1.4 cfs), consists of a proposed landscaped Tract. Developed flows within **Basin A** and offsite **Basin OS5C** are routed as surface runoff via a proposed 5' wide swale to **DP3** (Q_5=25.7 cfs, Q_{100}=58.1 cfs). The proposed 5' wide swale will be private and shall be maintained by the Paint Brush Hills Metropolitan District (see SC 250 Turf Reinforcement Mat in appendix). Surface runoff at **DP3** will be collected and conveyed via a 36" RCP FES and 36" RCP pipe (**PR2**) to **DP4**. In the event of clogging, flows at **DP3** will over top the embankment and shall be conveyed by a proposed swale, within a 20' storm drainage easement to **DP4**.

Basin J, 7.2 acres, (Q_5=5.6 cfs, Q_{100}=19.1 cfs), consists of proposed single family residential lots and proposed local residential streets. Surface runoff is routed via curb and gutter to **DP4** which will be collected by a proposed 15' Type R sump inlet. The intercepted flow (Q_5=5.6 cfs, Q_{100}=19.1 cfs) will combine with flows from **PR2** and be routed west via a 48" RCP pipe (**PR3**, Q_5=30.4 cfs, Q_{100}=74.0 cfs). In the event of clogging, flows at **DP4** will over top the high point and be routed via curb and gutter to **DP10**.

Basin K, 0.8 acres, (Q_5=1.1 cfs, Q_{100}=2.7 cfs), consists of proposed single family residential lots and proposed local residential streets. Surface runoff is routed via curb and gutter to **DP5** which will be collected by a proposed 5' Type R sump inlet. The intercepted flow (Q_5=1.1 cfs, Q_{100}=2.7 cfs) will be routed west via an 18" RCP pipe (**PR4**, Q_5=1.1 cfs, Q_{100}=2.7 cfs) to **PR5** (Q_5=31.2 cfs, Q_{100}=76.0 cfs). In the event of clogging, flows at **DP5** will over top the high point and be routed via curb and gutter to **DP10**.

Basin OS5B, 13.4 acres, (Q_5=4.6 cfs, Q_{100}=25.8 cfs), consist of existing developed 3.5-acre properties and streets. Runoff produced by the offsite area, will sheet flow into **Basin D**.

Basin D, 5.2 acres, (Q_5=3.8 cfs, Q_{100}=14.0 cfs), consists of a proposed single family residential lots. Cumulative developed flows within **Basin D** and offsite **Basin OS5B** are routed via curb and gutter and side lot swales to **DP6.**

Basin E, 0.5 acres, (Q_5=2.3 cfs, Q_{100}=4.1 cfs), consists of a proposed local residential street. Surface runoff from **Basin E** will combine with flows from **Basin OS5B** and **Basin D** and will be routed via curb and gutter to **DP6** which will be collected by a proposed 15' Type R sump inlet. The cumulative flow from **DP6** and **DP7** at **DP8** is Q_5=10.7 cfs, Q_{100}=44.4. The 100-year flow will be split between the two inlets. The intercepted flow at **DP6** (Q_5=9.3 cfs, Q_{100}=22.2) will be routed west via a 24" RCP pipe (**PR7,** Q_5=9.2 cfs, Q_{100}=22.2 cfs) to **PR9**. In the event of clogging, flows at **DP6** will over top the high point in Country Manor Drive and be routed to **DP12**.

Basin F, 1.6 acres, (Q_5=1.9 cfs, Q_{100}=5.4 cfs), consists of proposed single family residential lots and proposed local residential streets. Surface runoff is routed via curb and gutter to **DP7** which will be collected by a proposed 15' Type R sump inlet. The cumulative flow from **DP6** and **DP7** at **DP8** is

Q_5=10.7 cfs, Q_{100}=44.4. The 100-year flow will be split between the inlets. The intercepted flow at **DP7** (Q_5=1.9 cfs, Q_{100}=22.2) will be routed west via a 24" RCP pipe (**PR8,** Q_5=1.9 cfs, Q_{100}=22.2 cfs) to **PR9**. In the event of clogging, flows at **DP7** will over top the high point in Country Manor Drive and be routed to **DP12**.

Basin G, 12.2 acres, (Q_5=14.0 cfs, Q_{100}=34.8 cfs), consists of proposed single family residential lots and proposed local residential streets. Surface runoff from **Basin G** is routed via curb and gutter to **DP9** (Q_5=13.8 cfs, Q_{100}=34.4 cfs) which a portion of the flow will be collected by proposed dual 15' Type R at-grade inlets. The intercepted flow (Q_5=7.0 cfs, Q_{100}=13.7 cfs per side) will be routed south via (2) 24" RCP pipes (**PR10, PR11**, Q_5=7.0 cfs, Q_{100}=13.7 cfs per side) and will combine with **PR9** in **PR12** (Q_5=53.9 cfs, Q_{100}=142.5 cfs). In the event of clogging, flows at **DP9** will be routed via curb and gutter to **DP15**.

Basin I, 12.7 acres, (Q_5=14.5 cfs, Q_{100}=36.2 cfs), consists of proposed single family residential lots and proposed local residential streets. Surface runoff from **Basin I** is routed via curb and gutter to **DP10** which a portion of the flows will be collected by proposed dual 15' Type R at-grade inlets. The intercepted flow (Q_5=7.3 cfs, Q_{100}=14.0 cfs per side) will be routed west via a 18" RCP pipe (**PR13,** Q_5=7.3 cfs, Q_{100}=14.0 cfs) to **PR14**. Cumulative flows in the proposed 30" RCP pipe (**PR14,** Q_5=14.6 cfs, Q_{100}=27.9 cfs) will be routed south to an existing 30" RCP pipe **PR#38** (Q_5=14.6 cfs, Q_{100}=27.9 cfs). In the event of clogging, flows at **DP10** will be routed via curb and gutter to **DP11**. **PR#38 is** to be constructed as part of the Paint Brush Hills Filing No. 13E infrastructure, which is to precede construction of the subject filing.

Basin L, 3.4 acres, (Q_5=3.8 cfs, Q_{100}=9.5 cfs), consists of proposed single family residential lots and proposed local residential streets. Flowby from **DP10** and surface runoff from **Basin L** will be routed via curb and gutter to **DP11** (Q_5=3.7 cfs, Q_{100}=17.0 cfs) which a portion of the flows will be collected by an existing 15' Type R at-grade inlet. The intercepted flow will be routed east via a 24" RCP pipe (**PR#15,** Q_5=3.7 cfs, Q_{100}=13.5 cfs) and then south to an existing 30" RCP pipe (**PR#16,** Q_5=17.4 cfs, Q_{100}=39.7 cfs). In the event of clogging, flows at **DP11** will be routed via curb and gutter to **DP15**. Pipe's **PR#15** and **PR#16** are to be constructed as part of the Paint Brush Hills Filing No. 13E infrastructure.

Basin *TT, 5.1 acres, (Q_5=5.7 cfs, Q_{100}=13.0 cfs), consists of proposed single family residential lots and proposed local residential streets. **Basin *TT** is to be constructed with Paint Brush Hills Filing No. 13E, however surface runoff is to be captured and routed to Pond C. Surface runoff is routed via curb and gutter to **DP*37** (Q_5=5.7 cfs, Q_{100}=13.0 cfs) which will be collected by an existing 15' Type R at-grade inlet. The intercepted flow will be routed west via an existing 24" RCP pipe (**PR#39,** Q_5=5.7 cfs, Q_{100}=13.0 cfs). The combined flows from **PR#16** and **PR#39** will be routed west to a existing 36" RCP pipe (**PR#17,** Q_5=22.8 cfs, Q_{100}=51.3 cfs). In the event of clogging, flows at **DP*37** will be routed via curb and gutter into the existing Paint Brush Hills Filing No. 12 subdivision. The combined flowby from **DP*37** and flow from **Basin *UU** is (Q_5=1.4 cfs, Q_{100}=3.2 cfs) and will be discussed in the Paint Brush Hills Filing No. 13E report. Pipe Run **PR#16** and **PR#39** to be constructed as part of the Paint Brush Hills Filing No. 13E infrastructure.

Basin H, 10.8 acres, (Q_5=11.9 cfs, Q_{100}=29.7 cfs), consists of proposed single family residential lots and proposed local residential streets. Surface runoff is routed via curb and gutter to **DP12** which will be collected by proposed dual 15' Type R at-grade inlets. The intercepted flow (Q_5=6.0 cfs, Q_{100}=12.4 cfs per side) will be routed east and west via a (2) 18" RCP pipes (**PR18-18.1,** Q_5=6.0 cfs, Q_{100}=12.4 cfs) and then south to a proposed 30" RCP pipe (**PR19,** (Q_5=11.9 cfs, Q_{100}=24.8 cfs). The combined flows from **PR17** and **PR19** will be routed west to a proposed 42" RCP pipe (**PR20,** Q_5=34.4 cfs, Q_{100}=75.3 cfs). The combined flows from **PR12** and **PR20** will be routed west to a proposed 54" RCP pipe (**PR21,** Q_5=86.8 cfs, Q_{100}=214.5 cfs). In the event of clogging, flows at **DP12** will be routed via curb and gutter to **DP15**.

Basin M, 2.53 acres, (Q_5=2.6 cfs, Q_{100}=7.8 cfs), consists of proposed single family residential lots and proposed local residential streets. Flowby from **DP9, DP11, DP12** and surface runoff from **Basin M** will be routed via curb and gutter to **DP13** (Q_5=2.1 cfs, Q_{100}=21.3 cfs). See **Basin C** for discussion of intercepted flow.

Basin OS5A, 3.7 acres, (Q_5=1.5 cfs, Q_{100}=8.4 cfs), consist of existing developed 3.5-acre properties and streets. Runoff produced by the offsite area, will sheet flow onto **Basin C** which will be routed via side lot swales and curb and gutter to **DP14**.

Basin C, 11.8 acres, (Q_5=9.2 cfs, Q_{100}=28.6 cfs), consists of proposed single family residential lots and proposed local residential streets. Surface runoff is routed via curb and gutter to **DP14** (Q_5=10.3 cfs, Q_{100}=34.8 cfs). The combined flows from **DP13** and **DP14** will be captured by proposed dual 20' Type R sump inlets at **DP15** (Q_5=12.3 cfs, Q_{100}=55.4 cfs). The intercepted flow will be routed south via a 30" RCP pipe (**PR22,** Q_5=6.1 cfs, Q_{100}=2 (Q_5=12.3 cfs, Q_{100}=55.4 cfs). proposed 60" RCP pipe (**PR24,** concrete lined forebay in Pond C

Submittal 2 proposes a swale along the rear of the lots 7 through 18 to address review 1 comment. However, this swale is conveying up to 20 cfs across multiple lots, locate the swale within a tract and identify who is responsible for maintenance. As designed, homeowners will install fencing that would impede flow.

Basin B, 8.31 acres, (Q_5=5.6 c residential lots. Minimal impr collected by a 2' wide swale (see Table 10-4 in appendix) to **DP16** a CDOT type C inlet. The intercepted flow will be routed east via a 30" RCP pipe (**PR25,** Q_5=5.6 cfs, Q_{100}=20.8 cfs). The cumulative flows from PR24 and PR 25 will combine and be routed south to a proposed 66" RCP pipe (**PR26,** Q_5=103.8 cfs, Q_{100}=287.3 cfs) which will outfall into a proposed concrete lined forebay in Pond C.

Basin N, 8.94 acres, (Q_5=6.2 cfs, Q_{100}=23.0 cfs), consists of backyards of proposed single family residential lots, backyards of existing residential lots from Paint Brush Hills Filing No. 12 and existing Pond C. The combined surface runoff and PR26 will be collected at **DP17** (existing **Pond C,** Q_5=109.0 cfs, Q_{100}=306.7 cfs). The existing Pond C will require modifications in order to function as an Full Spectrum Extended Detention Basin (EDB). These modifications will be addressed in the Street and Storm Sewer Construction drawings for Paint Brush Hills Filing No. 14. The proposed Detention Pond C functions to provide full spectrum detention and water quality for runoff calculated onsite and offsite flows. The pond is designed to treat approx 137.6 acres, and provide 1.839 ac-ft of WQCV storage, 4.673 ac-ft of EURV and 11.583 ac-ft of 100-year storage. The forebay, trickle channel micropool, outlet structure and pipe have been designed per the UDFCD manual using the MHFD Detention v4.03 workbook. The detention pond will be private and shall be maint hall be granted to the owner and El Paso vate maintenance agreement document shall tlet structure, flows at **DP17** will over top s it previously was designed. Per the Paint 20' rip rap pad (D_{50} = 18") has been constr ate. The existing riprap pad will dissipate e rate from **Pond C** (**#PR27**, Q5=22.6 cfs ar ing swale. The flows exiting the site are and Q100=161 cfs. The proposed discharg eam infrastructure or affect water quality.

100% of the development site must be treated for water quality. Provide permanent stormwater quality control measure for basin B.

Unresolved. Update narrative to identify the specific criteria (See ECM I.7.1.C.1.a.) that allows exclusion from permanent WQ for this particular subbasin and include justification in the narrative. In the narrative identify basin B1's percentage of the subdivision.

Basin Tributary to Adj

Basin B1, 0.92 acres, (Q_5 family residential lots and routed to drain to Keynes to the adjacent property.

1. **Water Quality Capture Volume (WQCV) Standard.**

The control measures is designed to provide treatment and/or infiltration of the WQCV and:

a. 100% of the applicable development site is captured, except the County may exclude up to 20 percent, not to exceed 1 acre, of the applicable development site area when the County has determined that it is not practicable to capture runoff from portions of the site that will not drain towards control measures. In addition, the County must also determine that the implementation of a separate control measure for that portion of the site is not practicable (e.g., driveway access that drains directly to street).

Basins Tributary to Adjacent Detention Pond D

As previously mentioned in the Purpose section of this report, approximately 5.99 acres of Paint Brush Hills Filing No. 14 runoff will be tributary to Paint Brush Hills Filing 13E (Pond D). The **Basin** description will show that the changes in drainage patterns will not adversely affect downstream infrastructure. **Basin **OS1** was initially part of **Basin **SS** and **Basin *OO** in the "Final Drainage Report for Paint Brush Hills Filing NO. 13E (FDRPBH-13E)". Due to site layout and grading **Basin **OS1** was created and accounted for this drainage report. Other than the basins describe below, the information provided (areas, C values, times of concentration, intensity) by the FDRPBH-13E report was used to quantify the flows in the proposed drainage spreadsheets for **Design Point 34A**, (Q_5=51 cfs, Q_{100}=113 cfs) .

Basin **SS, 3.01 acres, (Q_5=2.8 cfs, Q_{100}=8.4 cfs), consists of a planned single family residential lots and proposed local residential streets. The developed flows within the **Basin **SS** are routed via curb and gutter to a planned 6' Type R sump inlet at **DP**34** (Q_5=2.8 cfs, Q_{100}=8.4 cfs). Due to changes in the grading and drainage patterns the acreage and surface runoff has been reduced from the FDRPBH-13E report (Q_5=14.0 cfs, Q_{100}=29.0 cfs). The combined flows from **DP*33** and **DP**34** (Q_5=6.9 cfs, Q_{100}=19.4 cfs) will be routed east, as planned in the PDRPBH-13E report, via a planned 30" RCP pipe and outlet into Basin OO (within an overhead electric utility easement). See the FDRPBH-13E report and construction plans, by Classic Engineers and Surveyors for additional details.

Basin **OS1, 4.44 acres, (Q_5=4.9 cfs, Q_{100}=13.7 cfs), consists of a planned single family residential lots and proposed local residential streets. The developed flows within the **Basin **OS1** are routed via curb and gutter to a planned 10' Type R sump inlet at **DP1** (Q_5=4.9 cfs, Q_{100}=13.7 cfs). Due to changes in the grading and drainage patterns the acreage and surface runoff has been increased but has been offset by acreage taken away from Basins **SS and *OO. The flows from **DP1** will be routed east via a proposed 18" RCP pipe (**PR1**)and outlet into Basin OO and an existing swale(within an overhead electric utility easement, see Table 10-4 in appendix). Caution will be taken working under the power lines and no amount of fill is anticipated as **PR1** and outfall are installed. A rip rap apron will be constructed to dissipate energy and prevent local scour at the outlet. In the event of clogging or total inlet failure, flows at **DP1** will over top the curb and gutter and outfall into overhead electric utility easement. See Paint Brush Hills Filing No. 14 Street and Storm Sewer construction plans, provided by M&S Civil Consultants for details. The proposed discharge from the subject site will not adversely affect the downstream infrastructure or affect water quality.

DETENTION POND PROVISIONS AND MAINTENANCE

Detention Pond C, has combined upstream developed runoff of Q5=109.0 cfs and Q100=306.7 cfs. The existing Pond C will require modifications in order to function as an Full Spectrum Extended Detention Basin (EDB). The proposed Detention Pond functions to provide detention and water quality for runoff calculated onsite. These modifications will be addressed in the Street and Storm Sewer Construction drawings for Paint Brush Hills Filing No. 14. The pond is designed to treat approx 137.6 acres, and provide 1.839 ac-ft of WQCV storage, 4.673 ac-ft of EURV and 11.583 ac-ft of 100-year storage. The forebay, trickle channel micropool, outlet structure and pipe have been designed per the UDFCD manual using the MHFD Detention v4.03 workbook. The detention pond will be private and shall be maintained by the Paint Brush Hills Metropolitan District. Access shall be granted to the owner and El Paso County for maintenance of the private detention pond. A private maintenance agreement document shall accompany the submittal. In the event of clogging of the outlet structure, flows at **DP17** will over top the emergency spillway and outfall onto an existing swale, as it previously was designed. Per the Paint Brush Hills Filing No. 12 Construction Plans, an existing 20' x 20' rip rap pad (D_{50} = 18") has been constructed and is in general conformance with the present release rate. The existing riprap pad will dissipate energy and prevent local scour at the outlet. The peak release rate from **Pond C** (**#PR27**, Q5=22.6 cfs and

Q100=92.8cfs ~an existing 48" RCP) outfalls into an existing swale. The flows exiting the site are less than the flows as stated in the MDDP of Q5=22 cfs and Q100=161 cfs. Flows will not adversely affect the downstream infrastructure.

EROSION CONTROL

It is the policy of the El Paso County that we submit a grading and erosion control plan with the drainage report. Proposed erosion control blanket, silt fence, vehicle traffic control, and concrete washout area are proposed as erosion control measures.

CONSTRUCTION COST OPINION

Private Drainage Facilities NON-Reimbursable:

Item	Description	Quantity		Unit Cost		Cost
1.	18"RCP	151	LF	$40	/LF	$6,040.00
2.	24"RCP	46	LF	$50	/LF	$2,300.00
3.	30"RCP	674	LF	$65	/LF	$43,810.00
4.	36"RCP	340	LF	$75	/LF	$25,500.00
5.	42"RCP	261	LF	$85	/LF	$22,185.00
6.	48"RCP	2455	LF	$150	/LF	$368,250.00
7.	54"RCP	171	LF	$200	/LF	$34,200.00
8.	60"RCP	285	LF	$250	/LF	$71,250.00
9.	18"FES	1	EA	$245	/EA	$245.00
10.	36"FES	1	EA	$775	/EA	$775.00
11.	60"END TREATEMENT HEADWALL/W ING WALLS	1	EA	$15000/	/EA	$15,000.00
12.	5' TYPE R SUMP INLET	3	EA	$4000	/EA	$12,000.00
13.	10' TYPE R SUMP INLET	1	EA	$4700	/EA	$4,700.00
14.	15' TYPE R SUMP INLET	1	EA	$6000	/EA	$6,000.00
15.	15'TYPE R ATGRADE INLET	6	EA	$6000	/EA	$36,000.00
16.	3'x3' CDOT TYPE C	1	EA	$4000	/EA	$4,000.00
17.	TYPE I MH	12	EA	$6000	/EA	$72,000.00
4.	EDB Pond	1	EA	$20,000	/EA	$20,000.00
5.	Pond Outlet MOD TYPE D	1	EA	$15,000	/EA	$15,000.00
6.	RIPRAP OUTFALL TYPE L	27	CY	$50	/CY	$1,350.00
7.	RIPRAP SPILLWAY TYPE M	384	CY	$65	/CY	$24,960.00
					Total $	**$785,565.00**

DRAINAGE & BRIDGE FEES

Drainage and Bridge Fees for the **Paint Brush Hills Filing No. 14** site are as follows:

	Acres		Imperviousness		Falcon Drainage Basin Fee		
2020 Drainage Fees:	88.631	x	36.8%	x	$30,807.00	=	$1,004,807.52
2020 Bridge Fees:	88.631	x	36.8%	x	$4,232.00	=	$138,031.79
						Total	**$1,142,839.31**

M &S Civil Consultants, Inc. (M &S) cannot and does not guarantee the construction cost will not vary from these opinions of probable costs. These opinions represent our best judgment as design professionals familiar with the construction industry and this development in particular. The above is only an estimate of the facility cost and drainage basin fee amounts in 2020.

SUMMARY

Development of the Paint Brush Hills Filing No. 14 site shall not adversely affect adjacent or downstream properties per this final drainage report. The proposed drainage facilities will adequately convey, detain and route runoff from tributary onsite and existing offsite flows to the Chico Creek receiving waters. Full Spectrum Detention and Water Quality Pond will be used to discharge developed flows into the Chico Creek receiving waters per the Urban Drainage criteria flow rates, which are at or less than the historic flow. Care will be taken to accommodate overland emergency flow routes on site and temporary drainage conditions. The development of the Paint Brush Hills Filing No. 14 project shall not adversely affect adjacent or downstream property. The proposed discharge from the subject site will not adversely affect the downstream infrastructure or affect water quality.

REFERENCES

1.) "El Paso County and City of Colorado Springs Drainage Criteria Manual".

2.) "Urban Storm Drainage Criteria Manual"

3.) SCS Soils Map for El Paso County.

4.) Flood Insurance Rate Map (FIRM), Federal Emergency Management Agency, Effective date March 17, 1997.

5.) "Master Development Drainage Plan for Falcon Hills Development" prepared by Kiowa Engineering Corporation, approved November 2002.

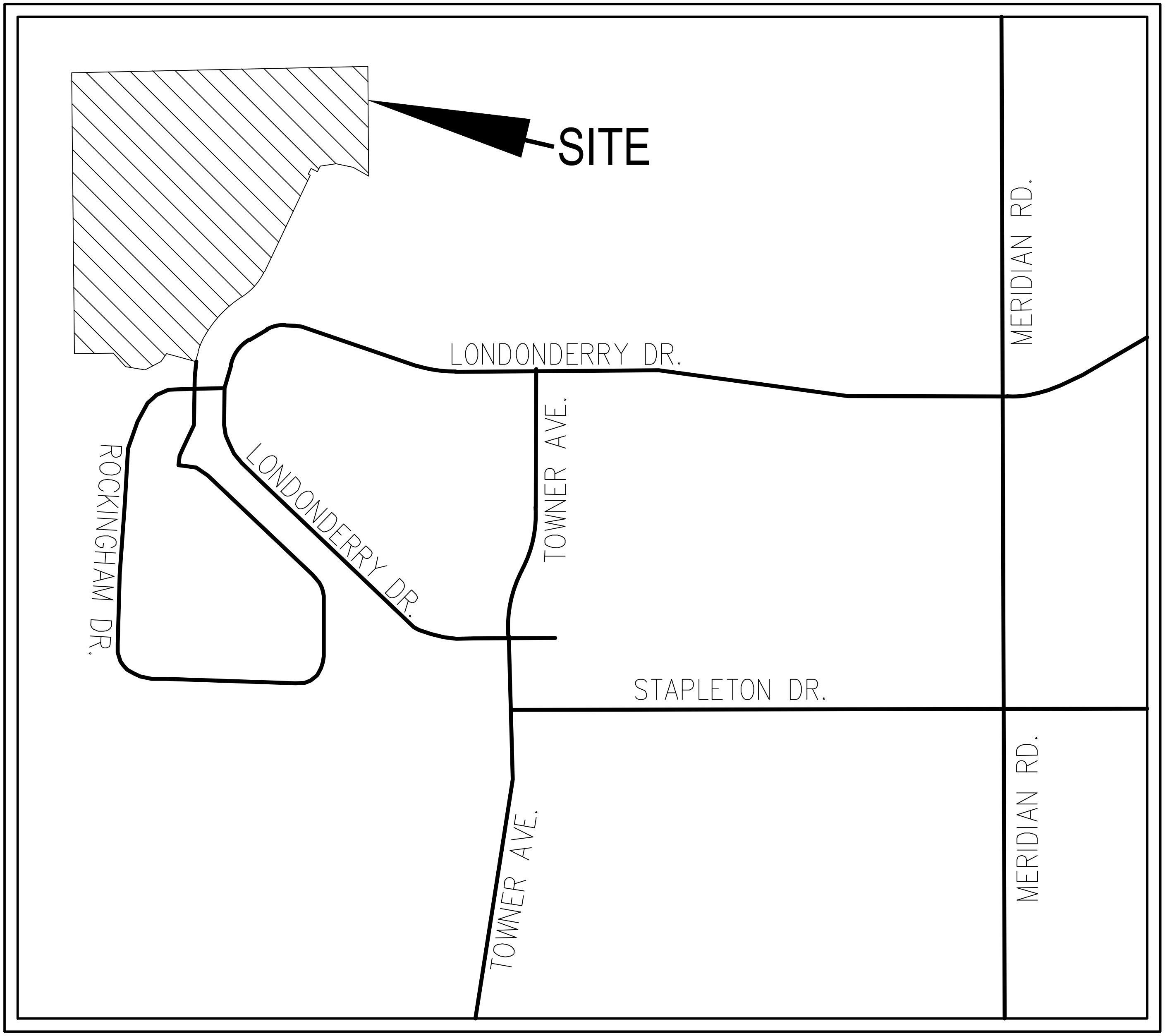
6.) "Final Drainage Report for Paint Brush Hill Filing Nos. 10, 11 & 12" prepared by Classic Consulting Engineers and Surveyors, rev. July 2003.

7.) "Final Drainage Report for Paint Brush Hills-Phase 2 (Filing No. 13)", prepared by Classic Consulting Engineers and Surveyors, submitted on rev. June 2008.

8.) "Final Drainage Report for Paint Brush Hills Filing 13E", prepared by Classic Consulting Engineers and Surveyors, submitted on September 2018.

APPENDIX

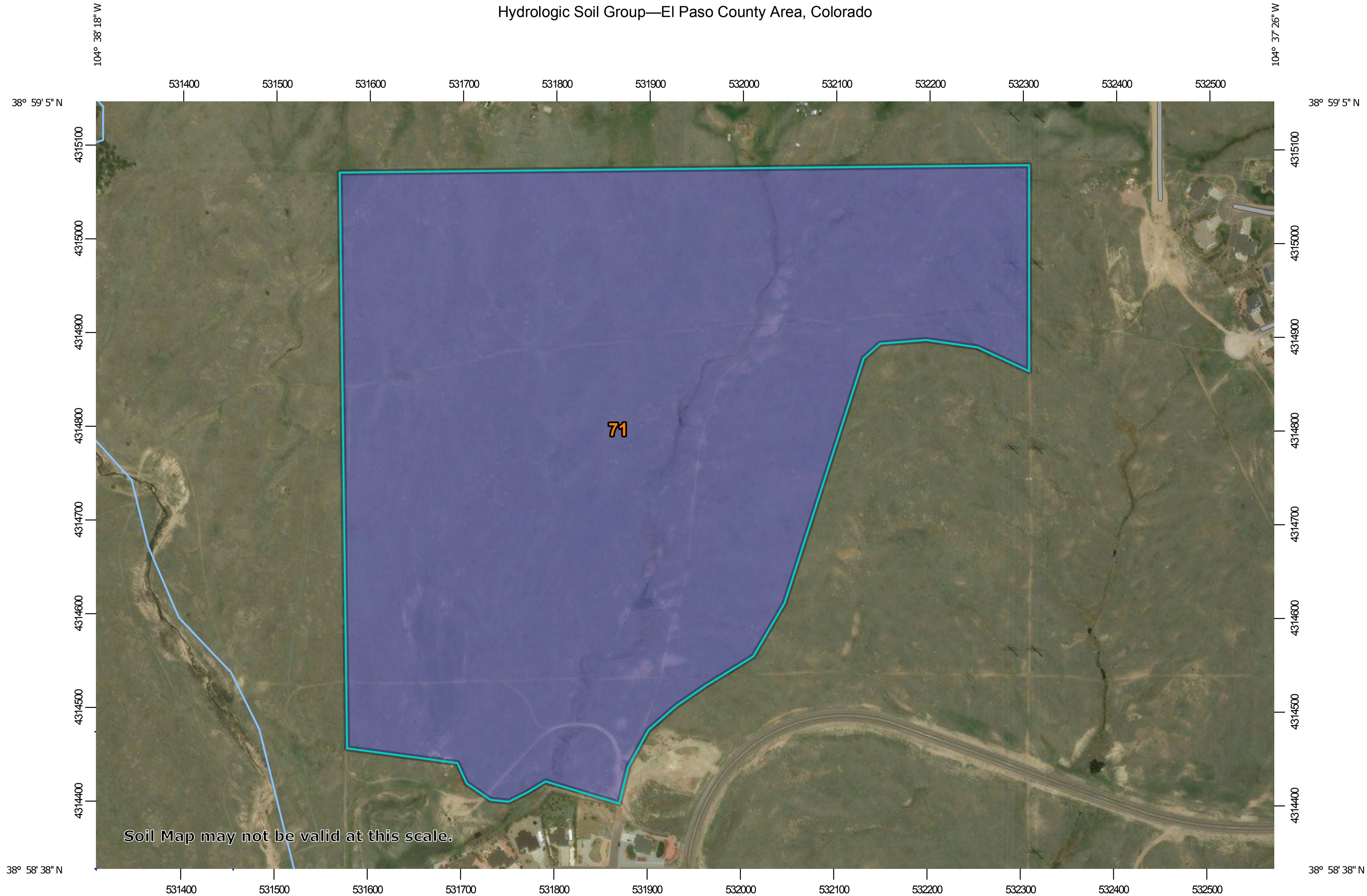
VICINITY MAP



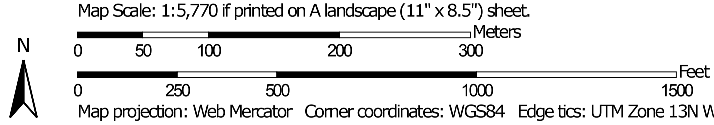
VICINITY MAP

N.T.S.

SOILS MAP



Map Scale: 1:5,770 if printed on A landscape (11" x 8.5") sheet.



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

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

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

Soil Rating Lines

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

Soil Rating Points

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

Water Features

Streams and Canals

Transportation

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

Background

Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 15, Oct 10, 2017

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

Date(s) aerial images were photographed: May 22, 2016—Mar 9, 2017

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
71	Pring coarse sandy loam, 3 to 8 percent slopes	B	87.6	100.0%
Totals for Area of Interest			**87.6**	**100.0%**

Description

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

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

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

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

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

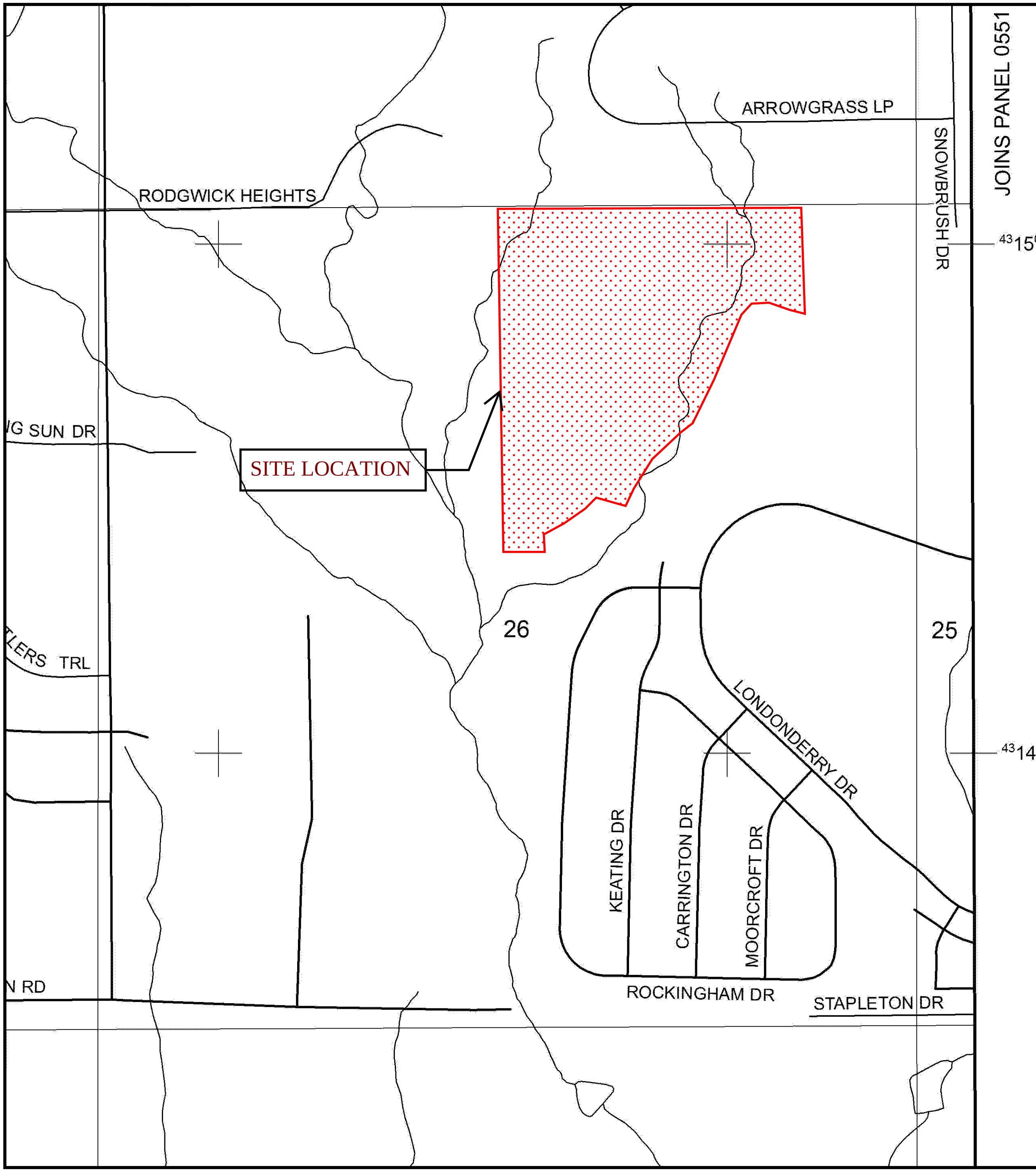
Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over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

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

Rating Options

Aggregation Method: Dominant Condition

FIRM PANEL



MAP SCALE 1" = 1000'

0 1000 2000 FEET

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0535G

FIRM
FLOOD INSURANCE RATE MAP
EL PASO COUNTY, COLORADO
AND INCORPORATED AREAS

PANEL 535 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	080060	0535	G
EL PASO COUNTY	080059	0535	G

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

MAP NUMBER
08041C0535G

MAP REVISED
DECEMBER 7, 2018

Federal Emergency Management Agency

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

HYDROLOGIC CALCULATIONS

PAINTBRUSH HILLS FILING NO. 14
FINAL DRAINAGE CALCULATIONS
(Area Runoff Coefficient Summary)

			IMPERVIOUS AREA/STREET			*LANDSCAPED/UNDEVELOPED*			*RESIDENTIAL*			*WEIGHTED*	
BASIN	**TOTAL AREA (Sq Ft)**	**TOTAL AREA *(Acres)***	**AREA *(Acres)***	C_5	C_{100}	**AREA *(Acres)***	C_5	C_{100}	**AREA *(Acres)***	C_5	C_{100}	C_5	C_{100}
***RR**	*182952*	4.20	0.00	0.90	0.96	0.00	0.16	0.41	4.20	0.30	0.50	***0.30***	***0.50***
****SS**	*131167*	3.01	0.00	0.90	0.96	0.00	0.16	0.41	3.01	0.30	0.50	***0.30***	***0.50***
****OS1**	*193584*	4.44	0.00	0.90	0.96	0.00	0.16	0.41	4.44	0.30	0.50	***0.30***	***0.50***
***OO**	*1268037*	29.11	0.00	0.90	0.96	29.11	0.16	0.41	0.00	0.22	0.46	***0.16***	***0.41***
***TT**	*219978*	5.05	0.00	0.90	0.96	0.00	0.16	0.41	5.05	0.35	0.45	***0.35***	***0.45***
***UU**	*55321*	1.27	0.00	0.90	0.96	0.00	0.16	0.41	1.27	0.35	0.45	***0.35***	***0.45***
*****OS-5**	*2008124*	46.10	0.00	0.90	0.96	0.00	0.16	0.41	46.10	0.30	0.40	***0.30***	***0.40***
OS5A	*159430*	3.66	0.00	0.90	0.96	0.00	0.16	0.41	3.66	0.11	0.37	***0.11***	***0.37***
OS5B	*585306*	13.44	0.00	0.90	0.96	0.00	0.16	0.41	13.44	0.11	0.37	***0.11***	***0.37***
OS5C	*1263404*	29.00	0.00	0.90	0.96	0.00	0.16	0.41	29.00	0.30	0.40	***0.30***	***0.40***
A	*22798*	0.52	0.01	0.90	0.96	0.51	0.16	0.41	0.00	0.22	0.46	***0.18***	***0.42***
B	*361915*	8.31	0.00	0.90	0.96	0.00	0.16	0.41	8.31	0.20	0.44	***0.20***	***0.44***
B1	*40214*	0.92	0.00	0.90	0.96	0.00	0.16	0.41	0.92	0.16	0.41	***0.16***	***0.41***
C	*514010*	11.80	0.00	0.90	0.96	0.00	0.16	0.41	11.80	0.26	0.48	***0.26***	***0.48***
D	*226401*	5.20	0.00	0.90	0.96	0.00	0.16	0.41	5.20	0.20	0.44	***0.20***	***0.44***
E	*21364*	0.49	0.49	0.90	0.96	0.00	0.16	0.41	0.00	0.20	0.44	***0.90***	***0.96***
F	*70330*	1.61	0.00	0.90	0.96	0.00	0.16	0.41	1.61	0.30	0.50	***0.30***	***0.50***
G	*531342*	12.20	0.00	0.90	0.96	0.00	0.16	0.41	12.20	0.35	0.52	***0.35***	***0.52***
H	*469586*	10.78	0.00	0.90	0.96	0.00	0.16	0.41	10.78	0.35	0.52	***0.35***	***0.52***
I	*554956*	12.74	0.00	0.90	0.96	0.00	0.16	0.41	12.74	0.35	0.52	***0.35***	***0.52***
J	*313307*	7.19	0.00	0.90	0.96	0.00	0.16	0.41	7.19	0.22	0.45	***0.22***	***0.45***
K	*32632*	0.75	0.00	0.90	0.96	0.00	0.16	0.41	0.75	0.36	0.54	***0.36***	***0.54***
L	*146850*	3.37	0.00	0.90	0.96	0.00	0.16	0.41	3.37	0.36	0.54	***0.36***	***0.54***
M	*110207*	2.53	0.00	0.90	0.96	0.00	0.16	0.41	2.53	0.27	0.48	***0.27***	***0.48***
N	*389341*	8.94	0.00	0.90	0.96	3.19	0.16	0.41	5.75	0.22	0.46	***0.20***	***0.44***

