

PRELIMINARY/FINAL DRAINAGE REPORT

FOR PAINT BRUSH HILLS FILING NO. 14

EL PASO COUNTY, COLORADO

MARCH 2021

Since this is a combined PDR/FDR. Address the review 2 comments to the drainage report uploaded with the final plat application.

Prepared for:

The Landhuis Company
212 N. Wahsatch Ave, Suite 301
Colorado Springs, CO 80903
(719) 635-3200

COMMENT ADDRESSED.

Prepared by:



102 E. Pikes Peak, 5th Floor
Colorado Springs, CO 80903
(719) 955-5485

Project #10-014
PCD Project # SP206 & SF2024

**PRELIMINARY/FINAL DRAINAGE REPORT
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: _____
Mr. Jeff Mark
TITLE: Owner and Manager
ADDRESS: Landuis Company
212 N. Washatch Ave, Suite 301
Colorado Springs, CO 80903

DATE: 3-8-21

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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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,

Step 4: Consider Need for Industrial and Commercial BMPs

- There are no commercial or industrial components of this development, therefore no BMPs of this nature are required. The Full Spectrum Detention BMP is provided for the proposed Development by the East Pond.

Hydrologic calculations were performed to determine runoff quantities for the 5-year and 100-year frequency storms for developed conditions using the Rational Method as required for basins having areas less than 130 acres (in accordance with Chapter 6 of the City of Colorado Springs DCM Volume 1). Full spectrum detention facilities have been designed in accordance with Section 3.2.1. of Chapter 13 of the City of Colorado Springs DCM Volume 1, dated May 2014, effective January 31, 2015 and Urban Drainage and Flood Control District M

FOUR STEP PROCESS

Step1 Employ Runoff Reduction Practices – Approx. within the project has been set aside for an EDB landscaped areas to minimize direct connection of in corner of the site will have roof drains directed to the

Step 2 Stabilize Drainageways – The site outfall at Design tailwater riprap basin will dissipated energy and ve avoid erosion. Existing Pond D ultimately will outfall at Design Point 17 (existing Pond C) is upstream of dissipated energy and velocities to avoid erosion of flows have been restricted to less than existing condi on the downstream drainageway

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 reseedling to mitigate the potential for erosion across the site.

EXISTING DRAINAGE CONDITIONS

The Paint Brush H Basin with Chico Drainage Plan for approved Novemb

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

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

Review 2. Unresolved. Read Step 4 and revise the narrative appropriately. See snippet below.

Review 3. Unresolved. Contact the review engineer if you require clarification. Attached is a snippet from a similar project with no planned industrial or commercial site. If there are specialized BMPs, then update the narrative to describe said BMPs.

**COMMENT ADDRESSED.
STEP 4 UPDATED. NO SPECIALIZED
BMPs REQUIRED.**

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

Basins Tributary to Detention Pond C

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, 3.82 acres, ($Q_5=2.9$ cfs, $Q_{100}=10.7$ cfs), consists of a proposed single family residential lots and proposed landscaped Tract. Developed flows within **Basin A** and offsite **Basin OS5C** are routed as surface runoff via an existing swale, in a 75' drainage easement, to **DP3** ($Q_5=27.7$ cfs, $Q_{100}=65.3$ cfs). Surface runoff at **DP3** will be collected and conveyed via a 36" RCP FES and 36" RCP pipe (**PR2**) to **DP4**. The existing swale shall be natural, except for the lower portion where it will be graded to the 36" RCP FES. This portion of the swale shall be maintained by the Paint Brush Hills Metropolitan District (see SC 150 Turf Reinforcement Mat in appendix). In the event of clogging, flows at **DP3** will over top the embankment and shall be conveyed via curb and gutter to **DP4**.

Basin J, 3.9 acres, ($Q_5=3.0$ cfs, $Q_{100}=10.4$ 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 10' Type R sump inlet. The intercepted flow ($Q_5=3.0$ cfs, $Q_{100}=10.4$ cfs) will be routed west via an 18" RCP pipe (**PR3**, $Q_5=3.0$ cfs, $Q_{100}=10.4$ cfs) to **PR5** ($Q_5=31.0$ cfs, $Q_{100}=75.9$ cfs), a 48" RCP. 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** ($Q_5=31.0$ cfs, $Q_{100}=75.5$ cfs), a 48" RCP. 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** ($Q_5=14.0$ cfs, $Q_{100}=34.8$ 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** ($Q_5=53.7$ cfs, $Q_{100}=142.4$ 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**, $Q_5=86.6$ cfs, $Q_{100}=214.4$ cfs). In the event of clogging, flows at **DP12** will be routed via curb and gutter to **DP15**.

drainage easement. The sole responsibility for maintenance of these easements is hereby vested owners.

15. Lots 1-30 (RS-20000) to allow split rail fence only along rear and side lot lines.

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 **COMMENT ADDRESSED**. intercepted flow.

BASIN B REVISED TO REFLECT DRAINAGE EASEMENT AND

Basin OS5A, 3.7 acres, ($Q_5=1.5$ cfs, $Q_{100}=8.4$ cfs), consist of existing develop 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

SPLIT RAIL FENCE.

Basin C, 11.8 acres, ($Q_5=9.2$ cfs, $Q_{100}=34.8$ cfs). The combined flow from sump inlets at **DP15** ($Q_5=12.3$ cfs, $Q_{100}=55.4$ cfs) and a 60" RCP pipe (**PR24**, $Q_5=6.1$ cfs, $Q_{100}=12.3$ cfs) will be routed to a 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.

Unresolved. Update narrative to describe the mitigation proposed.

Basin B, 8.31 acres, ($Q_5=5.6$ cfs, $Q_{100}=20.8$ cfs), consists of the backyards of proposed single family residential lots. Minimal improvements to the backyards will be implemented. Surface runoff will be 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, $Q_{100}=287.2$ cfs) which will outfall into a proposed concrete lined forebay.

COMMENT ADDRESSED.

BASIN B1 REVISED TO REFLECT ECM I.7.1.C.1.a. AND JUSTIFICATION.

Basin N, 8.94 acres, ($Q_5=6.2$ cfs, $Q_{100}=306.5$ cfs). The combined surface runoff and Pond C will be routed to an Extended Detention Basin (EDB). These Construction drawings for Paint Brush H provide full spectrum detention and water is designed to treat approx 137.6 acres, a and 11.583 ac-ft of 100-year storage. TI have been designed per the UDFCD man pond will be private and shall be maintained be granted to the owner and El Paso Co maintenance agreement document shall a structure, flows at **DP17** will over top th previously was designed. Per the Paint Br rip rap pad ($D_{50} = 18"$) has been construc The existing riprap pad will dissipate ene from **Pond C** (**PR27**, $Q_5=22.6$ cfs and $Q_{100}=161$ cfs). The proposed discharge from the subject site will not adversely affect the downstream 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.

Review 2. Unresolved. See ECM Appendix I Section I.7.1.B and Section I.7.1.C.1.a for exclusion from permanent WQ. Update the narrative to explain/identify the relevant exclusion from permanent water quality. If no exclusion is applicable then original comment remains.

Review 3. Unresolved. Contact the review engineer (Gilbert LaForce) if you require clarification regarding review 2 comments. 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 Adjacent I

Basin B1, 0.92 acres, ($Q_5=0.6$ cfs, $Q_{100}=1.6$ cfs), consists of proposed single family residential lots and an up

1. Water Quality Capture Volume (WQCV) Standard.

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

- 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).

routed to drain to Keynes Drive. Surface runoff will sheet flow west and follow historic drainage patterns to the adjacent property. Flows will not adversely affect the downstream infrastructure.

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 $Q_5=108.8$ cfs and $Q_{100}=306.5$ 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 (D₅₀ = 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	187 LF	\$40 /LF	\$7,480.00
2.	24"RCP	46 LF	\$50 /LF	\$2,300.00
3.	30"RCP	674 LF	\$65 /LF	\$43,810.00
4.	36"RCP	280 LF	\$75 /LF	\$21,000.00
5.	42"RCP	261 LF	\$85 /LF	\$22,185.00
6.	48"RCP	2419 LF	\$150 /LF	\$362,850.00
7.	54"RCP	171 LF	\$200 /LF	\$34,200.00
8.	60"RCP	163 LF	\$250 /LF	\$40,750.00
10.	66"RCP	112 LF	\$350 /LF	\$39,200.00
11.	18"FES	1 EA	\$245 /EA	\$245.00
12.	36"FES	1 EA	\$775 /EA	\$775.00
13.	66"END TREATMENT	1 EA	\$15000/ /EA	\$15,000.00
HEADWALL/W ING WALLS				
14.	5' TYPE R SUMP INLET	3 EA	\$4000 /EA	\$12,000.00
15.	10' TYPE R SUMP INLET	2 EA	\$4700 /EA	\$9,400.00
16.	15' TYPE R SUMP INLET	2 EA	\$6000 /EA	\$12,000.00
17.	15'TYPE R ATGRADE INLET	6 EA	\$6000 /EA	\$36,000.00
18.	20'TYPE R ATGRADE INLET	2 EA	\$8000 /EA	\$16,000.00
19.	3'x3' CDOT TYPE C	1 EA	\$4000 /EA	\$4,000.00
20.	TYPE I MH	13 EA	\$6000 /EA	\$78,000.00
21.	EDB Pond	1 EA	\$20,000 /EA	\$20,000.00
22.	Pond Outlet MOD TYPE D	1 EA	\$15,000 /EA	\$15,000.00
23.	RIPRAP OUTFALL TYPE L	27 CY	\$50 /CY	\$1,350.00
24.	RIPRAP SPILLWAY TYPE M	384 CY	\$65 /CY	\$24,960.00
Total \$				\$818,505.00

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	=	<u>\$138,031.79</u>
					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

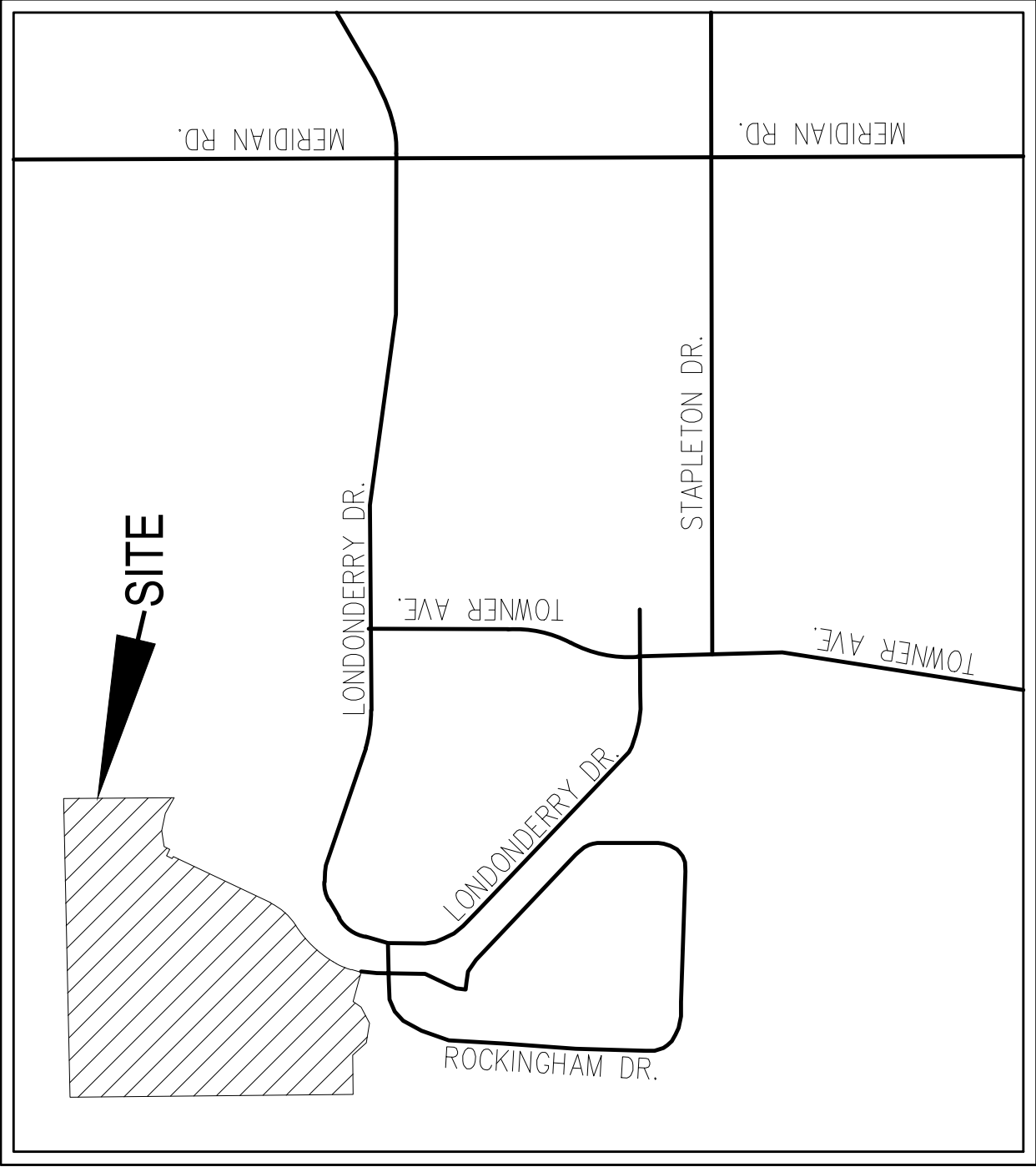
Development of the Paint Brush Hills Filing No. 14 site shall not adversely affect adjacent or downstream properties per this final drainage report. The proposed drainage facilities will adequately convey, detain and route runoff from tributary onsite and existing offsite flows to the Chico Creek receiving 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

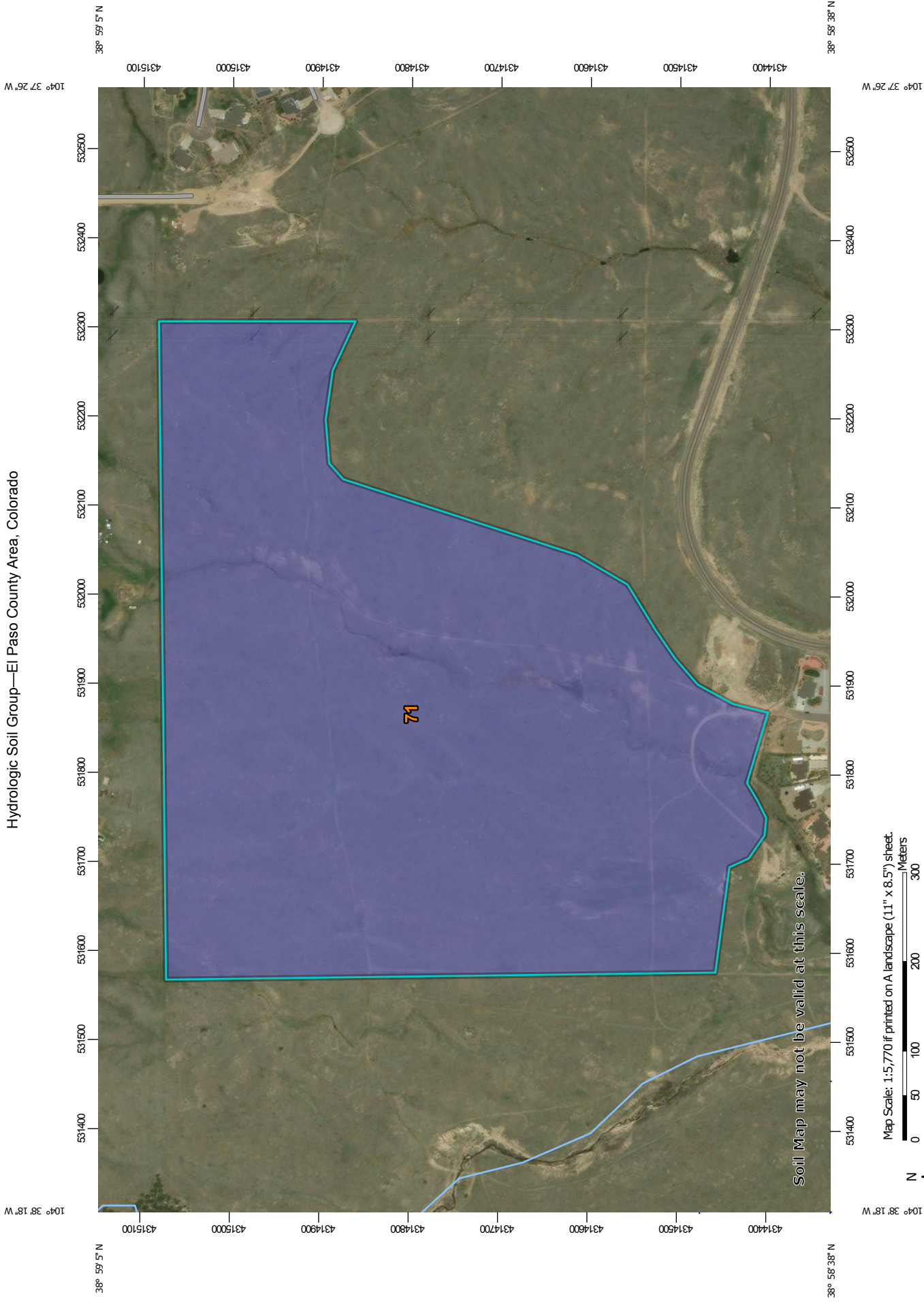


VICINITY MAP

N.T.S.


SOILS MAP

Hydrologic Soil Group—El Paso County Area, Colorado




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

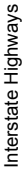
 B/D


Water Features

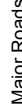
 Streams and Canals

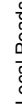
Transportation

 Rails


 Interstate Highways

 US Routes


 Major Roads


 Local Roads


Background


 Aerial Photography

C

 C

 C/D

 D

 Not rated or not available

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: [Web Soil Survey](#)

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.

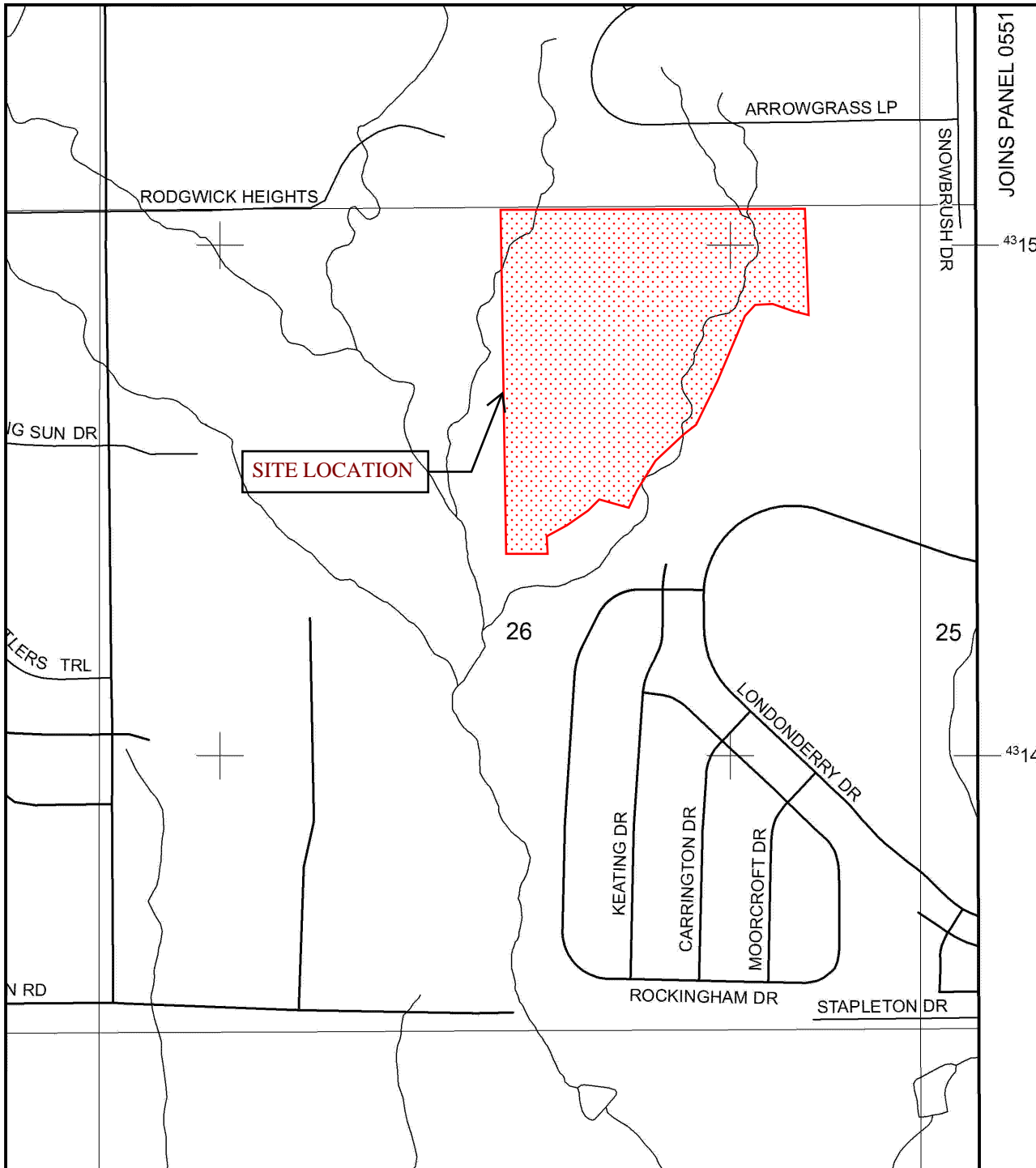
Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over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

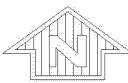
If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

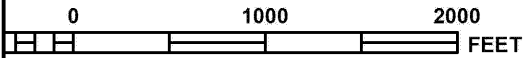
Aggregation Method: Dominant Condition

FIRM PANEL





MAP SCALE 1" = 1000'



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	080050	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)

BASIN	TOTAL AREA (Sq Ft)	TOTAL AREA (Acres)	IMPERVIOUS AREA/STREET			LANDSCAPED/UNDEVELOPED			RESIDENTIAL			WEIGHTED	
			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
**OSI	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	166371	3.82	0.00	0.90	0.96	0.00	0.16	0.41	3.82	0.20	0.44	0.20	0.44
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
BI	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	169859	3.90	0.00	0.90	0.96	0.00	0.16	0.41	3.90	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: 3/4/2021