***** Values taken from "Final Drainage Report for Paint Brush Hills Filing 13E" (*FDRPBH-13E) prepared by Classic Consulting Engineers and Surveyors, dated Sept 2018***

***** Revised from "Preliminary Drainage Report for Paint Brush Hills Filing 13E" (**PDRPBH13E) prepared by Classic Consulting Engineers and Surveyors, dated Feb 2018***

****** "Final Drainage Report for Paint Brush Hills-Phase 2 (Filing 13)" (FDRPBH-PH2-13) prepared by Classic Consulting Engineers and Surveyors, revised June 2008***

Calculated by: GT
Date: 11/20/2020
Checked by: VAS

PAINTBRUSH HILLS FILING NO. 14
FINAL DRAINAGE CALCULATIONS
(Area Drainage Summary)

From Area Runoff Coefficient Summary				*OVERLAND*				*STREET / CHANNEL FLOW*				*Time of Travel*		*INTENSITY **		*TOTAL FLOWS*	
BASIN	AREA TOTAL	C_5	C_{100}	C_5	Length	Height	T_C	Length	Slope	Velocity	T_t	TOTAL	CHECK	I_5	I_{100}	Q_5	Q_{100}
	(Acres)	*From DCM Table 5-1*			*(ft)*	*(ft)*	*(min)*	*(ft)*	*(%)*	*(fps)*	*(min)*	*(min)*	*(min)*	*(in/hr)*	*(in/hr)*	*(c.f.s.)*	*(c.f.s.)*
Proposed Area Drainage Summary																	
***RR**	4.20	0.30	0.50	0.25												***8.0***	***17.0***
****SS**	3.01	0.30	0.50	0.25	170	3.4	16.5	800	3.9%	6.9	1.9	18.4	15.4	3.1	5.6	***2.8***	***8.4***
****OS1**	4.44	0.30	0.50	0.30	100	5	8.5	616	1.0%	2.0	5.1	13.6	14.0	3.7	6.2	***4.9***	***13.7***
***OO**	29.11	0.16	0.41	0.16												***22.0***	***51.0***
***TT**	5.05	0.35	0.45	0.25	180	3.6	17.0	150	1.5%	4.3	0.6	17.6	11.8	3.2	5.7	***5.7***	***13.0***
***UU**	1.27	0.35	0.45	0.25	180	3.6	17.0	475	2.5%	5.5	1.4	18.4	13.6	3.1	5.6	***1.4***	***3.2***
*****OS-5**	46.10	0.30	0.40	0.30												***14.0***	***32.0***
OS5A	3.66	0.11	0.37	0.11	100	2	14.2	527	1.5%	1.8	4.8	19.0	13.5	3.7	6.2	***1.5***	***8.4***
OS5B	13.44	0.11	0.37	0.11	100	2	14.2	1684	1.5%	1.8	15.3	29.5	19.9	3.1	5.2	***4.6***	***25.8***
OS5C	29.00	0.30	0.40	0.30	100	2	11.5	2110	1.0%	2.0	17.6	29.1	22.3	2.9	4.9	***25.5***	***57.0***
A	0.52	0.18	0.42	0.18	100	5	9.8	569	4.3%	3.1	3.1	12.8	13.7	3.8	6.3	***0.4***	***1.4***
B	8.31	0.20	0.44	0.20	100	3	11.3	1063	3.2%	2.7	6.6	17.9	16.5	3.4	5.7	***5.6***	***20.8***
B1	0.92	0.16	0.41	0.16	100	3	11.8	265	2.6%	3.2	1.4	13.2	12.0	3.9	6.5	***0.6***	***2.4***
C	11.80	0.26	0.48	0.26	100	3	10.6	2030	2.6%	3.2	10.6	21.1	21.8	3.0	5.0	***9.2***	***28.6***
D	5.20	0.20	0.44	0.20	100	4	10.3	593	2.0%	2.1	4.7	14.9	13.9	3.6	6.1	***3.8***	***14.0***
E	0.49	0.90	0.96	0.90	10	0.2	0.9	471	2.0%	2.8	2.8	5.0	12.7	5.2	8.7	***2.3***	***4.1***
F	1.61	0.30	0.50	0.30	60	1.2	8.9	362	2.0%	2.8	2.1	11.0	12.3	4.0	6.7	***1.9***	***5.4***
G	12.20	0.35	0.52	0.35	100	2	10.8	1381	2.8%	3.3	6.9	17.7	18.2	3.3	5.5	***14.0***	***34.8***
H	10.78	0.35	0.52	0.35	100	2	10.8	1543	2.1%	2.9	8.9	19.6	19.1	3.2	5.3	***11.9***	***29.7***
I	12.70	0.35	0.52	0.35	100	2	10.8	1309	2.1%	2.9	7.5	18.3	17.8	3.3	5.5	***14.5***	***36.2***
J	7.19	0.22	0.45	0.22	100	2	12.6	799	1.9%	2.7	4.9	17.5	15.0	3.5	5.9	***5.6***	***19.1***
K	0.75	0.36	0.54	0.36	72	1.4	9.1	277	1.6%	2.5	1.8	10.9	11.9	4.0	6.7	***1.1***	***2.7***
L	3.37	0.36	0.54	0.36	75	1.5	9.2	1802	2.1%	2.9	10.4	19.6	20.4	3.1	5.2	***3.8***	***9.5***
M	2.53	0.27	0.48	0.27	100	2	11.9	318	2.1%	2.9	1.8	13.8	12.3	3.8	6.4	***2.6***	***7.8***
N	8.94	0.20	0.44	0.20	100	2	12.9	902	3.2%	3.6	4.2	17.1	15.6	3.5	5.8	***6.2***	***23.0***

Values taken from "Final Drainage Report for Paint Brush Hills Filing 13E" (*FDRPBH13E) prepared by Classic Consulting Engineers and Surveyors, dated Sept 2018

***** Revised from "Preliminary Drainage Report for Paint Brush Hills Filing 13E" (**PDRPBH13E) prepared by Classic Consulting Engineers and Surveyors, dated Feb 2018***

****** "Final Drainage Report for Paint Brush Hills-Phase 2 (Filing 13)" (FDRPBH-PH2-13) prepared by Classic Consulting Engineers and Surveyors, revised June 2008***

Calculated by: GT
Date: 11/20/2020
ked by: VAS

PAINTBRUSH HILLS FILING NO. 14
FINAL DRAINAGE CALCULATIONS
(Basin Routing Summary)

From Area Runoff Coefficient Summary				OVERLAND				PIPE / CHANNEL FLOW				Time of Travel (T_t)	INTENSITY *		TOTAL FLOWS		
DESIGN POINT	CONTRIBUTING BASINS	CA_5	CA_{100}	C_5	Length (ft)	Height (ft)	T_C (min)	Length (ft)	Slope (%)	Velocity (fps)	T_t (min)	TOTAL (min)	I_5 (in/hr)	I_{100} (in/hr)	Q_5 (c.f.s.)	Q_{100} (c.f.s.)	COMMENTS
PROPOSED DRAINAGE BASIN ROUTING SUMMARY																	
1	**OS1	1.33	2.22									13.6	3.7	6.2	*4.9*	*13.7*	PROP 10' SUMP TYPE R INLET
																	REV **PDRPBH13E
																	W/18" RCP
**33*	*RR	1.26	2.10									14.9	3.5	5.9	*8.0*	*17.0*	*6' SUMP TYPE R INLET
																	*PDRPBH13E
																	*W/24" RCP
***34*	**SS	0.90	1.51									18.4	3.1	5.6	*2.8*	*8.4*	*6' SUMP TYPE R INLET
																	**PDRPBH13E
																	*W/30" RCP
3	A	0.09	0.22									22.3	2.9	4.9	*25.7*	*58.1*	PROP 36" RCP FES
	OS5C	8.70	11.60														
		8.79	11.82														
4	J	1.58	3.24									15.0	3.5	5.9	*5.6*	*19.1*	PROP 15' SUMP TYPE R INLET
																	W/24" RCP
5	K	0.27	0.40									10.9	4.0	6.7	*1.1*	*2.7*	PROP 5' SUMP TYPE R INLET
																	W/18" RCP
6	OS5B	1.48	4.97									19.9	3.1	5.2	*9.2*	*40.2*	PROP 15' SUMP TYPE R INLET
	D	1.04	2.29														W/24" RCP
	E	0.44	0.47														
		2.96	7.73														
7	F	0.48	0.81									11.0	4.0	6.7	*1.9*	*5.4*	PROP 15' SUMP TYPE R INLET
																	W/24" RCP
8	DP 6 & 7	3.44	8.54									19.9	3.1	5.2	*10.7*	*44.4*	PROP DUAL 15' SUMP TYPE R INLET
																	100-YEAR
																22.2	FLOWS SPLIT @ DP8
9	G	4.27	6.34									18.2	3.2	5.4	*13.8*	*34.4*	PROP DUAL 15' AT-GRADE TYPE R INLET
																	W/24" RCPS
																	FLOWS SPLIT @ DP9
10	I	4.45	6.60									17.8	3.3	5.5	*14.5*	*36.2*	PROP DUAL 15' AT-GRADE TYPE R INLET
																	W/18" RCP & 30" RCP
																	FLOWS SPLIT @ DP10
11	L	1.21	1.82									20.4	3.1	5.1	*3.7*	*17.0*	EX. 15' AT-GRADE TYPE R INLET
	Flowby DP10	0.00	1.49														W/24" RCP
		1.21	3.31														
**37*	*TT	1.77	2.27									11.8	3.2	5.7	*5.7*	*13.0*	EX. 15' AT-GRADE TYPE R INLET
																	W/24" RCP
																	FLOWS SPLIT @ DP12
12	H	3.77	5.61									19.1	3.2	5.3	*11.9*	*29.7*	PROP DUAL 15' AT-GRADE TYPE R INLET
																	W/18" RCP & 30" RCP
																	FLOWS SPLIT @ DP12
13	M	0.68	1.21									20.4	3.1	5.1	*2.1*	*21.3*	SEE DP15 FOR CUMMULATIVE FLOW
	FLOWBY DP9	0.00	1.35														
	FLOWBY DP12	0.00	0.90														
	FLOWBY DP11	0.00	0.68														
		0.68	4.15														
14	C	3.07	5.66									21.8	3.0	5.0	*10.3*	*34.8*	SEE DP15 FOR CUMMULATIVE FLOW
	OS5A	0.40	1.35														
		3.47	7.02														
15	DP13	0.68	4.15									21.8	3.0	5.0	*12.3*	*55.4*	PROP DUAL 20' SUMP TYPE R INLET
	DP14	3.47	7.02														W/30" & 36"RCP
		4.15	11.16														FLOWS SPLIT @ DP15
16	B	1.66	3.66									16.5	3.4	5.7	*5.6*	*20.8*	PROP CDOT TYPE C INLET
17	N	1.78	3.95									22.3	2.9	4.9	*109.0*	*306.7*	EX. POND C
	PR26	35.50	58.54														
		37.27	62.49														

**** Values taken from "Final Drainage Report for Paint Brush Hills Filing 13E" (*FDRPBH13E) prepared by Classic Consulting Engineers and Surveyors, dated September 2018***

***** Revised from "Preliminary Drainage Report for Paint Brush Hills Filing 13E" (**PDRPBH13E) prepared by Classic Consulting Engineers and Surveyors, dated Feb 2018***

****** "Final Drainage Report for Paint Brush Hills-Phase 2 (Filing 13)" (FDRPBH-PH2-13) prepared by Classic Consulting Engineers and Surveyors, revised June 2008***

Calculated by: GT
Date: 11/20/2020
Checked by: VAS

PAINTBRUSH HILLS FILING NO. 14
FINAL DRAINAGE CALCULATIONS
(Storm Sewer Routing Summary)

PIPE RUN	Contributing Pipes/Design Points	Equivalent CA_5	Equivalent CA_{100}	Maximum T_C	Intensity*		Flow		PIPE SIZE
					I_5	I_{100}	Q_5	Q_{100}	
*36	PDRPBH-13E DP33	1.26	2.10	14.9	3.5	5.9	4.4	12.4	*24" RCP
*37	DP**34, DP*33	2.16	3.61	18.4	3.2	5.4	6.9	19.4	*30" RCP
1	DP1	1.33	2.22	13.6	3.7	6.2	4.9	13.7	18" RCP
2	DP3	8.79	11.82	22.3	2.9	4.9	25.7	58.1	36" RCP
3	DP4, PR2	10.38	15.06	22.3	2.9	4.9	30.4	74.0	48" RCP
4	DP5	0.27	0.40	10.9	4.0	6.7	1.1	2.7	18" RCP
5	PR3, PR4	10.65	15.46	22.3	2.9	4.9	31.2	76.0	48" RCP
7	DP6	2.96	4.27	19.9	3.1	5.2	9.2	22.2	24" RCP
8	DP7	0.48	4.27	19.9	4.0	5.2	1.9	22.2	24" RCP
9	PR5, PR7, PR8	14.09	24.00	22.3	2.9	4.9	41.2	117.8	48" RCP
10	1/2 DP9 CAPTURE	2.17	2.52	18.2	3.2	5.4	7.0	13.7	24" RCP
11	1/2 DP9 CAPTURE	2.17	2.52	18.2	3.2	5.4	7.0	13.7	24" RCP
12	PR9, PR10, PR11	18.43	29.04	22.3	2.9	4.9	53.9	142.5	48" RCP
13	1/2 DP 10 CAPTURE	2.24	2.55	17.8	3.3	5.5	7.3	14.0	18" RCP
14	1/2 DP 10 CAPTURE, PR13	4.48	5.10	17.8	3.3	5.5	14.6	27.9	30" RCP
#38	PR14	4.48	5.10	17.8	3.3	5.5	14.6	27.9	*30" RCP
#15	DP 11 CAPTURE	1.22	2.63	20.4	3.1	5.1	3.7	13.5	*24" RCP
#16	#PR38, #PR15	5.70	7.73	20.4	3.1	5.1	17.4	39.7	*30" RCP
#39	DP*37	1.77	2.27	11.8	3.2	5.7	5.7	13.0	*24" RCP
#17	PR#16, PR#39	7.47	10.00	20.4	3.1	5.1	22.8	51.3	*36" RCP
18	1/2 DP12	1.89	2.34	19.1	3.2	5.3	6.0	12.4	18" RCP
18.1	1/2 DP12	1.89	2.34	19.1	3.2	5.3	6.0	12.4	18" RCP
19	PR18, PR18.1	3.78	4.68	19.1	3.2	5.3	11.9	24.8	30" RCP
20	PR#17, PR19	11.25	14.68	20.4	3.1	5.1	34.4	75.3	42" RCP
21	PR12, PR20	29.68	43.72	22.3	2.9	4.9	86.8	214.5	54" RCP
22	1/2 DP15	2.08	5.58	21.8	3.0	5.0	6.1	27.7	30" RCP
23	1/2 DP15, PR22	4.15	11.16	21.8	3.0	5.0	12.3	55.4	36" RCP
24	PR21, PR23	33.84	54.88	22.3	2.9	4.9	98.9	269.3	60" RCP
25	B	1.66	3.66	16.5	3.4	5.7	5.6	20.8	30" RCP
26	PR24, PR25	35.50	58.54	22.3	2.9	4.9	103.8	287.3	66" RCP
#27	DP 17	POND C OUTFALL RESTRICTED FLOW FROM MHFD SHT					22.6	92.8	EX 48" RCP

** Values taken from "Final Drainage Report for Paint Brush Hills Filing 13E" (*FDRPBH13E)*
prepared by Classic Consulting Engineers and Surveyors, dated September 2018
 # Values adjusted from FDR PBH 14

Calculated by: GT
Date: 11/20/2020
Checked by: VAS

DP - Design Point
EX - Existing Design Point
FB- Flow By from Design Point
INT- Intercepted Flow from Design Point

HYDRAULIC CALCULATIONS / EDB WQCV CALCULATIONS

PAINTBRUSH HILLS FILING NO. 14
FINAL DRAINAGE REPORT
(CDOT Type R Inlet Calculations - Sump Condition)

Urban Local Roadway-50' ROW-30' Pavement-6" Vertical Curb
Maximum allowable depth for **MINOR (0.43')** & **MAJOR (0.66')** storm

Inlet Length	Storm	Depth	Eqn. 7-31	Eqn. 7-32	Eqn. 7-29
			$Q_w=C_wN_wL_eD^{3/2}$	$Q_o=C_oN_o(L_eH_c)(2g(D-0.5H_c))^{1/2}$	$Q_m=C_m(Q_wQ_o)^{1/2}$
5	Q_5	0.43	5.1	5.7	5.0
5	Q_{100}	0.66	9.7	8.6	8.5
6	Q_5	0.43	6.1	6.8	6.0
6	Q_{100}	0.66	11.6	10.3	10.2
8	Q_5	0.43	8.1	9.1	8.0
8	Q_{100}	0.66	15.4	13.8	13.6
10	Q_5	0.43	10.2	11.4	10.0
10	Q_{100}	0.66	19.3	17.2	17.0
12	Q_5	0.43	12.2	13.7	12.0
12	Q_{100}	0.66	23.2	20.7	20.3
14	Q_5	0.43	14.2	16.0	14.0
14	Q_{100}	0.66	27.0	24.1	23.7
15	Q_5	0.43	15.2	17.1	15.0
15	Q_{100}	0.66	29.0	25.8	25.4
16	Q_5	0.43	16.2	18.2	16.0
16	Q_{100}	0.66	30.9	27.5	27.1
18	Q_5	0.43	18.3	20.5	18.0
18	Q_{100}	0.66	34.7	31.0	30.5
20	Q_5	0.43	20.3	22.8	20.0
20	Q_{100}	0.66	38.6	34.4	33.9

Table 7-7. Coefficients for various inlets in sumps

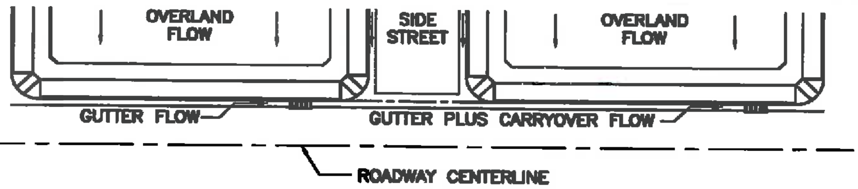
Inlet Type	Nw	Cw	No	Co	Cm
CDOT Type 13 Grate	0.7	3.3	0.43	0.6	0.93
Denver No. 16 Grate	0.73	3.6	0.31	0.6	0.9
Curb Opening for Type 13/No. 16 Combination	1	3.7	1	0.66	0.86
CDOT Type R Curb Opening	1	3.6	1	0.67	0.93

Worksheet Protected

DESIGN PEAK FLOW FOR ONE-HALF OF STREET OR GRASS-LINED CHANNEL BY THE RATIONAL METHOD

Project: PAINT BRUSH HILLS FILING NO. 14

Inlet ID: SUMP INLET DP1



Show Details

Design Flow: ONLY if already determined through other methods:

		Minor Storm	Major Storm	
(local peak flow for 1/2 of street OR grass-lined channel):	$*Q_{Known}$ =	4.9	13.7	cfs

* If you enter values in Row 14, skip the rest of this sheet and proceed to sheet Q-Allow or Area Inlet.

<-- FILL IN THIS SECTION OR...

FILL IN THE SECTIONS BELOW. <--

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

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

Site Type:
- ○ Site is Urban
- ○ Site is Non-Urban

Flows Developed For:
- ○ Street Inlets
- ○ Area Inlets in a Median

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

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

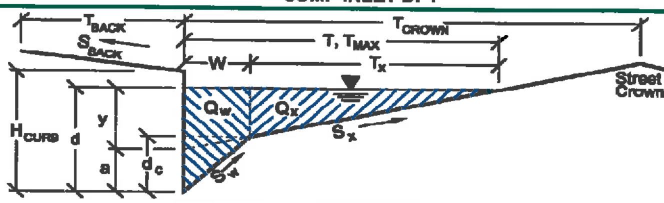
	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	0.0	0.0	cfs
Total Design Peak Flow, Q =	4.9	13.7	cfs

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

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

Project: PAINT BRUSH HILLS FILING NO. 14

Inlet ID: SUMP INLET DP1



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	8.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.020	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	5.6	7.9	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☑	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	4.08	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline	d =	5.59	5.59	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	15.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.350	0.350	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	Q_T =	**SUMP**	**SUMP**	cfs
Flow Velocity within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	0.0	0.0	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	17.0	26.6	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	15.0	24.6	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.349	0.220	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	0.0	0.0	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	0.0	0.0	cfs
Average Flow Velocity Within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.0	0.0	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d ≥ 6") Storm	R =	SUMP	SUMP	
Max Flow Based on Allowable Depth (Safety Factor Applied)	Q_d =	**SUMP**	**SUMP**	cfs
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =			inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =			inches

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

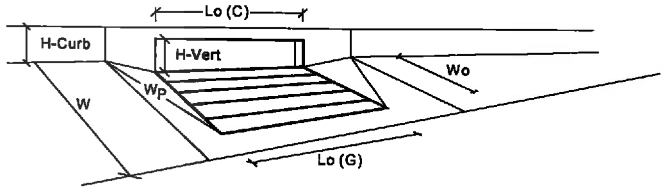
Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

INLET IN A SUMP OR SAG LOCATION

Project = PAINT BRUSH HILLS FILING NO. 14

Inlet ID = SUMP INLET DP1

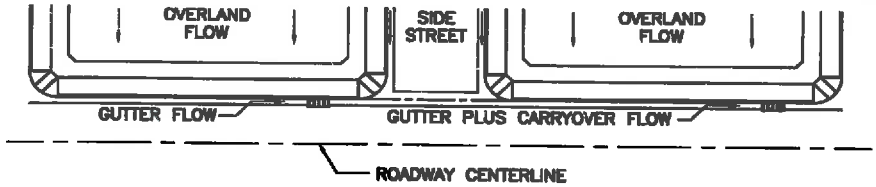


Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Inlet Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	2.0	2	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	5.6	7.9	inches ☑ Override Depths
Grate Information		MINOR	MAJOR	
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	8.7	19.0	cfs
Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	4.9	13.7	cfs

Worksheet Protected

DESIGN PEAK FLOW FOR ONE-HALF OF STREET OR GRASS-LINED CHANNEL BY THE RATIONAL METHOD

Project: PAINT BRUSH HILLS FILING NO. 14
Inlet ID: SUMP INLET DP**34



Show Details

Design Flow: ONLY if already determined through other methods:

	Minor Storm	Major Storm	
(local peak flow for 1/2 of street OR grass-lined channel): *Q_{Known} =	3.5	9.7	cfs

* If you enter values in Row 14, skip the rest of this sheet and proceed to sheet Q-Allow or Area Inlet.

<-- FILL IN THIS SECTION OR...

FILL IN THE SECTIONS BELOW. <--

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

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

Site Type:
- ○ Site is Urban
- ○ Site is Non-Urban

Flows Developed For:
- ○ Street Inlets
- ○ Area Inlets in a Median

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

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

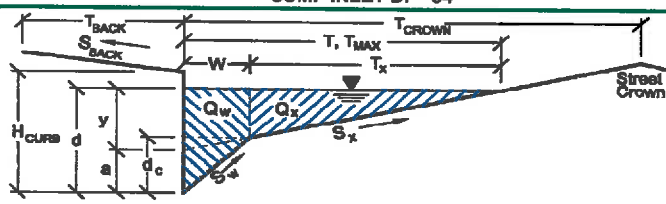
	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	0.0	0.0	cfs
Total Design Peak Flow, Q =	3.5	9.7	cfs

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

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

Project: PAINT BRUSH HILLS FILING NO. 14

Inlet ID: SUMP INLET DP**34



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	8.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.020	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	5.6	7.9	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☑	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	4.08	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline	d =	5.59	5.59	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	15.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.350	0.350	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	Q_T =	**SUMP**	**SUMP**	cfs
Flow Velocity within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	0.0	0.0	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	17.0	26.6	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	15.0	24.6	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.349	0.220	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	0.0	0.0	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	0.0	0.0	cfs
Average Flow Velocity Within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.0	0.0	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d ≥ 6") Storm	R =	SUMP	SUMP	
Max Flow Based on Allowable Depth (Safety Factor Applied)	Q_d =	**SUMP**	**SUMP**	cfs
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =			inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =			inches

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

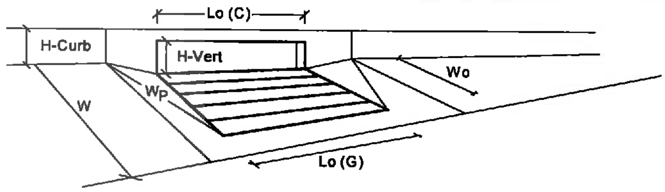
Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

INLET IN A SUMP OR SAG LOCATION

Project = PAINT BRUSH HILLS FILING NO. 14

Inlet ID = SUMP INLET DP**34

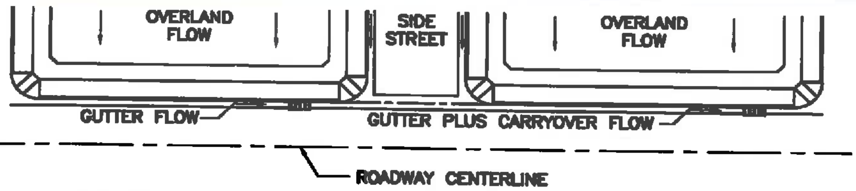


		MINOR	MAJOR	
Design Information (Input)				
Type of Inlet	Inlet Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	2.0	2	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	5.6	7.9	inches ☑ Override Depths
Grate Information		MINOR	MAJOR	
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	8.7	19.0	cfs
Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	3.5	9.7	cfs

Worksheet Protected

DESIGN PEAK FLOW FOR ONE-HALF OF STREET OR GRASS-LINED CHANNEL BY THE RATIONAL METHOD

Project: PAINT BRUSH HILLS FILING NO. 14
Inlet ID: SUMP INLET DP4



Show Details

Design Flow: ONLY if already determined through other methods:

		Minor Storm	Major Storm	
(local peak flow for 1/2 of street OR grass-lined channel):	$^*Q_{Known}$ =	5.6	19.1	cfs

* If you enter values in Row 14, skip the rest of this sheet and proceed to sheet Q-Allow or Area Inlet.

<-- FILL IN THIS SECTION OR...

FILL IN THE SECTIONS BELOW. <--

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

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

Site Type:
- O Site is Urban
- O Site is Non-Urban

Flows Developed For:
- O Street Inlets
- O Area Inlets in a Median

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

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

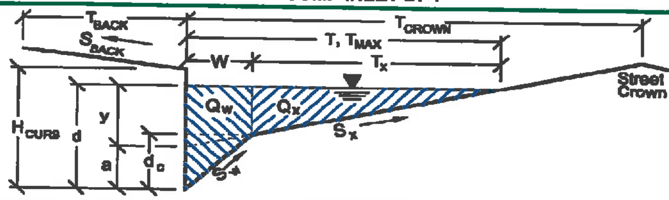
	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	0.0	0.0	cfs
Total Design Peak Flow, Q =	5.6	19.1	cfs

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

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

Project: PAINT BRUSH HILLS FILING NO. 14

Inlet ID: SUMP INLET DP4



Gutter Geometry (Enter data in the blue cells)

Description	Symbol	Value	Unit
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	8.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.020	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	5.6	7.9	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☑	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	4.08	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline	d =	5.59	5.59	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	15.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.350	0.350	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	Q_T =	**SUMP**	**SUMP**	**cfs**
Flow Velocity within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	0.0	0.0	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	17.0	26.6	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\ TH}$ =	15.0	24.6	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.349	0.220	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\ TH}$	$Q_{X\ TH}$ =	0.0	0.0	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	0.0	0.0	cfs
Average Flow Velocity Within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.0	0.0	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d ≥ 6") Storm	R =	SUMP	SUMP	
Max Flow Based on Allowable Depth (Safety Factor Applied)	Q_d =	**SUMP**	**SUMP**	cfs
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =			inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =			inches

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

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

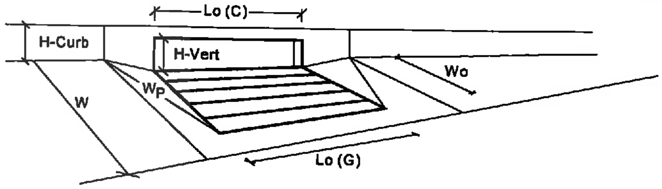
Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

INLET IN A SUMP OR SAG LOCATION

Project = PAINT BRUSH HILLS FILING NO. 14

Inlet ID = SUMP INLET DP4

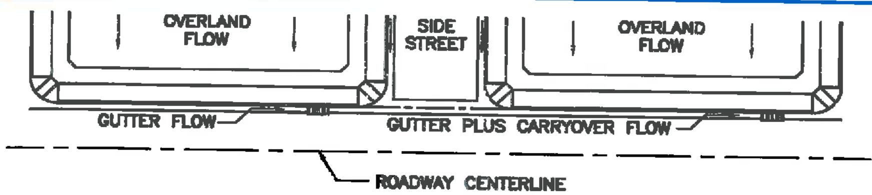


Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Inlet Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	3.0	3	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	5.6	7.9	inches
				☑ Override Depths
Grate Information		MINOR	MAJOR	
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	11.1	27.3	cfs
Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)	Q PEAK REQUIRED =	5.6	19.1	cfs

Worksheet Protected

DESIGN PEAK FLOW FOR ONE-HALF OF STREET OR GRASS-LINED CHANNEL BY THE RATIONAL METHOD

Project: PAINT BRUSH HILLS FILING NO. 14
Inlet ID: SUMP INLET DP5



Show Details

Design Flow: ONLY if already determined through other methods:

		Minor Storm	Major Storm	
(local peak flow for 1/2 of street OR grass-lined channel):	$^{*}Q_{Known}$ =	1.1	2.7	cfs

<-- FILL IN THIS SECTION OR...

* If you enter values in Row 14, skip the rest of this sheet and proceed to sheet Q-Allow or Area Inlet.

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

FILL IN THE SECTIONS BELOW. <--

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

Site Type:
- ○ Site is Urban
- ○ Site is Non-Urban

Flows Developed For:
- ○ Street Inlets
- ○ Area Inlets in a Median

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

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

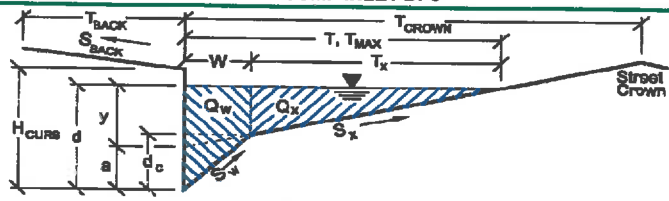
	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	0.0	0.0	cfs
Total Design Peak Flow, Q =	1.1	2.7	cfs

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

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

Project: PAINT BRUSH HILLS FILING NO. 14

Inlet ID: SUMP INLET DP5



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	8.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.020	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	5.6	7.9	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☑	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	4.08	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline	d =	5.59	5.59	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	15.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.350	0.350	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	Q_T =	**SUMP**	**SUMP**	cfs
Flow Velocity within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	0.0	0.0	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	17.0	26.6	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	15.0	24.6	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.349	0.220	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	0.0	0.0	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	0.0	0.0	cfs
Average Flow Velocity Within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.0	0.0	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d ≥ 6") Storm	R =	SUMP	SUMP	
Max Flow Based on Allowable Depth (Safety Factor Applied)	Q_d =	**SUMP**	**SUMP**	cfs
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =			inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =			inches

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

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

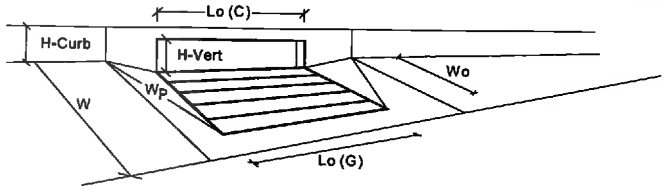
Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

INLET IN A SUMP OR SAG LOCATION

Project = PAINT BRUSH HILLS FILING NO. 14

Inlet ID = SUMP INLET DP5

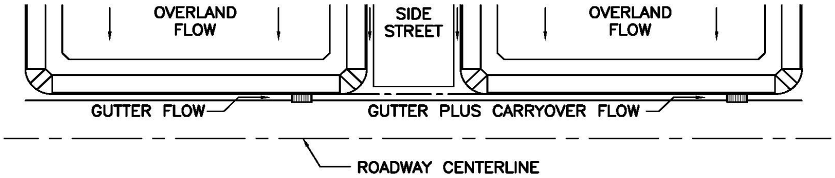


Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Inlet Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1.0	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	5.6	7.9	inches ☑ Override Depths
Grate Information		MINOR	MAJOR	
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	4.6	9.1	cfs
Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	1.1	2.7	cfs

Worksheet Protected

DESIGN PEAK FLOW FOR ONE-HALF OF STREET OR GRASS-LINED CHANNEL BY THE RATIONAL METHOD

Project: PAINT BRUSH HILLS FILING NO. 14
Inlet ID: SUMP INLET DP6



Show Details

Design Flow: ONLY if already determined through other methods:

(local peak flow for 1/2 of street OR grass-lined channel):

	Minor Storm	Major Storm	
*Q_{Known} =	9.2	22.2	cfs

* If you enter values in Row 14, skip the rest of this sheet and proceed to sheet Q-Allow or Area Inlet.

<--- FILL IN THIS SECTION OR…

FILL IN THE SECTIONS BELOW. <---

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

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

Site Type:
- Site is Urban
- Site is Non-Urban

Flows Developed For:
- Street Inlets
- Area Inlets in a Median

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

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

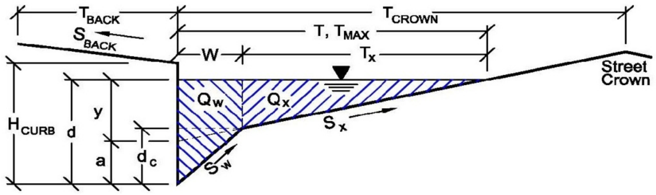
	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	0.0	0.0	cfs
Total Design Peak Flow, Q =	9.2	22.2	cfs

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

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

Project: **PAINT BRUSH HILLS FILING NO. 14**

Inlet ID: **SUMP INLET DP6**



Gutter Geometry (Enter data in the blue cells)			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	8.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.020	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	5.6	7.9	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☑	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	4.08	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline	d =	5.59	5.59	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	15.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.350	0.350	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**SUMP**	**SUMP**	**cfs**
Flow Velocity within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	0.0	0.0	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	17.0	26.6	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	15.0	24.6	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.349	0.220	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	0.0	0.0	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	0.0	0.0	cfs
Average Flow Velocity Within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.0	0.0	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	SUMP	SUMP	
Max Flow Based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**SUMP**	**SUMP**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =			inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =			inches

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

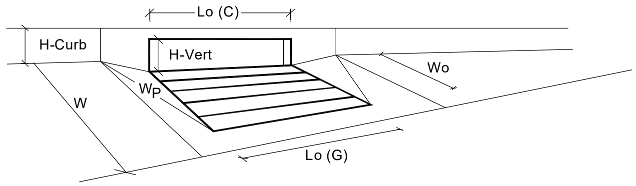
Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

INLET IN A SUMP OR SAG LOCATION

Project = **PAINT BRUSH HILLS FILING NO. 14**

Inlet ID = **SUMP INLET DP6**

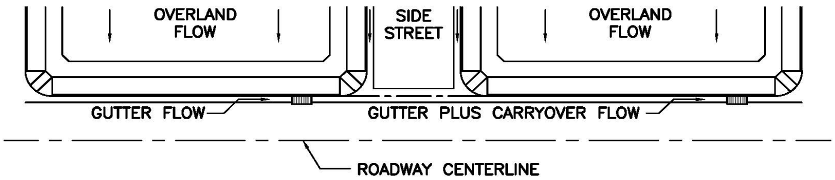


Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Inlet Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	3.0	3	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	5.6	7.9	inches
				☑ Override Depths
Grate Information		MINOR	MAJOR	
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**11.1**	**27.3**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	9.2	22.2	cfs

Worksheet Protected

DESIGN PEAK FLOW FOR ONE-HALF OF STREET OR GRASS-LINED CHANNEL BY THE RATIONAL METHOD

Project: PAINT BRUSH HILLS FILING NO. 14
Inlet ID: SUMP INLET DP7



Show Details

Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street OR grass-lined channel):

	Minor Storm	Major Storm	
*Q_{Known} =	1.9	22.2	cfs

*** If you enter values in Row 14, skip the rest of this sheet and proceed to sheet Q-Allow or Area Inlet.**

<--- FILL IN THIS SECTION OR…

FILL IN THE SECTIONS BELOW. <---

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

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

Site Type:
- Site is Urban
- Site is Non-Urban

Flows Developed For:
- Street Inlets
- Area Inlets in a Median

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

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

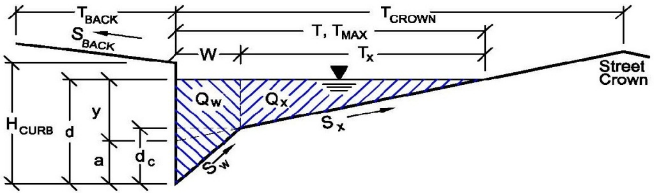
	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	0.0	0.0	cfs
Total Design Peak Flow, Q =	1.9	22.2	cfs

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

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

Project: PAINT BRUSH HILLS FILING NO. 14

Inlet ID: SUMP INLET DP7



Gutter Geometry (Enter data in the blue cells)				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	8.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0		ft
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.020		ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083		ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.020		
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	5.6	7.9	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☑	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	4.08	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline	d =	5.59	5.59	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	15.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.350	0.350	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	Q_T =	**SUMP**	**SUMP**	**cfs**
Flow Velocity within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	0.0	0.0	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	17.0	26.6	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\ TH}$ =	15.0	24.6	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.349	0.220	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\ TH}$	$Q_{X\ TH}$ =	0.0	0.0	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	0.0	0.0	cfs
Average Flow Velocity Within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.0	0.0	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	SUMP	SUMP	
Max Flow Based on Allowable Depth (Safety Factor Applied)	Q_d =	**SUMP**	**SUMP**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =			inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =			inches

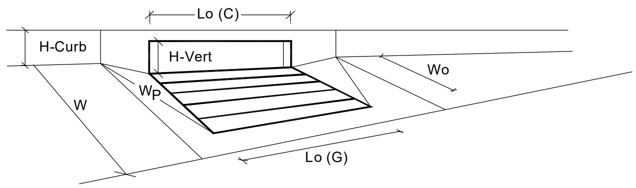
MINOR STORM Allowable Capacity is based on Depth Criterion		Minor Storm	Major Storm	
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**SUMP**	**SUMP**	**cfs**

Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'
Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

INLET IN A SUMP OR SAG LOCATION

Project = PAINT BRUSH HILLS FILING NO. 14

Inlet ID = SUMP INLET DP7

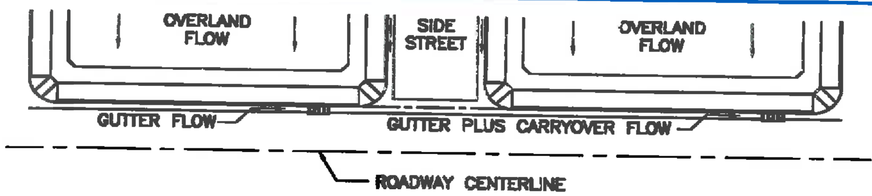


Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Inlet Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	3.0	3	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	5.6	7.9	inches
				☑ Override Depths
Grate Information		MINOR	MAJOR	
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**11.1**	**27.3**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)	Q PEAK REQUIRED =	1.9	22.2	cfs

Worksheet Protected

DESIGN PEAK FLOW FOR ONE-HALF OF STREET OR GRASS-LINED CHANNEL BY THE RATIONAL METHOD

Project: PAINT BRUSH HILLS FILING NO. 14
Inlet ID: AT-GRADE INLET DP9



Show Details

Design Flow: ONLY if already determined through other methods:

		Minor Storm	Major Storm	
(local peak flow for 1/2 of street OR grass-lined channel):	*Q_{Known} =	7.0	17.4	cfs

* If you enter values in Row 14, skip the rest of this sheet and proceed to sheet Q-Allow or Area Inlet.