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 (Acres)	C ₅	C ₁₀₀	C ₅	Length (ft)	Height (ft)	T _c (min)	Length (ft)	Slope (%)	Velocity (fps)	T _i (min)	TOTAL	CHECK	I ₅	I ₁₀₀	Q ₅	Q ₁₀₀
		From DCM Table 5-1										(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
OSSA	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
OSSB	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
OSSC	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	3.82	0.20	0.44	0.20	100	4	10.3	373	3.2%	2.7	2.3	12.6	12.6	3.8	6.3	2.9	10.7
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	3.90	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	3.0	10.4
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: 3/4/2021
 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		COMMENTS
DESIGN POINT	CONTRIBUTING BASINS	CA _s	CA ₁₀₀	C _s	Length (ft)	Height (ft)	T _c (min)	Length (ft)	Slope (%)	Velocity (fps)	T _t (min)	TOTAL (min)	I _s (in/hr)	I ₁₀₀ (in/hr)	Q _s (c.f.s.)	Q ₁₀₀ (c.f.s.)		
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 OSSC	0.76 8.70 9.47	1.68 11.60 13.28					358	1.7%	1.9	3.1	22.3	2.9	4.9	27.7	65.3	PROP 36" RCP FES	
4	J	0.86	1.75									15.0	3.5	5.9	3.0	10.4	PROP 10' SUMP TYPE R INLET W/18" 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 D E	1.48 1.04 0.44 2.96 7.73	4.97 2.29 0.47									19.9	3.1	5.2	9.2	40.2	PROP 15' SUMP TYPE R INLET W/24" RCP	
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 FLOWS SPLIT @ DP8	
9	G	4.27	6.34									17.7	3.3	5.5	14.0	34.8	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 Flowby DP10	1.21 0.00 1.21	1.82 1.49 3.31									20.4	3.1	5.1	3.7	17.0	EX. 15' AT-GRADE TYPE R INLET W/24" RCP	
*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 FLOWBY DP9 FLOWBY DP12 FLOWBY DP11	0.68 0.00 0.00 0.00 0.68 4.15	1.21 1.35 0.90 0.68									20.4	3.1	5.1	2.1	21.3	SEE DP15 FOR CUMMULATIVE FLOW	
14	C OS5A	3.07 0.40 3.47 7.02	5.66 1.35									21.8	3.0	5.0	10.3	34.8	SEE DP15 FOR CUMMULATIVE FLOW	
15	DP13 DP14	0.68 3.47 4.15 11.16	4.15 7.02									21.8	3.0	5.0	12.3	55.4	PROP DUAL 20' SUMP TYPE R INLET W/30" & 36"RCP 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 PR26	1.78 35.44 37.22	3.95 58.52 62.47									22.3	2.9	4.9	108.8	306.5	EX. POND C	

* 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: 3/4/2021
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	9.47	13.28	22.3	2.9	4.9	27.7	65.3	36" RCP
3	DP4	0.86	1.75	15.0	3.5	5.9	3.0	10.4	18" RCP
4	DP5	0.27	0.40	10.9	4.0	6.7	1.1	2.7	18" RCP
5	PR2, PR3, PR4	10.59	15.44	22.3	2.9	4.9	31.0	75.9	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	14.04	23.97	22.3	2.9	4.9	41.0	117.7	48" RCP
10	1/2 DP9 CAPTURE	2.17	2.52	17.7	3.3	5.5	7.1	13.9	24" RCP
11	1/2 DP9 CAPTURE	2.17	2.52	17.7	3.3	5.5	7.1	13.9	24" RCP
12	PR9, PR10, PR11	18.38	29.02	22.3	2.9	4.9	53.7	142.4	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	29.63	43.70	22.3	2.9	4.9	86.6	214.4	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	33.78	54.86	22.3	2.9	4.9	98.8	269.2	60" RCP
25	B	1.66	3.66	16.5	3.4	5.7	5.6	20.8	30" RCP
26	PR24, PR25	35.44	58.52	22.3	2.9	4.9	103.6	287.2	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

DP - Design Point

EX - Existing Design Point

FB- Flow By from Design Point

INT- Intercepted Flow from Design Point

Calculated by: GT

Date: 3/4/2021

Checked by: VAS

HYDRAULIC CALCULATIONS / EDB WQCV CALCULATIONS

PAINTBRUSH HILLS FILING NO. 14

FINAL DRAINAGE REPORT

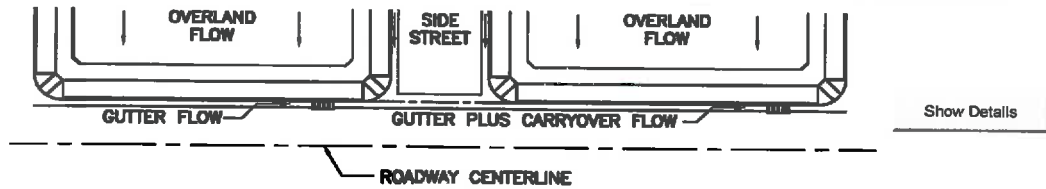
(CDOT Type R Inlet Calculations - Sump Condition)

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
			$Q_w=C_wN_wLeD^{3/2}$	$Q_o=CoNo(LeHc)(2g(D-0.5Hc))^{1/2}$	$Q_m=Cm(QwQo)^{1/2}$
5	Q5	0.43	5.1	5.7	5.0
5	Q100	0.66	9.7	8.6	8.5
6	Q5	0.43	6.1	6.8	6.0
6	Q100	0.66	11.6	10.3	10.2
8	Q5	0.43	8.1	9.1	8.0
8	Q100	0.66	15.4	13.8	13.6
10	Q5	0.43	10.2	11.4	10.0
10	Q100	0.66	19.3	17.2	17.0
12	Q5	0.43	12.2	13.7	12.0
12	Q100	0.66	23.2	20.7	20.3
14	Q5	0.43	14.2	16.0	14.0
14	Q100	0.66	27.0	24.1	23.7
15	Q5	0.43	15.2	17.1	15.0
15	Q100	0.66	29.0	25.8	25.4
16	Q5	0.43	16.2	18.2	16.0
16	Q100	0.66	30.9	27.5	27.1
18	Q5	0.43	18.3	20.5	18.0
18	Q100	0.66	34.7	31.0	30.5
20	Q5	0.43	20.3	22.8	20.0
20	Q100	0.66	38.6	34.4	33.9

Table 7-7. Coefficients for various inlets in sumps				
Inlet Type	Nw	Cw	No	Cm
CDOT Type 13 Grate	0.7	3.3	0.43	0.93
Denver No. 16 Grate	0.73	3.6	0.31	0.9
Curb Opening for Type 13/No. 16 Combination	1	3.7	1	0.86
CDOT Type R Curb Opening	1	3.6	1	0.93

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



Design Flow: ONLY if already determined through other methods: (local peak flow for 1/2 of street OR grass-lined channel):		Minor Storm *Q _{Known} = <u>4.9</u> cfs	Major Storm <u>13.7</u> cfs
* 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):			
Site Type: <input type="radio"/> Site is Urban <input type="radio"/> Site is Non-Urban	Flows Developed For: <input type="radio"/> Street Inlets <input type="radio"/> Area Inlets in a Median	Subcatchment Area = <u> </u> Acres Percent Imperviousness = <u> </u> % NRCS Soil Type = <u> </u> A, B, C, or D	← FILL IN THIS SECTION OR... FILL IN THE SECTIONS BELOW. ←
		Slope (ft/ft) <u> </u> Length (ft) <u> </u> Overland Flow = <u> </u> Channel Flow = <u> </u>	
Rainfall Information: Intensity I (inch/hr) = $C_1 \cdot P_1 / (C_2 + T_o) \cdot C_3$		Minor Storm Design Storm Return Period, T _r = <u> </u> years Return Period One-Hour Precipitation, P ₁ = <u> </u> inches C ₁ = <u> </u> C ₂ = <u> </u> C ₃ = <u> </u> User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C = <u> </u> User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C ₅ = <u> </u> Bypass (Carry-Over) Flow from upstream Subcatchments, Q _b = <u>0.0</u> cfs	Major Storm <u> </u> years <u> </u> inches <u> </u> <u> </u> <u> </u> <u> </u> <u> </u> <u>0.0</u> cfs
		Total Design Peak Flow, Q = <u>4.9</u> cfs	<u>13.7</u> cfs

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

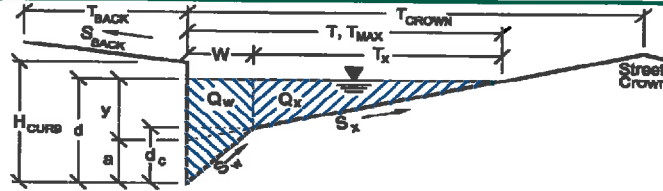
(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

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
 Side Slope Behind Curb (leave blank for no conveyance credit behind curb)
 Manning's Roughness Behind Curb (typically between 0.012 and 0.020)
 Height of Curb at Gutter Flow Line
 Distance from Curb Face to Street Crown
 Gutter Width
 Street Transverse Slope
 Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)
 Street Longitudinal Slope - Enter 0 for sump condition
 Manning's Roughness for Street Section (typically between 0.012 and 0.020)

T_{BACK}	8.0	ft
S_{BACK}	0.020	ft/ft
n_{BACK}	0.020	
H_{CURB}	6.00	inches
T_{CROWN}	17.0	ft
W	2.00	ft
S_X	0.020	ft/ft
S_W	0.083	ft/ft
S_O	0.000	ft/ft
n_{STREET}	0.020	

Max. Allowable Spread for Minor & Major Storm
 Max. Allowable Depth at Gutter Flowline for Minor & Major Storm
 Allow Flow Depth at Street Crown (leave blank for no)

	Minor Storm	Major Storm	
T_{MAX}	17.0	17.0	ft
d_{MAX}	5.6	7.9	inches
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread

Water Depth without Gutter Depression (Eq. ST-2)
 Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")
 Gutter Depression ($d_c = (W \cdot S_X \cdot 12)$)
 Water Depth at Gutter Flowline
 Allowable Spread for Discharge outside the Gutter Section W (T - W)
 Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)
 Discharge outside the Gutter Section W, carried in Section T_X
 Discharge within the Gutter Section W ($Q_T - Q_X$)
 Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)
 Maximum Flow Based On Allowable Spread
 Flow Velocity within the Gutter Section
 V*d Product: Flow Velocity times Gutter Flowline Depth

	Minor Storm	Major Storm	
y	4.08	4.08	inches
d_c	2.0	2.0	inches
a	1.51	1.51	inches
d	5.59	5.59	inches
T_X	15.0	15.0	ft
E_o	0.350	0.350	
Q_X	0.0	0.0	cfs
Q_W	0.0	0.0	cfs
Q_{BACK}	0.0	0.0	cfs
Q_T	SUMP	SUMP	cfs
V	0.0	0.0	fps
V*d	0.0	0.0	

Maximum Capacity for 1/2 Street based on Allowable Depth

Theoretical Water Spread
 Theoretical Spread for Discharge outside the Gutter Section W (T - W)
 Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)
 Theoretical Discharge outside the Gutter Section W, carried in Section T_{XTH}
 Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})
 Discharge within the Gutter Section W ($Q_d - Q_X$)
 Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)
 Total Discharge for Major & Minor Storm (Pre-Safety Factor)
 Average Flow Velocity Within the Gutter Section
 V*d Product: Flow Velocity Times Gutter Flowline Depth
 Slope-Based Depth Safety Reduction Factor for Major & Minor ($d \geq 6"$) Storm
 Max Flow Based on Allowable Depth (Safety Factor Applied)
 Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)
 Resultant Flow Depth at Street Crown (Safety Factor Applied)

	Minor Storm	Major Storm	
T_{TH}	17.0	26.6	ft
T_{XTH}	15.0	24.6	ft
E_o	0.349	0.220	
Q_{XTH}	0.0	0.0	cfs
Q_X	0.0	0.0	cfs
Q_W	0.0	0.0	cfs
Q_{BACK}	0.0	0.0	cfs
Q	0.0	0.0	cfs
V	0.0	0.0	fps
V*d	0.0	0.0	
R	SUMP	SUMP	
Q_d	SUMP	SUMP	cfs
d			inches
d_{CROWN}			inches

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

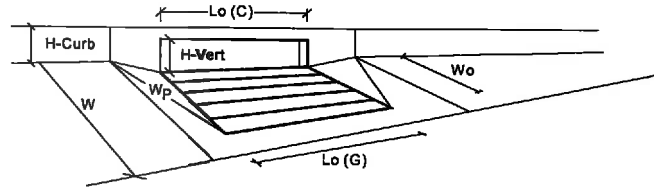
Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

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

	Minor Storm	Major Storm	
Q_{allow}	SUMP	SUMP	cfs

INLET IN A SUMP OR SAG LOCATION

Project = PAINT BRUSH HILLS FILING NO. 14
Inlet ID = SUMP INLET DP1



Design Information (Input)

Type of Inlet

Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')

Number of Unit Inlets (Grate or Curb Opening)

Water Depth at Flowline (outside of local depression)

Grate Information

Length of a Unit Grate

Width of a Unit Grate

Area Opening Ratio for a Grate (typical values 0.15-0.90)

Clogging Factor for a Single Grate (typical value 0.50 - 0.70)

Grate Weir Coefficient (typical value 2.15 - 3.60)

Grate Orifice Coefficient (typical value 0.60 - 0.80)

Curb Opening Information

Length of a Unit Curb Opening

Height of Vertical Curb Opening in Inches

Height of Curb Orifice Throat in Inches

Angle of Throat (see USDCM Figure ST-5)

Side Width for Depression Pan (typically the gutter width of 2 feet)

Clogging Factor for a Single Curb Opening (typical value 0.10)

Curb Opening Weir Coefficient (typical value 2.3-3.7)

Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)

	MINOR	MAJOR	
Inlet Type =	CDOT Type R Curb Opening		
a_{local} =	3.00	3.00	inches
N_o =	2.0	2	
Ponding Depth =	5.6	7.9	inches

☒ Override Depths

	MINOR	MAJOR	
$L_o (G)$ =	N/A	N/A	feet
W_o =	N/A	N/A	feet
A_{ratio} =	N/A	N/A	
$C_r (G)$ =	N/A	N/A	
$C_w (G)$ =	N/A	N/A	
$C_o (G)$ =	N/A	N/A	

	MINOR	MAJOR	
$L_o (C)$ =	5.00	5.00	feet
H_{vert} =	6.00	6.00	inches
H_{throat} =	6.00	6.00	inches
Theta =	63.40	63.40	degrees
W_p =	2.00	2.00	feet
$C_r (C)$ =	0.10	0.10	
$C_w (C)$ =	3.60	3.60	
$C_o (C)$ =	0.67	0.67	

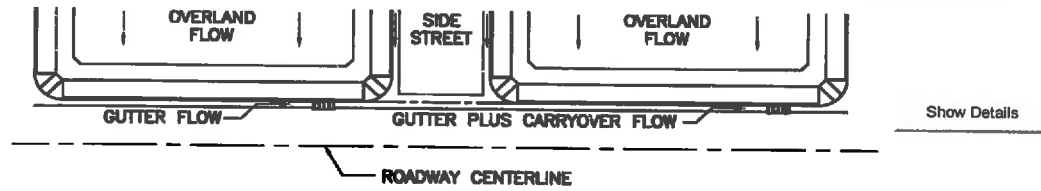
Total Inlet Interception Capacity (assumes clogged condition)

Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)

	MINOR	MAJOR	
Q_a =	8.7	19.0	cfs
$Q_{PEAK REQUIRED}$ =	4.9	13.7	cfs

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



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

*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):

Site Type:

☐ Site Is Urban

☐ Site Is Non-Urban

Flows Developed For:

☐ Street Inlets

☐ Area Inlets in a Median

Subcatchment Area = Acres

Percent Imperviousness = %

NRCS Soil Type = A, B, C, or D

Slope (ft/ft) = Length (ft) =

Overland Flow =

Channel Flow =

Rainfall Information: Intensity I (in/hr) = $C_1 \cdot P_1 / (C_2 + T_e)^{C_3}$

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

← FILL IN THIS SECTION
OR...

← FILL IN THE SECTIONS
BELOW.

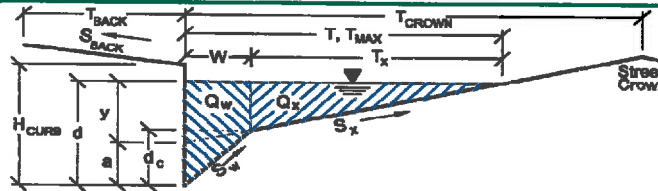
ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

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

Project:
Inlet ID:

PAINT BRUSH HILLS FILING NO. 14

SUMP INLET DP**34



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

T_{BACK}	=	8.0	ft
S_{BACK}	=	0.020	ft/ft
n_{BACK}	=	0.020	

H_{CURB}	=	6.00	inches
T_{CROWN}	=	17.0	ft
W	=	2.00	ft
S_x	=	0.020	ft/ft
S_w	=	0.083	ft/ft
S_o	=	0.000	ft/ft
n_{STREET}	=	0.020	

Max. Allowable Spread for Minor & Major Storm

Max. Allowable Depth at Gutter Flowline for Minor & Major Storm

Allow Flow Depth at Street Crown (leave blank for no)

	Minor Storm	Major Storm	
T_{MAX}	=	17.0	ft
d_{MAX}	=	5.6	inches
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread

Water Depth without Gutter Depression (Eq. ST-2)

Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")

Gutter Depression ($d_c - (W * S_x * 12)$)

Water Depth at Gutter Flowline

Allowable Spread for Discharge outside the Gutter Section W ($T - W$)

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)

Discharge outside the Gutter Section W, carried in Section T_x

Discharge within the Gutter Section W ($Q_T - Q_X$)

Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

Maximum Flow Based On Allowable Spread

Flow Velocity within the Gutter Section

$V*d$ Product: Flow Velocity times Gutter Flowline Depth

	Minor Storm	Major Storm	
y	=	4.08	inches
d_c	=	2.0	inches
a	=	1.51	inches
d	=	5.59	inches
T_x	=	15.0	ft
E_o	=	0.350	
Q_X	=	0.0	cfs
Q_W	=	0.0	cfs
Q_{BACK}	=	0.0	cfs
Q_T	=	SUMP	cfs
V	=	0.0	fps
$V*d$	=	0.0	

Maximum Capacity for 1/2 Street based on Allowable Depth

Theoretical Water Spread

Theoretical Spread for Discharge outside the Gutter Section W ($T - W$)

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)

Theoretical Discharge outside the Gutter Section W, carried in Section T_{XTH}

Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})

Discharge within the Gutter Section W ($Q_d - Q_X$)

Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

Total Discharge for Major & Minor Storm (Pre-Safety Factor)

Average Flow Velocity Within the Gutter Section

$V*d$ Product: Flow Velocity Times Gutter Flowline Depth

Slope-Based Depth Safety Reduction Factor for Major & Minor ($d \geq 6$ " Storm)

Max Flow Based on Allowable Depth (Safety Factor Applied)

Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)

Resultant Flow Depth at Street Crown (Safety Factor Applied)

	Minor Storm	Major Storm	
T_{TH}	=	17.0	ft
T_{XTH}	=	15.0	ft
E_o	=	0.349	
Q_{XTH}	=	0.0	cfs
Q_X	=	0.0	cfs
Q_W	=	0.0	cfs
Q_{BACK}	=	0.0	cfs
Q	=	0.0	cfs
V	=	0.0	fps
$V*d$	=	0.0	
R	=	SUMP	
Q_d	=	SUMP	cfs
d	=		inches
d_{CROWN}	=		inches

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

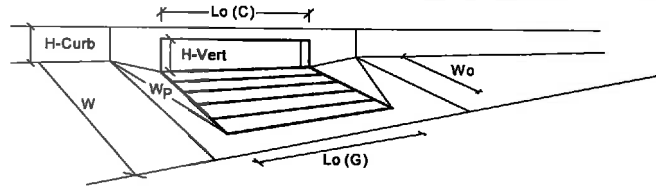
Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

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

	Minor Storm	Major Storm	
Q_{allow}	=	SUMP	cfs

INLET IN A SUMP OR SAG LOCATION

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



Design Information (Input)

Type of Inlet
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')
Number of Unit Inlets (Grate or Curb Opening)
Water Depth at Flowline (outside of local depression)
Grate Information
Length of a Unit Grate
Width of a Unit Grate
Area Opening Ratio for a Grate (typical values 0.15-0.90)
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)
Grate Weir Coefficient (typical value 2.15 - 3.60)
Grate Orifice Coefficient (typical value 0.60 - 0.80)
Curb Opening Information
Length of a Unit Curb Opening
Height of Vertical Curb Opening in Inches
Height of Curb Orifice Throat in Inches
Angle of Throat (see USDCM Figure ST-5)
Side Width for Depression Pan (typically the gutter width of 2 feet)
Clogging Factor for a Single Curb Opening (typical value 0.10)
Curb Opening Weir Coefficient (typical value 2.3-3.7)
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)

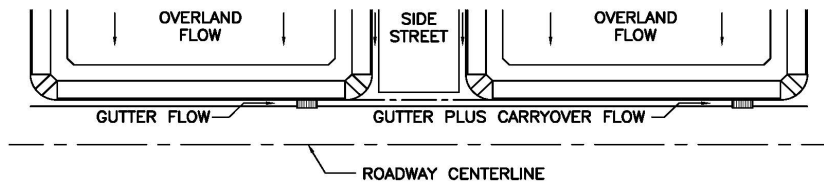
Total Inlet Interception Capacity (assumes clogged condition)

Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)

	MINOR	MAJOR	
Inlet Type =	CDOT Type R Curb Opening		
θ_{local} =	3.00	3.00	inches
No =	2.0	2	
Ponding Depth =	5.6	7.9	inches
	<input checked="" type="checkbox"/> Override Depths		
	MINOR	MAJOR	
$L_g (G)$ =	N/A	N/A	feet
W_g =	N/A	N/A	feet
A_{ratio} =	N/A	N/A	
$C_r (G)$ =	N/A	N/A	
$C_w (G)$ =	N/A	N/A	
$C_o (G)$ =	N/A	N/A	
	MINOR	MAJOR	
$L_g (C)$ =	5.00	5.00	feet
H_{vert} =	6.00	6.00	inches
H_{throat} =	6.00	6.00	inches
Theta =	63.40	63.40	degrees
W_p =	2.00	2.00	feet
$C_r (C)$ =	0.10	0.10	
$C_w (C)$ =	3.60	3.60	
$C_o (C)$ =	0.67	0.67	
	MINOR	MAJOR	
Q_a =	8.7	19.0	cfs
$Q_{PEAK REQUIRED}$ =	3.5	9.7	cfs

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

* Q_{known} =

Minor Storm	Major Storm
3.0	10.4

 cfs

* 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):

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

Flows Developed For:
☐ Street Inlets
☐ Area Inlets in a Medial

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

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

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

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 =

Minor Storm	Major Storm
0.0	0.0

 cfs

Total Design Peak Flow, Q =

Minor Storm	Major Storm
3.0	10.4

 cfs

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FILL IN THIS SECTION
OR...