← FILL IN THIS SECTION OR...

FILL IN THE SECTIONS BELOW. ←

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

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

Site Type:
- ○ Site is Urban
- ○ Site is Non-Urban

Flows Developed For:
- ○ Street Inlets
- ○ Area Inlets in a Median

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

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

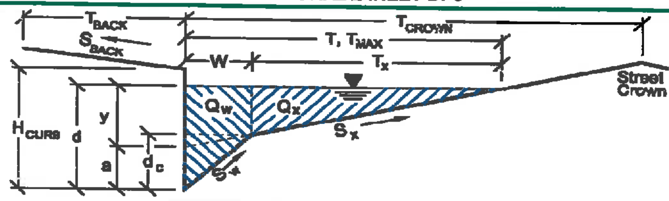
	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	0.0	0.0	cfs
Total Design Peak Flow, Q =	7.0	17.4	cfs

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

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

Project: PAINT BRUSH HILLS FILING NO. 14

Inlet ID: AT-GRADE INLET DP9



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	8.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.018	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.020	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	5.6	7.9	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☑	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	4.08	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline	d =	5.59	5.59	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	15.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.350	0.350	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	7.6	7.6	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	4.1	4.1	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	Q_T =	**11.7**	**11.7**	**cfs**
Flow Velocity within the Gutter Section	V =	5.3	5.3	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	2.5	2.5	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	17.0	26.6	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\ TH}$ =	15.0	24.6	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.349	0.220	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\ TH}$	$Q_{X\ TH}$ =	7.6	28.4	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	7.6	26.1	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	4.1	8.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	1.4	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	11.7	35.5	cfs
Average Flow Velocity Within the Gutter Section	V =	5.3	7.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.5	4.6	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d ≥ 6") Storm	R =	1.00	0.91	
Max Flow Based on Allowable Depth (Safety Factor Applied)	Q_d =	**11.7**	**32.2**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.60	7.66	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.01	2.07	inches

MINOR STORM Allowable Capacity is based on Spread Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

		Minor Storm	Major Storm	
	Q_{allow} =	**11.7**	**32.2**	**cfs**

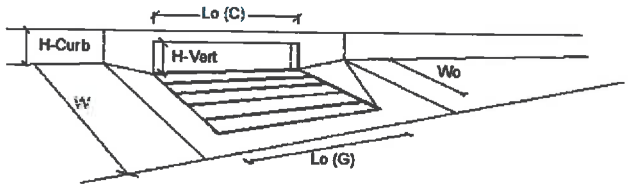
Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: PAINT BRUSH HILLS FILING NO. 14

Inlet ID: AT-GRADE INLET DP9



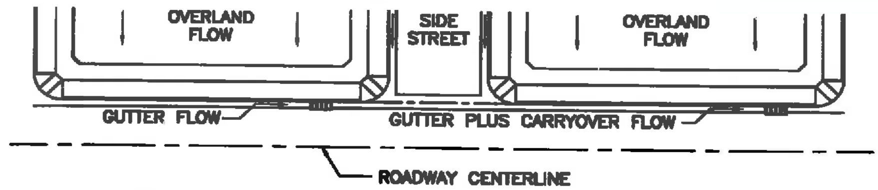
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	3	3	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	

Street Hydraulics: OK - Q < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	7.00	13.72	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	0.0	3.7	cfs
Capture Percentage = Q_a/Q_o =	C% =	100	79	%

Worksheet Protected

DESIGN PEAK FLOW FOR ONE-HALF OF STREET OR GRASS-LINED CHANNEL BY THE RATIONAL METHOD

Project: PAINT BRUSH HILLS FILING NO. 14
Inlet ID: AT-GRADE INLET DP10



Show Details

Design Flow: ONLY if already determined through other methods:

(local peak flow for 1/2 of street OR grass-lined channel):

	Minor Storm	Major Storm	
*Q_{Known} =	7.3	18.1	cfs

* If you enter values in Row 14, skip the rest of this sheet and proceed to sheet Q-Allow or Area Inlet.

<-- FILL IN THIS SECTION OR...

FILL IN THE SECTIONS BELOW. <--

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

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

Site Type:
- ○ Site is Urban
- ○ Site is Non-Urban

Flows Developed For:
- ○ Street Inlets
- ○ Area Inlets in a Median

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

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

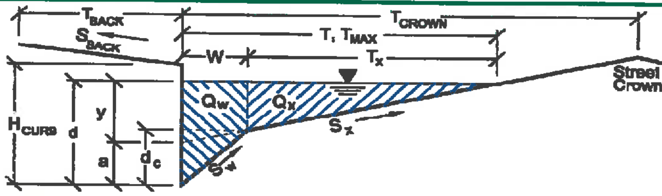
	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	0.0	0.0	cfs
Total Design Peak Flow, Q =	7.3	18.1	cfs

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

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

Project: PAINT BRUSH HILLS FILING NO. 14

Inlet ID: AT-GRADE INLET DP10



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	8.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.016	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.020	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	5.6	7.9	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☑	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	4.08	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline	d =	5.59	5.59	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	15.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.350	0.350	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	7.1	7.1	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	3.8	3.8	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	Q_T =	**11.0**	**11.0**	cfs
Flow Velocity within the Gutter Section	V =	5.0	5.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	2.3	2.3	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	17.0	26.6	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	15.0	24.6	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.349	0.220	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	7.2	26.8	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	7.2	24.6	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	3.9	7.5	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	1.3	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	11.0	33.4	cfs
Average Flow Velocity Within the Gutter Section	V =	5.0	6.6	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.3	4.3	
Slope-Based Depth Safety Reduction Factor for Major & Minor ($d \geq 6"$) Storm	R =	1.00	1.00	
Max Flow Based on Allowable Depth (Safety Factor Applied)	Q_d =	**11.0**	**33.3**	cfs
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.60	7.90	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.01	2.30	inches

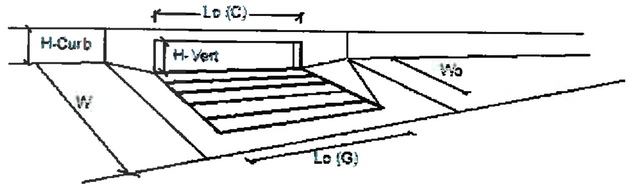
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	11.0	33.3	cfs

Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: PAINT BRUSH HILLS FILING NO. 14
Inlet ID: AT-GRADE INLET DP10

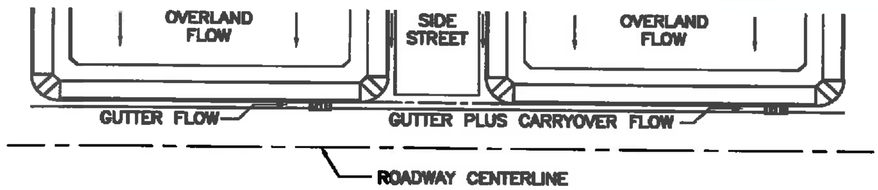


Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	3	3	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	
Street Hydraulics: OK - Q < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	7.25	14.01	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	0.0	4.1	cfs
Capture Percentage = Q_a/Q_o =	C% =	100	77	%

Worksheet Protected

DESIGN PEAK FLOW FOR ONE-HALF OF STREET OR GRASS-LINED CHANNEL BY THE RATIONAL METHOD

Project: PAINT BRUSH HILLS FILING NO. 14
Inlet ID: AT-GRADE INLET DP11



Show Details

Design Flow: ONLY if already determined through other methods:

	Minor Storm	Major Storm	
(local peak flow for 1/2 of street OR grass-lined channel): *Q_{Known} =	3.7	17.0	cfs

* If you enter values in Row 14, skip the rest of this sheet and proceed to sheet Q-Allow or Area Inlet.

← FILL IN THIS SECTION OR...

← FILL IN THE SECTIONS BELOW.

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

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

Site Type:
- ○ Site is Urban
- ○ Site is Non-Urban

Flows Developed For:
- ○ Street Inlets
- ○ Area Inlets in a Median

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

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

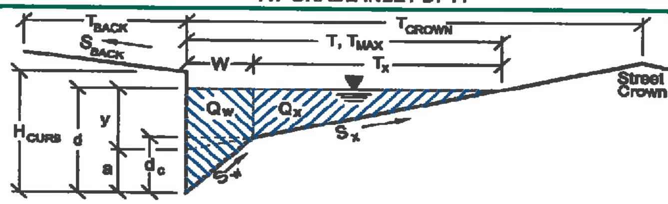
	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	0.0	0.0	cfs
Total Design Peak Flow, Q =	3.7	17.0	cfs

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

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

Project: PAINT BRUSH HILLS FILING NO. 14

Inlet ID: AT-GRADE INLET DP11



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	8.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.014	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.020	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	5.6	7.9	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☑	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	4.08	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline	d =	5.59	5.59	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	15.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.350	0.350	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	6.7	6.7	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	3.6	3.6	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	Q_T =	**10.3**	**10.3**	**cfs**
Flow Velocity within the Gutter Section	V =	4.7	4.7	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	2.2	2.2	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	17.0	26.6	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	15.0	24.6	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.349	0.220	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	6.7	25.0	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	6.7	23.0	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	3.6	7.1	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	1.2	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	10.3	31.3	cfs
Average Flow Velocity Within the Gutter Section	V =	4.7	6.1	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.2	4.0	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d ≥ 6") Storm	R =	1.00	1.00	
Max Flow Based on Allowable Depth (Safety Factor Applied)	Q_d =	**10.3**	**31.3**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.60	7.90	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.01	2.31	inches

MINOR STORM Allowable Capacity is based on Spread Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

		Minor Storm	Major Storm	
	Q_{allow} =	10.3	31.3	cfs

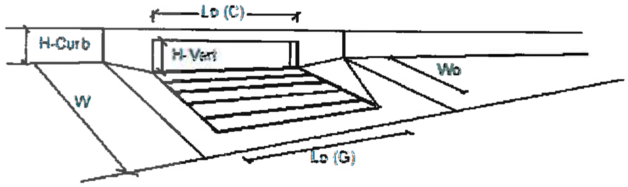
Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: PAINT BRUSH HILLS FILING NO. 14

Inlet ID: AT-GRADE INLET DP11



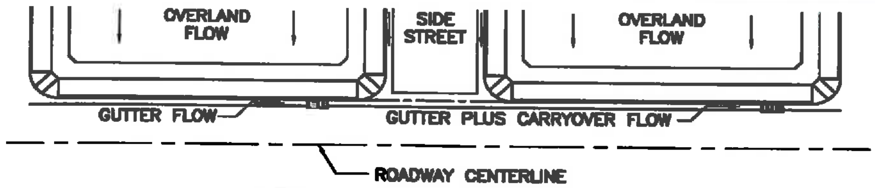
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	3	3	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	
Street Hydraulics: OK - Q < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	3.70	13.51	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	0.0	3.5	cfs
Capture Percentage = Q_a/Q_o =	C% =	100	79	%

Worksheet Protected

DESIGN PEAK FLOW FOR ONE-HALF OF STREET OR GRASS-LINED CHANNEL BY THE RATIONAL METHOD

Project: PAINT BRUSH HILLS FILING NO. 14

Inlet ID: AT-GRADE INLET *DP37



Show Details

Design Flow: ONLY if already determined through other methods:

		Minor Storm	Major Storm	
(local peak flow for 1/2 of street OR grass-lined channel):	*Q_{Known} =	3.7	13.0	cfs

* If you enter values in Row 14, skip the rest of this sheet and proceed to sheet Q-Allow or Area Inlet.

← FILL IN THIS SECTION OR...

FILL IN THE SECTIONS BELOW. ←

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

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

Site Type:
- ○ Site is Urban
- ○ Site is Non-Urban

Flows Developed For:
- ○ Street Inlets
- ○ Area Inlets in a Median

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

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

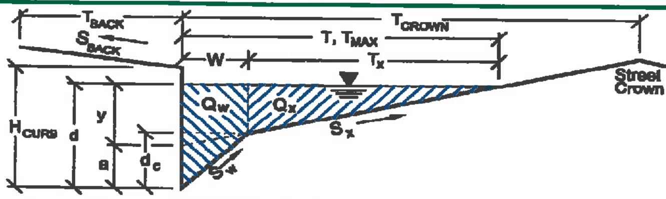
	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	0.0	0.0	cfs
Total Design Peak Flow, Q =	3.7	13.0	cfs

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

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

Project: PAINT BRUSH HILLS FILING NO. 14

Inlet ID: AT-GRADE INLET *DP37



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	8.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.014	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.020	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	5.6	7.9	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☑	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	4.08	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline	d =	5.59	5.59	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	15.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.350	0.350	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	6.7	6.7	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	3.6	3.6	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	Q_T =	**10.3**	**10.3**	**cfs**
Flow Velocity within the Gutter Section	V =	4.7	4.7	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	2.2	2.2	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	17.0	26.6	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X TH}$ =	15.0	24.6	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.349	0.220	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X TH}$	$Q_{X TH}$ =	6.7	25.0	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	6.7	23.0	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	3.6	7.1	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	1.2	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	10.3	31.3	cfs
Average Flow Velocity Within the Gutter Section	V =	4.7	6.1	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.2	4.0	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d ≥ 6") Storm	R =	1.00	1.00	
Max Flow Based on Allowable Depth (Safety Factor Applied)	Q_d =	**10.3**	**31.3**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.60	7.90	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.01	2.31	inches

MINOR STORM Allowable Capacity is based on Spread Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

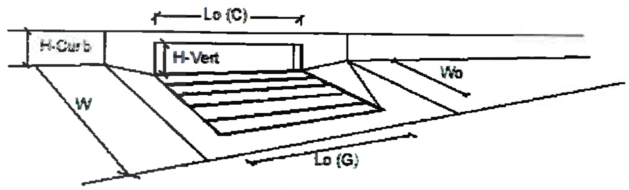
		Minor Storm	Major Storm	
	Q_{allow} =	**10.3**	**31.3**	cfs

Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: PAINT BRUSH HILLS FILING NO. 14
Inlet ID: AT-GRADE INLET *DP37

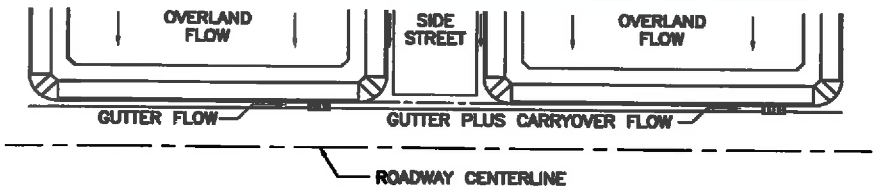


Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	3	3	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	
Street Hydraulics: OK - Q < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	**3.70**	**11.48**	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	**0.0**	**1.5**	cfs
Capture Percentage = Q_a/Q_o =	C% =	**100**	**88**	%

Worksheet Protected

DESIGN PEAK FLOW FOR ONE-HALF OF STREET OR GRASS-LINED CHANNEL BY THE RATIONAL METHOD

Project: PAINT BRUSH HILLS FILING NO. 14
Inlet ID: AT-GRADE INLET DP12



Show Details

Design Flow: ONLY if already determined through other methods:

	Minor Storm	Major Storm	
(local peak flow for 1/2 of street OR grass-lined channel): $^*Q_{Known}$ =	6.0	14.9	cfs

* If you enter values in Row 14, skip the rest of this sheet and proceed to sheet Q-Allow or Area Inlet.

<--- FILL IN THIS SECTION OR...

FILL IN THE SECTIONS BELOW. <---

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

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

Site Type:
- ○ Site is Urban
- ○ Site is Non-Urban

Flows Developed For:
- ○ Street Inlets
- ○ Area Inlets in a Mediar

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

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

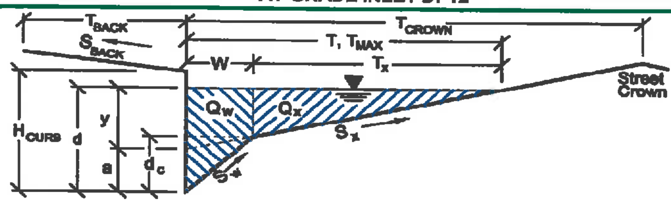
	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	0.0	0.0	cfs
Total Design Peak Flow, Q =	6.0	14.9	cfs

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

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

Project: PAINT BRUSH HILLS FILING NO. 14

Inlet ID: AT-GRADE INLET DP12



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	8.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.010	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.020	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	5.6	7.9	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☑	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	4.08	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline	d =	5.59	5.59	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	15.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.350	0.350	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	5.7	5.7	cfs
Discharge within the Gutter Section W (Q_T - 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
Maximum Flow Based On Allowable Spread	Q_T =	**8.8**	**8.8**	**cfs**
Flow Velocity within the Gutter Section	V =	4.0	4.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	1.9	1.9	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	17.0	26.6	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\ TH}$ =	15.0	24.6	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.349	0.220	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\ TH}$	$Q_{X\ TH}$ =	5.7	21.4	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	5.7	19.6	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	3.1	6.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	1.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	8.8	26.7	cfs
Average Flow Velocity Within the Gutter Section	V =	4.0	5.2	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	1.9	3.4	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d ≥ 6") Storm	R =	1.00	1.00	
Max Flow Based on Allowable Depth (Safety Factor Applied)	Q_d =	**8.8**	**26.7**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.60	7.90	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.01	2.31	inches

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	8.8	26.7	cfs

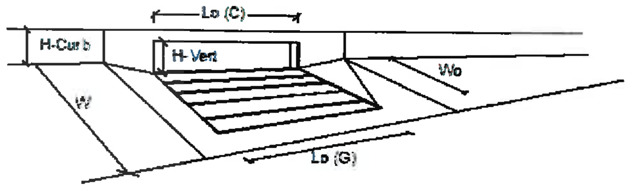
Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: PAINT BRUSH HILLS FILING NO. 14

Inlet ID: AT-GRADE INLET DP12

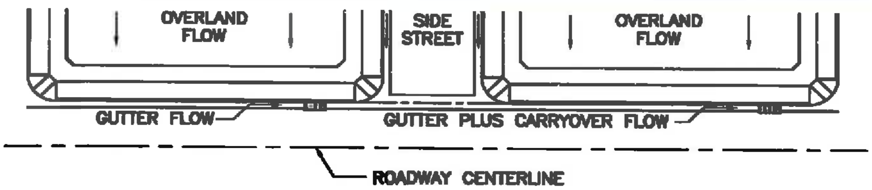


Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	3	3	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	
Street Hydraulics: OK - Q < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	5.95	12.44	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	0.0	2.4	cfs
Capture Percentage = Q_a/Q_o =	C% =	100	84	%

Worksheet Protected

DESIGN PEAK FLOW FOR ONE-HALF OF STREET OR GRASS-LINED CHANNEL BY THE RATIONAL METHOD

Project: PAINT BRUSH HILLS FILING NO. 14
Inlet ID: SUMP INLET DP15



Show Details

Design Flow: ONLY if already determined through other methods:

		Minor Storm	Major Storm	
(local peak flow for 1/2 of street OR grass-lined channel):	*Q_{Known} =	6.2	27.7	cfs

* If you enter values in Row 14, skip the rest of this sheet and proceed to sheet Q-Allow or Area Inlet.

← FILL IN THIS SECTION OR...

← FILL IN THE SECTIONS BELOW.

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

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

Site Type:
- ○ Site is Urban
- ○ Site is Non-Urban

Flows Developed For:
- ○ Street Inlets
- ○ Area Inlets in a Median

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

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

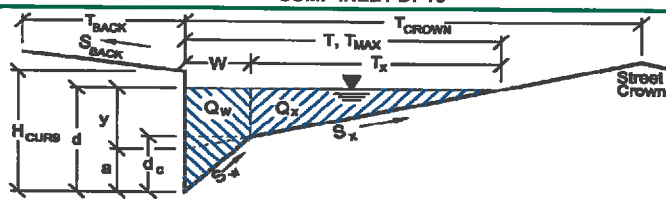
	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	0.0	0.0	cfs
Total Design Peak Flow, Q =	6.2	27.7	cfs

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

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

Project: PAINT BRUSH HILLS FILING NO. 14

Inlet ID: SUMP INLET DP15



Gutter Geometry (Enter data in the blue cells)			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	8.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.020	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	5.6	7.9	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☑	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	4.08	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline	d =	5.59	5.59	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	15.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.350	0.350	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	Q_T =	**SUMP**	**SUMP**	cfs
Flow Velocity within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	0.0	0.0	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	17.0	26.6	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	15.0	24.6	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.349	0.220	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	0.0	0.0	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	0.0	0.0	cfs
Average Flow Velocity Within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.0	0.0	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d ≥ 6") Storm	R =	SUMP	SUMP	
Max Flow Based on Allowable Depth (Safety Factor Applied)	Q_d =	**SUMP**	**SUMP**	cfs
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =			inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =			inches

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

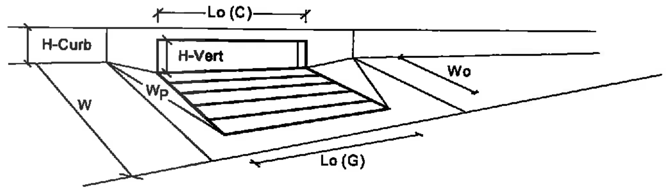
Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

INLET IN A SUMP OR SAG LOCATION

Project = PAINT BRUSH HILLS FILING NO. 14

Inlet ID = SUMP INLET DP15

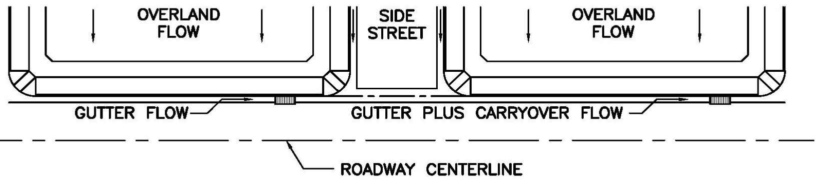


Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Inlet Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	4.0	4	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	5.6	7.9	inches ☑ Override Depths
Grate Information		MINOR	MAJOR	
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	15.0	36.7	cfs
Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	6.2	27.7	cfs

Worksheet Protected

DESIGN PEAK FLOW FOR ONE-HALF OF STREET
OR GRASS-LINED CHANNEL BY THE RATIONAL METHOD

Project: PAINT BRUSH HILLS FILING NO. 14
Inlet ID: SUMP INLET DP16



Show Details

Design Flow: ONLY if already determined through other methods:

	Minor Storm	Major Storm	
(local peak flow for 1/2 of street OR grass-lined channel): *Q_{Known} =	5.6	20.8	cfs

* If you enter values in Row 14, skip the rest of this sheet and proceed to sheet Q-Allow or Area Inlet.

<--- FILL IN THIS SECTION OR…
FILL IN THE SECTIONS BELOW. <---

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

You cannot enter values for Q and use the Q calculator at the same time

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

Site Type:
- ● Site is Urban
- ○ Site is Non-Urban

Flows Developed For:
- ○ Street Inlets
- ● Area Inlets in a Mediai

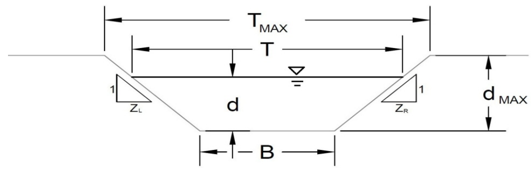
	Slope (ft/ft)	Length (ft)
Overland Flow =		
Channel Flow =		

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

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	0.0	0.0	cfs
Total Design Peak Flow, Q =	5.6	20.8	cfs

AREA INLET IN A TRAPEZOIDAL GRASS-LINED CHANNEL

PAINT BRUSH HILLS FILING NO. 14
SUMP INLET DP16



Grass Type	Limiting Manning's n
A	0.06
B	0.04
C	0.033
D	0.03
E	0.024

Analysis of Trapezoidal Grass-Lined Channel Using SCS Method

NRCS Vegetal Retardance (A, B, C, D, or E)	A, B, C, D or E	E	
Manning's n (Leave cell D16 blank to manually enter an n value)	n =	see details below	
Channel Invert Slope	S_O =	0.0348	ft/ft
Bottom Width	B =	2.00	ft
Left Side Slope	Z1 =	3.00	ft/ft
Right Side Slope	Z2 =	3.00	ft/ft

Check one of the following soil types:

Soil Type:	Max. Velocity (V_{MAX})	Max Froude No. (F_{MAX})
Sandy	5.0 fps	0.50
Non-Sandy	7.0 fps	0.80

Choose One:
◉ Sandy
○ Non-Sandy

		Minor Storm	Major Storm	
Max. Allowable Top Width of Channel for Minor & Major Storm	T_{MAX} =	**5.00**	**6.80**	**feet**
Max. Allowable Water Depth in Channel for Minor & Major Storm	d_{MAX} =	**0.46**	**0.78**	**feet**

Maximum Channel Capacity Based On Allowable Top Width		Minor Storm	Major Storm	
Max. Allowable Top Width	T_{MAX} =	**5.00**	**6.80**	**ft**
Water Depth	d =	0.50	0.80	ft
Flow Area	A =	1.75	3.52	sq ft
Wetted Perimeter	P =	5.16	7.06	ft
Hydraulic Radius	R =	0.34	0.50	ft
Manning's n based on NRCS Vegetal Retardance	n =	0.035	0.028	
Flow Velocity	V =	3.91	6.27	fps
Velocity-Depth Product	VR =	1.33	3.13	ft^2/s
Hydraulic Depth	D =	0.35	0.52	ft
Froude Number	Fr =	1.17	1.54	
Max. Flow Based On Allowable Top Width	Q_T =	**6.85**	**22.07**	**cfs**

Maximum Channel Capacity Based On Allowable Water Depth		Minor Storm	Major Storm	
Max. Allowable Water Depth	d_{MAX} =	**0.46**	**0.78**	**feet**
Top Width	T =	4.76	6.68	feet
Flow Area	A =	1.55	3.39	square feet
Wetted Perimeter	P =	4.91	6.93	feet
Hydraulic Radius	R =	0.32	0.49	feet
Manning's n based on NRCS Vegetal Retardance	n =	0.036	0.028	
Flow Velocity	V =	3.63	6.16	fps
Velocity-Depth Product	VR =	1.15	3.01	ft^2/s
Hydraulic Depth	D =	0.33	0.51	feet
Froude Number	Fr =	1.12	1.52	
Max. Flow Based On Allowable Water Depth	Q_d =	**5.64**	**20.84**	**cfs**

Allowable Channel Capacity Based On Channel Geometry		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**5.64**	**20.84**	**cfs**
MAJOR STORM Allowable Capacity is based on Depth Criterion	d_{allow} =	**0.46**	**0.78**	**ft**

Water Depth in Channel Based On Design Peak Flow

	Design Peak Flow	Q_o =	**5.60**	**20.80**	**cfs**
	Water Depth	**d =**	**0.46**	**0.78**	**feet**
	Top Width	T =	4.75	6.68	feet
	Flow Area	A =	1.55	3.38	square feet
	Wetted Perimeter	P =	4.90	6.93	feet
	Hydraulic Radius	R =	0.32	0.49	feet
	Manning's n based on NRCS Vegetal Retardance	n =	0.036	0.028	
Warning 03	Flow Velocity	V =	3.62	6.15	fps
	Velocity-Depth Product	VR =	1.14	3.00	ft^2/s
	Hydraulic Depth	D =	0.33	0.51	feet
Warning 04	Froude Number	Fr =	1.12	1.52	

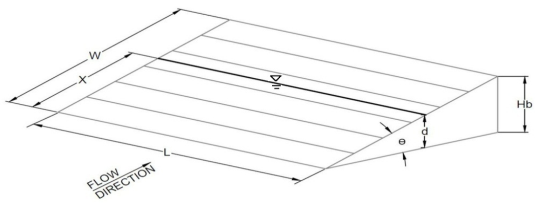
Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'
Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

AREA INLET IN A TRAPEZOIDAL GRASS-LINED CHANNEL

PAINT BRUSH HILLS FILING NO. 14
SUMP INLET DP16

Inlet Design Information (Input)

Type of Inlet	Inlet Type =	CDOT Type C (Depressed)	
Angle of Inclined Grate (must be <= 30 degrees)	θ =	0.10	degrees
Width of Grate	W =	3.00	feet
Length of Grate	L =	3.00	feet
Open Area Ratio	A_{RATIO} =	0.70	
Height of Inclined Grate	H_B =	0.01	feet
Clogging Factor	C_f =	0.50	
Grate Discharge Coefficient	C_d =	0.84	
Orifice Coefficient	C_o =	0.56	
Weir Coefficient	C_w =	1.79	



		MINOR	MAJOR	
Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)	d =	1.46	1.78	
Grate Capacity as a Weir				
Submerged Side Weir Length	X =	3.00	3.00	feet
Inclined Side Weir Flow	Q_{ws} =	16.56	22.32	cfs
Base Weir Flow	Q_{wb} =	23.71	31.95	cfs
Interception without Clogging	Q_{wi} =	56.83	76.59	cfs
Interception with Clogging	Q_{wa} =	28.41	38.29	cfs
Grate Capacity as an Orifice				
Interception without Clogging	Q_{oi} =	48.78	53.87	cfs
Interception with Clogging	Q_{oa} =	24.39	26.94	cfs
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**24.39**	**26.94**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms (> Q PEAK)	**Bypassed Flow, Q_b =**	**0.00**	**0.00**	**cfs**
	Capture Percentage = Q_a/Q_o = C%	**100**	**100**	**%**

Warning 03: Velocity exceeds USDCM Volume I recommendation.
Warning 04: Froude No. exceeds USDCM Volume I recommendation.

Partially Full Pipe Flow Calculator and Equations

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This engineering calculator determines the Flow within a partially full pipe using the Manning equation. This calculator can also be used for uniform flow in a pipe, but the Manning roughness coefficient needs to be considered to be variable, dependent upon the depth of flow.

Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: *Enter values in blue boxes. Calculations in yellow*

Inputs

Pipe Diameter, D =	18	in
Depth of flow, y =	17	in

(must have y ≥ D/2)

Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.016	ft/ft

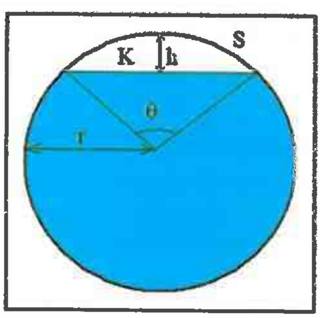
Calculations

n/n_{full} =	1.027777
Partially Full Manning roughness, n =	0.013

Calculations

Pipe Diameter, D =	1.5	ft
Pipe Radius, r =	0.75	ft
Circ. Segment Height, h =	0.083	ft
Central Angle, q =	0.95	radians
Cross-Sect. Area, A =	1.73	ft^2
Wetted Perimeter, P =	4.0	ft
Hydraulic Radius, R =	0.43	ft
Discharge, Q =	13.94	cfs
Ave. Velocity, V =	8.06	ft/sec

pipe % full [$(A/A_{full})*100\%$] = 97.8%



Partially Full Pipe Flow Parameters (More Than Half Full)

r = D/2

h = 2r - y

(hydraulic radius)

R = A/P

(Manning Equation)

$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$

V = Q/A

P

$$\theta = 2\arccos\left(\frac{r-h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r*\theta$$

Equation used for n/n_{full}: $n/n_{full} = 1.25 - (y/D - 0.5)*0.5$ (for $0.5 \le y/D \le 1$)

PR1 Q100= 13.7 CFS

Partially Full Pipe Flow Calculator and Equations

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Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: *Enter values in blue boxes. Calculations in yellow*

Inputs

Pipe Diameter, D =	36	in
Depth of flow, y =	29	in

(must have y ≥ D/2)

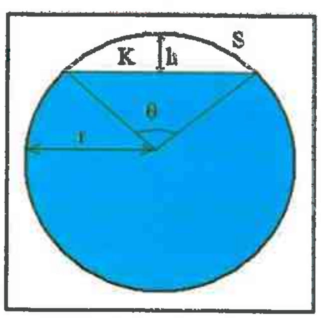
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.01	ft/ft

Calculations

n/n_{full} =	1.0972222
Partially Full Manning roughness, n =	0.014

Calculations

Pipe Diameter, D =	3	ft
Pipe Radius, r =	1.5	ft
Circ. Segment Height, h =	0.583	ft
Central Angle, q =	1.83	radians
Cross-Sect. Area, A =	6.10	ft^2
Wetted Perimeter, P =	6.7	ft
Hydraulic Radius, R =	0.91	ft
Discharge, Q =	59.98	cfs
Ave. Velocity, V =	9.83	ft/sec
pipe % full [(A/A_{full})*100%] =	86.3%	



Partially Full Pipe Flow Parameters
(More Than Half Full)

$r = D/2$

$h = 2r - y$

(hydraulic radius)

$R = A/P$

(Manning Equation)

$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$

$V = Q/A$ P

$$\theta = 2 \arccos\left(\frac{r-h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r^*\theta$$

Equation used for n/n_{full}: $n/n_{full} = 1.25 - (y/D - 0.5)*0.5$ (for $0.5 \le y/D \le 1$)

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PR2 Q100= 58.1 CFS

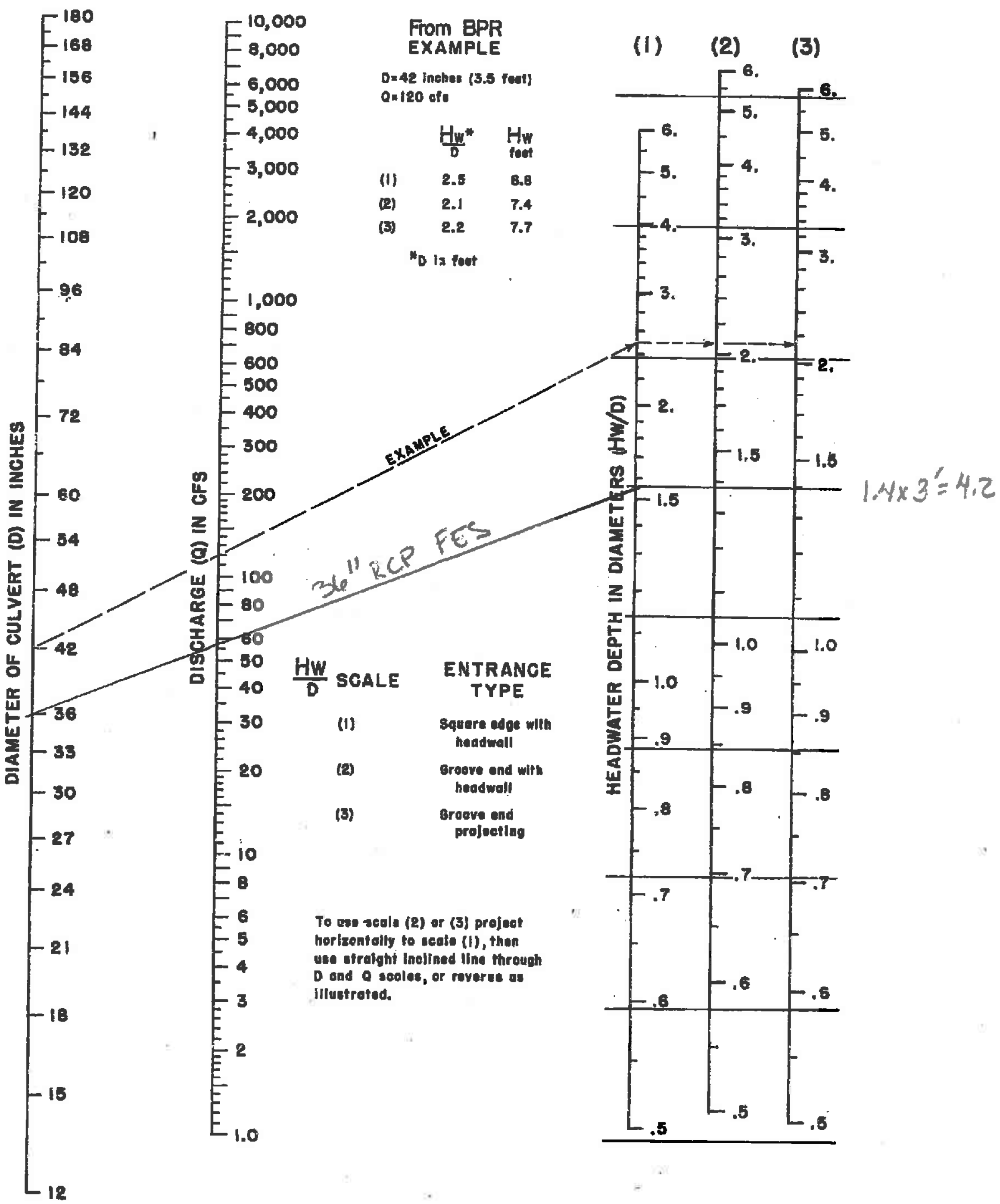

Figure CU-9—Inlet Control Nomograph—Example

DP3 Q100= 58.1 CFS

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Partially Full Pipe Flow Calculator and Equations

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Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: *Enter values in blue boxes. Calculations in yellow*

Inputs

Input	Value	Units
Pipe Diameter, D =	48	in
Depth of flow, y =	28	in

(must have y ≥ D/2)

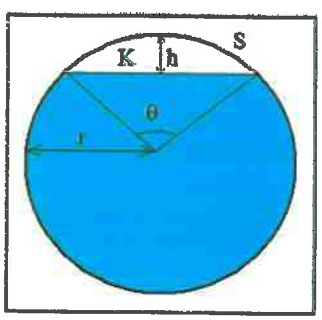
Input	Value	Units
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.01	ft/ft

Calculations

n/n_{full} =	1.2083333	
Partially Full Manning roughness, n =	0.016	

Calculations

Quantity	Value	Units
Pipe Diameter, D =	4	ft
Pipe Radius, r =	2	ft
Circ. Segment Height, h =	1.667	ft
Central Angle, q =	2.81	radians
Cross-Sect. Area, A =	7.61	ft^2
Wetted Perimeter, P =	7.0	ft
Hydraulic Radius, R =	1.09	ft
Discharge, Q =	76.67	cfs
Ave. Velocity, V =	10.07	ft/sec
pipe % full [(A/A_{full})*100%] =	60.6%	



Partially Full Pipe Flow Parameters (More Than Half Full)

r = D/2

h = 2r - y

(hydraulic radius)

R = A/P

(Manning Equation)

$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$

V = Q/A   P

$$\theta = 2\arccos\left(\frac{r-h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r*\theta$$

Equation used for n/n_{full}: $n/n_{full} = 1.25 - (y/D - 0.5)*0.5$ (for $0.5 \le y/D \le 1$)

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Partially Full Pipe Flow Calculator and Equations

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This engineering calculator determines the Flow within a partially full pipe using the Manning equation. This calculator can also be used for uniform flow in a pipe, but the Manning roughness coefficient needs to be considered to be variable, dependent upon the depth of flow.

Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: *Enter values in blue boxes. Calculations in yellow*

Inputs

Pipe Diameter, D =	18	in
Depth of flow, y =	8	in

(must have y ≥ D/2)

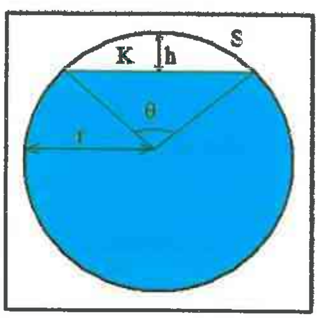
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.01	ft/ft

Calculations

n/n_{full} =	1.277777
Partially Full Manning roughness, n =	0.017

Calculations

Pipe Diameter, D =	1.5	ft
Pipe Radius, r =	0.75	ft
Circ. Segment Height, h =	0.833	ft
Central Angle, q =	3.36	radians
Cross-Sect. Area, A =	0.76	ft^2
Wetted Perimeter, P =	2.2	ft
Hydraulic Radius, R =	0.35	ft
Discharge, Q =	3.36	cfs
Ave. Velocity, V =	4.43	ft/sec
pipe % full [(A/A_{full})*100%] =	42.9%	



Partially Full Pipe Flow Parameters
(More Than Half Full)

r = D/2

h = 2r - y

(hydraulic radius)

R = A/P

(Manning Equation)

$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$

V = Q/A P

$$\theta = 2\arccos\left(\frac{r-h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r*\theta$$

Equation used for n/n_{full}: $n/n_{full} = 1.25 - (y/D - 0.5)*0.5$ (for $0.5 \le y/D \le 1$)

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Partially Full Pipe Flow Calculator and Equations

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This engineering calculator determines the Flow within a partially full pipe using the Manning equation. This calculator can also be used for uniform flow in a pipe, but the Manning roughness coefficient needs to be considered to be variable, dependent upon the depth of flow.

Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: *Enter values in blue boxes. Calculations in yellow*

Inputs

Pipe Diameter, D =	42	in
Depth of flow, y =	30	in

(must have $y \geq D/2$)

Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.01	ft/ft

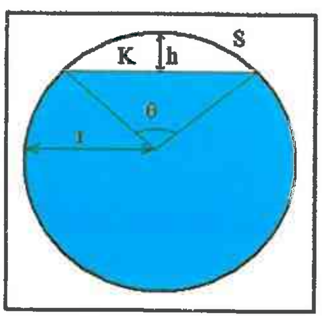
Calculations

n/n_{full} =	1.142857:
Partially Full Manning roughness, n =	0.015

Calculations

Pipe Diameter, D =	3.5	ft
Pipe Radius, r =	1.75	ft
Circ. Segment Height, h =	1.000	ft
Central Angle, q =	2.26	radians
Cross-Sect. Area, A =	7.35	ft^2
Wetted Perimeter, P =	7.0	ft
Hydraulic Radius, R =	1.04	ft
Discharge, Q =	75.85	cfs
Ave. Velocity, V =	10.32	ft/sec

pipe % full [(A/A_{full})*100%] = 76.4%



Partially Full Pipe Flow Parameters
(More Than Half Full)

r = D/2

h = 2r - y

(hydraulic radius)

R = A/P

(Manning Equation)

$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$

V = Q/A P

$$\theta = 2\arccos\left(\frac{r-h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r*\theta$$

Equation used for n/n_{full}: $n/n_{full} = 1.25 - (y/D - 0.5)*0.5$ (for $0.5 \leq y/D \leq 1$)

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Partially FULL Pipe Flow Calculator and Equations

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This engineering calculator determines the Flow within a partially full pipe (&e1/2 fullusing the Manning equation. This calculator can also be used for uniform flow in a pipe, but the Manning roughness coefficient needs to be considered to be variable, dependent upon the depth of flow.

Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: *Enter values in blue boxes. Calculations in yellow*

Inputs

Pipe Diameter, **D** =	24	in
Depth of flow, **y** =	24	in

(must have y ≥ D/2)

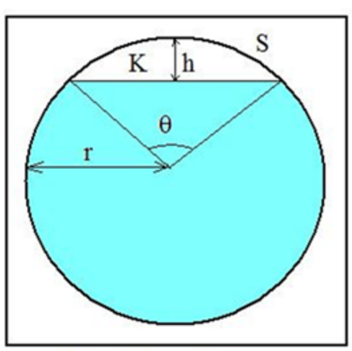
Full Pipe Manning roughness, $\mathbf{n_{full}}$ =	0.013	
Channel bottom slope, **S** =	0.01	ft/ft

Calculations

$\mathbf{n/n_{full}}$ =	1
Partially Full Manning roughness, **n** =	0.013

Calculations

Pipe Diameter, **D** =	2	ft
Pipe Radius, **r** =	1	ft
Circ. Segment Height, **h** =	0.000	ft
Central Angle, **q** =	0.00	radians
Cross-Sect. Area, **A** =	3.14	ft^2
Wetted Perimeter, **P** =	6.3	ft
Hydraulic Radius, **R** =	0.50	ft
Discharge, **Q** =	22.68	cfs
Ave. Velocity, **V** =	7.22	ft/sec
pipe % full [(A/A_{full})*100%] =	100.0%	



Partially Full Pipe Flow Parameters
(More Than Half Full)

r = D/2

h = 2r - y

(hydraulic radius)

R = A/P

(Manning Equation)

$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$

V = Q/A P

$$\theta = 2 \arccos\left(\frac{r-h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r*\theta$$

Equation used for n/n_{full}: $\mathbf{n/n_{full} = 1.25 - (y/D - 0.5)*0.5}$ (for $0.5 \le y/D \le 1$)

**PR7 & PR8 Q100=22.2 CFS
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Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: *Enter values in blue boxes. Calculations in yellow*

Inputs

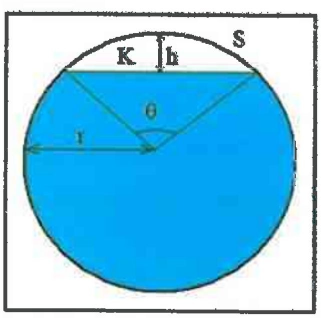
Pipe Diameter, D =	48	in
Depth of flow, y =	37	in
(must have y ≥ D/2)		
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.01	ft/ft

Calculations

n/n_{full} =	1.1145833	
Partially Full Manning roughness, n =	0.014	

Calculations

Pipe Diameter, D =	4	ft
Pipe Radius, r =	2	ft
Circ. Segment Height, h =	0.917	ft
Central Angle, q =	2.00	radians
Cross-Sect. Area, A =	10.39	ft^2
Wetted Perimeter, P =	8.6	ft
Hydraulic Radius, R =	1.21	ft
Discharge, Q =	121.53	cfs
Ave. Velocity, V =	11.69	ft/sec
pipe % full [(A/A_{full})*100%] =	82.7%	



Partially Full Pipe Flow Parameters
(More Than Half Full)

r = D/2

h = 2r - y

(hydraulic radius)

R = A/P

(Manning Equation)

$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$

V = Q/A P

$$\theta = 2\arccos\left(\frac{r-h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r*\theta$$

Equation used for n/n_{full}: $n/n_{full} = 1.25 - (y/D - 0.5)*0.5$ (for $0.5 \le y/D \le 1$)

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Partially Full Pipe Flow Calculator and Equations

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Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: *Enter values in blue boxes. Calculations in yellow*

Inputs

Pipe Diameter, D =	24	in
Depth of flow, y =	15	in

(must have $y \geq D/2$)

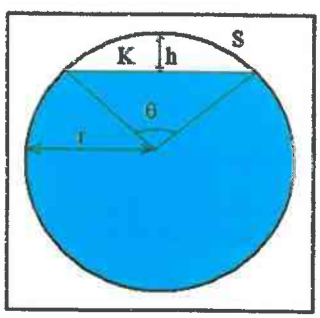
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.01	ft/ft

Calculations

n/n_{full} =	1.1875
Partially Full Manning roughness, n =	0.015

Calculations

Pipe Diameter, D =	2	ft
Pipe Radius, r =	1	ft
Circ. Segment Height, h =	0.750	ft
Central Angle, q =	2.64	radians
Cross-Sect. Area, A =	2.07	ft^2
Wetted Perimeter, P =	3.6	ft
Hydraulic Radius, R =	0.57	ft
Discharge, Q =	13.65	cfs
Ave. Velocity, V =	6.61	ft/sec
pipe % full [(A/A_{full})*100%] =	65.7%	



Partially Full Pipe Flow Parameters
(More Than Half Full)

r = D/2

h = 2r - y

(hydraulic radius)

R = A/P

(Manning Equation)

$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$

V = Q/A

P

$$\theta = 2 \arccos\left(\frac{r-h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r*\theta$$

Equation used for n/n_{full}: $n/n_{full} = 1.25 - (y/D - 0.5)*0.5$ (for $0.5 \leq y/D \leq 1$)

PR10 & PR11 Q100= 13.7 CFS
FLOW SPLIT

Partially Full Pipe Flow Calculator and Equations

Fluid Flow Table of Contents | Hydraulic and Pneumatic Knowledge
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This engineering calculator determines the Flow within a partially full pipe using the Manning equation. This calculator can also be used for uniform flow in a pipe, but the Manning roughness coefficient needs to be considered to be variable, dependent upon the depth of flow.

Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: *Enter values in blue boxes. Calculations in yellow*

Inputs

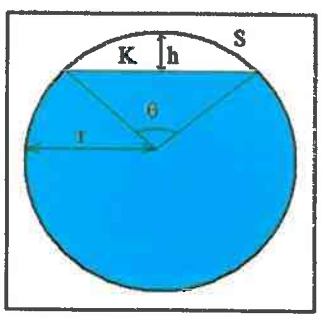
Pipe Diameter, D =	48	in
Depth of flow, y =	42	in
(must have $y \geq D/2$)		
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.01	ft/ft

Calculations

n/n_{full} =	1.0625	
Partially Full Manning roughness, n =	0.014	

Calculations

Pipe Diameter, D =	4	ft
Pipe Radius, r =	2	ft
Circ. Segment Height, h =	0.500	ft
Central Angle, q =	1.45	radians
Cross-Sect. Area, A =	11.66	ft^2
Wetted Perimeter, P =	9.7	ft
Hydraulic Radius, R =	1.21	ft
Discharge, Q =	142.43	cfs
Ave. Velocity, V =	12.22	ft/sec
pipe % full [(A/A_{full})*100%] =	92.8%	



Partially Full Pipe Flow Parameters
(More Than Half Full)

$r = D/2$

$h = 2r - y$

(hydraulic radius)

$R = A/P$

(Manning Equation)

$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$

$V = Q/A$ P

$$\theta = 2 \arccos\left(\frac{r-h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r*\theta$$

Equation used for n/n_{full}: $n/n_{full} = 1.25 - (y/D - 0.5)*0.5$ (for $0.5 \leq y/D \leq 1$)

PR12 Q100= 142.5 CFS

Partially Full Pipe Flow Calculator and Equations

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This engineering calculator determines the Flow within a partially full pipe using the Manning equation. This calculator can also be used for uniform flow in a pipe, but the Manning roughness coefficient needs to be considered to be variable, dependent upon the depth of flow.

Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: *Enter values in blue boxes. Calculations in yellow*

Inputs

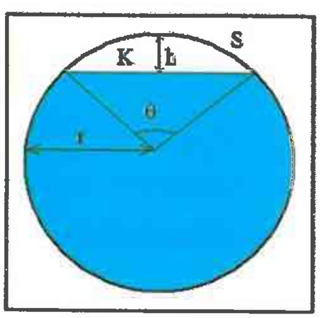
Pipe Diameter, D =	18	in
Depth of flow, y =	17	in
(must have y ≥ D/2)		
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.016	ft/ft

Calculations

n/n_{full} =	1.027777	
Partially Full Manning roughness, n =	0.013	

Calculations

Pipe Diameter, D =	1.5	ft
Pipe Radius, r =	0.75	ft
Circ. Segment Height, h =	0.083	ft
Central Angle, q =	0.95	radians
Cross-Sect. Area, A =	1.73	ft^2
Wetted Perimeter, P =	4.0	ft
Hydraulic Radius, R =	0.43	ft
Discharge, Q =	13.94	cfs
Ave. Velocity, V =	8.06	ft/sec
pipe % full [(A/A_{full})*100%] =	97.8%	



Partially Full Pipe Flow Parameters
(More Than Half Full)

r = D/2

h = 2r - y

(hydraulic radius)

R = A/P

(Manning Equation)

$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$

V = Q/A P

$$\theta = 2 \arccos\left(\frac{r-h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r^*\theta$$

Equation used for n/n_{full}: $n/n_{full} = 1.25 - (y/D - 0.5)^*0.5$ (for $0.5 \le y/D \le 1$)

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PR13 Q100= 14.0 CFS

Partially Full Pipe Flow Calculator and Equations

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This engineering calculator determines the Flow within a partially full pipe using the Manning equation. This calculator can also be used for uniform flow in a pipe, but the Manning roughness coefficient needs to be considered to be variable, dependent upon the depth of flow.

Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: *Enter values in blue boxes. Calculations in yellow*

Inputs

Pipe Diameter, D =	30	in
Depth of flow, y =	18	in

(must have y ≥ D/2)

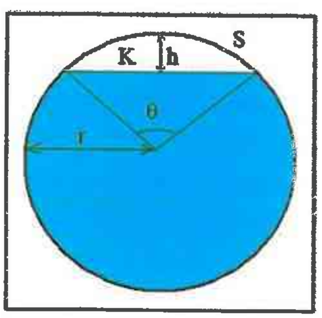
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.016	ft/ft

Calculations

n/n_{full} =	1.2
Partially Full Manning roughness, n =	0.016

Calculations

Pipe Diameter, D =	2.5	ft
Pipe Radius, r =	1.25	ft
Circ. Segment Height, h =	1.000	ft
Central Angle, q =	2.74	radians
Cross-Sect. Area, A =	3.08	ft^2
Wetted Perimeter, P =	4.4	ft
Hydraulic Radius, R =	0.69	ft
Discharge, Q =	29.13	cfs
Ave. Velocity, V =	9.47	ft/sec
pipe % full [(A/A_{full})*100%] =	62.6%	



Partially Full Pipe Flow Parameters
(More Than Half Full)

r = D/2

h = 2r - y

(hydraulic radius)

R = A/P

(Manning Equation)

$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$

V = Q/A P

$$\theta = 2\arccos\left(\frac{r-h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r*\theta$$

Equation used for n/n_{full}: $n/n_{full} = 1.25 - (y/D - 0.5)*0.5$ (for $0.5 \le y/D \le 1$)

PR14 Q100= 27.9 CFS

Partially Full Pipe Flow Calculator and Equations

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This engineering calculator determines the Flow within a partially full pipe using the Manning equation. This calculator can also be used for uniform flow in a pipe, but the Manning roughness coefficient needs to be considered to be variable, dependent upon the depth of flow.

Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: *Enter values in blue boxes. Calculations in yellow*

Inputs

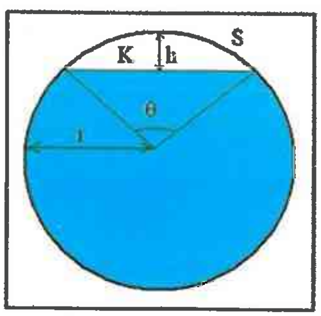
Pipe Diameter, D =	30	in
Depth of flow, y =	21	in
(must have y ≥ D/2)		
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.01	ft/ft

Calculations

n/n_{full} =	1.15
Partially Full Manning roughness, n =	0.015

Calculations

Pipe Diameter, D =	2.5	ft
Pipe Radius, r =	1.25	ft
Circ. Segment Height, h =	0.750	ft
Central Angle, q =	2.32	radians
Cross-Sect. Area, A =	3.67	ft²
Wetted Perimeter, P =	5.0	ft
Hydraulic Radius, R =	0.74	ft
Discharge, Q =	29.94	cfs
Ave. Velocity, V =	8.16	ft/sec
pipe % full [(A/A_{full})*100%] =	74.8%	



Partially Full Pipe Flow Parameters
(More Than Half Full)

r = D/2

h = 2r - y

(hydraulic radius)

R = A/P

(Manning Equation)

$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$

V = Q/A P

$$\theta = 2\arccos\left(\frac{r-h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r*\theta$$

Equation used for n/n_{full}: n/n_{full} **= 1.25 - (y/D -0.5)*0.5** (for 0.5 ≤ y/D ≤ 1)

#PR38 Q100= 27.9 CFS

Partially Full Pipe Flow Calculator and Equations

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This engineering calculator determines the Flow within a partially full pipe using the Manning equation. This calculator can also be used for uniform flow in a pipe, but the Manning roughness coefficient needs to be considered to be variable, dependent upon the depth of flow.

Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: *Enter values in blue boxes. Calculations in yellow*

Inputs

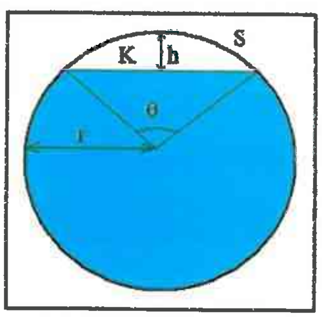
Pipe Diameter, D =	24	in
Depth of flow, y =	15	in
(must have y ≥ D/2)		
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.01	ft/ft

Calculations

n/n_{full} =	1.1875
Partially Full Manning roughness, n =	0.015

Calculations

Pipe Diameter, D =	2	ft
Pipe Radius, r =	1	ft
Circ. Segment Height, h =	0.750	ft
Central Angle, q =	2.64	radians
Cross-Sect. Area, A =	2.07	ft^2
Wetted Perimeter, P =	3.6	ft
Hydraulic Radius, R =	0.57	ft
Discharge, Q =	13.65	cfs
Ave. Velocity, V =	6.61	ft/sec
pipe % full [(A/A_{full})*100%] =	65.7%	



Partially Full Pipe Flow Parameters (More Than Half Full)

r = D/2

h = 2r - y

(hydraulic radius)

R = A/P

(Manning Equation)

$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$

V = Q/A

P

$$\theta = 2\arccos\left(\frac{r-h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r*\theta$$

Equation used for n/n_{full}: $n/n_{full} = 1.25 - (y/D - 0.5)*0.5$ (for $0.5 \le y/D \le 1$)

#PR15 Q100= 13.5 CFS

Partially Full Pipe Flow Calculator and Equations

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This engineering calculator determines the Flow within a partially full pipe using the Manning equation. This calculator can also be used for uniform flow in a pipe, but the Manning roughness coefficient needs to be considered to be variable, dependent upon the depth of flow.

Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: *Enter values in blue boxes. Calculations in yellow*

Inputs

Pipe Diameter, D =	30	in
Depth of flow, y =	26	in

(must have y ≥ D/2)

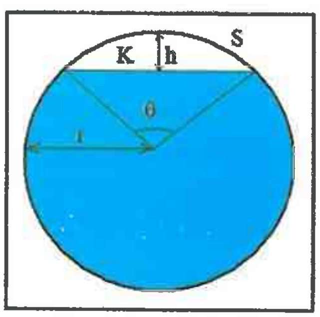
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.01	ft/ft

Calculations

n/n_{full} =	1.066666
Partially Full Manning roughness, n =	0.014

Calculations

Pipe Diameter, D =	2.5	ft
Pipe Radius, r =	1.25	ft
Circ. Segment Height, h =	0.333	ft
Central Angle, q =	1.50	radians
Cross-Sect. Area, A =	4.52	ft^2
Wetted Perimeter, P =	6.0	ft
Hydraulic Radius, R =	0.76	ft
Discharge, Q =	40.27	cfs
Ave. Velocity, V =	8.91	ft/sec
pipe % full [(A/A_{full})*100%] =	92.1%	



Partially Full Pipe Flow Parameters
(More Than Half Full)

r = D/2

h = 2r - y

(hydraulic radius)

R = A/P

(Manning Equation)

$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$

V = Q/A   P

$$\theta = 2 \arccos\left(\frac{r-h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r*\theta$$

Equation used for n/n_{full}: $n/n_{full} = 1.25 - (y/D - 0.5)*0.5$ (for $0.5 \le y/D \le 1$)

#PR16 Q100= 39.7 CFS

Partially Full Pipe Flow Calculator and Equations

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This engineering calculator determines the Flow within a partially full pipe using the Manning equation. This calculator can also be used for uniform flow in a pipe, but the Manning roughness coefficient needs to be considered to be variable, dependent upon the depth of flow.

Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: *Enter values in blue boxes. Calculations in yellow*

Inputs

Pipe Diameter, D =	24	in
Depth of flow, y =	14	in

(must have y ≥ D/2)

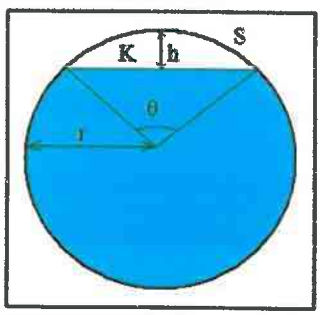
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.01	ft/ft

Calculations

n/n_{full} =	1.208333:
Partially Full Manning roughness, n =	0.016

Calculations

Pipe Diameter, D =	2	ft
Pipe Radius, r =	1	ft
Circ. Segment Height, h =	0.833	ft
Central Angle, q =	2.81	radians
Cross-Sect. Area, A =	1.90	ft^2
Wetted Perimeter, P =	3.5	ft
Hydraulic Radius, R =	0.55	ft
Discharge, Q =	12.07	cfs
Ave. Velocity, V =	6.35	ft/sec
pipe % full [(A/A_{full})*100%] =	60.6%	



Partially Full Pipe Flow Parameters (More Than Half Full)

r = D/2

h = 2r - y

(hydraulic radius)

R = A/P

(Manning Equation)

$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$

V = Q/A P

$$\theta = 2\arccos\left(\frac{r-h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r*\theta$$

Equation used for n/n_{full}: $n/n_{full} = 1.25 - (y/D - 0.5)*0.5$ (for $0.5 \le y/D \le 1$)

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#PR39 Q100= 13.0 CFS

Partially Full Pipe Flow Calculator and Equations

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This engineering calculator determines the Flow within a partially full pipe using the Manning equation. This calculator can also be used for uniform flow in a pipe, but the Manning roughness coefficient needs to be considered to be variable, dependent upon the depth of flow.

Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: *Enter values in blue boxes. Calculations in yellow*

Inputs

Pipe Diameter, D =	36	in
Depth of flow, y =	26	in

(must have y ≥ D/2)

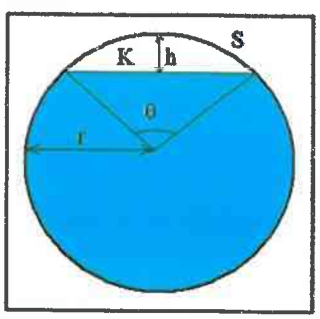
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.01	ft/ft

Calculations

n/n_{full} =	1.138888
Partially Full Manning roughness, n =	0.015

Calculations

Pipe Diameter, D =	3	ft
Pipe Radius, r =	1.5	ft
Circ. Segment Height, h =	0.833	ft
Central Angle, q =	2.22	radians
Cross-Sect. Area, A =	5.47	ft^2
Wetted Perimeter, P =	6.1	ft
Hydraulic Radius, R =	0.90	ft
Discharge, Q =	51.17	cfs
Ave. Velocity, V =	9.36	ft/sec
pipe % full [(A/A_{full})*100%] =	77.3%	



Partially Full Pipe Flow Parameters
(More Than Half Full)

r = D/2

h = 2r - y

(hydraulic radius)

R = A/P

(Manning Equation)

$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$

V = Q/A

P

$$\theta = 2\arccos\left(\frac{r-h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r^*\theta$$

Equation used for n/n_{full}: $n/n_{full} = 1.25 - (y/D - 0.5)*0.5$ (for $0.5 \le y/D \le 1$)

#PR17 Q100= 51.3 CFS

Partially Full Pipe Flow Calculator and Equations

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This engineering calculator determines the Flow within a partially full pipe using the Manning equation. This calculator can also be used for uniform flow in a pipe, but the Manning roughness coefficient needs to be considered to be variable, dependent upon the depth of flow.

Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: *Enter values in blue boxes. Calculations in yellow*

Inputs

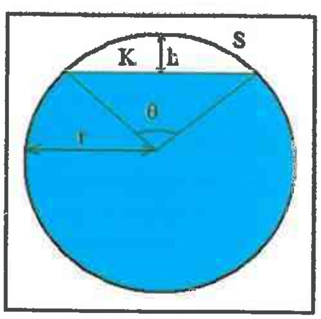
Pipe Diameter, D =	18	in
Depth of flow, y =	17	in
(must have y ≥ D/2)		
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.013	ft/ft

Calculations

n/n_{full} =	1.027777	
Partially Full Manning roughness, n =	0.013	

Calculations

Pipe Diameter, D =	1.5	ft
Pipe Radius, r =	0.75	ft
Circ. Segment Height, h =	0.083	ft
Central Angle, q =	0.95	radians
Cross-Sect. Area, A =	1.73	ft^2
Wetted Perimeter, P =	4.0	ft
Hydraulic Radius, R =	0.43	ft
Discharge, Q =	12.57	cfs
Ave. Velocity, V =	7.27	ft/sec
pipe % full [(A/A_{full})*100%] =	97.8%	



Partially Full Pipe Flow Parameters
(More Than Half Full)

r = D/2

h = 2r - y

(hydraulic radius)

R = A/P

(Manning Equation)

$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$

V = Q/A

$$\theta = 2\arccos\left(\frac{r-h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r*\theta$$

Equation used for n/n_{full}: $n/n_{full} = 1.25 - (y/D - 0.5)^{0.5}$ (for $0.5 < y/D < 1$)

PR18 Q100= 12.4 CFS

Partially Full Pipe Flow Calculator and Equations

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Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: *Enter values in blue boxes. Calculations in yellow*

Inputs

Pipe Diameter, D =	30	in
Depth of flow, y =	19	in

(must have y ≥ D/2)

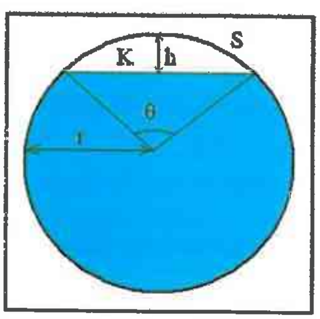
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.01	ft/ft

Calculations

n/n_{full} =	1.183333
Partially Full Manning roughness, n =	0.015

Calculations

Pipe Diameter, D =	2.5	ft
Pipe Radius, r =	1.25	ft
Circ. Segment Height, h =	0.917	ft
Central Angle, q =	2.60	radians
Cross-Sect. Area, A =	3.28	ft^2
Wetted Perimeter, P =	4.6	ft
Hydraulic Radius, R =	0.71	ft
Discharge, Q =	25.32	cfs
Ave. Velocity, V =	7.72	ft/sec
pipe % full [(A/A_{full})*100%] =	66.8%	



Partially Full Pipe Flow Parameters
(More Than Half Full)

r = D/2

h = 2r - y

(hydraulic radius)

R = A/P

(Manning Equation)

$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$

V = Q/A P

$$\theta = 2 \arccos\left(\frac{r-h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r*\theta$$

Equation used for n/n_{full}: $n/n_{full} = 1.25 - (y/D - 0.5)*0.5$ (for $0.5 \le y/D \le 1$)

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PR19 Q100= 24.8 CFS

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Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: *Enter values in blue boxes. Calculations in yellow*

Inputs

Pipe Diameter, D =	42	in
Depth of flow, y =	30	in

(must have y ≥ D/2)

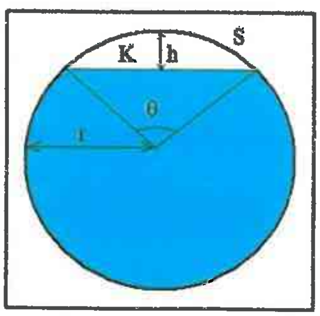
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.01	ft/ft

Calculations

n/n_{full} =	1.142857
Partially Full Manning roughness, n =	0.015

Calculations

Pipe Diameter, D =	3.5	ft
Pipe Radius, r =	1.75	ft
Circ. Segment Height, h =	1.000	ft
Central Angle, q =	2.26	radians
Cross-Sect. Area, A =	7.35	ft^2
Wetted Perimeter, P =	7.0	ft
Hydraulic Radius, R =	1.04	ft
Discharge, Q =	75.85	cfs
Ave. Velocity, V =	10.32	ft/sec
pipe % full [(A/A_{full})*100%] =	76.4%	



Partially Full Pipe Flow Parameters
(More Than Half Full)

r = D/2

h = 2r - y

(hydraulic radius)

R = A/P

(Manning Equation)

$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$

V = Q/A P

$$\theta = 2 \arccos\left(\frac{r-h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r*\theta$$

Equation used for n/n_{full}: $n/n_{full} = 1.25 - (y/D - 0.5)*0.5$ (for $0.5 \le y/D \le 1$)

PR20 Q100= 75.3 CFS

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Partially Full Pipe Flow Calculator and Equations

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This engineering calculator determines the Flow within a partially full pipe using the Manning equation. This calculator can also be used for uniform flow in a pipe, but the Manning roughness coefficient needs to be considered to be variable, dependent upon the depth of flow.

Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: *Enter values in blue boxes. Calculations in yellow*

Inputs

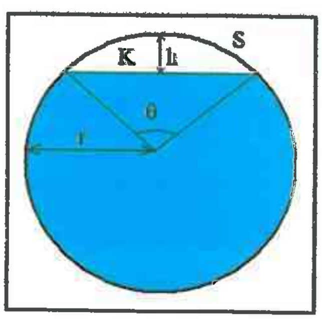
Pipe Diameter, D =	54	in
Depth of flow, y =	53	in
(must have y ≥ D/2)		
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.011	ft/ft

Calculations

n/n_{full} =	1.009259;	
Partially Full Manning roughness, n =	0.013	

Calculations

Pipe Diameter, D =	4.5	ft
Pipe Radius, r =	2.25	ft
Circ. Segment Height, h =	0.083	ft
Central Angle, q =	0.55	radians
Cross-Sect. Area, A =	15.84	ft^2
Wetted Perimeter, P =	12.9	ft
Hydraulic Radius, R =	1.23	ft
Discharge, Q =	216.17	cfs
Ave. Velocity, V =	13.65	ft/sec
pipe % full [(A/A_{full})*100%] =	99.6%	



Partially Full Pipe Flow Parameters
(More Than Half Full)

r = D/2

h = 2r - y

(hydraulic radius)

R = A/P

(Manning Equation)

$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$

V = Q/A

P

$$\theta = 2\arccos\left(\frac{r-h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r*\theta$$

Equation used for n/n_{full}: $n/n_{full} = 1.25 - (y/D - 0.5)*0.5$ (for $0.5 \le y/D \le 1$)

PR21 Q100= 214.5 CFS

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Partially Full Pipe Flow Calculator and Equations

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This engineering calculator determines the Flow within a partially full pipe using the Manning equation. This calculator can also be used for uniform flow in a pipe, but the Manning roughness coefficient needs to be considered to be variable, dependent upon the depth of flow.

Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V for pipes more than half full

Instructions: *Enter values in blue boxes. Calculations in yellow*

Inputs

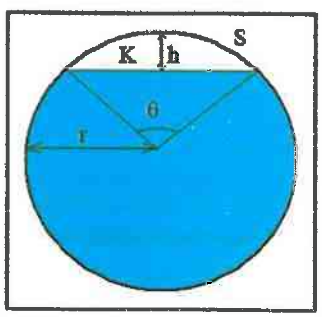
Pipe Diameter, D =	30	in
Depth of flow, y =	20	in
(must have y ≥ D/2)		
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.01	ft/ft

Calculations

n/n_{full} =	1.166666(	
Partially Full Manning roughness, n =	0.015	

Calculations

Pipe Diameter, D =	2.5	ft
Pipe Radius, r =	1.25	ft
Circ. Segment Height, h =	0.833	ft
Central Angle, q =	2.46	radians
Cross-Sect. Area, A =	3.48	ft^2
Wetted Perimeter, P =	4.8	ft
Hydraulic Radius, R =	0.73	ft
Discharge, Q =	27.63	cfs
Ave. Velocity, V =	7.95	ft/sec
pipe % full [$(A/A_{full})*100\%$] =	70.8%	



Partially Full Pipe Flow Parameters (More Than Half Full)

r = D/2

h = 2r - y

(hydraulic radius)

R = A/P

(Manning Equation)

$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$

V = Q/A

P

$$\theta = 2 \arccos\left(\frac{r-h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r*\theta$$

Equation used for n/n_{full}: $n/n_{full} = 1.25 - (y/D - 0.5)*0.5$ (for $0.5 \le y/D \le 1$)

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PR22 Q100= 27.7 CFS

Partially Full Pipe Flow Calculator and Equations

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This engineering calculator determines the Flow within a partially full pipe using the Manning equation. This calculator can also be used for uniform flow in a pipe, but the Manning roughness coefficient needs to be considered to be variable, dependent upon the depth of flow.

Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: *Enter values in blue boxes. Calculations in yellow*

Inputs

Pipe Diameter, D =	36	in
Depth of flow, y =	28	in

(must have y ≥ D/2)

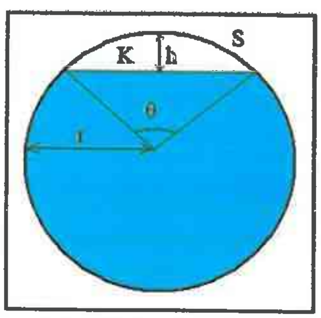
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.01	ft/ft

Calculations

n/n_{full} =	1.111111
Partially Full Manning roughness, n =	0.014

Calculations

Pipe Diameter, D =	3	ft
Pipe Radius, r =	1.5	ft
Circ. Segment Height, h =	0.667	ft
Central Angle, q =	1.96	radians
Cross-Sect. Area, A =	5.90	ft^2
Wetted Perimeter, P =	6.5	ft
Hydraulic Radius, R =	0.91	ft
Discharge, Q =	57.16	cfs
Ave. Velocity, V =	9.69	ft/sec
pipe % full [(A/A_{full})*100%] =	83.5%	



Partially Full Pipe Flow Parameters
(More Than Half Full)

r = D/2

h = 2r - y

(hydraulic radius)

R = A/P

(Manning Equation)

$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$

V = Q/A   P

$$\theta = 2\arccos\left(\frac{r-h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r*\theta$$

Equation used for n/n_{full}: $n/n_{full} = 1.25 - (y/D - 0.5)*0.5$ (for $0.5 \le y/D \le 1$)

PR23 Q100= 55.4 CFS

Partially FULL Pipe Flow Calculator and Equations

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This engineering calculator determines the Flow within a partially full pipe (&e1/2 fullusing the Manning equation. This calculator can also be used for uniform flow in a pipe, but the Manning roughness coefficient needs to be considered to be variable, dependent upon the depth of flow.

Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: *Enter values in blue boxes. Calculations in yellow*

Inputs

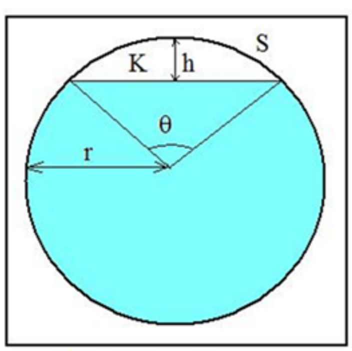
Pipe Diameter, **D** =	60	in
Depth of flow, **y** =	56	in
(must have y ≥ D/2)		
Full Pipe Manning roughness, $\mathbf{n_{full}}$ =	0.013	
Channel bottom slope, **S** =	0.01	ft/ft

Calculations

$\mathbf{n/n_{full}}$ =	1.0333333
Partially Full Manning roughness, **n** =	0.013

Calculations

Pipe Diameter, **D** =	5	ft
Pipe Radius, **r** =	2.5	ft
Circ. Segment Height, **h** =	0.333	ft
Central Angle, **q** =	1.04	radians
Cross-Sect. Area, **A** =	19.07	ft^2
Wetted Perimeter, **P** =	13.1	ft
Hydraulic Radius, **R** =	1.46	ft
Discharge, **Q** =	271.81	cfs
Ave. Velocity, **V** =	14.25	ft/sec
pipe % full [(A/A_{full})*100%] =	97.1%	



Partially Full Pipe Flow Parameters
(More Than Half Full)

r = D/2

h = 2r - y

(hydraulic radius)

R = A/P

(Manning Equation)

$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$

V = Q/A P

$$\theta = 2\arccos\left(\frac{r-h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r*\theta$$

Equation used for n/n_{full}: $\mathbf{n/n_{full} = 1.25 - (y/D - 0.5)*0.5}$ (for $0.5 \le y/D \le 1$)

PR24 Q100= 269.3 CFS

Partially FULL Pipe Flow Calculator and Equations

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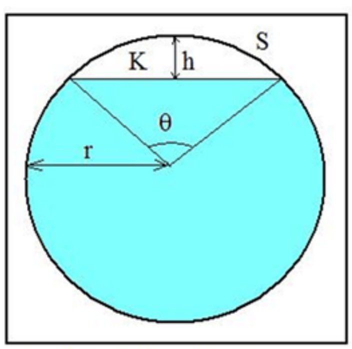
This engineering calculator determines the Flow within a partially full pipe (&e1/2 fullusing the Manning equation. This calculator can also be used for uniform flow in a pipe, but the Manning roughness coefficient needs to be considered to be variable, dependent upon the depth of flow.

Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: *Enter values in blue boxes. Calculations in yellow*

Inputs			**Calculations**		
Pipe Diameter, **D** =	30	in	Pipe Diameter, **D** =	2.5	ft
Depth of flow, **y** =	17	in	Pipe Radius, **r** =	1.25	ft
(must have y ≥ D/2)					
			Circ. Segment Height, **h** =	1.083	ft
Full Pipe Manning roughness, $\mathbf{n_{full}}$ =	0.013		Central Angle, **q** =	2.87	radians
Channel bottom slope, **S** =	0.01	ft/ft	Cross-Sect. Area, **A** =	2.87	ft^2
			Wetted Perimeter, **P** =	4.3	ft
Calculations			Hydraulic Radius, **R** =	0.67	ft
$\mathbf{n/n_{full}}$ =	1.2166666		Discharge, **Q** =	20.77	cfs
Partially Full Manning roughness, **n** =	0.016		Ave. Velocity, **V** =	7.24	ft/sec
			pipe % full [(A/A_{full})*100%] =	58.5%	



Partially Full Pipe Flow Parameters
(More Than Half Full)

r = D/2

h = 2r - y

(hydraulic radius)

R = A/P

(Manning Equation)

$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$

V = Q/A P

$$\theta = 2\arccos\left(\frac{r-h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r*\theta$$

Equation used for n/n_{full}: $\mathbf{n/n_{full} = 1.25 - (y/D - 0.5)*0.5}$ (for $0.5 \le y/D \le 1$)

PR25 Q100= 20.8 CFS

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Partially FULL Pipe Flow Calculator and Equations

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This engineering calculator determines the Flow within a partially full pipe (&e1/2 fullusing the Manning equation. This calculator can also be used for uniform flow in a pipe, but the Manning roughness coefficient needs to be considered to be variable, dependent upon the depth of flow.

Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: *Enter values in blue boxes. Calculations in yellow*

Inputs

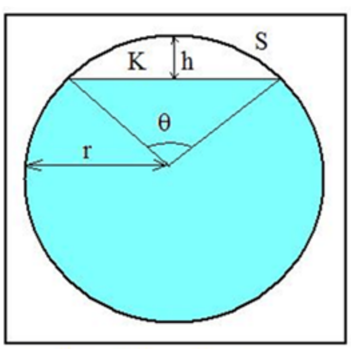
Input	Value	Unit
Pipe Diameter, **D** =	66	in
Depth of flow, **y** =	64	in
(must have y ≥ D/2)		
Full Pipe Manning roughness, $\mathbf{n_{full}}$ =	0.013	
Channel bottom slope, **S** =	0.005	ft/ft

Calculations

$\mathbf{n/n_{full}}$ =	1.0151515
Partially Full Manning roughness, **n** =	0.013

Calculations

Quantity	Value	Unit
Pipe Diameter, **D** =	5.5	ft
Pipe Radius, **r** =	2.75	ft
Circ. Segment Height, **h** =	0.167	ft
Central Angle, **q** =	0.70	radians
Cross-Sect. Area, **A** =	23.55	ft^2
Wetted Perimeter, **P** =	15.4	ft
Hydraulic Radius, **R** =	1.53	ft
Discharge, **Q** =	250.01	cfs
Ave. Velocity, **V** =	10.62	ft/sec
pipe % full [(A/A_{full})*100%] =	99.1%	



Partially Full Pipe Flow Parameters
(More Than Half Full)

r = D/2

h = 2r - y

(hydraulic radius)

R = A/P

(Manning Equation)

$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$

V = Q/A P

$$\theta = 2\arccos\left(\frac{r-h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r*\theta$$

Equation used for n/n_{full}: $\mathbf{n/n_{full} = 1.25 - (y/D - 0.5)*0.5}$ (for $0.5 \le y/D \le 1$)

PR26 Q100= 287.3 CFS

Partially FULL Pipe Flow Calculator and Equations

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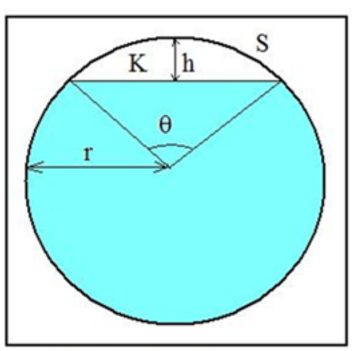
This engineering calculator determines the Flow within a partially full pipe (&e1/2 fullusing the Manning equation. This calculator can also be used for uniform flow in a pipe, but the Manning roughness coefficient needs to be considered to be variable, dependent upon the depth of flow.

Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: *Enter values in blue boxes. Calculations in yellow*

Inputs			**Calculations**		
Pipe Diameter, **D** =	48	in	Pipe Diameter, **D** =	4	ft
Depth of flow, **y** =	32	in	Pipe Radius, **r** =	2	ft
(must have y ≥ D/2)			Circ. Segment Height, **h** =	1.333	ft
Full Pipe Manning roughness, $\mathbf{n_{full}}$ =	0.013		Central Angle, **q** =	2.46	radians
Channel bottom slope, **S** =	0.01	ft/ft	Cross-Sect. Area, **A** =	8.90	ft^2
			Wetted Perimeter, **P** =	7.6	ft
Calculations			Hydraulic Radius, **R** =	1.16	ft
$\mathbf{n/n_{full}}$ =	1.1666666		Discharge, **Q** =	96.77	cfs
Partially Full Manning roughness, **n** =	0.015		Ave. Velocity, **V** =	10.87	ft/sec
			pipe % full $[(A/A_{full})*100\%]$ =	70.8%	



Partially Full Pipe Flow Parameters
(More Than Half Full)

r = D/2

h = 2r - y

(hydraulic radius)

R = A/P

(Manning Equation)

$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$

V = Q/A P

$$\theta = 2\arccos\left(\frac{r-h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r*\theta$$

Equation used for n/n_{full}: $\mathbf{n/n_{full} = 1.25 - (y/D - 0.5)*0.5}$ (for $0.5 \le y/D \le 1$)

#PR27 Q100= 92.8 CFS

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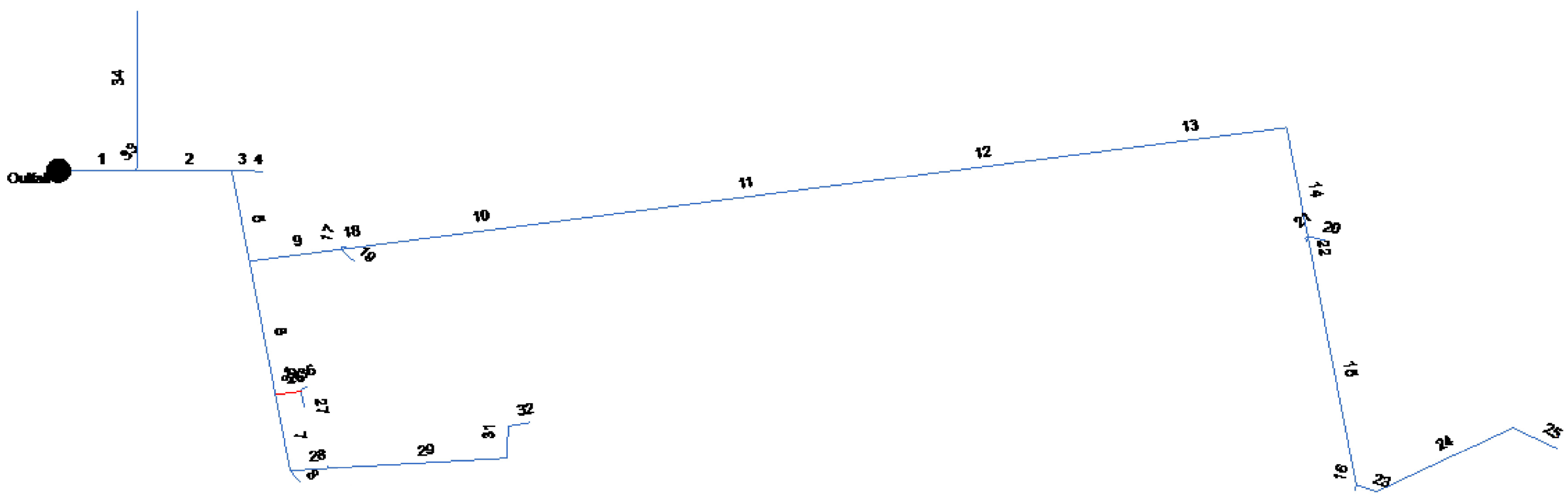
STORM 1, 2, 3, 4, 5, 7 & 9 PIPE RUN INDEX MAP



Line No.	Line ID	Line Type	Junct Type	J-Loss Coeff	n-val Pipe	Flow Rate (cfs)	Invert Dn (ft)	Invert Up (ft)	Line Slope (%)	HGL Dn (ft)	HGL Up (ft)	Minor Loss (ft)	HGL Jnct (ft)	Vel Ave (ft/s)	Line Length (ft)	Rim-Hw (ft)
1	Storm 1	Cir	MH	0.75	0.013	287.30	7191.76	7192.37	0.50	7197.26	7198.15	1.71	7199.86	12.09	121.710	5.64
2	Storm 1(2)	Cir	MH	0.99 z	0.013	269.30	7192.87	7202.30	5.95	7199.86	7206.83	n/a	7206.83	14.06	158.500	5.17
3	Storm 1	Cir	Generic	0.50	0.013	55.40	7204.30	7204.67	2.57	7209.10	7209.20	0.48	7209.68	7.84	14.400	1.72
4	Storm 1	Cir	Generic	1.00	0.013	27.70	7205.17	7206.51	3.79	7210.14	7210.30	0.50	7210.79	5.64	35.350	0.61
5	Storm 2	Cir	MH	1.00 z	0.013	214.50	7202.80	7205.94	1.72	7207.23	7210.06	3.07	7210.06	13.79	182.370	3.94
6	Storm 2	Cir	MH	1.00 z	0.013	75.30	7206.94	7213.72	2.51	7212.18	7216.43	1.38	7216.43	8.62	270.010	3.57
7	Storm 2	Cir	MH	1.00 z	0.013	51.30	7214.22	7218.47	2.77	7216.99	7220.80	n/a	7220.80	8.12	153.240	3.00
8	Storm 2	Cir	Generic	1.00	0.013	11.50	7218.58	7219.65	3.74	7221.77	7221.85	0.21	7222.05	3.66	28.586	2.03
9	Storm 3	Cir	MH	0.89 z	0.013	142.50	7206.44	7208.80	1.58	7211.13	7212.33	2.04	7212.33	11.74	149.360	3.83
10	Storm 3	Cir	MH	0.15 z	0.013	117.80	7209.10	7217.15	1.85	7213.25	7220.42	n/a	7220.42	10.05	435.420	3.58
11	Storm 3	Cir	MH	0.15 z	0.013	117.80	7217.45	7225.32	1.81	7220.84	7228.59	n/a	7228.59	10.55	435.420	3.87
12	Storm 3	Cir	MH	0.15 z	0.013	117.80	7225.63	7240.60	4.41	7229.01	7243.87	n/a	7243.87	10.56	339.480	3.88
13	Storm 3	Cir	MH	1.00 z	0.013	117.80	7240.89	7246.33	1.60	7244.29	7249.60	n/a	7249.60	10.54	339.480	6.89
14	Storm 3	Cir	MH	0.92	0.013	117.80	7246.63	7247.95	0.60	7250.17	7251.49	1.44	7252.92	10.02	219.470	2.34
15	Storm 3	Cir	MH	0.88	0.013	76.00	7248.25	7251.41	0.63	7253.92	7255.21	0.52	7255.73	6.11	502.070	2.73
16	Storm 3	Cir	Generic	1.00	0.013	2.70	7254.23	7254.75	4.89	7256.28	7256.29	0.04	7256.32	1.53	10.640	2.33
17	Storm 3_Lat 1	Cir	None	0.89	0.013	13.70	7211.10	7211.21	2.51	7213.69	7213.76	0.83	7214.59	7.75	4.375	1.87
18	Storm 3_Lat 1	Cir	Generic	1.00	0.013	13.70	7211.21	7211.41	2.50	7214.59	7214.73	0.93	7215.66	7.75	8.000	0.59
19	Storm 3_Lat 2	Cir	Generic	1.00	0.013	13.70	7211.10	7211.91	2.50	7213.69	7214.24	0.93	7215.17	7.75	32.420	1.17
20	Storm 3_Lat 3	Cir	Generic	1.00	0.013	22.20	7249.95	7250.33	1.26	7253.71	7254.00	0.78	7254.78	7.07	30.230	0.47
21	Storm 3_Lat 4	Cir	None	0.75	0.013	22.20	7249.95	7250.01	1.36	7253.71	7253.75	0.58	7254.33	7.07	4.380	1.03
22	Storm 3_Lat 4(2)	Cir	Generic	1.00	0.013	22.20	7250.01	7250.11	1.25	7254.33	7254.41	0.78	7255.19	7.07	8.000	0.27
23	Storm 4	Cir	Generic	1.23	0.013	74.00	7251.73	7251.99	0.75	7255.74	7255.81	0.69	7256.49	5.94	34.736	1.80

Project File: Storm Main System.stm | Number of lines: 36 | Date: 12/12/2020

NOTES: ** Critical depth

MyReport

STORM 1, 2, 3, 4, 5, 7 & 9 incl LATERALS

Line No.	Line ID	Line Type	Junct Type	J-Loss Coeff	n-val Pipe	Flow Rate (cfs)	Invert Dn (ft)	Invert Up (ft)	Line Slope (%)	HGL Dn (ft)	HGL Up (ft)	Minor Loss (ft)	HGL Jnct (ft)	Vel Ave (ft/s)	Line Length (ft)	Rim-Hw (ft)
24	Storm 4	Cir	None	0.89	0.013	58.10	7252.99	7255.10	0.83	7256.49	7258.43	0.93	7259.36	8.22	254.990	4.14
25	Storm 4	Cir	Hdwall	1.00	0.013	58.10	7255.10	7255.80	0.83	7259.36	7260.00	1.05	7261.05	8.22	84.020	-5.25
26	Storm 5	Cir	MH	1.00	0.013	24.80	7214.72	7215.24	1.23	7217.28	7217.33	0.50	7217.83	5.35	42.170	2.65
27	Storm 5(2)	Cir	Generic	1.00 z	0.013	12.40	7216.24	7217.19	2.98	7217.83	7218.52 j	n/a	7218.52	7.25	31.900	1.87
28	Storm Planned	Cir	MH	1.00	0.013	39.70	7218.08	7219.19	1.83	7220.96	7221.32	1.24	7222.55	8.51	60.570	1.98
29	Storm Planned	Cir	MH	1.00 z	0.013	27.90	7219.49	7223.85	1.50	7223.29	7225.65 j	n/a	7225.65	6.53	290.660	3.30
31	Storm 7	Cir	Generic	1.46 z	0.013	27.90	7224.15	7224.80	1.01	7225.99	7226.60 j	n/a	7226.60	7.28	64.530	3.04
32	Storm 7	Cir	Generic	1.00	0.013	14.00	7225.80	7226.17	1.01	7227.30	7227.95	0.98	7228.92	7.92	36.470	0.85
33	Storm 9	Cir	None	0.75	0.013	20.80	7195.47	7195.56	1.03	7201.85	7201.87	0.21	7202.08	4.24	8.700	1.92
34	Storm 9 (2)	Cir	Dp-Grate	1.00	0.013	20.80	7195.56	7198.67	1.00	7202.08	7202.88	0.28	7203.16	4.24	310.630	0.06
35	STRM 5 LAT1	Cir	None	0.75	0.013	12.34	7216.24	7216.29	0.92	7217.83	7217.90	0.57	7218.47	6.98	5.390	2.23
36	STRM 5 LAT1 (2)	Cir	Generic	1.00	0.013	12.40	7216.29	7216.37	1.00	7218.47	7218.58	0.77	7219.35	7.02	8.000	1.42

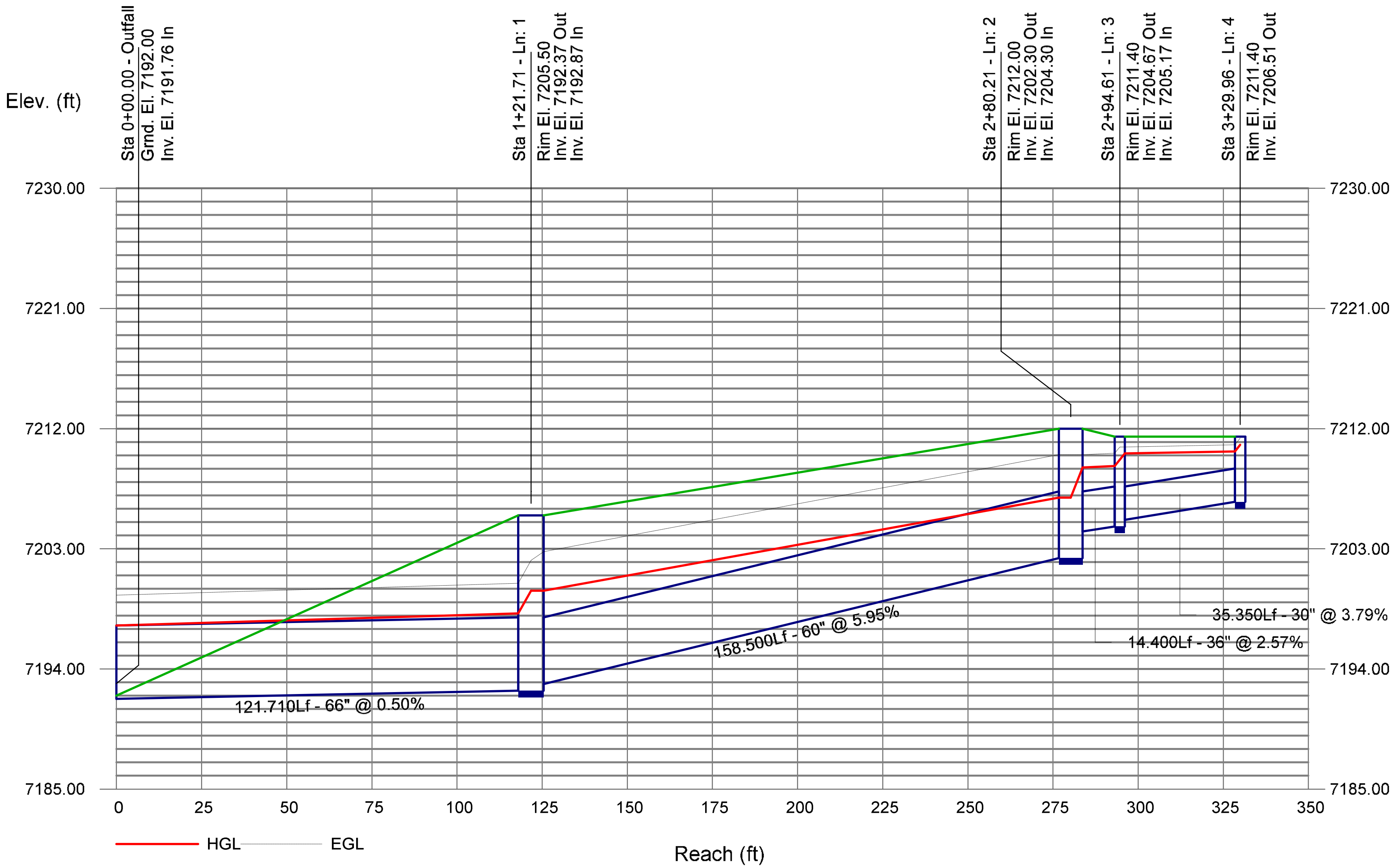
Project File: Storm Main System.stm | Number of lines: 36 | Date: 12/12/2020