FILL IN THE
SECTIONS BELOW.
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ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

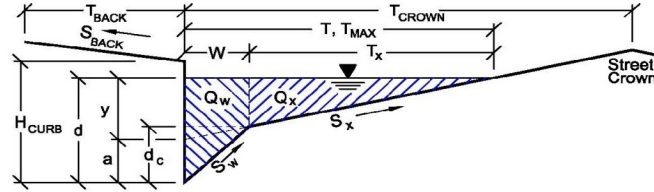
(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

PAINT BRUSH HILLS FILING NO. 14

Inlet ID:

SUMP INLET DP4



Gutter Geometry (Enter data in the blue cells)

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)

$n_{STREET} = 0.020$

Max. Allowable Spread for Minor & Major Storm

Minor Storm 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

Water Depth without Gutter Depression (Eq. ST-2)

Minor Storm Major Storm
 $y = 4.08$ 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

Theoretical Water Spread

Minor Storm Major Storm
 $T_{TH} = 17.0$ 26.6 ft

Theoretical Spread for Discharge outside the Gutter Section W ($T - W$)

$T_{XTH} = 15.0$ 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_{XTH}

$Q_{XTH} = 0.0$ 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

MAJOR STORM Allowable Capacity is based on Depth Criterion

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

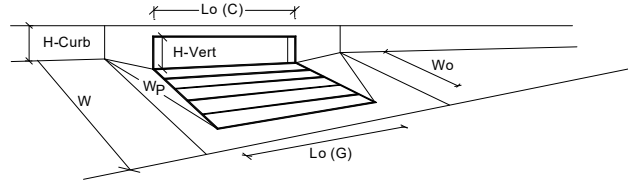
Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

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)

Type of Inlet

Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')

Number of Unit Inlets (Grate or Curb Opening)

Water Depth at Flowline (outside of local depression)

Grate Information

Length of a Unit Grate

Width of a Unit Grate

Area Opening Ratio for a Grate (typical values 0.15-0.90)

Clogging Factor for a Single Grate (typical value 0.50 - 0.70)

Grate Weir Coefficient (typical value 2.15 - 3.60)

Grate Orifice Coefficient (typical value 0.60 - 0.80)

Curb Opening Information

Length of a Unit Curb Opening

Height of Vertical Curb Opening in Inches

Height of Curb Orifice Throat in Inches

Angle of Throat (see USDCM Figure ST-5)

Side Width for Depression Pan (typically the gutter width of 2 feet)

Clogging Factor for a Single Curb Opening (typical value 0.10)

Curb Opening Weir Coefficient (typical value 2.3-3.7)

Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)

Total Inlet Interception Capacity (assumes clogged condition)

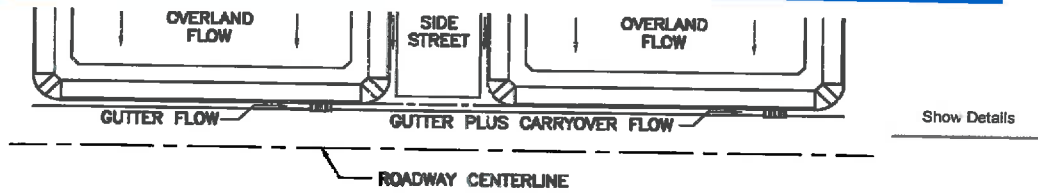
Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)

	MINOR	MAJOR	
Inlet Type =	CDOT Type R Curb Opening		
a _{local} =	3.00	3.00	inches
No =	2.0	2	
Ponding Depth =	5.6	7.9	inches
	MINOR	MAJOR	<input checked="" type="checkbox"/> Override Depths
L _o (G) =	N/A	N/A	feet
W _o =	N/A	N/A	feet
A _{ratio} =	N/A	N/A	
C _r (G) =	N/A	N/A	
C _w (G) =	N/A	N/A	
C _o (G) =	N/A	N/A	
	MINOR	MAJOR	
L _o (C) =	5.00	5.00	feet
H _{vert} =	6.00	6.00	inches
H _{throat} =	6.00	6.00	inches
Theta =	63.40	63.40	degrees
W _p =	2.00	2.00	feet
C _r (C) =	0.10	0.10	
C _w (C) =	3.60	3.60	
C _o (C) =	0.67	0.67	
	MINOR	MAJOR	
Q _a =	8.7	19.0	cfs
Q _{PEAK REQUIRED} =	3.0	10.4	cfs

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

Project:
Inlet ID:

PAINT BRUSH HILLS FILING NO. 14
SUMP INLET DP5



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} = $ <input type="text" value="1.1"/> <input type="text" value="2.7"/> cfs		← FILL IN THIS SECTION OR... ← FILL IN THE SECTIONS BELOW.
* 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):				
Site Type: <input type="radio"/> Site is Urban <input type="radio"/> Site is Non-Urban	Flows Developed For: <input type="radio"/> Street Inlets <input type="radio"/> Area Inlets in a Median	Subcatchment Area = <input type="text"/> Acres Percent Imperviousness = <input type="text"/> % NRCS Soil Type = <input type="text"/> A, B, C, or D		
		Slope (ft/ft) Length (ft) Overland Flow = <input type="text"/> <input type="text"/> Channel Flow = <input type="text"/> <input type="text"/>		
Rainfall Information: Intensity I (in/hr) = $C_1 \cdot P_1 / (C_2 + T_e) \wedge C_3$				
Design Storm Return Period, $T_r = $ <input type="text"/> years Return Period One-Hour Precipitation, $P_1 = $ <input type="text"/> inches		Minor Storm Major Storm		
		$C_1 = $ <input type="text"/> $C_2 = $ <input type="text"/> $C_3 = $ <input type="text"/>		
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), $C = $ <input type="text"/> User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), $C_5 = $ <input type="text"/>		$C_1 = $ <input type="text"/> $C_2 = $ <input type="text"/> $C_3 = $ <input type="text"/>		
Bypass (Carry-Over) Flow from upstream Subcatchments, $Q_b = $ <input type="text"/>		0.0 0.0 cfs		
Total Design Peak Flow, $Q = $ <input type="text" value="1.1"/> <input type="text" value="2.7"/> cfs				

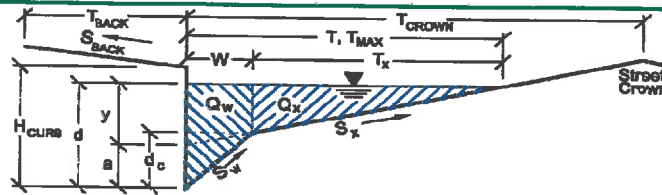
ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

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

Project:
Inlet ID:

PAINT BRUSH HILLS FILING NO. 14

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)

$n_{STREET} = 0.020$

Max. Allowable Spread for Minor & Major Storm

Minor Storm 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

Water Depth without Gutter Depression (Eq. ST-2)

Minor Storm Major Storm
 $y = 4.08$ 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

$Q_T = \text{SUMP}$ 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

Theoretical Water Spread

Minor Storm Major Storm
 $T_{TH} = 17.0$ 26.6 ft

Theoretical Spread for Discharge outside the Gutter Section W (T - W)

$T_{XTH} = 15.0$ 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_{XTH}

$Q_{XTH} = 0.0$ 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

$R = \text{SUMP}$ SUMP

Max Flow Based on Allowable Depth (Safety Factor Applied)

$Q_d = \text{SUMP}$ 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 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'

Minor Storm Major Storm
 $Q_{allow} = \text{SUMP}$ SUMP cfs

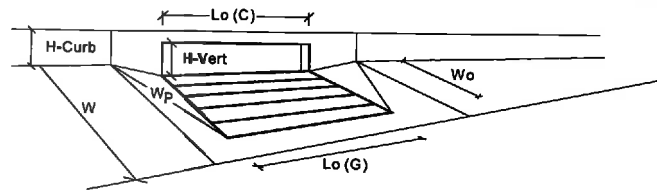
INLET IN A SUMP OR SAG LOCATION

Project =

PAINT BRUSH HILLS FILING NO. 14

Inlet ID =

SUMP INLET DP5



Design Information (Input)

Type of Inlet

Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')

Number of Unit Inlets (Grate or Curb Opening)

Water Depth at Flowline (outside of local depression)

Grate Information

Length of a Unit Grate

Width of a Unit Grate

Area Opening Ratio for a Grate (typical values 0.15-0.90)

Clogging Factor for a Single Grate (typical value 0.50 - 0.70)

Grate Weir Coefficient (typical value 2.15 - 3.60)

Grate Orifice Coefficient (typical value 0.60 - 0.80)

Curb Opening Information

Length of a Unit Curb Opening

Height of Vertical Curb Opening in Inches

Height of Curb Orifice Throat in Inches

Angle of Throat (see USDCM Figure ST-5)

Side Width for Depression Pan (typically the gutter width of 2 feet)

Clogging Factor for a Single Curb Opening (typical value 0.10)

Curb Opening Weir Coefficient (typical value 2.3-3.7)

Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)

	MINOR	MAJOR
Inlet Type =	CDOT Type R Curb Opening	
a_{local} =	3.00	3.00
N_o =	1.0	1
Ponding Depth =	5.6	7.9

☒ Override Depths

	MINOR	MAJOR
$L_o (G)$ =	N/A	N/A
W_o =	N/A	N/A
A_{ratio} =	N/A	N/A
$C_r (G)$ =	N/A	N/A
$C_w (G)$ =	N/A	N/A
$C_o (G)$ =	N/A	N/A

	MINOR	MAJOR
$L_o (C)$ =	5.00	5.00
H_{vert} =	6.00	6.00
H_{throat} =	6.00	6.00
Θ =	63.40	63.40
W_p =	2.00	2.50
$C_r (C)$ =	0.10	0.10
$C_w (C)$ =	3.60	3.60
$C_o (C)$ =	0.67	0.67

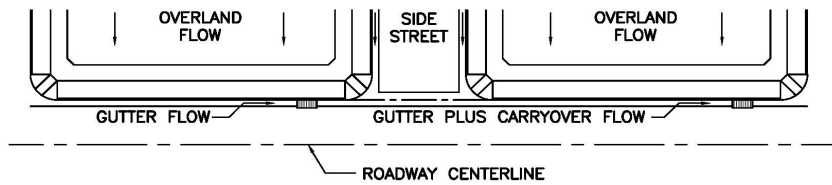
Total Inlet Interception Capacity (assumes clogged condition)

Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)

	MINOR	MAJOR
Q_a =	4.6	9.1
$Q_{\text{PEAK REQUIRED}}$ =	1.1	2.7

**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 *Q _{known} = <u>9.2</u> cfs	Major Storm <u>22.2</u> cfs
* 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):			
Site Type: <input type="radio"/> Site is Urban <input type="radio"/> Site is Non-Urban	Flows Developed For: <input type="radio"/> Street Inlets <input type="radio"/> Area Inlets in a Medial	Subcatchment Area = <u> </u> Acres Percent Imperviousness = <u> </u> % NRCS Soil Type = <u> </u> A, B, C, or D	<--- FILL IN THIS SECTION OR... FILL IN THE SECTIONS BELOW. <---
		Slope (ft/ft) Length (ft) Overland Flow = <u> </u> <u> </u> Channel Flow = <u> </u> <u> </u>	
Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + I_c)^{C_3}$		Minor Storm Design Storm Return Period, T _r = <u> </u> years Return Period One-Hour Precipitation, P ₁ = <u> </u> inches C ₁ = <u> </u> C ₂ = <u> </u> C ₃ = <u> </u> User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C = <u> </u> User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C ₅ = <u> </u>	Major Storm <u> </u> years <u> </u> inches <u> </u> <u> </u> <u> </u> <u> </u>
Bypass (Carry-Over) Flow from upstream Subcatchments, Q _b = <u> </u>		<u>0.0</u>	<u>0.0</u> cfs
Total Design Peak Flow, Q = <u> </u>		<u>9.2</u>	<u>22.2</u> cfs

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

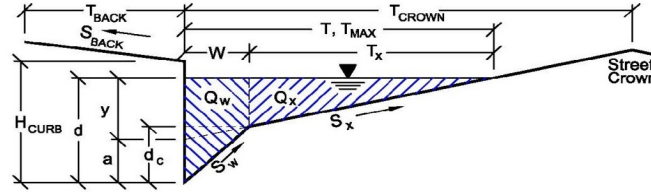
(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

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)

$n_{STREET} = 0.020$

Max. Allowable Spread for Minor & Major Storm

Minor Storm 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

Water Depth without Gutter Depression (Eq. ST-2)

Minor Storm Major Storm
 $y = 4.08$ 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

Theoretical Water Spread

Minor Storm Major Storm
 $T_{TH} = 17.0$ 26.6 ft

Theoretical Spread for Discharge outside the Gutter Section W ($T - W$)

$T_{XTH} = 15.0$ 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_{XTH}

$Q_{XTH} = 0.0$ 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

MAJOR STORM Allowable Capacity is based on Depth Criterion

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

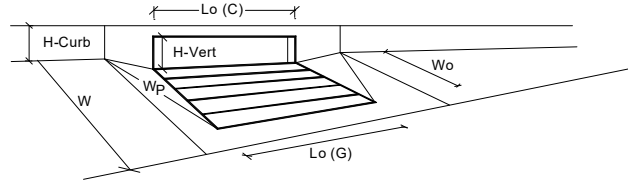
Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

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 DP6



Design Information (Input)

Type of Inlet

Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')

Number of Unit Inlets (Grate or Curb Opening)

Water Depth at Flowline (outside of local depression)

Grate Information

Length of a Unit Grate

Width of a Unit Grate

Area Opening Ratio for a Grate (typical values 0.15-0.90)

Clogging Factor for a Single Grate (typical value 0.50 - 0.70)

Grate Weir Coefficient (typical value 2.15 - 3.60)

Grate Orifice Coefficient (typical value 0.60 - 0.80)

Curb Opening Information

Length of a Unit Curb Opening

Height of Vertical Curb Opening in Inches

Height of Curb Orifice Throat in Inches

Angle of Throat (see USDCM Figure ST-5)

Side Width for Depression Pan (typically the gutter width of 2 feet)

Clogging Factor for a Single Curb Opening (typical value 0.10)

Curb Opening Weir Coefficient (typical value 2.3-3.7)

Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)

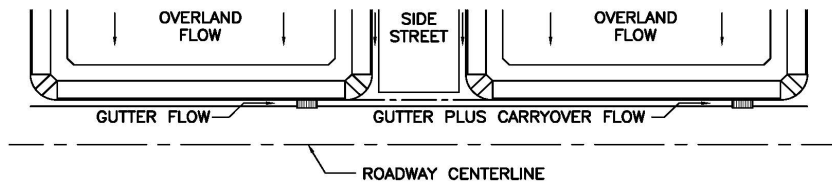
Total Inlet Interception Capacity (assumes clogged condition)

Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)

	MINOR	MAJOR	
Inlet Type =	CDOT Type R Curb Opening		
a_{local} =	3.00	3.00	inches
N_o =	3.0	3	
Ponding Depth =	5.6	7.9	inches
	MINOR	MAJOR	<input checked="" type="checkbox"/> Override Depths
$L_o (G)$ =	N/A	N/A	feet
W_o =	N/A	N/A	feet
A_{ratio} =	N/A	N/A	
$C_r (G)$ =	N/A	N/A	
$C_w (G)$ =	N/A	N/A	
$C_o (G)$ =	N/A	N/A	
	MINOR	MAJOR	
$L_o (C)$ =	5.00	5.00	feet
H_{vert} =	6.00	6.00	inches
H_{throat} =	6.00	6.00	inches
Θ =	63.40	63.40	degrees
W_p =	2.00	2.00	feet
$C_r (C)$ =	0.10	0.10	
$C_w (C)$ =	3.60	3.60	
$C_o (C)$ =	0.67	0.67	
	MINOR	MAJOR	
Q_a =	11.1	27.3	cfs
$Q_{PEAK REQUIRED}$ =	9.2	22.2	cfs

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

Project: PAINTE 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 *Q _{known} = <u>1.9</u> cfs	Major Storm <u>22.2</u> cfs	<--- FILL IN THIS SECTION OR... FILL IN THE SECTIONS BELOW. <---
* 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):				
Site Type: <input type="radio"/> Site is Urban <input type="radio"/> Site is Non-Urban	Flows Developed For: <input type="radio"/> Street Inlets <input type="radio"/> Area Inlets in a Medial	Subcatchment Area = <u> </u> Acres Percent Imperviousness = <u> </u> % NRCS Soil Type = <u> </u> A, B, C, or D		
		Slope (ft/ft) Length (ft) Overland Flow = <u> </u> <u> </u> Channel Flow = <u> </u> <u> </u>		
Rainfall Information: Intensity I (inch/hr) = $C_1 \cdot P_1 / (C_2 + I_c)^{C_3}$				
Design Storm Return Period, T _r = <u> </u> years Return Period One-Hour Precipitation, P ₁ = <u> </u> inches C ₁ = <u> </u> C ₂ = <u> </u> C ₃ = <u> </u>		Minor Storm <u> </u> <u> </u> <u> </u> <u> </u>	Major Storm <u> </u> <u> </u> <u> </u> <u> </u>	
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C = <u> </u> User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C ₅ = <u> </u>				
Bypass (Carry-Over) Flow from upstream Subcatchments, Q _b = <u> </u>		Minor Storm <u>0.0</u>	Major Storm <u>0.0</u>	cfs
Total Design Peak Flow, Q = <u> </u>		<u>1.9</u>	<u>22.2</u>	cfs

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

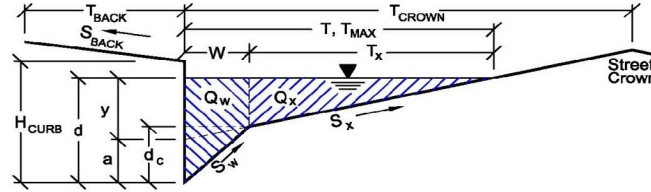
(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

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)

$n_{STREET} = 0.020$

Max. Allowable Spread for Minor & Major Storm

Minor Storm 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

Water Depth without Gutter Depression (Eq. ST-2)

Minor Storm Major Storm
 $y = 4.08$ 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

Theoretical Water Spread

Minor Storm Major Storm
 $T_{TH} = 17.0$ 26.6 ft

Theoretical Spread for Discharge outside the Gutter Section W ($T - W$)

$T_{xTH} = 15.0$ 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_{xTH}

$Q_{xTH} = 0.0$ 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

MAJOR STORM Allowable Capacity is based on Depth Criterion

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

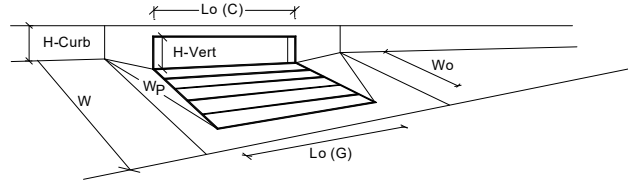
Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

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 DP7



Design Information (Input)

Type of Inlet

Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')

Number of Unit Inlets (Grate or Curb Opening)

Water Depth at Flowline (outside of local depression)

Grate Information

Length of a Unit Grate

Width of a Unit Grate

Area Opening Ratio for a Grate (typical values 0.15-0.90)

Clogging Factor for a Single Grate (typical value 0.50 - 0.70)

Grate Weir Coefficient (typical value 2.15 - 3.60)

Grate Orifice Coefficient (typical value 0.60 - 0.80)

Curb Opening Information

Length of a Unit Curb Opening

Height of Vertical Curb Opening in Inches

Height of Curb Orifice Throat in Inches

Angle of Throat (see USDCM Figure ST-5)

Side Width for Depression Pan (typically the gutter width of 2 feet)

Clogging Factor for a Single Curb Opening (typical value 0.10)

Curb Opening Weir Coefficient (typical value 2.3-3.7)

Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)

Total Inlet Interception Capacity (assumes clogged condition)

Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)

	MINOR	MAJOR	
Inlet Type =	CDOT Type R Curb Opening		
a_{local} =	3.00	3.00	inches
N_o =	3.0	3	
Ponding Depth =	5.6	7.9	inches
	MINOR	MAJOR	<input checked="" type="checkbox"/> Override Depths
$L_o (G)$ =	N/A	N/A	feet
W_o =	N/A	N/A	feet
A_{ratio} =	N/A	N/A	
$C_r (G)$ =	N/A	N/A	
$C_w (G)$ =	N/A	N/A	
$C_o (G)$ =	N/A	N/A	
	MINOR	MAJOR	
$L_o (C)$ =	5.00	5.00	feet
H_{vert} =	6.00	6.00	inches
H_{throat} =	6.00	6.00	inches
Θ =	63.40	63.40	degrees
W_p =	2.00	2.00	feet
$C_r (C)$ =	0.10	0.10	
$C_w (C)$ =	3.60	3.60	
$C_o (C)$ =	0.67	0.67	
	MINOR	MAJOR	
Q_a =	11.1	27.3	cfs
$Q_{PEAK REQUIRED}$ =	1.9	22.2	cfs

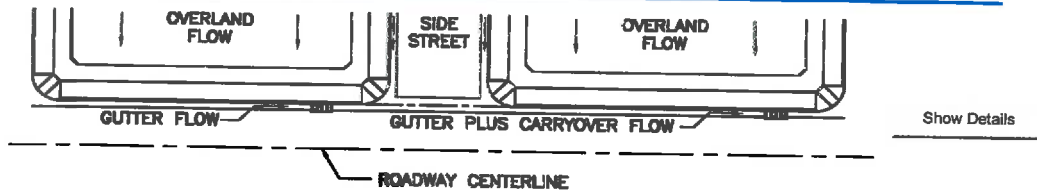
DESIGN PEAK FLOW FOR ONE-HALF OF STREET OR GRASS-LINED CHANNEL BY THE RATIONAL METHOD

Project:

PAINT BRUSH HILLS FILING NO. 14

Inlet ID:

AT-GRADE INLET DP9



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

***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):

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

Flows Developed For: ☐ Street Inlets ☐ Area Inlets in a Medial

Subcatchment Area = Acres

Percent Imperviousness = %

NRCS Soil Type = A, B, C, or D

Slope (ft/ft) Length (ft)

Overland Flow =

Channel Flow =

Rainfall Information: Intensity I (in/hr) = $C_1 \cdot P_1 / (C_2 + 1.0)^{C_3}$

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 = cfs

Total Design Peak Flow, Q = cfs

← FILL IN THIS SECTION
OR...

← FILL IN THE SECTIONS
BELOW.

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

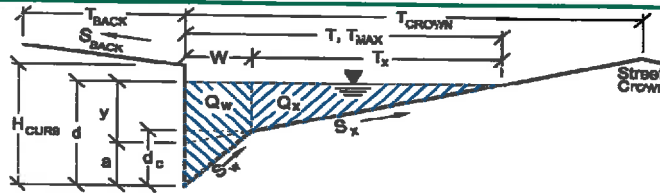
(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

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)

$n_{STREET} = 0.020$

Max. Allowable Spread for Minor & Major Storm

	Minor Storm	Major Storm
$T_{MAX} =$	17.0	17.0

 ft

Max. Allowable Depth at Gutter Flowline for Minor & Major Storm

	Minor Storm	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

Water Depth without Gutter Depression (Eq. ST-2)

	Minor Storm	Major Storm
$y =$	4.08	4.08

 inches

Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")

	Minor Storm	Major Storm
$d_c =$	2.0	2.0

 inches

Gutter Depression ($d_c - (W * S_X * 12)$)

	Minor Storm	Major Storm
$a =$	1.51	1.51

 inches

Water Depth at Gutter Flowline

	Minor Storm	Major Storm
$d =$	5.59	5.59

 inches

Allowable Spread for Discharge outside the Gutter Section W ($T - W$)

	Minor Storm	Major Storm
$T_X =$	15.0	15.0

 ft

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)

	Minor Storm	Major Storm
$E_o =$	0.350	0.350

Discharge outside the Gutter Section W, carried in Section T_X

	Minor Storm	Major Storm
$Q_X =$	7.6	7.6

 cfs

Discharge within the Gutter Section W ($Q_T - Q_X$)

	Minor Storm	Major Storm
$Q_W =$	4.1	4.1

 cfs

Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

	Minor Storm	Major Storm
$Q_{BACK} =$	0.0	0.0

 cfs

Maximum Flow Based On Allowable Spread

	Minor Storm	Major Storm
$Q_T =$	11.7	11.7

 cfs

Flow Velocity within the Gutter Section

	Minor Storm	Major Storm
$V =$	5.3	5.3

 fps

$V*d$ Product: Flow Velocity times Gutter Flowline Depth

	Minor Storm	Major Storm
$V*d =$	2.5	2.5

Maximum Capacity for 1/2 Street based on Allowable Depth

Theoretical Water Spread

	Minor Storm	Major Storm
$T_{TH} =$	17.0	26.6

 ft

Theoretical Spread for Discharge outside the Gutter Section W ($T - W$)

	Minor Storm	Major Storm
$T_{XTH} =$	15.0	24.6

 ft

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)

	Minor Storm	Major Storm
$E_o =$	0.349	0.220

Theoretical Discharge outside the Gutter Section W, carried in Section T_{XTH}

	Minor Storm	Major Storm
$Q_{XTH} =$	7.6	28.4

 cfs

Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})

	Minor Storm	Major Storm
$Q_X =$	7.6	26.1

 cfs

Discharge within the Gutter Section W ($Q_d - Q_X$)

	Minor Storm	Major Storm
$Q_W =$	4.1	8.0

 cfs

Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

	Minor Storm	Major Storm
$Q_{BACK} =$	0.0	1.4

 cfs

Total Discharge for Major & Minor Storm (Pre-Safety Factor)

	Minor Storm	Major Storm
$Q =$	11.7	35.5

 cfs

Average Flow Velocity Within the Gutter Section

	Minor Storm	Major Storm
$V =$	5.3	7.0

 fps

$V*d$ Product: Flow Velocity Times Gutter Flowline Depth

	Minor Storm	Major Storm
$V*d =$	2.5	4.6

Slope-Based Depth Safety Reduction Factor for Major & Minor ($d \geq 6"$) Storm

	Minor Storm	Major Storm
$R =$	1.00	0.91

Max Flow Based on Allowable Depth (Safety Factor Applied)

	Minor Storm	Major Storm
$Q_d =$	11.7	32.2

 cfs

Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)

	Minor Storm	Major Storm
$d =$	5.60	7.66

 inches

Resultant Flow Depth at Street Crown (Safety Factor Applied)

	Minor Storm	Major Storm
$d_{CROWN} =$	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

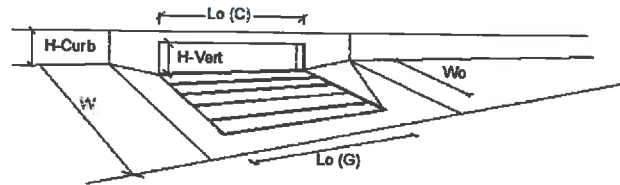
 cfs

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

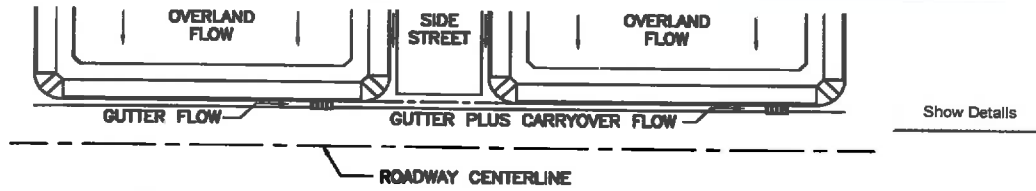
Project: PAINT BRUSH HILLS FILING NO. 14
Inlet ID: AT-GRADE INLET DP9



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)	N_o =	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_{r-G} =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_{r-C} =	0.10	0.10	
Street Hydraulics: OK - $Q < \text{maximum allowable from sheet 'Q-Allow'}$				
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_i/Q_o =	$C\%$ =	100	78	%

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



Design Flow: ONLY if already determined through other methods: (local peak flow for 1/2 of street OR grass-lined channel):		Minor Storm *Q _{Known} = <u>7.3</u> cfs	Major Storm <u>18.1</u> cfs
* 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):			
Site Type: <input type="radio"/> Site is Urban <input type="radio"/> Site is Non-Urban	Flows Developed For: <input type="radio"/> Street Inlets <input type="radio"/> Area Inlets in a Medial	Subcatchment Area = <u> </u> Acres Percent Imperviousness = <u> </u> % NRCS Soil Type = <u> </u> A, B, C, or D	← FILL IN THIS SECTION OR... FILL IN THE SECTIONS BELOW. ←
		Slope (ft/ft) Length (ft) Overland Flow = <u> </u> <u> </u> Channel Flow = <u> </u> <u> </u>	
Rainfall Information: Intensity I (inch/hr) = $C_1 \cdot P_1 / (C_2 + 1.0) \cdot C_3$			
		Design Storm Return Period, T _r = <u> </u> years Return Period One-Hour Precipitation, P ₁ = <u> </u> inches C ₁ = <u> </u> C ₂ = <u> </u> C ₃ = <u> </u>	Minor Storm <u> </u> Major Storm <u> </u>
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C = <u> </u> User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C ₅ = <u> </u>			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q _b = <u> </u>		<u>0.0</u>	<u>0.0</u> cfs
Total Design Peak Flow, Q = <u> </u>		<u>7.3</u>	<u>18.1</u> cfs

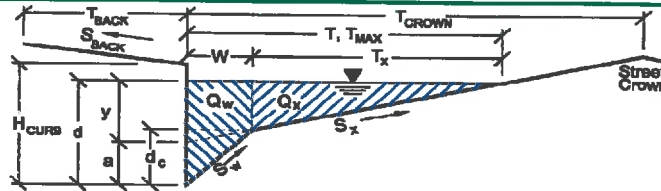
ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

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

Project:
Inlet ID:

PAINT BRUSH HILLS FILING NO. 14

AT-GRADE INLET DP10



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)
Height of Curb at Gutter Flow Line
Distance from Curb Face to Street Crown
Gutter Width
Street Transverse Slope
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)
Street Longitudinal Slope - Enter 0 for sump condition
Manning's Roughness for Street Section (typically between 0.012 and 0.020)

T _{BACK}	8.0	ft
S _{BACK}	0.020	ft/ft
n _{BACK}	0.020	
H _{CURB}	6.00	inches
T _{CROWN}	17.0	ft
W	2.00	ft
S _x	0.020	ft/ft
S _w	0.083	ft/ft
S _o	0.016	ft/ft
n _{STREET}	0.020	

Max. Allowable Spread for Minor & Major Storm
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm
Allow Flow Depth at Street Crown (leave blank for no)

	Minor Storm	Major Storm	
T _{MAX}	17.0	17.0	ft
d _{MAX}	5.6	7.9	inches
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread

Water Depth without Gutter Depression (Eq. ST-2)
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")
Gutter Depression (d_c - (W * S_x * 12))
Water Depth at Gutter Flowline
Allowable Spread for Discharge outside the Gutter Section W (T - W)
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)
Discharge outside the Gutter Section W, carried in Section T_x
Discharge within the Gutter Section W (Q_T - Q_x)
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

	Minor Storm	Major Storm	
y	4.08	4.08	inches
d _c	2.0	2.0	inches
a	1.51	1.51	inches
d	5.59	5.59	inches
T _x	15.0	15.0	ft
E _o	0.350	0.350	
Q _x	7.1	7.1	cfs
Q _w	3.8	3.8	cfs
Q _{BACK}	0.0	0.0	cfs
Q _T	11.0	11.0	cfs
V	5.0	5.0	fps
V*d	2.3	2.3	

Maximum Flow Based On Allowable Spread

Flow Velocity within the Gutter Section
V*d Product: Flow Velocity times Gutter Flowline Depth

Maximum Capacity for 1/2 Street based on Allowable Depth

Theoretical Water Spread
Theoretical Spread for Discharge outside the Gutter Section W (T - W)
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)
Theoretical Discharge outside the Gutter Section W, carried in Section T_x TH
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})
Discharge within the Gutter Section W (Q_d - Q_x)
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)
Total Discharge for Major & Minor Storm (Pre-Safety Factor)
Average Flow Velocity Within the Gutter Section
V*d Product: Flow Velocity Times Gutter Flowline Depth
Slope-Based Depth Safety Reduction Factor for Major & Minor (d ≥ 6") Storm
Max Flow Based on Allowable Depth (Safety Factor Applied)
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)
Resultant Flow Depth at Street Crown (Safety Factor Applied)