NOTES: ** Critical depth

Storm Sewer Profile

STORM 1 PROFILE

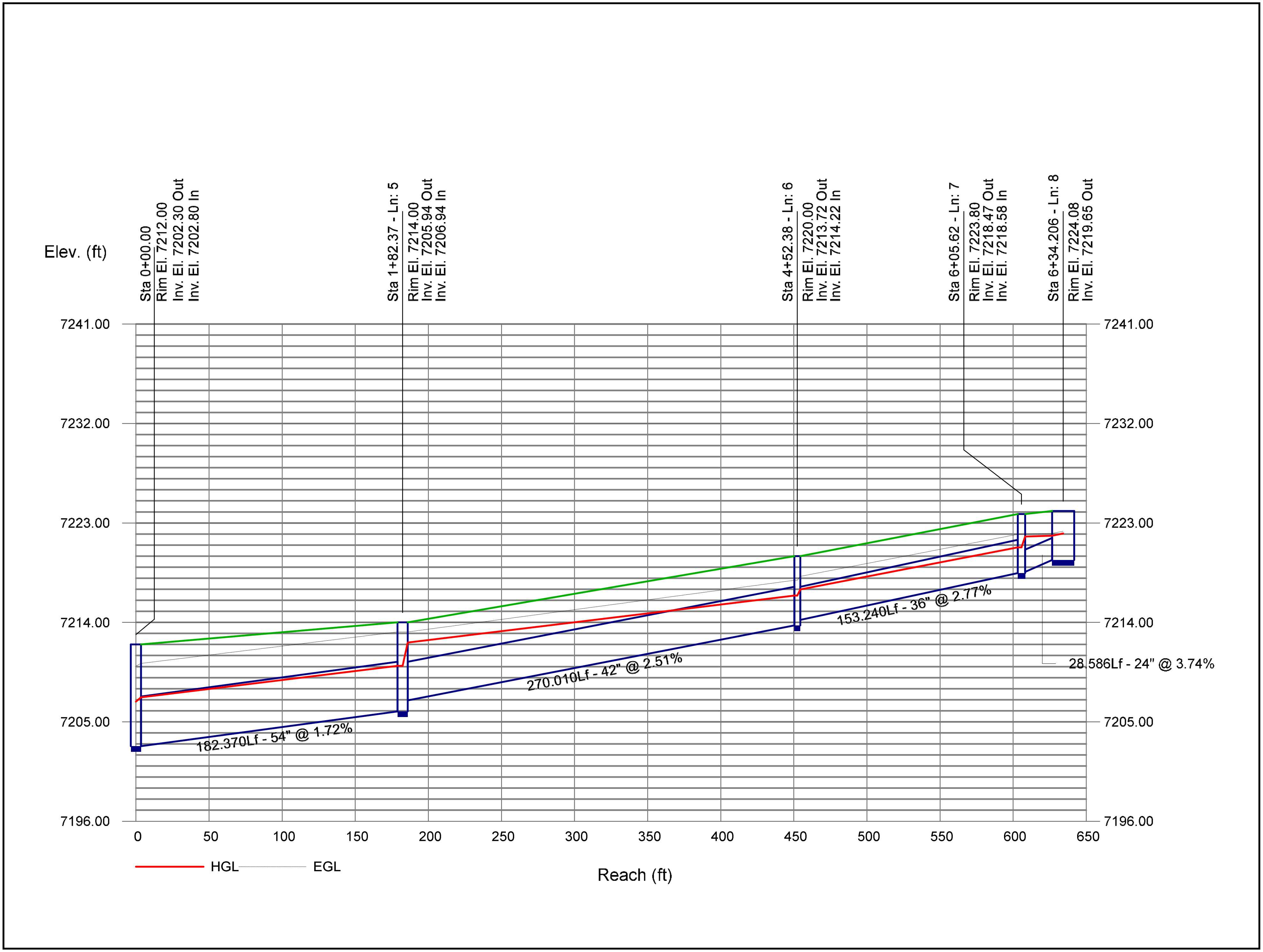
Proj. file: Storm Main System.stm



Storm Sewer Profile

STORM 2 PROFILE

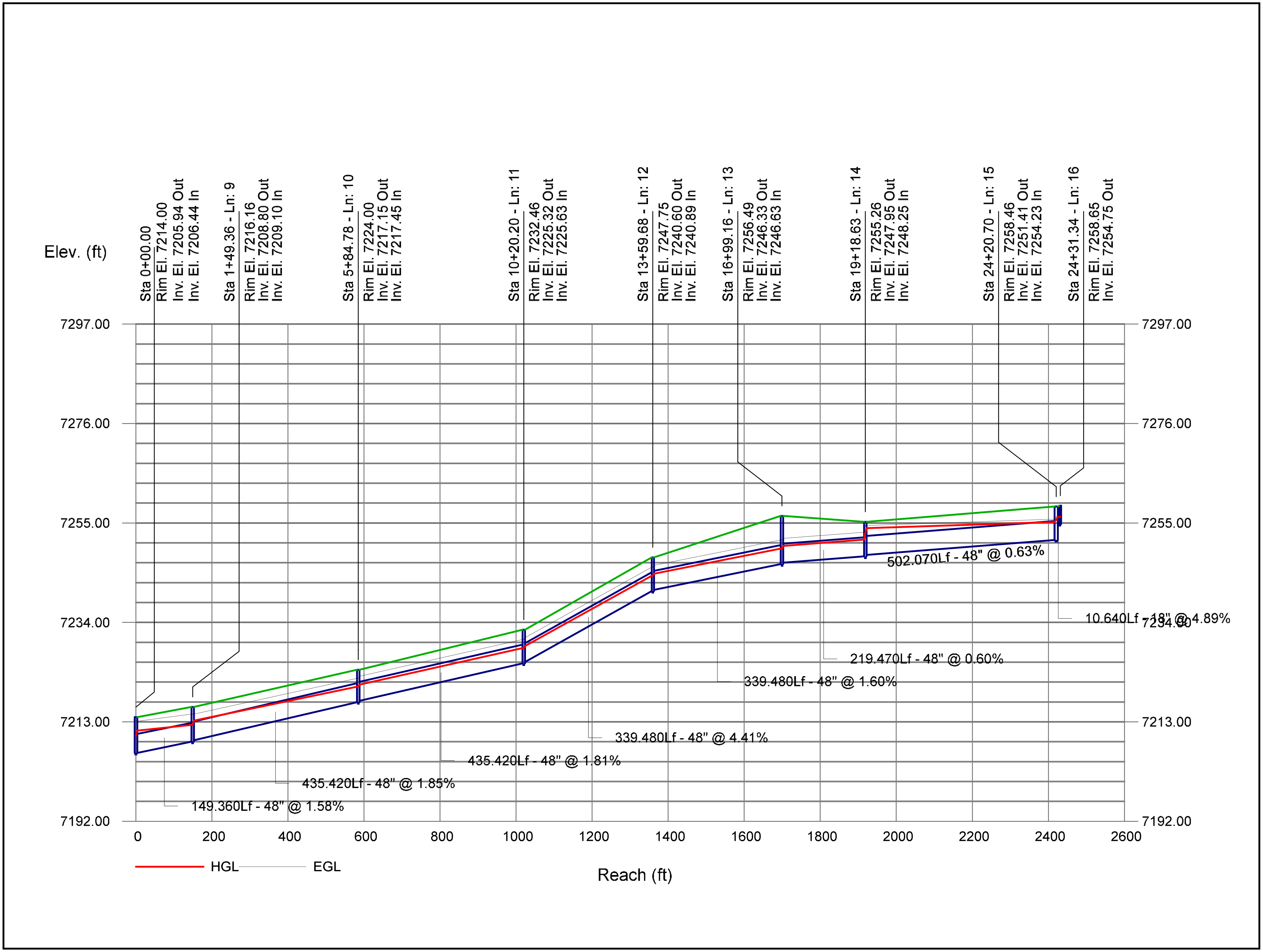
Proj. file: Storm Main System.stm



Storm Sewer Profile

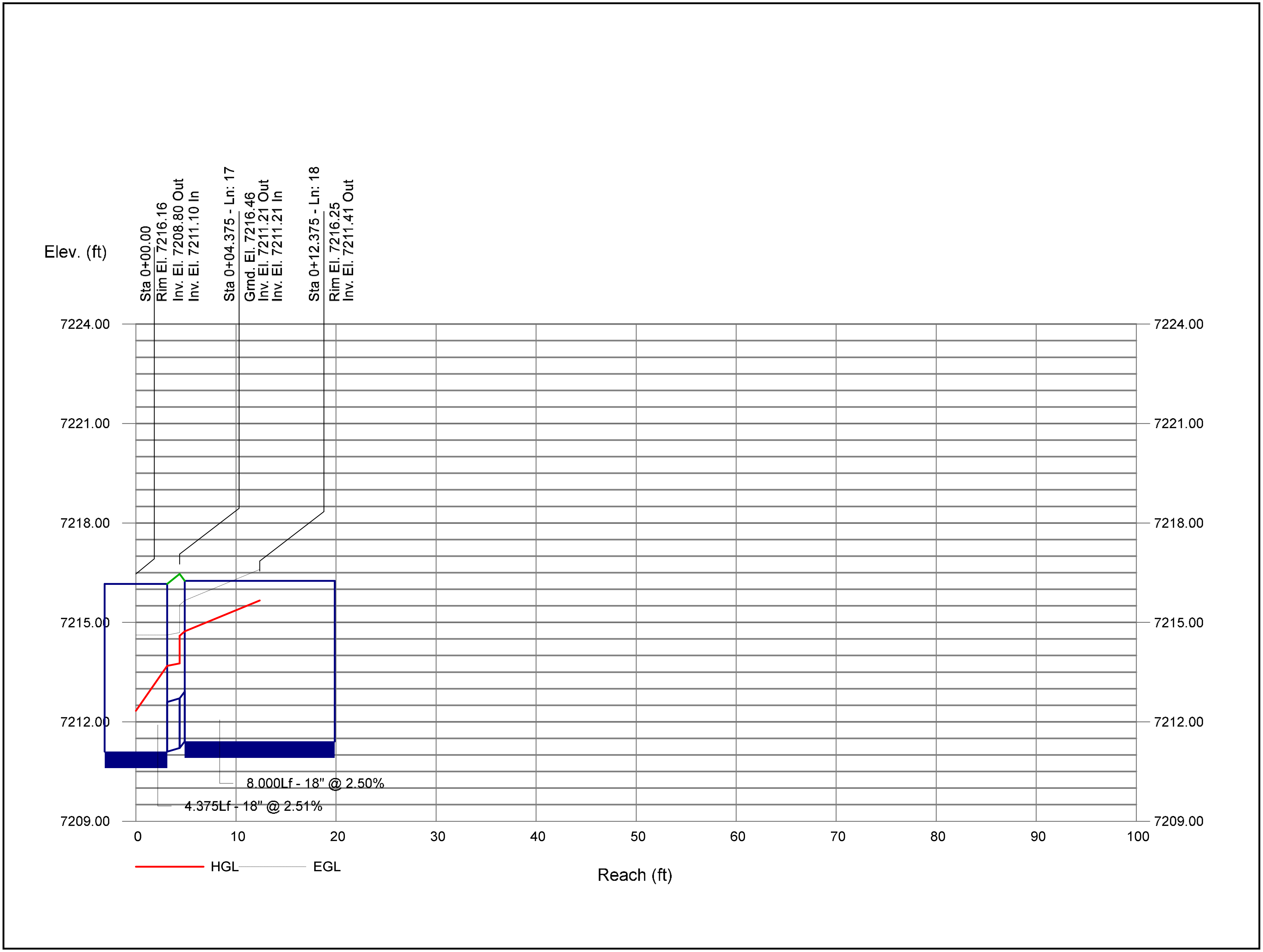
STORM 3 PROFILE

Proj. file: Storm Main System.stm



Storm Sewer Profile

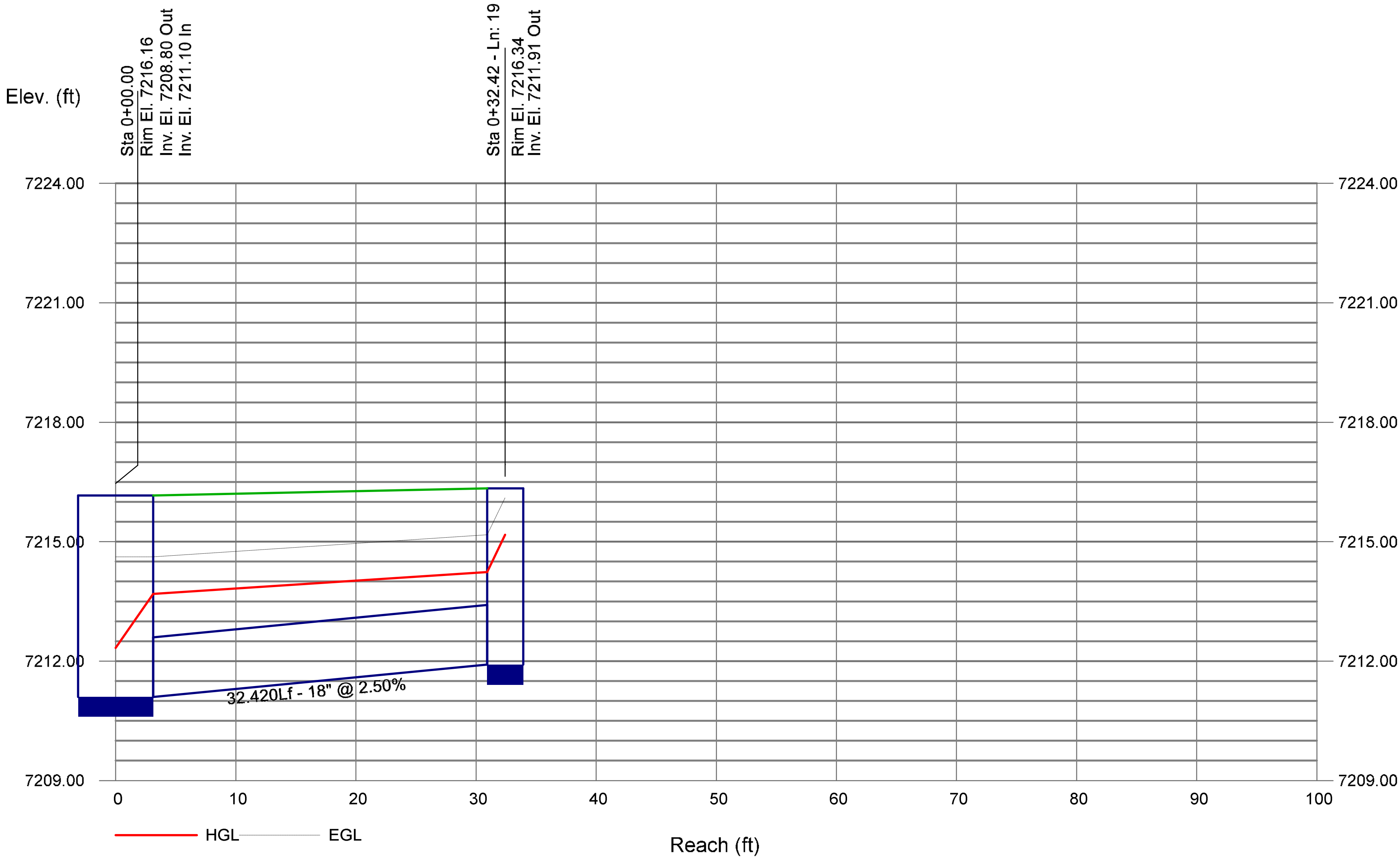
STORM 3-LAT 1 PROFILE



Storm Sewer Profile

STORM 3-LAT 2 PROFILE

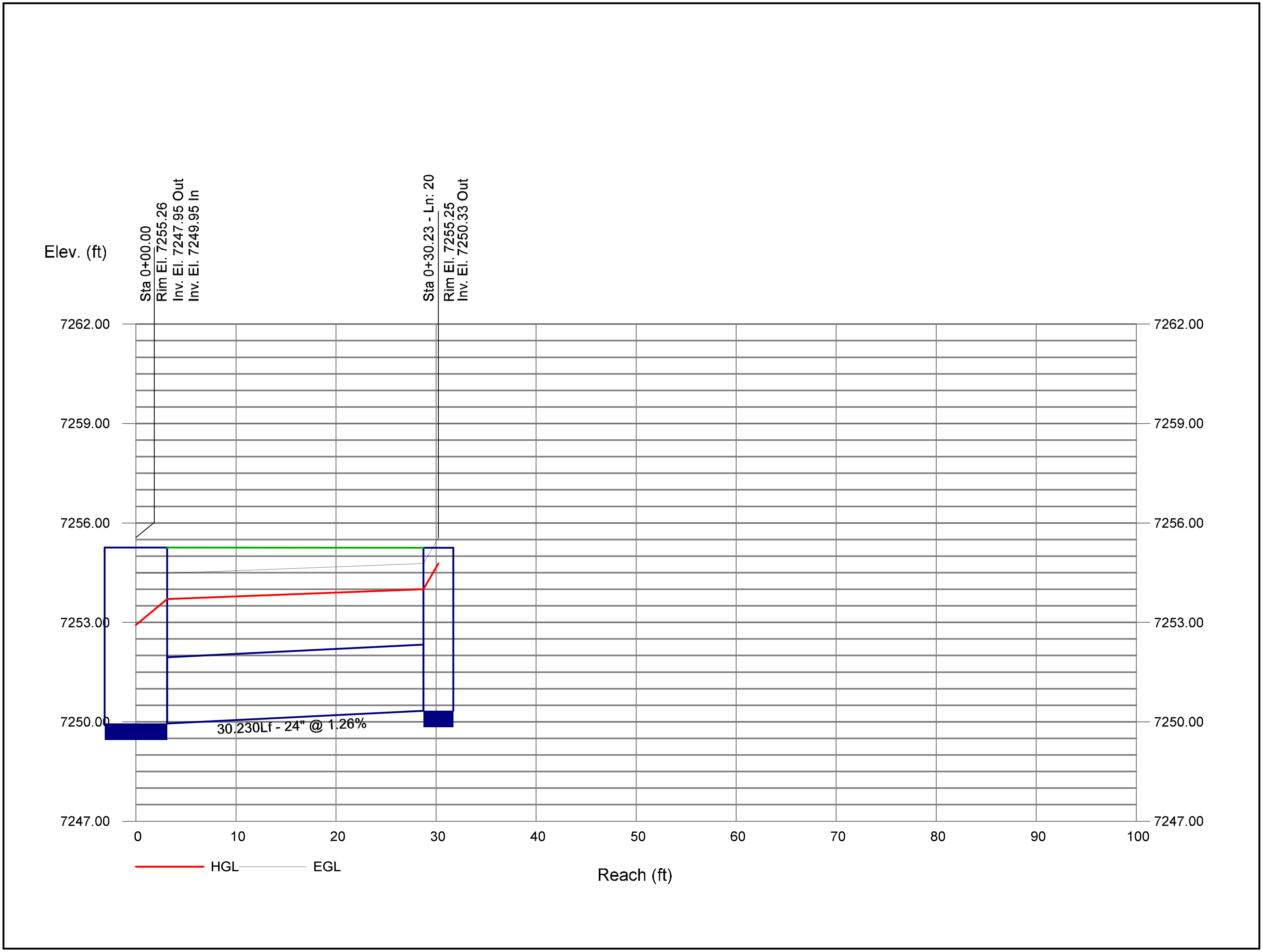
Proj. file: Storm Main System.stm



Storm Sewer Profile

STORM 3-LAT 3 PROFILE

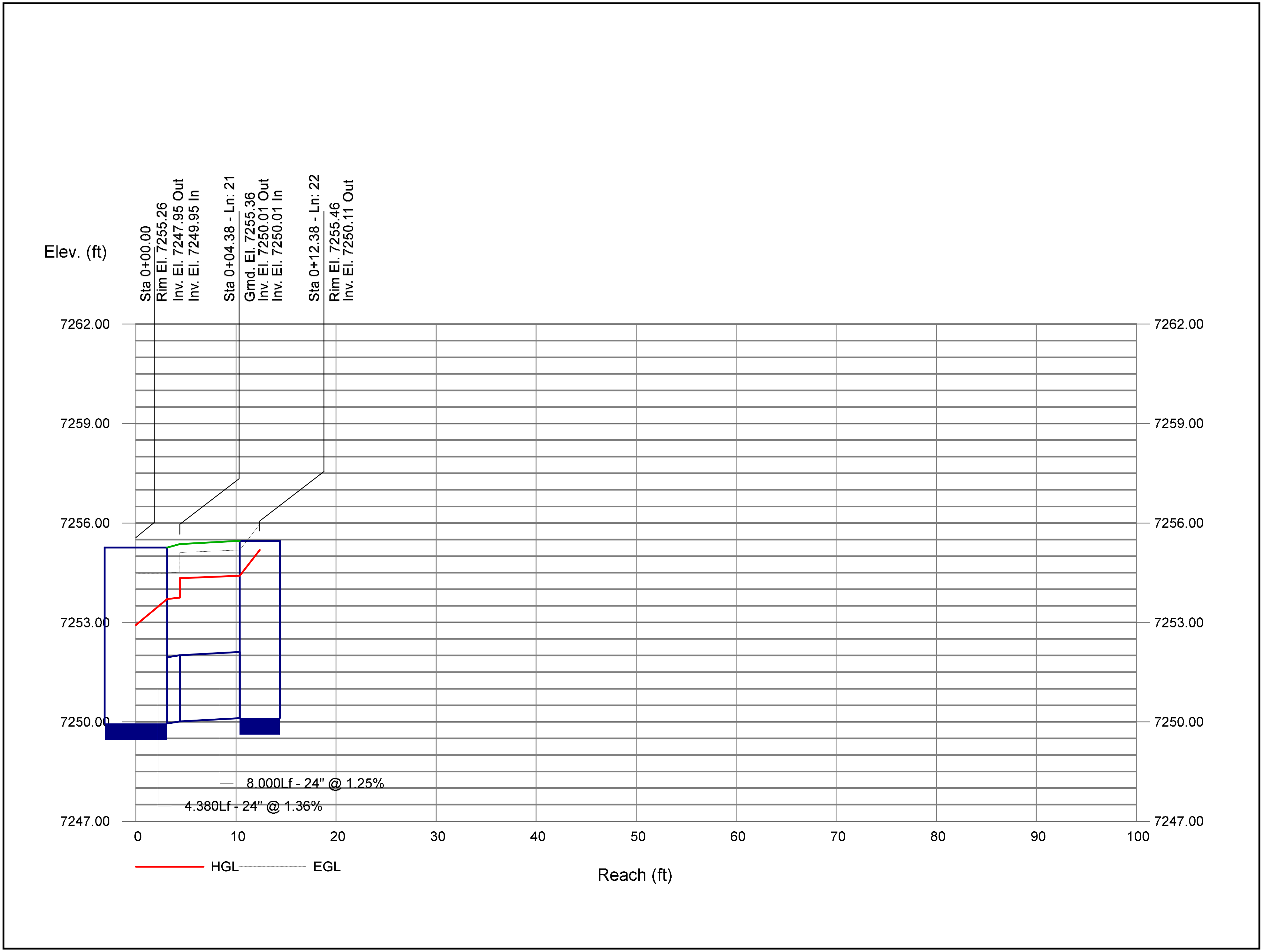
Proj. file: Storm Main System.stm



Storm Sewer Profile

STORM 3-LAT 4 PROFILE

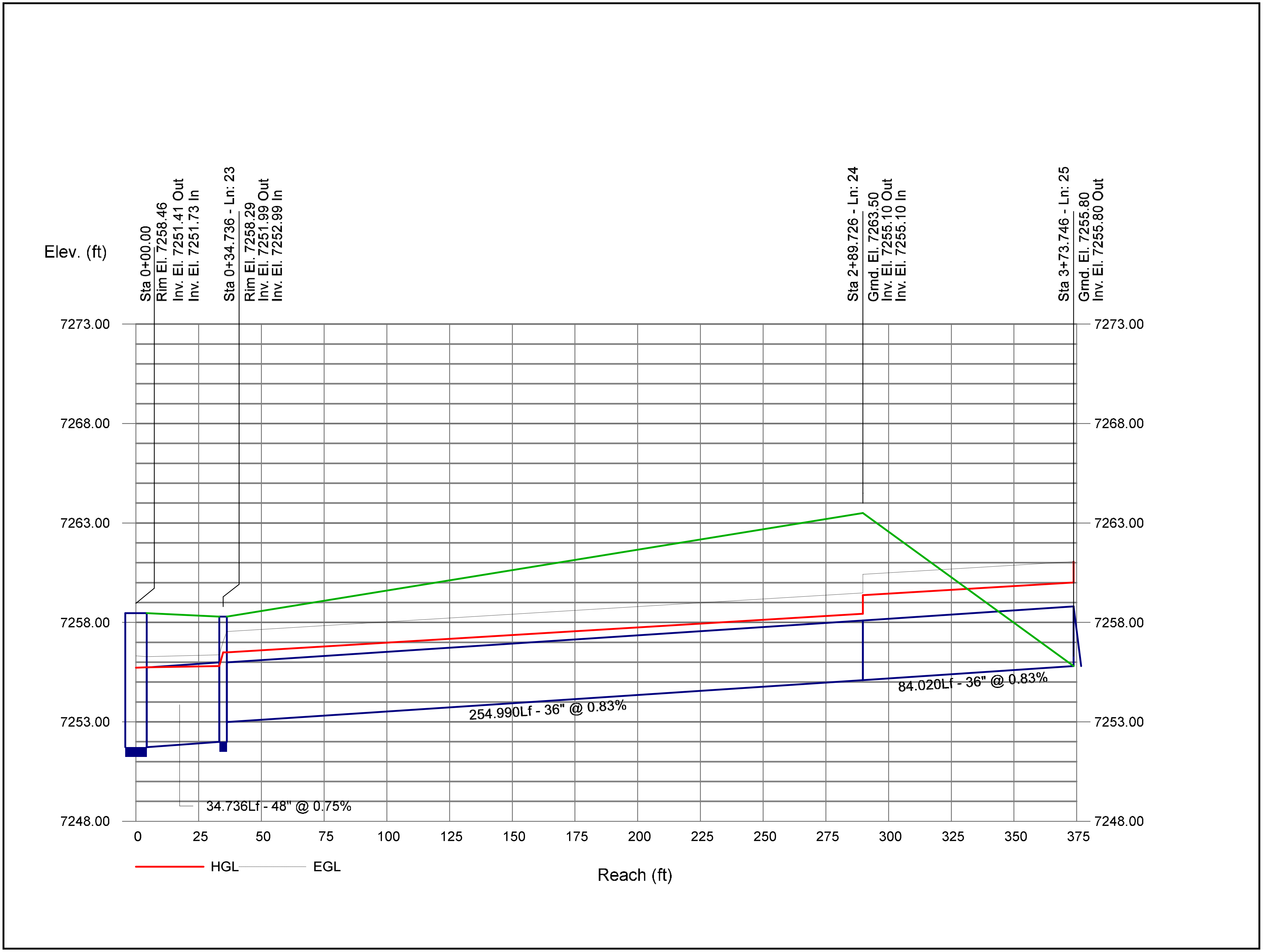
Proj. file: Storm Main System.stm



Storm Sewer Profile

STORM 4 PROFILE

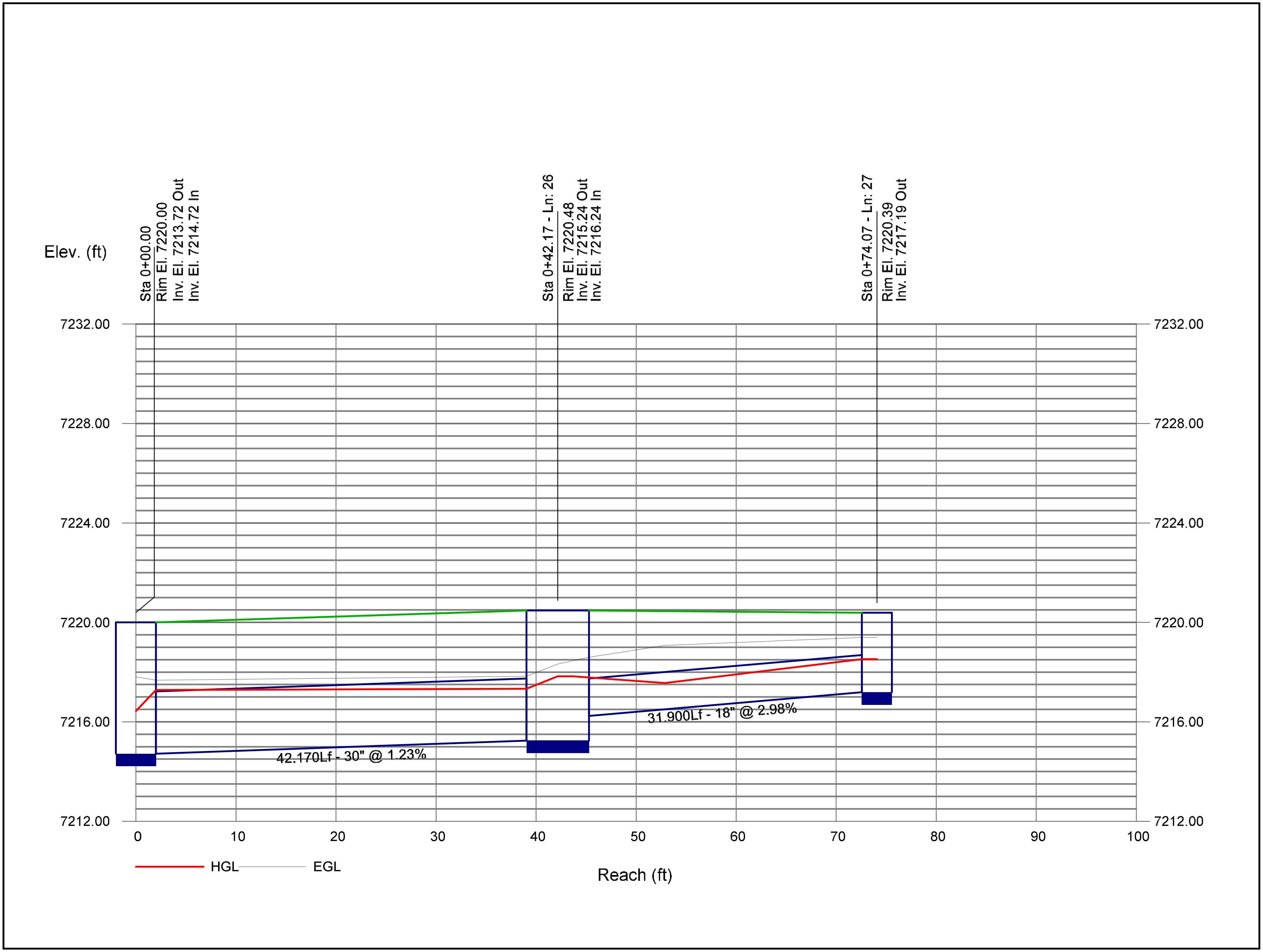
Proj. file: Storm Main System.stm



Storm Sewer Profile

STORM 5 PROFILE

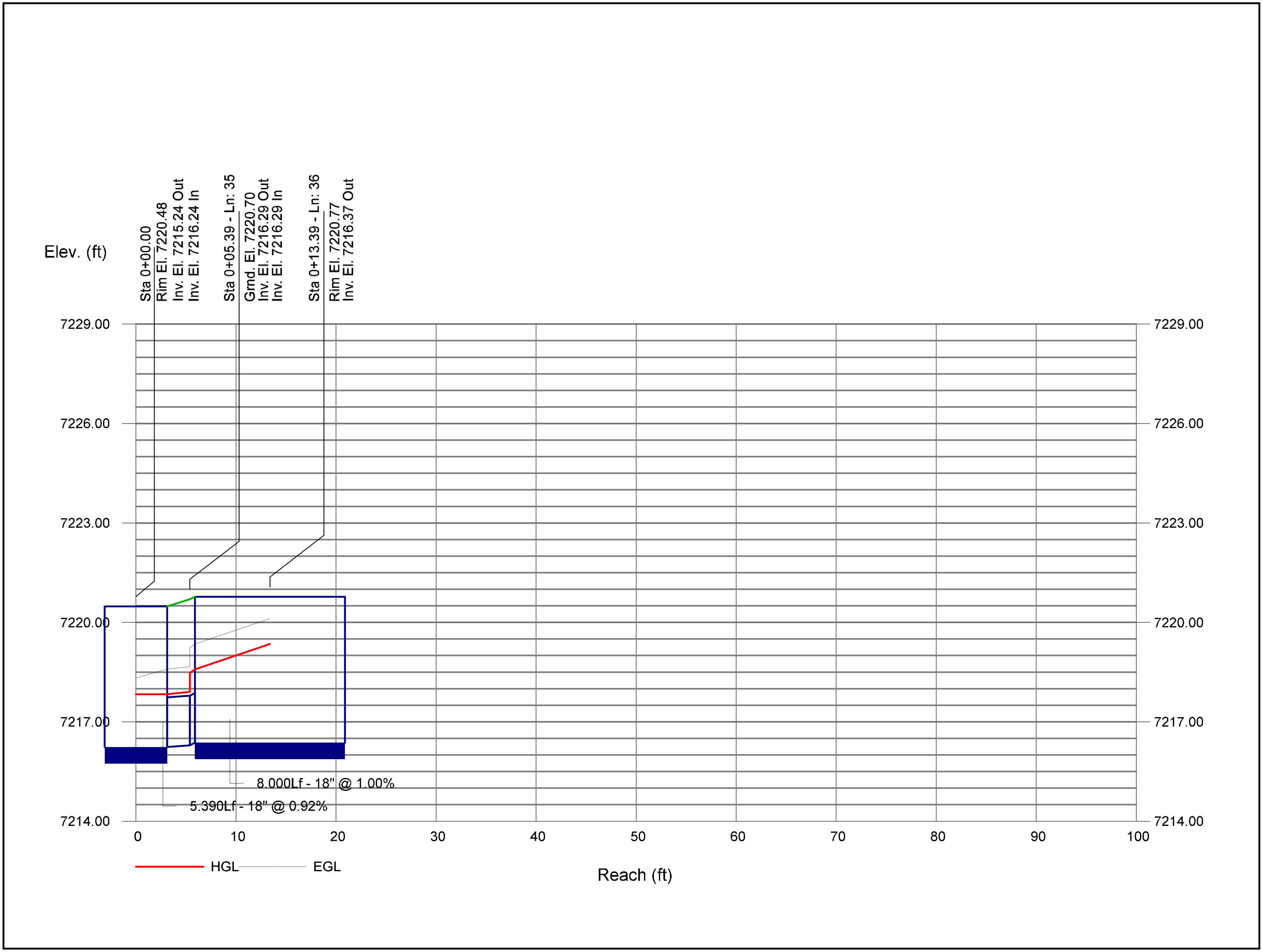
Proj. file: Storm Main System.stm



Storm Sewer Profile

STORM 5-LAT 1 PROFILE

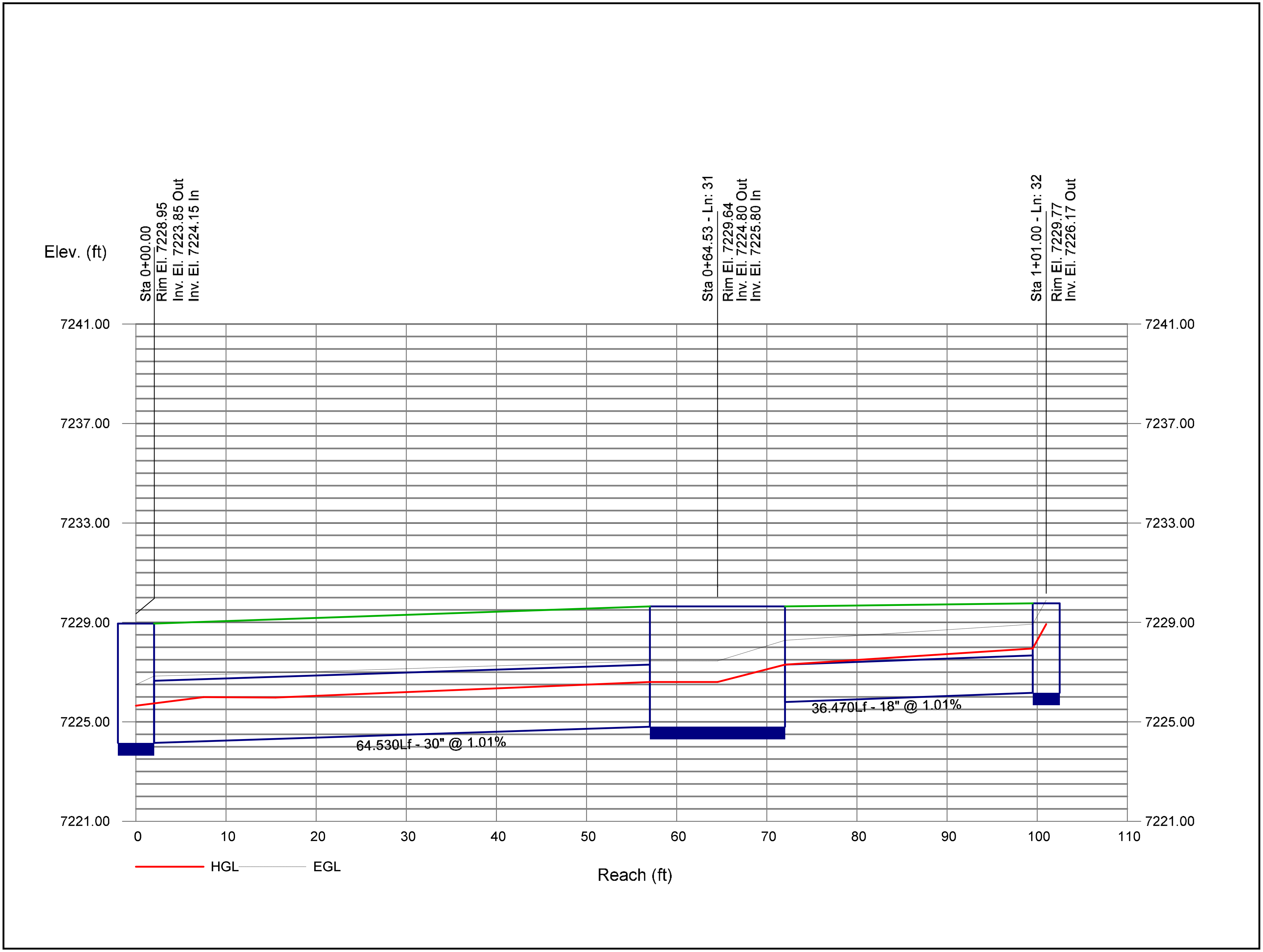
Proj. file: Storm Main System.stm



Storm Sewer Profile

STORM 7 PROFILE

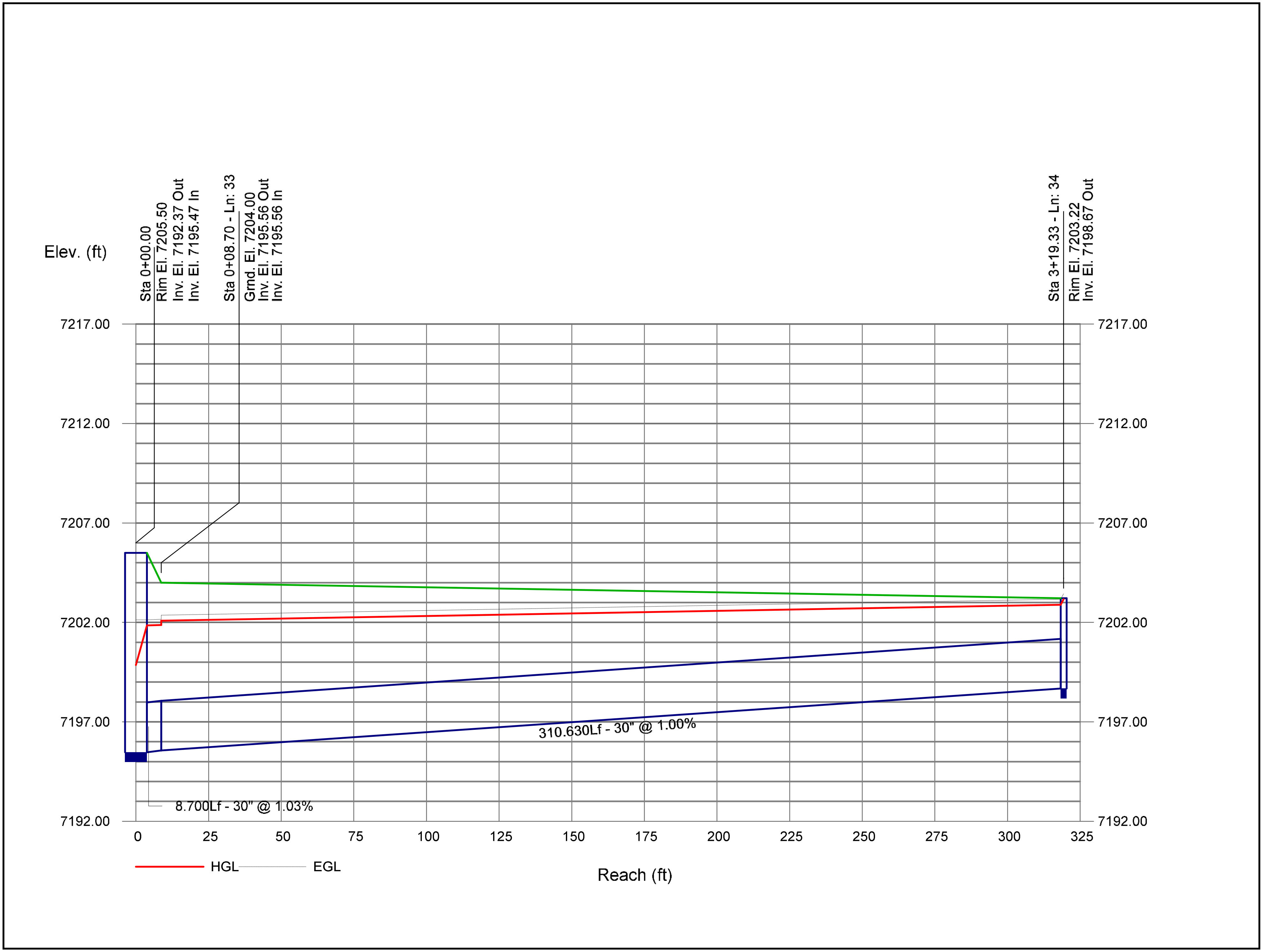
Proj. file: Storm Main System.stm



Storm Sewer Profile

STORM 9 PROFILE

Proj. file: Storm Main System.stm



STORM 8 PIPE RUN INDEX MAP

MyReport

Line No.	Line ID	Line Type	Junct Type	J-Loss Coeff	n-val Pipe	Flow Rate (cfs)	Invert Dn (ft)	Invert Up (ft)	Line Slope (%)	HGL Dn (ft)	HGL Up (ft)	Minor Loss (ft)	HGL Jnct (ft)	Vel Ave (ft/s)	Line Length (ft)	Rim-Hw (ft)
1	Storm 8	Cir	Generic	1.25 z	0.013	13.70	7248.00	7249.01	1.70	7249.23	7250.38	n/a	7250.38	8.46	59.460	2.27

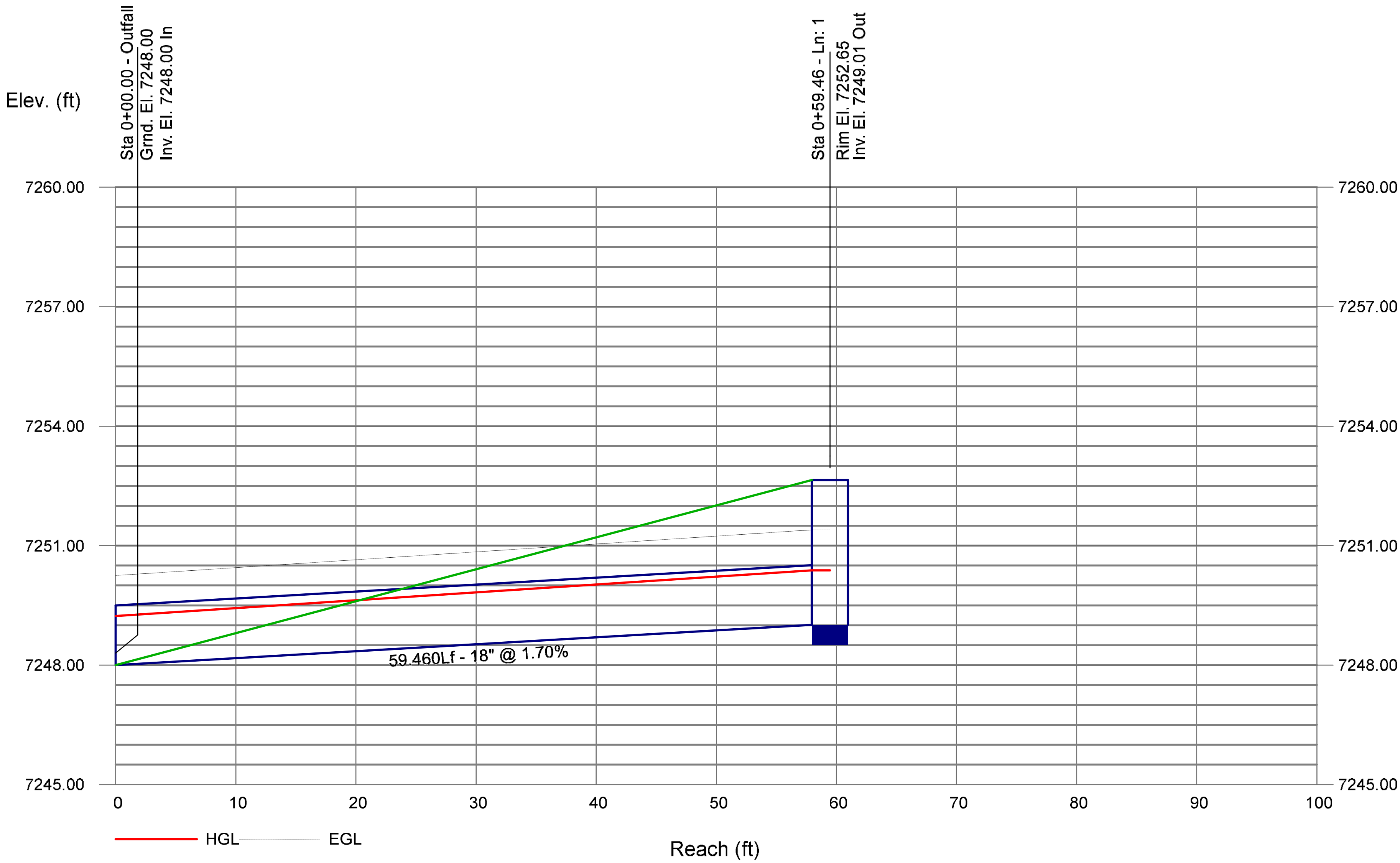
Paint Brush Hills Filing 14	Number of lines: 1	Date: 12/10/2020

NOTES: ** Critical depth

Storm Sewer Profile

STORM 8

Proj. file: Storm 8.stm



Storm Sewers

Weighted Percent Imperviousness of PBH Filing 14				
Contributing Basins	***Area (Acres)***	***C_5***	***Impervious % (I)***	***(Acres)*(I)***
*****OS1***	4.44	0.30	40	177.60
A	0.52	0.18	16	8.32
B	8.31	0.20	20	166.17
B1	0.92	0.16	13	12.00
C	11.50	0.26	32	368.00
D	5.20	0.20	20	104.00
E	0.49	0.90	100	49.00
F	1.61	0.30	40	64.40
G	12.20	0.35	48	585.60
H	10.78	0.35	48	517.44
I	12.74	0.35	48	611.52
J	7.19	0.22	25	179.75
K	0.75	0.36	50	37.50
L	3.37	0.36	50	168.50
M	2.53	0.27	34	86.02
N	6.08	0.20	20	121.62
Totals	***88.63***			***3257.44***
Imperviousness of PBH 14	***36.8***			

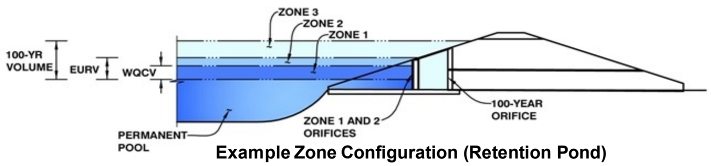
Weighted Percent Imperviousness of WQ Pond C				
Contributing Basins	***Area (Acres)***	***C_5***	***Impervious % (I)***	***(Acres)*(I)***
OS5A	3.66	0.11	5	18.30
OS5B	13.44	0.11	5	67.18
OS5C	29.00	0.30	40	1160.15
A	0.52	0.18	16	8.37
B	8.31	0.20	20	166.17
C	11.80	0.26	32	377.60
D	5.20	0.20	20	103.95
E	0.49	0.90	100	49.04
F	1.61	0.30	40	64.58
G	12.20	0.35	48	585.50
H	10.78	0.35	48	517.45
I	12.74	0.35	48	611.52
J	**7.19**	**0.22**	**25**	**179.81**
K	0.75	0.36	50	37.46
L	3.37	0.36	50	168.56
M	2.53	0.27	34	86.02
N	8.94	0.20	20	178.76
****TT***	5.05	0.35	25	126.25
Totals	***137.58***			***4506.69***
Imperviousness of WQ Pond C	***32.8***			

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.03 (May 2020)

Project: Paint Brush Hills Filing No.14

Basin ID: FSD Pond C



Example Zone Configuration (Retention Pond)

Depth Increement = | ft

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	137.58	acres
Watershed Length =	3,440	ft
Watershed Length to Centroid =	2,149	ft
Watershed Slope =	0.025	ft/ft
Watershed Imperviousness =	32.80%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	1.834	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	4.664	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	4.688	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	7.414	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	9.906	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	13.603	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	16.440	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	20.186	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	27.480	acre-feet		inches
Approximate 2-yr Detention Volume =	3.368	acre-feet		
Approximate 5-yr Detention Volume =	4.783	acre-feet		
Approximate 10-yr Detention Volume =	6.844	acre-feet		
Approximate 25-yr Detention Volume =	7.840	acre-feet		
Approximate 50-yr Detention Volume =	8.251	acre-feet		
Approximate 100-yr Detention Volume =	9.664	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	1.834	acre-feet
Zone 2 Volume (EURV - Zone 1) =	2.831	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	5.000	acre-feet
Total Detention Basin Volume =	9.664	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

	Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
7190.09	**Top of Micropool**	--	0.00	--	--	--	180	0.004		
7191		--	0.91	--	--	--	457	0.010	290	0.007
		--	1.91	--	--	--	14,185	0.326	7,611	0.175
		--	2.91	--	--	--	41,901	0.962	35,654	0.818
		--	3.91	--	--	--	61,466	1.411	87,337	2.005
		--	4.91	--	--	--	72,754	1.670	154,447	3.546
7196.00		--	5.91	--	--	--	81,398	1.869	231,523	5.315
7197.00		--	6.91	--	--	--	86,246	1.980	315,345	7.239
7198.00		--	7.91	--	--	--	92,877	2.132	404,906	9.295
7199.00		--	8.91	--	--	--	98,536	2.262	500,613	11.492
7200		--	9.91	--	--	--	105,513	2.422	602,637	13.835
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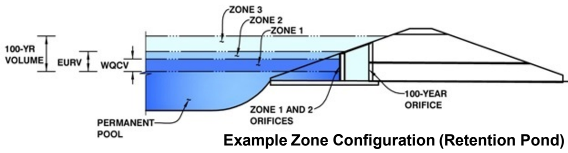
DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.03 (May 2020)

Project: **Paint Brush Hills Filing No.14**
Basin ID: **FSD Pond C**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	3.79	1.834	Orifice Plate
Zone 2 (EURV)	5.56	2.831	Orifice Plate
Zone 3 (100-year)	8.09	5.000	Weir&Pipe (Restrict)
Total (all zones)		9.664	

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

			Calculated Parameters for Underdrain		
Underdrain Orifice Invert Depth =		ft (distance below the filtration media surface)	Underdrain Orifice Area =		ft^2
Underdrain Orifice Diameter =		inches	Underdrain Orifice Centroid =		feet

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

			Calculated Parameters for Plate		
Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	4.597E-02	ft^2
Depth at top of Zone using Orifice Plate =	5.56	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	22.20	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	6.62	sq. inches (use rectangular openings)	Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.85	3.71					
Orifice Area (sq. inches)	6.62	6.62	6.62					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

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

	Zone 3 Weir	Not Selected		Calculated Parameters for Overflow Weir	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	5.57	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	5.57	N/A	feet
Overflow Weir Front Edge Length =	8.50	N/A	feet	Overflow Weir Slope Length =	2.90	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	1.37	N/A	
Horiz. Length of Weir Sides =	2.90	N/A	feet	Overflow Grate Open Area w/o Debris =	17.26	N/A	ft^2
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area	Overflow Grate Open Area w/ Debris =	8.63	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

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

	Zone 3 Restrictor	Not Selected		Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.25	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	12.57	N/A	ft^2
Outlet Pipe Diameter =	48.00	N/A	inches	Outlet Orifice Centroid =	2.00	N/A	feet
Restrictor Plate Height Above Pipe Invert =	48.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	3.14	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

			Calculated Parameters for Spillway		
Spillway Invert Stage=	8.97	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.87	feet
Spillway Crest Length =	96.00	feet	Stage at Top of Freeboard =	10.84	feet
Spillway End Slopes =	8.33	H:V	Basin Area at Top of Freeboard =	2.42	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	13.83	acre-ft

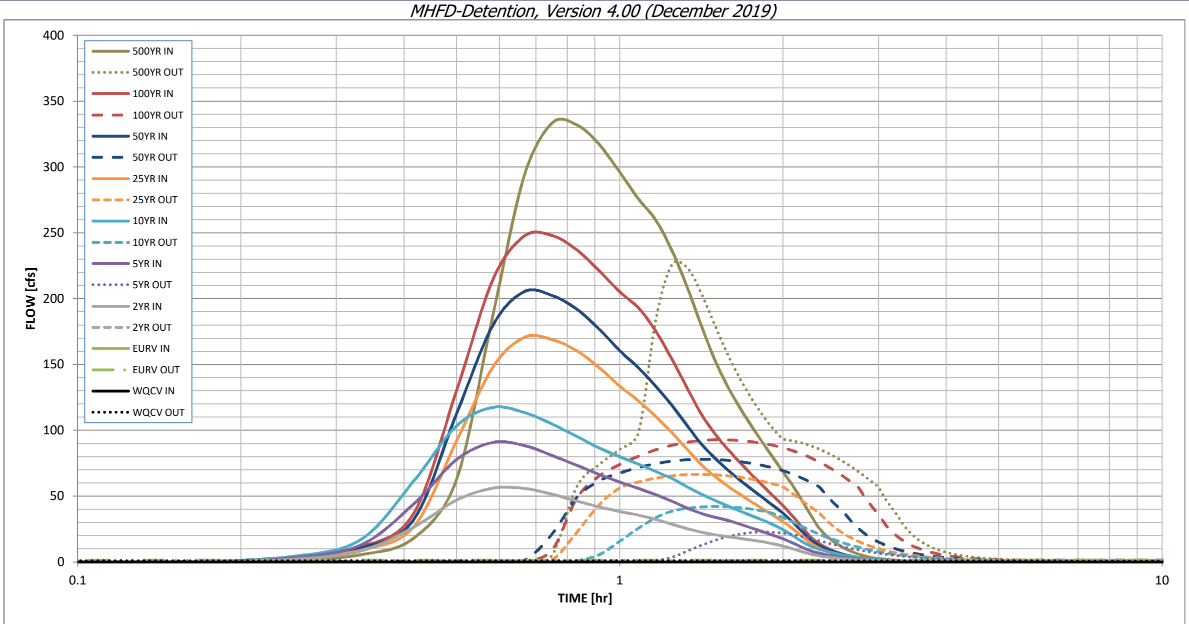
Routed Hydrograph Results

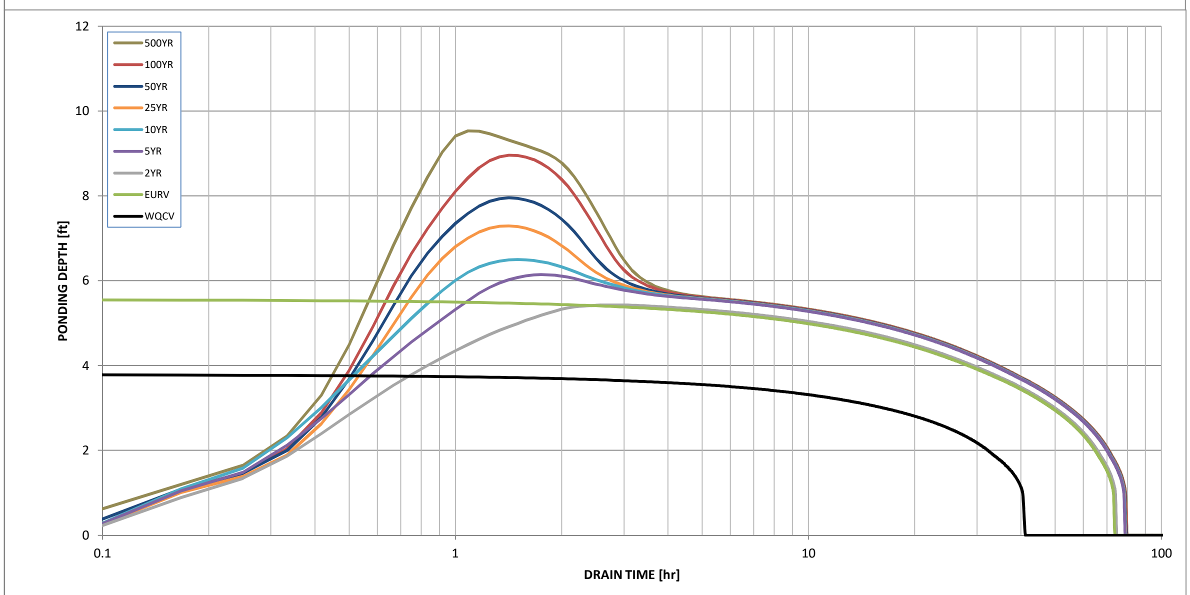
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

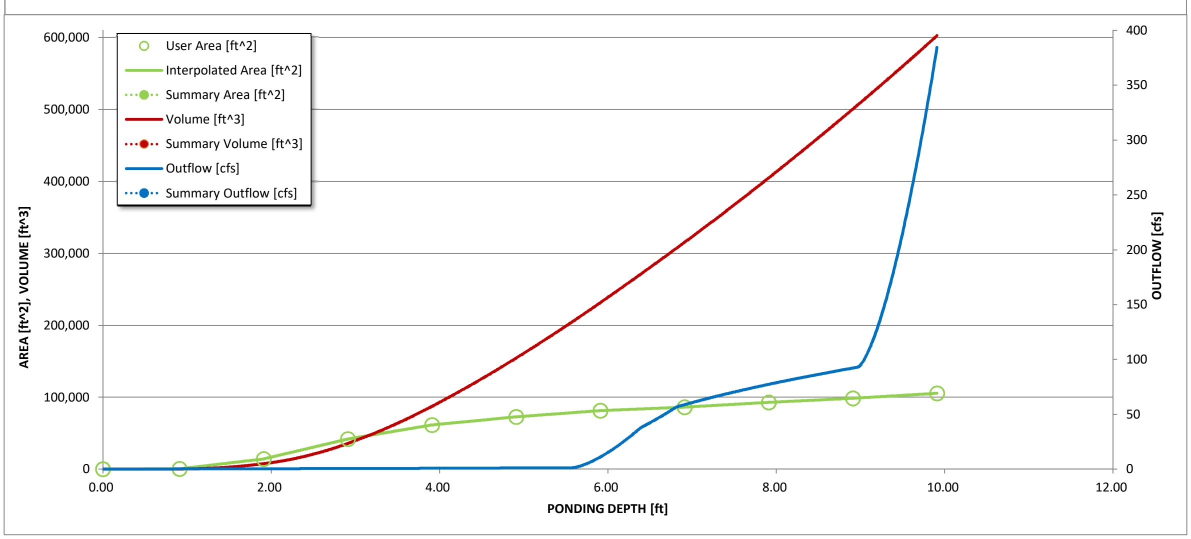
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	1.834	4.664	4.688	7.414	9.906	13.603	16.440	20.186	27.480
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	4.688	7.414	9.906	13.603	16.440	20.186	27.480
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	13.4	37.5	57.3	104.5	131.2	167.6	233.6
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.10	0.27	0.42	0.76	0.95	1.22	1.70
Peak Inflow Q (cfs) =	N/A	N/A	56.0	90.7	117.3	170.5	205.3	248.0	333.2
Peak Outflow Q (cfs) =	0.8	1.2	1.2	22.6	42.3	66.5	78.0	92.8	226.2
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.6	0.7	0.6	0.6	0.6	1.0
Structure Controlling Flow =	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	1.2	2.4	3.8	4.4	5.3	5.7
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	67	68	70	68	65	63	61	57
Time to Drain 99% of Inflow Volume (hours) =	**40**	71	72	75	74	73	72	71	69
Maximum Ponding Depth (ft) =	3.79	5.56	5.43	6.14	6.50	7.29	7.95	8.96	9.53
Area at Maximum Ponding Depth (acres) =	1.36	1.80	1.77	1.89	1.93	2.04	2.14	2.27	2.36
Maximum Volume Stored (acre-ft) =	1.839	4.673	4.423	5.747	6.417	8.002	9.380	11.583	12.925

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)







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

Stormwater Detention and Infiltration Design Data Sheet

Workbook Protected Worksheet Protected

Stormwater Facility Name: **Pond C**

Facility Location & Jurisdiction: **Paint Brush Hills Filing No. 14, Londonderry Drive, El Paso County / El Paso County**

User Input: Watershed Characteristics

Watershed Slope =	0.025	ft/ft
Watershed Length =	3440	ft
Watershed Area =	137.58	acres
Watershed Imperviousness =	32.8%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent

Location for 1-hr Rainfall Depths (use dropdown):

User Input

WQCV Treatment Method = Extended Detention

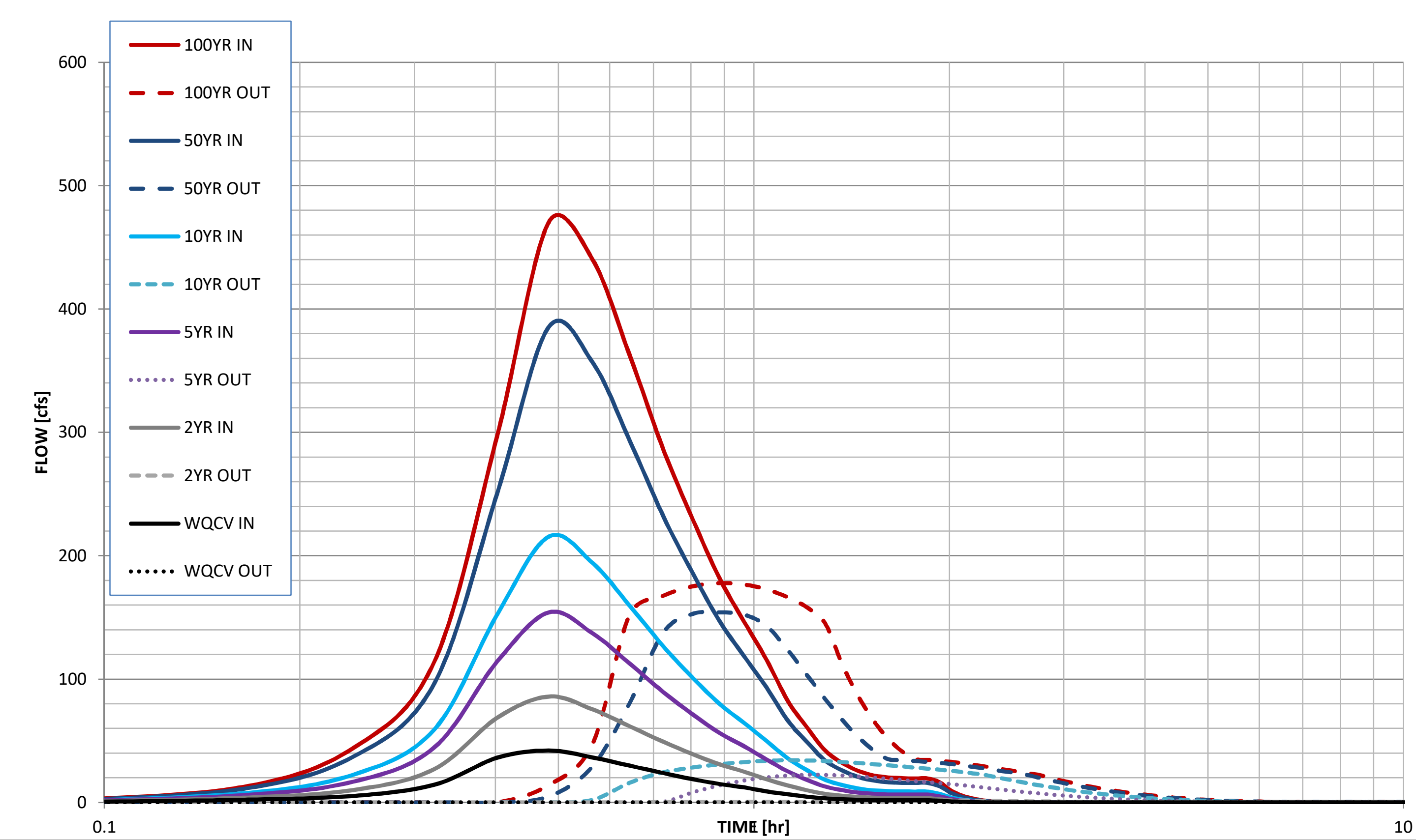
User Defined Stage [ft]	User Defined Area [ft^2]	User Defined Stage [ft]	User Defined Discharge [cfs]
0.00	180	0.00	0.00
0.91	457	0.91	0.00
2.00	14,185	2.00	0.00
3.00	41,901	3.00	0.01
4.00	61,466	4.00	0.05
5.00	72,754	5.00	0.50
6.00	81,398	6.00	22.50
7.00	86,246	7.00	35.30
8.00	92,877	8.00	150.00
9.00	98,536	9.00	180.00
10.00	105,513	10.00	307.00

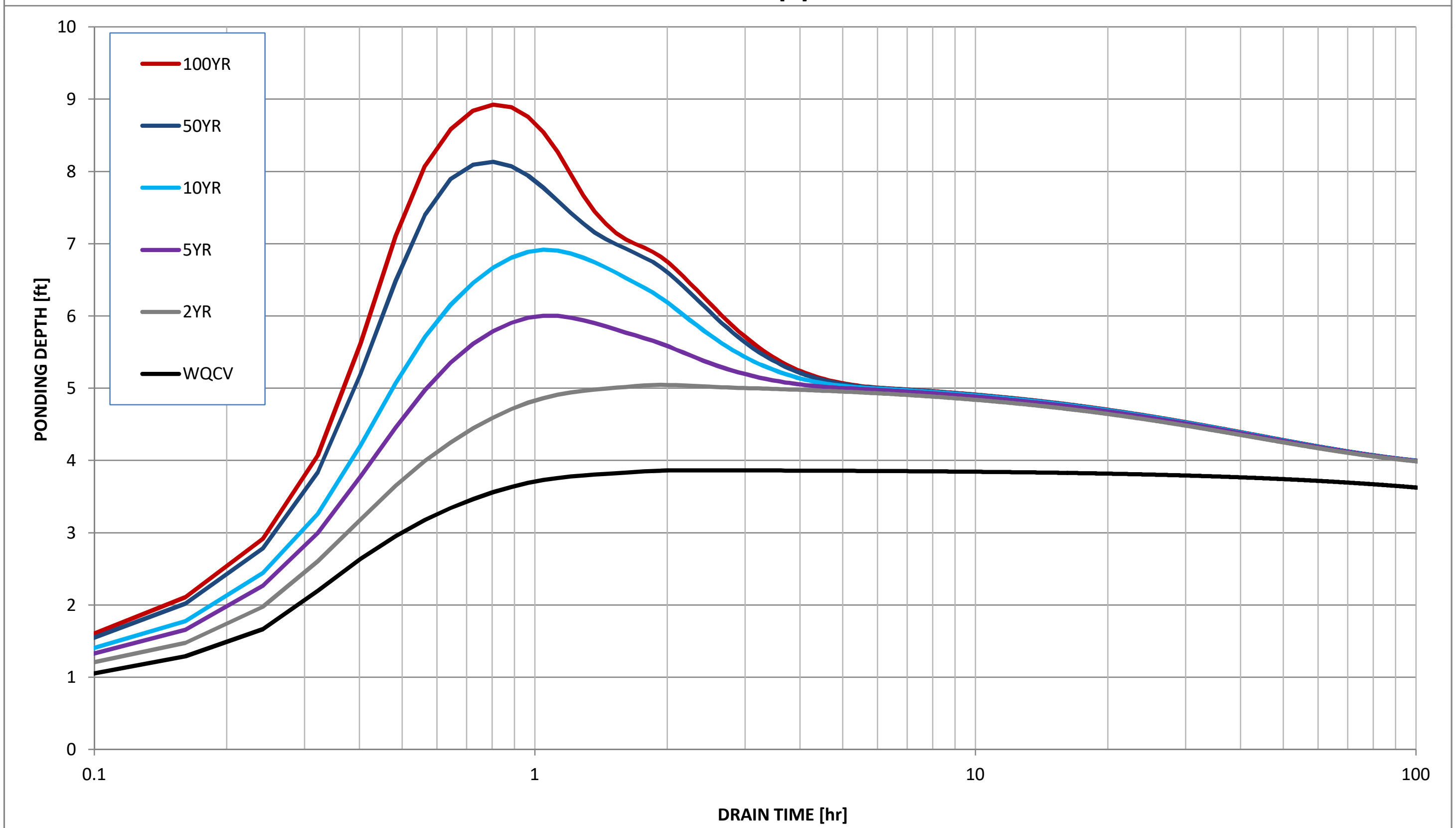
After completing and printing this worksheet to a pdf, go to:
https://maperture.digitaldataservices.com/gvh/?viewer=cswdif
create a new stormwater facility, and
attach the pdf of this worksheet to that record.

Routed Hydrograph Results

Design Storm Return Period =	WQCV	2 Year	5 Year	10 Year	50 Year	100 Year	
One-Hour Rainfall Depth =	0.53	1.19	1.50	1.75	2.25	2.52	in
Calculated Runoff Volume =	1.834	3.720	6.657	9.301	16.738	20.491	acre-ft
OPTIONAL Override Runoff Volume =							acre-ft
Inflow Hydrograph Volume =	1.833	3.719	6.650	9.300	16.729	20.487	acre-ft
Time to Drain 97% of Inflow Volume =	>116	>116	**>116**	>116	>116	>116	hours
Time to Drain 99% of Inflow Volume =	>116	>116	>116	>116	>116	**>116**	hours
Maximum Ponding Depth =	3.86	5.05	6.00	6.92	8.13	8.93	ft
Maximum Ponded Area =	1.35	1.68	1.87	1.97	2.15	**2.25**	acres
Maximum Volume Stored =	1.817	3.627	5.321	7.073	9.584	11.330	acre-ft

Stormwater Detention and Infiltration Design Data Sheet





Paint Brush Hills Filing No.14

EMERGENCY SPILLWAY CALCULATIONS FSD POND C

Horizontal Broad-Crested Weir (Eqn 12-20 UDFCD)						
Variable				***Solve For***		
C	**3.00**			L (ft)	H (ft)	Q (cfs)
L	**96.00**	ft		**0.0**	**0.0**	**288.0**
H	**1.00**	ft				
Q		cfs				

Total Q	**307.99**

Equation 12-20

$$Q = C_{BCW} L H^{1.5}$$

Sloping Broad-Crested Weir (Eqn 12-21 UDFCD)						
Variable				***Solve For***		
C	**3.00**			Z (ft)	H (ft)	Q (cfs)
Z	**8.33**	ft		**0.0**	**0.0**	**10.0**
H	**1.00**	ft				
Q		cfs				

Equation 12-21

$$Q = \left(\frac{2}{5}\right) C_{BCW} Z H^{2.5}$$

Where:

Q = discharge (cfs)

C_{BCW} = broad-crested weir coefficient (This ranges from 2.6 to 3.0. A value of 3.0 is often used in practice.) See Hydraulic Engineering Circular No. 22 for additional information.

L = broad-crested weir length (ft)

H = head above weir crest (ft)

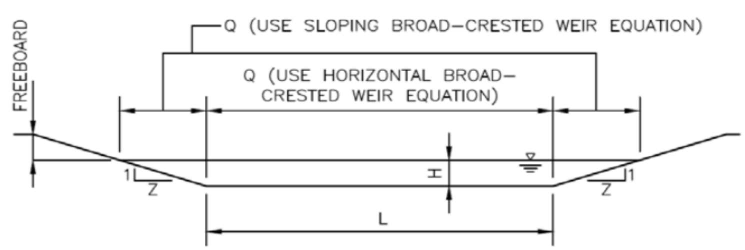
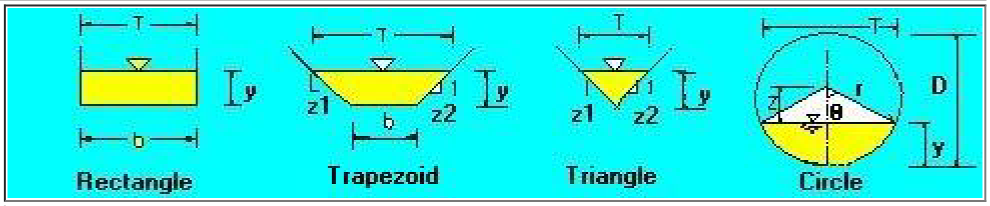


Figure 12-20. Sloping broad-crest weir

The open channel flow calculator



Select Channel Type: Trapezoid		
Velocity(V)&Discharge(Q)	Select unit system: Feet(ft)	
Channel slope: 0.33 ft/ft	Water depth(y): 0.241 ft	Bottom width(b) 96 ft
Flow velocity 13.0435 ft/s	LeftSlope (Z1): 8.33 to 1 (H:V)	RightSlope (Z2): 8.33 to 1 (H:V)
Flow discharge 308.0843 ft^3/s	Input n value 0.025 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 100.04 ft	Flow area 23.62 ft^2	Top width(T) 100.02 ft
Specific energy 2.88 ft	Froude number 4.73	Flow status Supercritical flow
Critical depth 0.67 ft	Critical slope 0.0105 ft/ft	Velocity head 2.64 ft

POND C SPILLWAY RUNDOWN

MS CIVIL CONSULTANTS, INC.
20 BOULDER CRESCENT, STE 110
COLORADO SPRINGS, CO 80903
(719) 955-5485

PROJECT: PAINT BRUSH HILLS FILING 14

DATE:

POND C SURCHARGE VOL.

ACRES 137.58 AC. WATERSHED IMPERVIOUS = 32.80%
TRIBUTARY IMPERVIOUS AREA 137.58 AC × 32.80% = 45.12 ≅ 45 AC.
FROM FIG 1 MICROPOOL SURFACE AREA = 180 SF DESIGN = 180 SF ACTUAL

MINIMUM FOREBAY VOLUME

3% OF WQCV 3% × 1.839 AC-FT × $\frac{43560 \text{ cu-ft}}{1 \text{ AC-FT}}$ = 2403 cu-FT

2403 cu ft ÷ 1.5 ft = 1602 sq ft DESIGN ≤ 1623 SQ FT ACTUAL

FOREBAY RELEASE & CONFIGURATION

PEAK 100 YEAR DISCHARGE Q_{100} = 92.8 cfs × 2% RELEASE = 1.86 cfs
WEIR EQN $Q = CLH^{3/2}$ FOREBAY 1.5 ft DEEP
$Q = 3.0\,(0.33')(1.5)^{3/2}$ = 1.82 cfs ACTUAL ≅ 1.86 cfs DESIGN

TRICKLE CHANNEL CAPACITY

TRICKLE CHANNEL 2'W × 6"H $Q = 3.0\,(2')\,(0.5')^{3/2}$ = 2.12 cfs

2.12 cfs ACTUAL > 1.82 cfs ACTUAL
SEE OPEN CHANNEL FLOW CALCULATOR FOR
TRICKLE CHANNEL WITH SLOPE 0.5%

POND C SPILLWAY

FIG 13-12d RIPRAP TYPES FOR SPILLWAY PROTECTION (DCM, V1)
UNIT DISCHARGE 306.7 cfs / 96 ft = 3.2 3:1 LONGITUDINAL SLOPE

FROM FIG 13-12d TYPE M RIPRAP D_{50} = 12"

$2D_{50}$ = 2 × 12" = 24" DEEP

Figure 13-12c. Emergency Spillway Protection

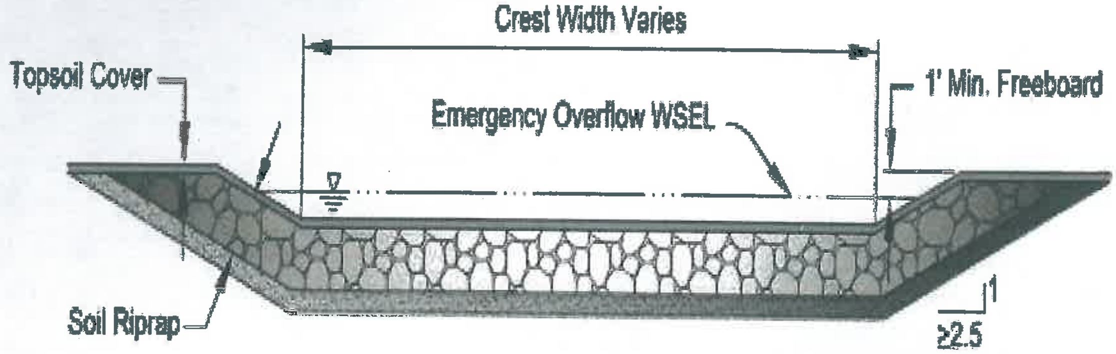
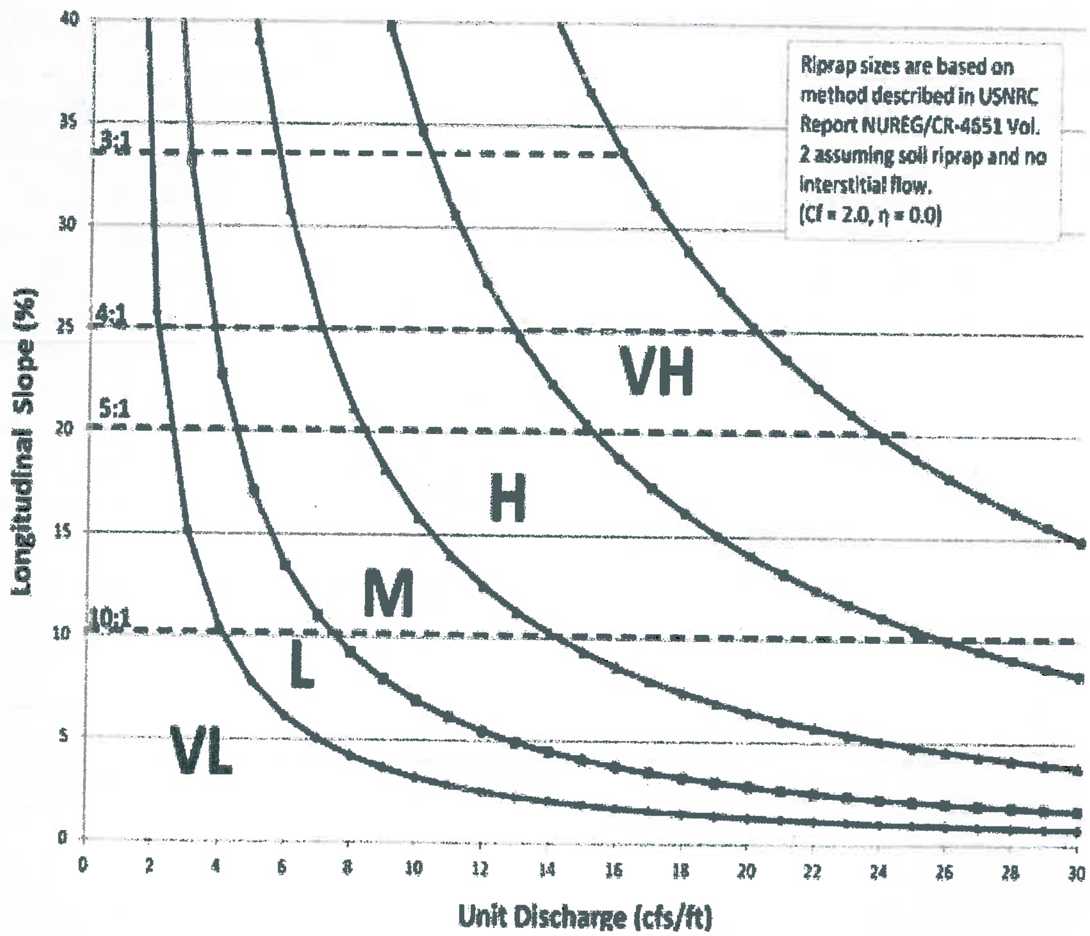


Figure 13-12d. Riprap Types for Emergency Spillway Protection



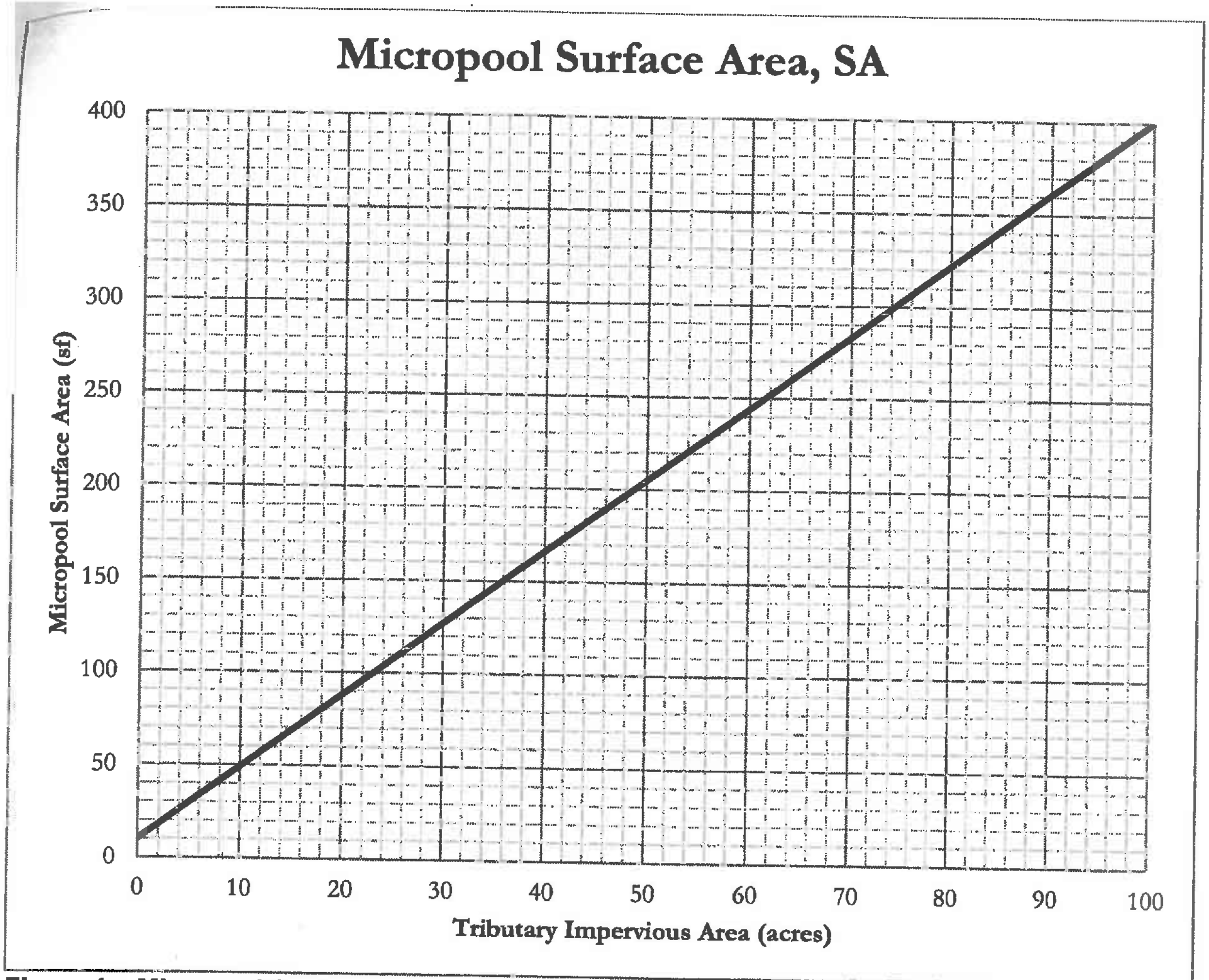


Figure 1 – Micropool Surface Area (SA) Determination Chart

The tributary impervious area is the effective number of impervious acres that will be treated by the extended detention basin (EDB). It is calculated by multiplying the tributary area to be treated by the impervious fraction of that area.

$$TIA = I \times A$$

TIA = Tributary impervious area (acres)
I = Imperviousness (fraction)
A = Tributary catchment area upstream (acres)

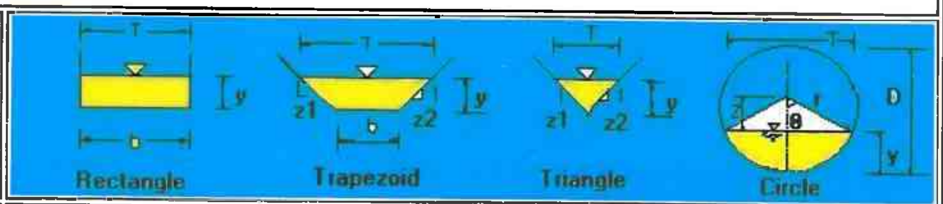
For EDBs with tributary impervious areas greater than 100 acres, the micropool surface area is 400 sf. The initial surcharge depth (ISD) is defined as the depth of the initial surcharge volume (ISV). The surface area determined using Figure 1 assumes an ISD of 4 inches. The initial surcharge volume is thus calculated by multiplying the micropool surface area by 4 inches.

$$ISV = SA \times 4\ inches$$

ISV = Initial surcharge volume (cf)
SA = Surface area (from Figure 1, sf)

The open channel flow calculator

Select Channel Type: Rectangle



Velocity(V)&Discharge(Q) | Select unit system: Feet(ft)

Channel slope: 0.005 ft/ft	Water depth(y): 0.5 ft	Bottom W(b) 2 ft
Flow velocity 3.8858 ft/s	LeftSlope (Z1): 0 to 1 (H:V)	RightSlope (Z2): 0 to 1 (H:V
Flow discharge 3.8858 ft^3/s	Input n value 0.013 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 3 ft	Flow area 1 ft^2	Top width(T) 2 ft
Specific energy 0.73 ft	Froude number 0.97	Flow status Subcritical flow
Critical depth 0.49 ft	Critical slope 0.0053 ft/ft	Velocity head 0.23 ft

LOW FLOW TRICKLE CHANNEL

MS CIVIL CONSULTANTS, INC.
20 BOULDER CRESCENT, STE 110
COLORADO SPRINGS, CO 80903
(719) 955-5485

PROJECT: PAINT BRUSH HILLS FILING #4

DATE:

LOW TAILWATER RIP RAP BASIN PR 1

Q_{100} = 13.7 cfs 18" RCP

FIG. 9-37 LOW TAILWATER RIPRAP BASIN (UDFCD)
FOR 18" STORM PIPE RIPRAP BASIN 15' L x 10' W DESIGN
15' L x 30' W ACTUAL

FIG 9-38 RIPRAP EROSION PROTECTION (UDFCD)

Y_t/D ASSUMED 0.4

$Q/D^{1.5} = 13.7/1.5^{1.5} = 7.46$

FROM FIG 9-38 TYPE L RIPRAP D_{50} = 9"

$2D_{50} = 2 \times 9" =$ 18" THICK

LOW TAILWATER RIP RAP BASIN PR #27

Q_{100} = 92.8 cfs 48" RCP

FIG 9-37 LOW TAILWATER RIPRAP BASIN (UDFCD)
FOR 48" STORM PIPE 24' L x 19' W DESIGN
24' L x 19' W ACTUAL

FIG 9-38 RIPRAP EROSION PROTECTION (UDFCD)

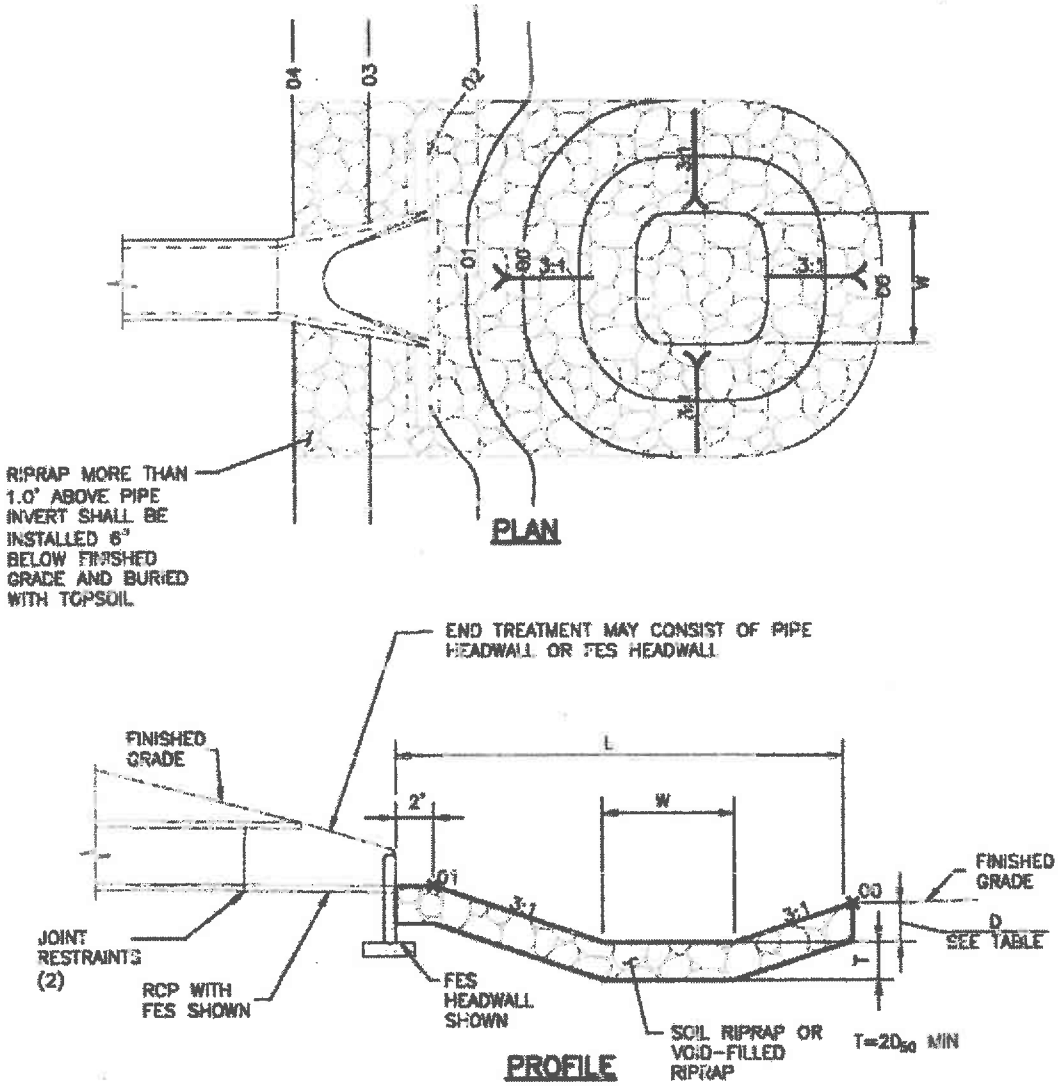
Y_t/D ASSUMED 0.4

$Q/D^{1.5}$ = 92.8 cfs $/4^{1.5}$ = 11.6

FROM FIG 9-38 TYPE M D_{50} = 12"

$2D_{50} = 2 \times 12" =$ 24" THICK

PER "PAINT BRUSH HILLS FILING 12" CONSTRUCTION PLANS
EXISTING RIP RAP FOR OUTFALL 20' x 20' x 3' THICK (D_{50}=18")
EXISTING RIP RAP PAD IS IN CONFORMANCE.



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

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

Figure 9-37. Low tailwater riprap basin

$$H_a = \frac{(H + Y_n)}{2}$$ Equation 9-19

Where the maximum value of H_a shall not exceed H, and:

D_a = parameter to use in place of D in Figure 9-38 when flow is supercritical (ft)

D_c = diameter of circular culvert (ft)

H_a = parameter to use in place of H in Figure 9-39 when flow is supercritical (ft)

H = height of rectangular culvert (ft)

Y_n = normal depth of supercritical flow in the culvert (ft)

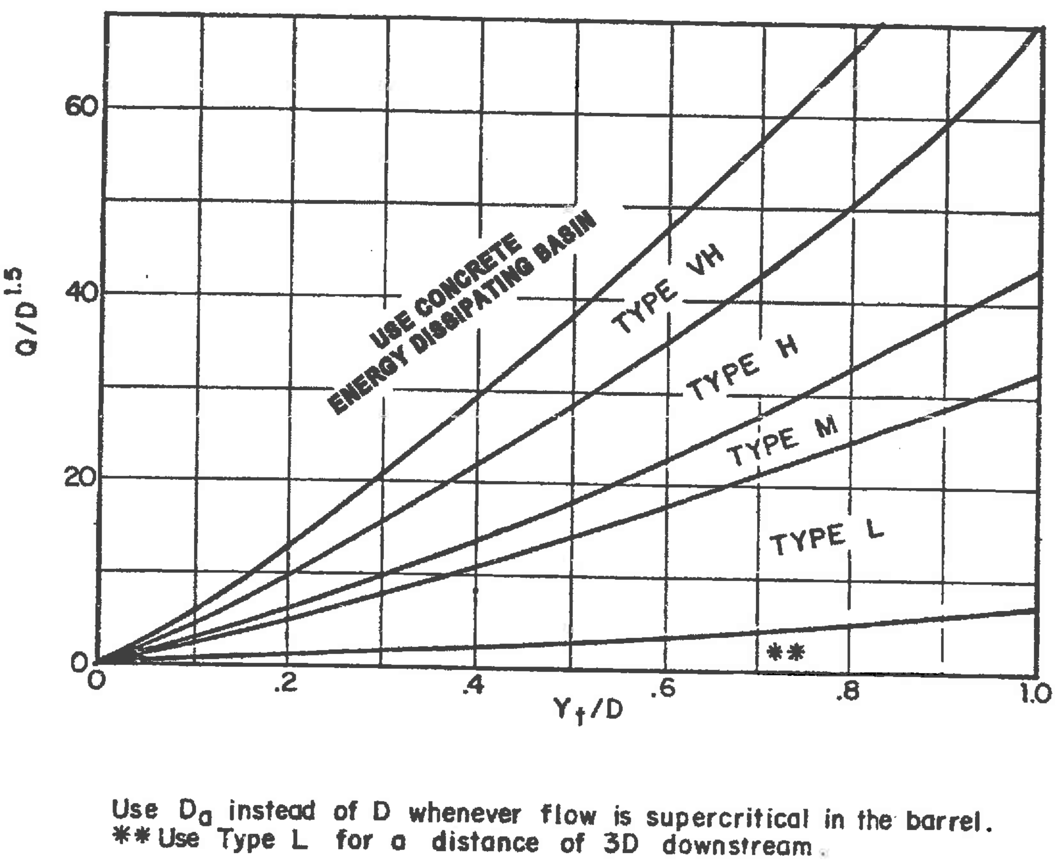
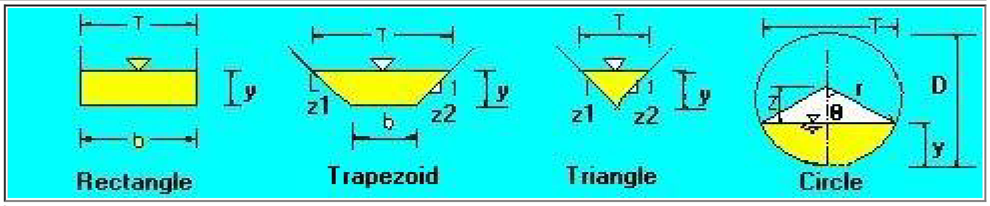


Figure 9-38. Riprap erosion protection at circular conduit outlet (valid for Q/D2.5 ≤ 6.0)

The open channel flow calculator

Select Channel Type: Trapezoid	
Velocity(V)&Discharge(Q)	Select unit system: Feet(ft)

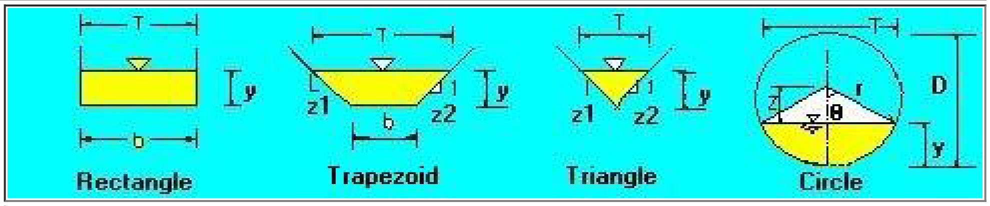
Channel slope: .0107 ft/ft	Water depth(y): .38 ft	Bottom width(b) 10 ft
Flow velocity 2.7996 ft/s	LeftSlope (Z1): 8 to 1 (H:V)	RightSlope (Z2): 8 to 1 (H:V)
Flow discharge 13.8728 ft^3/s	Input n value 0.025 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 16.13 ft	Flow area 4.96 ft^2	Top width(T) 16.08 ft
Specific energy 0.5 ft	Froude number 0.89	Flow status Subcritical flow
Critical depth 0.35 ft	Critical slope 0.0138 ft/ft	Velocity head 0.12 ft

DP1 EXISTING SWALE Q100= 13.7 CFS

SEE TABLE 10-4 FOR MAXIMUM PERMISSIBLE VELOTIES FOR EARTHEN CHANNELS WITH VARIED GRASS LININGS AND SLOPES

The open channel flow calculator

Select Channel Type: Trapezoid



Velocity(V)&Discharge(Q) | Select unit system: Feet(ft)

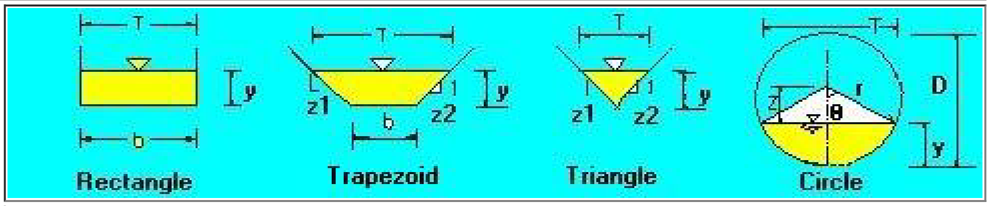
Channel slope: 0.048 ft/ft	Water depth(y): 0.83 ft	Bottom width(b) 5 ft
Flow velocity 9.3313 ft/s	LeftSlope (Z1): 3 to 1 (H:V)	RightSlope (Z2): 3 to 1 (H:V)
Flow discharge 58.0097 ft^3/s	Input n value 0.025 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 10.25 ft	Flow area 6.22 ft^2	Top width(T) 9.98 ft
Specific energy 2.18 ft	Froude number 2.08	Flow status Supercritical flow
Critical depth 1.25 ft	Critical slope 0.0099 ft/ft	Velocity head 1.35 ft

DP3 PROPOSED SWALE Q100=58.1 CFS

SEE SC250 TURF REINFORCEMENT MAT

The open channel flow calculator

Select Channel Type: Trapezoid



Velocity(V)&Discharge(Q)

Select unit system: Feet(ft)

Channel slope: 0.0145 ft/ft	Water depth(y): 0.91 ft	Bottom width(b) 2 ft
Flow velocity 4.8339 ft/s	LeftSlope (Z1): 3 to 1 (H:V)	RightSlope (Z2): 3 to 1 (H:V)
Flow discharge 20.8065 ft^3/s	Input n value 0.025 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 7.76 ft	Flow area 4.3 ft^2	Top width(T) 7.46 ft
Specific energy 1.27 ft	Froude number 1.12	Flow status Supercritical flow
Critical depth 0.97 ft	Critical slope 0.0112 ft/ft	Velocity head 0.36 ft

DP16 PROPOSED SWALE Q100= 20.8 CFS

SEE TABLE 10-4 FOR MAXIMUM PERMISSIBLE VELOTIES FOR EARTHEN CHANNELS WITH VARIED GRASS LININGS AND SLOPES

TABLE 10-4
MAXIMUM PERMISSIBLE VELOCITIES FOR EARTH CHANNELS WITH VARIED GRASS LININGS AND SLOPES

EXPAND

Channel Slope	Lining	Permissible Mean Channel Velocity* (ft/sec)
0 - 5% **DP1, DP16**	Sodded grass	7
DP1, DP16	Bermudagrass	6
DP1, DP16	Reed canarygrass	5
DP1, DP16	Tall fescue	5
DP1, DP16	Kentucky bluegrass	5
DP1	Grass-legume mixture	4
	Red fescue	2.5
	Redtop	2.5
	Sericea lespedeza	2.5
	Annual lespedeza	2.5
	Small grains (temporary)	2.5
5 - 10% **DP3**	Sodded grass	6
DP3	Bermudagrass	5
DP3	Reed canarygrass	4
DP3	Tall fescue	4

Channel Slope	Lining	Permissible Mean Channel Velocity* (ft/sec)
DP3	Kentucky bluegrass	4
DP3	Grass-legume mixture	3
Greater than 10%	Sodded grass	5
	Bermudagrass	4
	Reed canarygrass	3
	Tall fescue	3
	Kentucky bluegrass	3
*For highly erodible soils, decrease permissible velocities by 25%.		
*Grass lined channels are dependent upon assurances of continuous growth and maintenance of grass.		

North American Green
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Evansville, IN 47725
800-772-2040
FAX: 812-867-0247
www.nagreen.com

NORTH AMERICAN GREEN®
A tensar Company

Material and Performance Specification Sheet

SC250 Turf Reinforcement Mat

The composite turf reinforcement mat (C-TRM) shall be a machine-produced mat of 70% straw and 30% coconut fiber matrix incorporated into a permanent three-dimensional turf reinforcement matting. The matrix shall be evenly distributed across the entire width of the matting and stitch bonded between a heavy duty UV stabilized netting with 0.50 x 0.50 inch (1.27 x 1.27 cm) openings, an ultra heavy UV stabilized, dramatically corrugated (crimped) intermediate netting with 0.5 x 0.5 inch (1.27 x 1.27 cm) openings, and covered by an heavy duty UV stabilized nettings with 0.50 x 0.50 inch (1.27 x 1.27 cm) openings. The middle corrugated netting shall form prominent closely spaced ridges across the entire width of the mat. The three nettings shall be stitched together on 1.50 inch (3.81cm) centers with UV stabilized polypropylene thread to form a permanent three-dimensional turf reinforcement matting.

The SC250 shall meet requirements established by the Erosion Control Technology Council (ECTC) Specification and the US Department of Transportation, Federal Highway Administration's (FHWA) *Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects, FP-03 Section 713.18 as a type 5A, B, and C Permanent Turf Reinforcement Mat.*

Installation staple patterns shall be clearly marked on the turf reinforcement matting with environmentally safe paint. All mats shall be manufactured with a colored thread stitched along both outer edges (approximately 2-5 inches [5-12.5 cm] from the edge) as an overlap guide for adjacent mats.

Material Content		
Matrix	70% Straw / 30% Coconut fibers	0.35 lbs/yd² (0.19 kg/m²) / 0.15 lbs/yd² (0.08 kg/m²)
Nettings	Top and Bottom, UV stabilized Polypropylene	5 lb/1000 ft² (2.44 kg/100 m²)
	Middle, corrugated UV stabilized Polypropylene	24 lb/1000 ft² (11.7 kg/100 m²)
Thread	Polypropylene, UV stabilized	

SC250 is available in the following roll sizes:

Width	6.5 ft (2.0 m)
Length	55.5 ft (16.9 m)
Weight ± 10%	34 lbs (15.42 kg)
Area	40.0 yd² (33.4 m²)

Index Value Properties:

Property	Test Method	Typical	Net Only
Thickness	ASTM D6525	0.72 in (18.3 mm)	0.48 in
Resiliency	ASTM 6524	95.2%	---
Density	ASTM D792	0.53 oz/in³	---
Mass/Unit Area	ASTM 6566	17.88 oz/yd² (606 g/m²)	---
Porosity	ECTC Guidelines	99%	---
Stiffness	ASTM D1388	222.65 oz-in	---
Light Penetration	ECTC Guidelines	8.9%	---
UV Stability	ASTM D4355/ 1000 hr	100%	100%
Tensile Strength MD	ASTM D6818	620 lbs/ft (9.05 kN/m)	655 lbs/ft
Elongation MD	ASTM D6818	35%	25%
Tensile Strength TD	ASTM D6818	737 lbs/ft (10.75 kN/m)	666 lbs/ft
Elongation TD	ASTM D6818	16%	16%

Bench Scale Testing* (NTPEP):

Test Method	Parameters	Results
ECTC Method 2 Rainfall	50 mm (2 in)/hr for 30 min	SLR** = 18.25
	100mm (4 in)/hr for 30 min	SLR** = 20.97
	150 mm (6 in)/hr for 30 min	SLR** = 22.74
ECTC Method 3 Shear Resistance	**Shear at 0.50 inch soil loss**	**7.7 lbs/ft²**
ECTC Method 4 Germination	Top Soil, Fescue, 21 day incubation	523% improvement of biomass

* Bench Scale tests should not be used for design purposes

** Soil Loss Ratio = Soil loss with Bare Soil/Soil Loss with RECP (soil loss is based on regression analysis)

Performance Design Values:

Maximum Permissible Shear Stress		
	Short Duration	Long Duration
Phase 1 Unvegetated	3.0 lbs/ft² (144 Pa)	2.5 lbs/ft² (120 Pa)
Phase 2 Partially Veg.	8.0 lbs/ft² (383 Pa)	8.0 lbs/ft² (383 Pa)
Phase 3 Fully Veg.	10.0 lbs/ft² (480 Pa)	8.0 lbs/ft² (383 Pa)
Velocity Unveg	9.5 ft/s (2.9 m/s)	
Velocity Veg.	15 ft/s (4.6 m/s)	

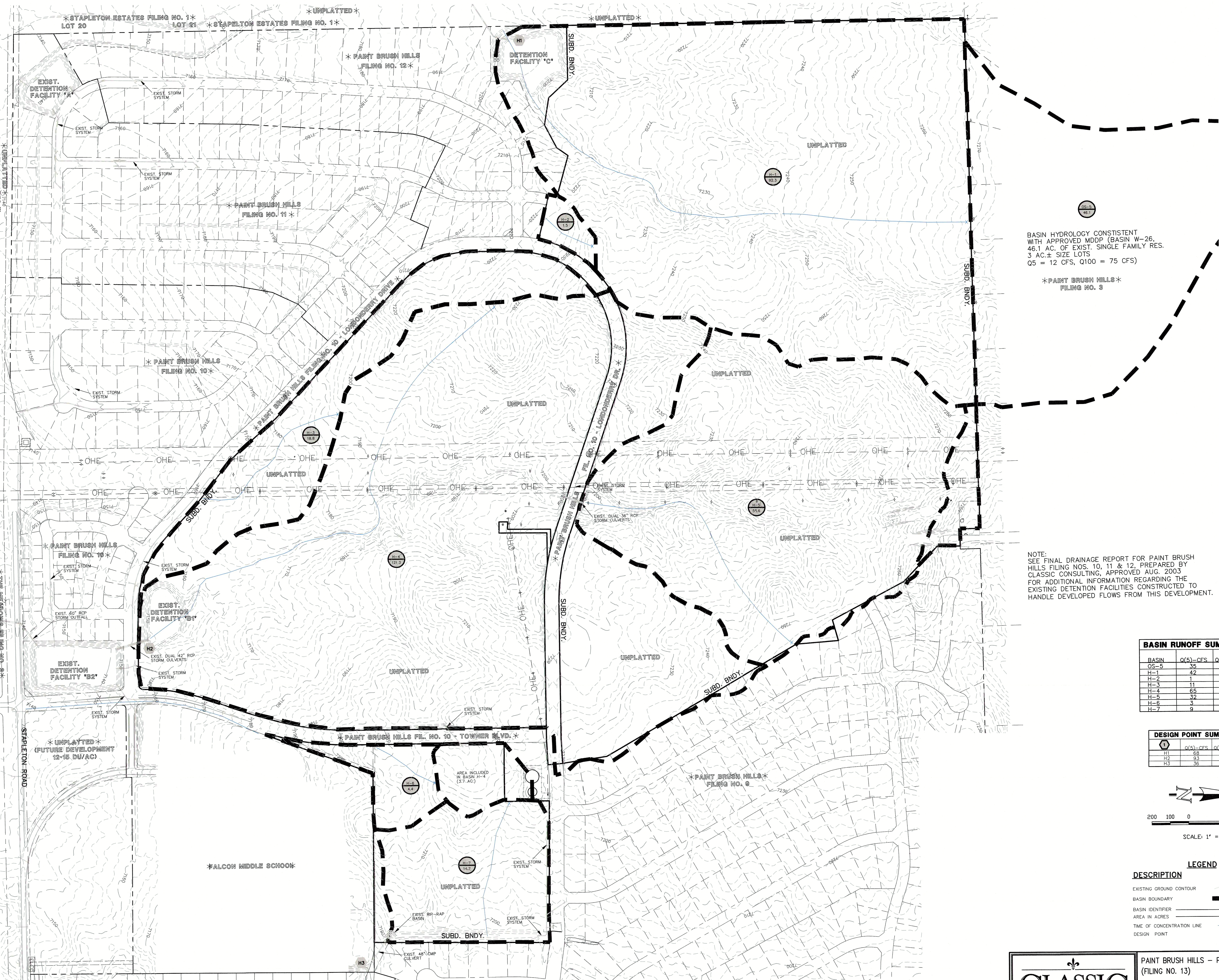
Slope Design Data: C Factors			
	Slope Gradients (S)		
Slope Length (L)	≤ 3:1	3:1 – 2:1	≥ 2:1
≤ 20 ft (6 m)	0.0010	0.0209	0.0507
20-50 ft	0.0081	0.0266	0.0574
≥ 50 ft (15.2 m)	0.0455	0.0555	0.081

Roughness Coefficients- Unveg.	
Flow Depth	Manning's n
≤ 0.50 ft (0.15 m)	0.040
0.50 – 2.0 ft	0.040 – 0.012
≥ 2.0 ft (0.60 m)	0.011

Product Participant of: QDOR

Updated 3/09

PROPOSED AND EXISTING DRAINAGE MAP
& REFERENCE MAPS



NOTE:
SEE FINAL DRAINAGE REPORT FOR PAINT BRUSH HILLS FILING NOS. 10, 11 & 12, PREPARED BY CLASSIC CONSULTING, APPROVED AUG. 2003 FOR ADDITIONAL INFORMATION REGARDING THE EXISTING DETENTION FACILITIES CONSTRUCTED TO HANDLE DEVELOPED FLOWS FROM THIS DEVELOPMENT.

BASIN RUNOFF SUMMARY:

BASIN	Q(5)-CFS	Q(100)-CFS
OS-5	35	79
H-1	42	108
H-2	1	3
H-3	11	27
H-4	65	158
H-5	32	80
H-6	3	8
H-7	9	23

DESIGN POINT SUMMARY

1	Q(5)-CFS	Q(100)-CFS
H1	68	169
H2	93	227
H3	36	73

N

200 100 0 200 400

SCALE: 1" = 200'

LEGEND

DESCRIPTION	SYMBOL
EXISTING GROUND CONTOUR	6910
BASIN BOUNDARY	
BASIN IDENTIFIER / AREA IN ACRES	BB 10.0
TIME OF CONCENTRATION LINE	
DESIGN POINT	1

CLASSIC CONSULTING ENGINEERS & SURVEYORS

6385 Corporate Drive, Suite 101 Colorado Springs, Colorado 80919 (719)785-0790 (719)785-0799 (Fax)

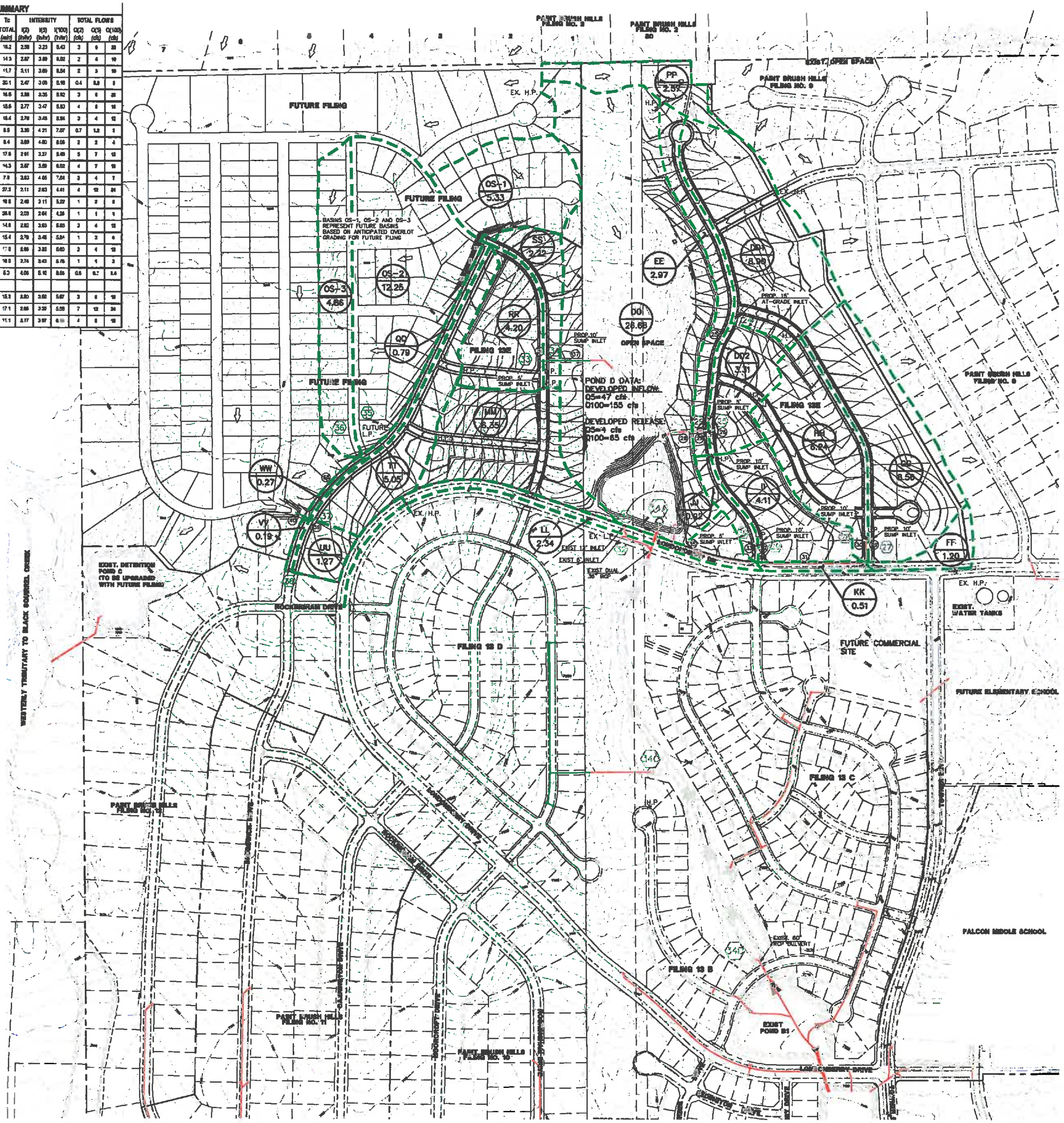
PAINT BRUSH HILLS – PHASE 2 (FILING NO. 13)
FINAL DRAINAGE REPORT
HISTORIC CONDITIONS DRAINAGE MAP

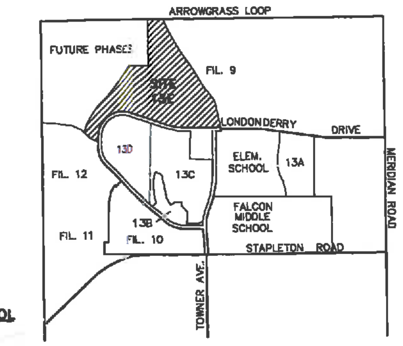
DESIGNED BY	MAW	SCALE		DATE	8/20/12
DRAWN BY	MAW	(H) 1"= 200'		SHEET 1	OF 2
CHECKED BY		(V) 1"= N/A		JOB NO.	2053.21

X:\205321\DRAINAGE\205321FDM-HISTORIC.dwg, 8/27/2012 7:53:29 AM, DWG To PDF.pc3

FINAL DRAINAGE REPORT ~ BASIN RUNOFF SUMMARY

BASIN	WEIGHTED CA(2)	CA(5)	CA(100)	OVERLAND C(5)	Length (ft)	Height (ft)	Tc (min)	STREET / CHANNEL FLOW Length (ft)	Slope (%)	Velocity (fps)	Tc (min)	Tc TOTAL (min)	INTENSITY I(2) (in/hr)	I(5) (in/hr)	I(100) (in/hr)	TOTAL FLOWS Q(2) (cfs)	Q(5) (cfs)	Q(100) (cfs)
DD1	1.34	1.98	4.09	0.22	180	4	16.4	400	3.0%	6.1	1.9	18.2	2.58	3.23	5.43	3	6	22
DD2	0.78	0.99	1.86	0.30	130	2.6	13.1	450	3.0%	6.1	1.2	14.3	2.87	3.60	6.02	2	4	10
EE	0.68	0.89	1.49	0.30	50	1	8.1	1300	3.0%	6.1	3.6	11.7	3.11	3.89	6.54	2	3	10
FF	0.18	0.26	0.55	0.22	280	6	18.6	300	1.3%	4.0	1.3	20.1	2.47	3.08	5.18	0.4	0.8	3
GG	1.28	1.88	3.94	0.22	180	6	14.3	900	3.0%	6.1	2.5	16.8	2.68	3.35	5.62	3	6	22
HH	1.44	1.87	3.12	0.30	120	2.4	12.8	750	1.5%	4.3	2.9	15.6	2.77	3.47	5.83	4	6	18
II	0.99	1.23	2.05	0.30	150	3	14.1	350	1.5%	4.3	1.4	15.4	2.78	3.48	5.84	3	4	12
JJ	0.21	0.28	0.48	0.30	50	1	8.1	360	1.5%	4.3	1.4	9.5	3.36	4.21	7.07	0.7	1.2	3
KK	0.45	0.48	0.49	0.08	20	1	4.8	400	1.5%	4.3	1.8	8.4	3.69	4.60	8.06	2	2	4
LL	2.09	2.11	2.25	0.08	150	4	16.3	350	1.3%	4.0	1.6	17.8	2.61	3.27	5.49	5	7	12
MM	1.45	1.91	3.18	0.30	130	2.6	13.1	520	4.0%	7.0	1.2	14.3	2.87	3.59	6.02	4	7	19
NN	0.81	0.92	0.98	0.08	20	1	4.8	650	1.3%	4.0	2.7	7.8	3.83	4.66	7.84	3	4	7
OO	1.86	4.48	11.50	0.10	300	10	19.8	2200	2.0%	4.9	7.4	27.2	2.11	2.63	4.41	4	12	51
PP	0.43	0.63	1.20	0.10	300	10	19.8					19.8	2.49	3.11	5.22	1	2	6
QQ	0.55	0.58	0.96	0.30	300	10	21.4	2200	2.0%	4.9	7.4	28.8	2.03	2.64	4.28	1	1	3
RR	0.97	1.28	2.10	0.30	[illegible]	3	14.1	250	2.0%	4.9	0.8	14.9	2.82	3.53	5.93	3	4	12
SS	0.51	0.67	1.11	0.30	150	3	14.1	400	2.0%	4.9	1.3	15.4	2.78	3.48	5.84	1	2	6
TT	0.76	1.11	2.32	0.22	150	3	15.8	450	2.0%	4.9	1.8	17.0	2.66	3.33	5.60	2	4	13
UU	0.19	0.28	0.58	0.22	150	3	15.5	150	2.0%	4.9	0.5	16.0	2.74	3.43	5.76	1	1	3
VV	0.14	0.14	0.18	0.22	20	0.5	8.3					5.0	4.08	5.10	8.65	0.6	0.7	1.6
OS-1	1.23	1.60	2.67	0.40	180	3	14.1	400	3.0%	5.5	1.1	15.2	2.80	3.50	5.87	3	6	16
OS-2	2.82	[illegible]	6.13	0.30	150	3	14.1	1100	3.0%	6.1	3.0	17.1	2.66	3.32	5.58	7	12	34
OS-3	1.12	1.46	2.43	0.30	50	1	8.1	1100	3.0%	6.1	3.0	11.1	3.17	3.97	6.66	4	6	16





VICINITY MAP
N.T.S.

LEGEND

DESCRIPTION	SYMBOL
EXISTING GROUND CONTOUR	5910
PROPOSED FINISHED CONTOUR	5910
BASIN BOUNDARY	
DESIGN POINT	3
BASIN IDENTIFIER / AREA IN ACRES	BB 10.0
EXISTING DIRECTION OF FLOW	
PROPOSED DIRECTION OF FLOW	
PROPOSED STORM SEWER	
PROPOSED STORM SEWER INLETS	
STORM PIPE RUN SIZING	20
TIME OF CONCENTRATION	

FINAL DRAINAGE REPORT ~ SURFACE ROUTING SUMMARY

Design Point(s)	Contributing Basins	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	Intensity I(5)	I(100)	Flow Q(5)	Q(100)	Inlet Size
24	DD1	1.98	4.09	18.2	3.23	5.43	6	22	15' Type R At-Grade
25	DD2, DD1 Flowby	0.99	3.01	18.7	3.19	5.36	3	16	10' Type R Sump
26	EE	0.89	1.49	11.7	3.89	6.54	3	10	5' Type R Sump
27	GG, FF	2.15	4.49	20.1	3.08	5.18	7	23	10' Type R Sump
28	HH	1.87	3.12	15.6	3.47	5.83	6	18	10' Type R Sump
29	II, KK	1.[illegible]	2.54	15.4	3.48	6.04	5	16	10' Type R Sump
30	JJ	0.28	0.48	9.5	4.21	7.07	1	3	5' Type R Sump
31	LL, MM	4.01	5.42	17.2	3.27	5.49	13	30	Ex. 12' Type R
32	NN	0.92	0.98	7.8	4.65	7.84	4	7	Ex. 8' Type R
33	RR	1.28	2.10	14.9	3.53	5.93	4	12	5' Type R Sump
34	SS, OS-1	2.27	3.78	16.2	3.40	5.71	8	22	10' Type R Sump
34A	Total Inflow to Pond D	17.84	35.53	27.2	2.63	4.41	47	155	
35	QQ, OS-2	4.29	6.79	17.1	3.32	5.58	14	38	15' Type R Sump
36	OS-3	1.46	2.43	11.1	3.97	6.66	6	16	10' Type R Sump
37	TT	1.11	2.32	17.0	3.33	5.60	4	13	15' Type R At-Grade
38	UU, VV and DP-37 Flow-by	0.42	0.88	17.2	3.32	5.57	1	5	

FINAL DRAINAGE REPORT ~ PIPE ROUTING SUMMARY

Pipe Run	Contributing Basins	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	Intensity I(5)	I(100)	Flow Q(5)	Q(100)	Pipe Size*	Velocity (ft/sec)
25	DP24 Pickup	1.98	2.74	18.2	3.23	5.43	6	15	24" RCP	
26	DP25	0.99	3.01	18.7	3.19	5.36	3	16	24" RCP	
27	PR25, PR26	2.88	5.75	18.8	3.18	5.33	9	31	30" RCP	
28	DP26, PR27	3.84	7.23	19.2	3.15	5.29	12	38	36" RCP	
29	DP27	2.15	4.49	20.1	3.08	5.18	7	23	30" RCP	
30	DP28	1.87	3.12	15.6	3.47	5.83	6	18	24" RCP	
31	PR29, PR30	4.02	7.61	20.8	3.05	5.11	12	39	36" RCP	
32	DP29	1.69	2.54	16.4	3.40	6.04	6	15	24" RCP	
33	DP30	0.28	0.48	9.5	4.21	7.07	1	3	18" RCP	
34	PR 32, PR33	1.97	3.00	12.9	3.43	5.81	7	17	24" RCP	
35	PR31, PR34	5.99	10.61	21.3	3.02	5.03	18	53	36" RCP	
36	DP 33	1.28	2.10	14.9	3.53	5.93	4	12	24" RCP	
37	DP34, PR35	3.63	[illegible]	16.5	3.38	5.67	12	33	30" RCP	
38	Future DP-35 and DP-36	5.71	9.22	17.3	3.31	5.55	19	51	36" RCP	
39	DP-37 Pick-up	1.11	2.07	17.8	3.30	5.54	4	12	24" RCP	
40	PR-38, PR-39	6.82	11.29	17.8	3.29	5.48	22	62	36" RCP	

FLOOD PLAIN STATEMENT:
NO PORTION OF THIS SITE IS LOCATED WITHIN A FEMA FLOODPLAIN AS DETERMINED BY THE FLOOD INSURANCE RATE MAPS (F.I.R.M.) MAP NUMBERS 08041C 0535F AND 08041C 0575, WITH EFFECTIVE DATES OF MARCH 17, 1997 (SEE APPENDIX).

NOTES:
THIS MAP IS FOR DRAINAGE PURPOSES ONLY. SEE GRADING PLAN FOR APPROPRIATE GRADING INFORMATION.

N
200 100 0 200 400
SCALE: 1" = 200'

POND D DESIGN DATA:
TRIBUTARY ACREAGE = 76.53 AC. @ 27% IMP
WQCV REQ. = 0.88 AC-FT
EURV REQ. = 2.10 AC-FT

RELEASE:
Q5 = 4.5 cfs @ WSE = 7203.88 (2.70 AC-FT)
Q100 = 85.3 cfs @ WSE = 7205.49 (5.86 AC-FT)

EMERGENCY SPILLWAY ELEV. = 7205.75
EMERGENCY OVERFLOW ELEV. = 7206.72

POND D STRUCTURE DESIGN DATA:
PIPE RUN 35 - 36" RCP (21.54 AC. @ 34% IMP.)
FOREBAY DESIGN:
261 CF REQ. - 268 CF PROVIDED W/18 IN. DEPTH & 6 IN. NOTCH

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

THE LOCATIONS OF EXISTING UNDERGROUND UTILITIES ARE SHOWN IN AN APPROXIMATE WAY ONLY. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL EXISTING UTILITIES BEFORE COMMENCING WORK. THE CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE CAUSED BY HIS FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL UNDERGROUND UTILITIES.

NO.	REVISION	DATE

REVIEW:
PREPARED UNDER MY DIRECT SUPERVISION FOR AND ON BEHALF OF CLASSIC CONSULTING ENGINEERS AND SURVEYORS, LLC

MARC A. WHORTON, COLORADO P.E. #37155 DATE

CLASSIC CONSULTING ENGINEERS & SURVEYORS
619 N. Cascade Avenue, Suite 200 Colorado Springs, Colorado 80903
(719)785-0790
(719)785-0799 (Fax)

PAINT BRUSH HILLS
FILING NO. 13E
FINAL DRAINAGE REPORT
PROPOSED CONDITIONS DRAINAGE MAP

DESIGNED BY	MAW	SCALE	DATE	2/12/18
DRAWN BY	MAW	(H) 1"= 200'	SHEET 2 OF 2	
CHECKED BY		(V) 1"= N/A	JOB NO.	2053.50

PAINT BRUSH HILLS FILING NO. 14

COUNTY OF EL PASO, STATE OF COLORADO

PROPOSED DRAINAGE MAP

DECEMBER 2020

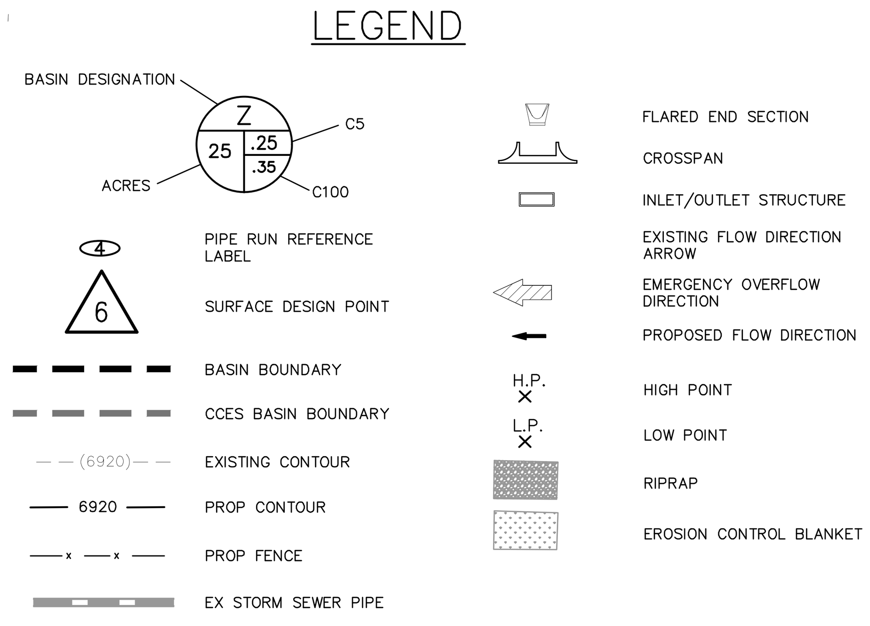
BASIN SUMMARY			
BASIN	AREA (ACRES)	Q_5	Q_{100}
*RR	4.20	8.0	17.0
**SS	3.01	2.8	8.4
**OS1	4.44	4.9	13.7
*OO	29.11	22.0	51.0
*TT	5.05	5.7	13.0
*UU	1.27	1.4	3.2
***OS-5	46.10	14.0	32.0
OS5A	3.66	1.5	8.4
OS5B	13.44	4.6	25.8
OS5C	29.00	25.5	57.0
A	0.52	0.4	1.4
B	8.31	5.6	20.8
B1	0.92	0.6	2.4
C	11.80	9.2	28.6
D	5.20	3.8	14.0
E	0.49	2.3	4.1
F	1.61	1.9	5.4
G	12.20	14.0	34.8
H	10.78	11.9	29.7
I	12.70	14.5	36.2
J	7.19	5.6	19.1
K	0.75	1.1	2.7
L	3.37	3.8	9.5
M	2.53	2.6	7.8
N	8.94	6.2	23.0

DESIGN POINT SUMMARY				
DESIGN POINT	Q_5	Q_{100}	CONTRIBUTING BASIN (S)	STRUCTURE
1	4.9	13.7	**OS1	PROP 10' TYPE R SUMP INLET
*33	8.0	17.0	*RR	*6' TYPE R SUMP INLET
**34	2.8	8.4	**SS	*6' TYPE R SUMP INLET
3	25.7	58.1	A, OS5C	PROP 36" RCP FES
4	5.6	19.1	J	PROP 15' TYPE R SUMP INLET
5	1.1	2.7	K	PROP 5' TYPE R SUMP INLET
6	9.2	22.2	OS5B, D, E	SEE DP8 FOR CUMULATIVE FLOW
7	1.9	22.2	F	SEE DP8 FOR CUMULATIVE FLOW
8	10.7	44.4	DP6, DP7	PROP DUAL 15' TYPE R SUMP INLET
9	13.8	34.4	G	PROP DUAL 15' TYPE R AT-GRADE INLET
10	14.5	36.2	I	PROP DUAL 15' TYPE R AT-GRADE INLET
11	3.7	17.0	L, FLOWBY DP10	EX 15' TYPE R AT-GRADE INLET
*37	5.7	13.0	*TT	EX 15' TYPE R AT-GRADE INLET
12	11.9	29.7	H	PROP DUAL 15' TYPE R AT-GRADE INELT
13	2.1	21.3	M,FLOWBY DP9, FLOWYBY DP12, FLOWBY DP11	SEE DP15 FOR CUMULATIVE FLOW
14	10.3	34.8	C, OS5A	SEE DP15 FOR CUMULATIVE FLOW
15	12.3	55.4	DP13, DP14	PROP DUAL 20' TYPE R SUMP INLET
16	5.6	20.8	B	PROP CDOT TYPE C INLET
17	109.0	306.7	N, PR26	EX POND C

STORM SEWER SUMMARY			
PIPE RUN	Q_5	Q_{100}	PIPE SIZE
*36	4.4	12.4	*24" RCP
*37	6.9	19.4	*30" RCP
1	4.9	13.7	18" RCP
2	25.7	58.1	36" RCP
3	30.4	74.0	48" RCP
4	1.1	2.7	18" RCP
5	31.2	76.0	48" RCP
7	9.2	22.2	24" RCP
8	1.5	22.2	24" RCP
9	41.2	117.8	48" RCP
10	7.0	13.7	24" RCP
11	7.0	13.7	24" RCP
12	53.9	142.5	48" RCP
13	7.3	14.0	18" RCP
14	14.6	27.9	30" RCP
#38	14.6	27.9	*30" RCP
#15	3.7	13.5	*24" RCP
#16	17.4	39.7	*30" RCP
#39	5.7	13.0	*24" RCP
#17	22.8	51.3	*36" RCP
18	6.0	12.4	18" RCP
18.1	6.0	12.4	18" RCP
19	11.9	24.8	30" RCP
20	34.4	75.3	42" RCP
21	86.8	214.5	54" RCP
22	6.1	27.7	30" RCP
23	12.3	55.4	36" RCP
24	98.6	269.3	60" RCP
25	5.6	20.8	30" RCP
26	103.8	287.3	66" RCP
#27	22.6	92.8	EX 48" RCP

POND C EDB SUMMARY	
EPC/URBAN DRAINAGE EDB	
WQ WATER SURFACE ELEV	7193.88
WQ VOLUME	1.839 AC-FT
EURV WATER SURFACE ELEV	7195.65
EURV VOLUME	4.673 AC-FT
100-YR WATER SURFACE ELEV	7198.00
100-YR VOLUME	9.490 AC-FT
SPILLWAY CREST ELEV	7199.00
TOP OF EMBANKMENT ELEV	7201.00
100-YR INFLOW	248.0 CFS
100-YR RELEASE	92.8 CFS

LEGEND



*VALUES TAKEN FROM "FINAL DRAINAGE REPORT FOR PAINT BRUSH HILLS FILING NO.13E" PREPARED BY CLASSIC ENGINEERS AND SURVEYORS, DATED SEPTEMBER. 2018 SEE PAINT BRUSH HILLS FILING NO.13E DRAINAGE MAP BASINS DD1, DD2, EE, FF, GG, HH, II, JJ AND KK FOR AREA DRAINAGE SUMMARY, BASIN ROUTING SUMMARY AND STORM SEWER ROUTING SUMMARY.

**REVISED FROM "PRELIMINARY DRAINAGE REPORT FOR PAINT BRUSH HILLS FILING NO.13E" PREPARED BY CLASSIC ENGINEERS AND SURVEYORS, DATED FEB. 2018

***"FINAL DRAINAGE REPORT FOR PAINT BRUSH HILLS PHASE 2 (FILING NO.13)" PREPARED BY CLASSIC ENGINEERS AND SURVEYORS, REVISED JUNE 2008

#REVISED FLOWS AND/OR PIPE SIZE FROM "FINAL DRAINAGE REPORT FOR PAINT BRUSH HILLS FILING NO.14" PREPARED BY MS CIVIL CONSULTANTS, DATED DECEMBER, 2020

Revise reference to "Final Drainage Report for Paint Brush Hills Filing 13E" dated Sep 2018.
See PCD File No SF189 for the approved report. Update any reference values that may have changed from the preliminary to the the final drainage report

Unresolved.

FOR LOCATING & MARKING GAS, ELECTRIC, WATER & TELEPHONE LINES

FOR BURIED UTILITY INFORMATION 48 HRS BEFORE YOU DIG CALL 1-800-922-1987

M&S CIVIL CONSULTANTS, INC.

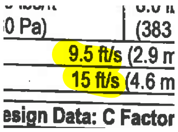
20 BOULDER CRESCENT, SUITE 110
COLORADO SPRINGS, CO 80903
PHONE: 719.955.5485

PAINT BRUSH HILLS FILING NO. 14			
PROPOSED DRAINAGE MAP			
PROJECT NO. 10-014	SCALE: HORIZONTAL: 1"=100' VERTICAL: N/A	DATE: 7/01/2020	
DESIGNED BY: GT DRAWN BY: CMN CHECKED BY: VAS		SHEET 1 OF 1	FDM

File: Q:\10014-PBH 14\PBH 14\dwg\Eng Exhibits\FDR Plan.dwg Plotstamp: 12/16/2020 2:55 PM

Drainage Report_V2.pdf Markup Summary

dsdlaforce (10)



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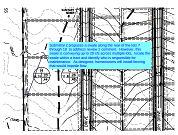

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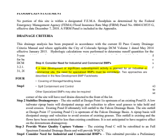
Submittal 2 proposes a swale along the rear of the lots 7 through 18 to address review 1 comment. However, this swale is conveying up to 20 cfs across multiple lots, locate the swale within a tract and identify who is responsible for maintenance. As designed, homeowners will install fencing that would impede flow.



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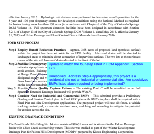

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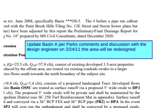
Update to match the four-step listed in ECM Appendix I Section I.7.2

Unresolved. Address Step 4 appropriately, this project is a residential site not an industrial or commercial site. Are specialized BMPs listed above required or being implemented?



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Author: dsdlaforce
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Update Basin A per Parks comments and discussion with the design engineer on 2/24/11 this area will be redesigned.

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Submittal 2 proposes a swale along the rear of the lots 7 through 18 to address review 1 comment. However, this swale is conveying up to 20 cfs across multiple lots, locate the swale within a tract and identify who is responsible for maintenance. As designed, homeowners will install fencing that would impede flow.

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Subject: Callout
Page Label: 9
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100% of the development site must be treated for water quality. Provide permanent stormwater quality control measure for basin B.

Unresolved. Update narrative to identify the specific criteria (See ECM I.7.1.C.1.a.) that allows exclusion from permanent WQ for this particular subbasin and include justification in the narrative. In the narrative identify basin B1's percentage of the subdivision.

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Subject: Callout
Page Label: [1] PDM
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Author: dsdlaforce
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Revise reference to "Final Drainage Report for Paint Brush Hills Filing 13E" dated Sep 2018. See PCD File No SF189 for the approved report. Update any reference values that may have changed from the preliminary to the the final drainage report

Unresolved.