	Minor Storm	Major Storm	
T _{TH}	17.0	26.6	ft
T _x TH	15.0	24.6	ft
E _o	0.349	0.220	
Q _x TH	7.2	26.8	cfs
Q _x	7.2	24.6	cfs
Q _w	3.9	7.5	cfs
Q _{BACK}	0.0	1.3	cfs
Q	11.0	33.4	cfs
V	5.0	6.6	fps
V*d	2.3	4.3	
R	1.00	1.00	
Q _d	11.0	33.3	cfs
d	5.60	7.90	inches
d _{CROWN}	0.01	2.30	inches

MINOR STORM Allowable Capacity is based on Spread Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

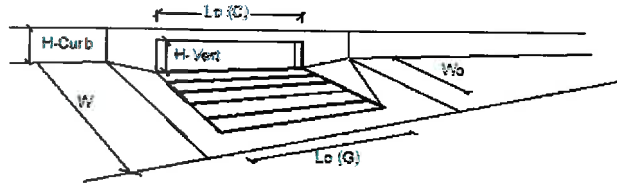
	Minor Storm	Major Storm	
Q _{allow}	11.0	33.3	cfs

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

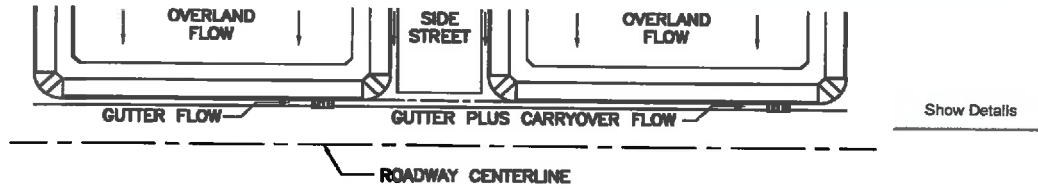
Project: PAINT BRUSH HILLS FILING NO. 14
Inlet ID: AT-GRADE INLET DP10



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)	$N_o =$	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)	$C_r-G =$	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	$C_r-C =$	0.10	0.10	
Street Hydraulics: OK - $Q < \text{maximum allowable from sheet 'Q-Allow'}$				
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 = $Q_d/Q_o =$	$C\% =$	100	77	%

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



Design Flow: ONLY if already determined through other methods: (local peak flow for 1/2 of street OR grass-lined channel):		*Q _{known} = <input type="text" value="3.7"/> <input type="text" value="17.0"/> cfs	← FILL IN THIS SECTION OR... ← FILL IN THE SECTIONS BELOW.
* 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):			
Site Type: <input type="radio"/> Site is Urban <input type="radio"/> Site is Non-Urban	Flows Developed For: <input type="radio"/> Street Inlets <input type="radio"/> Area Inlets in a Medial	Subcatchment Area = <input type="text"/> Acres Percent Imperviousness = <input type="text"/> % NRCS Soil Type = <input type="text"/> A, B, C, or D	
		Slope (ft/ft) <input type="text"/> Length (ft) <input type="text"/> Overland Flow = <input type="text"/> Channel Flow = <input type="text"/>	
Rainfall Information: Intensity I (inch/hr) = $C_1 \cdot P_1 / (C_2 + T_o)^{C_3}$			
		Design Storm Return Period, T _r = <input type="text"/> years Return Period One-Hour Precipitation, P ₁ = <input type="text"/> inches C ₁ = <input type="text"/> C ₂ = <input type="text"/> C ₃ = <input type="text"/> User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C = <input type="text"/> User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C ₅ = <input type="text"/> Bypass (Carry-Over) Flow from upstream Subcatchments, Q _b = <input type="text"/> 0.0 <input type="text"/> 0.0 cfs	
		Total Design Peak Flow, Q = <input type="text" value="3.7"/> <input type="text" value="17.0"/> cfs	

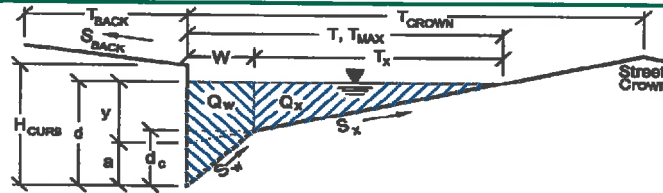
ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

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

Project:
Inlet ID:

PAINT BRUSH HILLS FILING NO. 14

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

$S_0 = 0.014$ ft/ft

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$n_{STREET} = 0.020$

Max. Allowable Spread for Minor & Major Storm

$T_{MAX} = 17.0$ Minor Storm 17.0 Major Storm 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

Water Depth without Gutter Depression (Eq. ST-2)

$y = 4.08$ Minor Storm 4.08 Major Storm inches

Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")

$d_c = 2.0$ 2.0 inches

Gutter Depression ($d_c - (W \cdot S_x \cdot 12)$)

$a = 1.51$ 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)

$E_0 = 0.350$ 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

$V \cdot d$ Product: Flow Velocity times Gutter Flowline Depth

$V \cdot d = 2.2$ 2.2

Maximum Capacity for 1/2 Street based on Allowable Depth

Theoretical Water Spread

$T_{TH} = 17.0$ Minor Storm 26.6 Major Storm 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)

$E_0 = 0.349$ 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

$V \cdot d$ Product: Flow Velocity Times Gutter Flowline Depth

$V \cdot d = 2.2$ 4.0

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)

$Q_d = 10.3$ 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

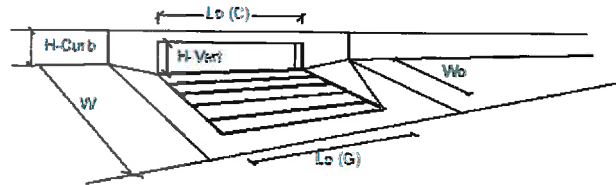
$Q_{allow} = 10.3$ Minor Storm 31.3 Major Storm cfs

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

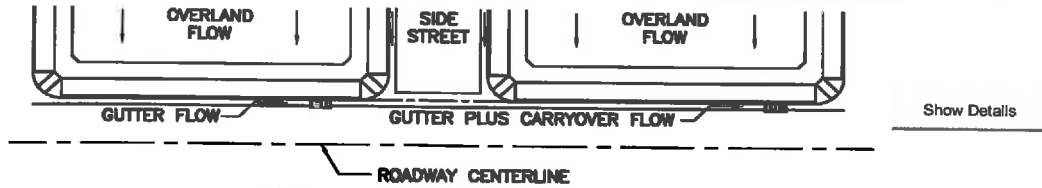
Project: PAINT BRUSH HILLS FILING NO. 14
 Inlet ID: AT-GRADE INLET DP11



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDDT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 's' from 'Q-Allow')	s_{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_rG =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_rC =	0.10	0.10	
Street Hydraulics: OK - $Q < \text{maximum allowable from sheet 'Q-Allow'}$				
Total Inlet Interception Capacity	Q_i =	3.70	13.51	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_o =	0.0	3.5	cfs
Capture Percentage = Q_i/Q_o =	C% =	100	79	%

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



Design Flow: ONLY if already determined through other methods: (local peak flow for 1/2 of street OR grass-lined channel):		Minor Storm *Q _{Known} = <u>3.7</u> cfs	Major Storm <u>13.0</u> cfs	← FILL IN THIS SECTION OR... ← FILL IN THE SECTIONS BELOW.
* 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):				
Site Type: <input type="radio"/> Site is Urban <input type="radio"/> Site is Non-Urban	Flows Developed For: <input type="radio"/> Street Inlets <input type="radio"/> Area Inlets in a Medial	Subcatchment Area = <u> </u> Acres Percent Imperviousness = <u> </u> % NRCS Soil Type = <u> </u> A, B, C, or D		
		Slope (ft/ft) <u> </u> Length (ft) <u> </u> Overland Flow = <u> </u> Channel Flow = <u> </u>		
Rainfall Information: Intensity I (inches/hr) = $C_1 \cdot P_1 / (C_2 + 10) \wedge C_3$				
		Design Storm Return Period, T _r = <u> </u> years Return Period One-Hour Precipitation, P ₁ = <u> </u> inches C ₁ = <u> </u> C ₂ = <u> </u> C ₃ = <u> </u> User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C = <u> </u> User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C ₅ = <u> </u> Bypass (Carry-Over) Flow from upstream Subcatchments, Q _b = <u>0.0</u> cfs		
		Total Design Peak Flow, Q = <u>3.7</u> cfs		

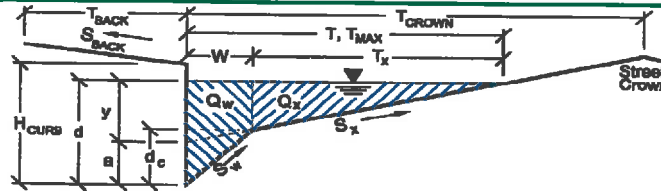
ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

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

Project:
Inlet ID:

PAINT BRUSH HILLS FILING NO. 14

AT-GRADE INLET *DP37



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)
Height of Curb at Gutter Flow Line
Distance from Curb Face to Street Crown
Gutter Width
Street Transverse Slope
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)
Street Longitudinal Slope - Enter 0 for sump condition
Manning's Roughness for Street Section (typically between 0.012 and 0.020)

T_{BACK}	8.0	ft
S_{BACK}	0.020	ft/ft
n_{BACK}	0.020	
H_{CURB}	6.00	inches
T_{CROWN}	17.0	ft
W	2.00	ft
S_X	0.020	ft/ft
S_W	0.083	ft/ft
S_O	0.014	ft/ft
n_{STREET}	0.020	

Max. Allowable Spread for Minor & Major Storm
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm
Allow Flow Depth at Street Crown (leave blank for no)

	Minor Storm	Major Storm	
T_{MAX}	17.0	17.0	ft
d_{MAX}	5.6	7.9	inches
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread

Water Depth without Gutter Depression (Eq. ST-2)
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")
Gutter Depression ($d_c - (W * S_x * 12)$)
Water Depth at Gutter Flowline
Allowable Spread for Discharge outside the Gutter Section W ($T - W$)
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)
Discharge outside the Gutter Section W, carried in Section T_X
Discharge within the Gutter Section W ($Q_T - Q_X$)
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)
Maximum Flow Based On Allowable Spread
Flow Velocity within the Gutter Section
 $V*d$ Product: Flow Velocity times Gutter Flowline Depth

	Minor Storm	Major Storm	
y	4.08	4.08	inches
d_c	2.0	2.0	inches
a	1.51	1.51	inches
d	5.59	5.59	inches
T_X	15.0	15.0	ft
E_o	0.350	0.350	
Q_X	6.7	6.7	cfs
Q_W	3.6	3.6	cfs
Q_{BACK}	0.0	0.0	cfs
Q_T	10.3	10.3	cfs
V	4.7	4.7	fps
$V*d$	2.2	2.2	

Maximum Capacity for 1/2 Street based on Allowable Depth

Theoretical Water Spread
Theoretical Spread for Discharge outside the Gutter Section W ($T - W$)
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)
Theoretical Discharge outside the Gutter Section W, carried in Section T_{XTH}
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})
Discharge within the Gutter Section W ($Q_d - Q_X$)
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)
Total Discharge for Major & Minor Storm (Pre-Safety Factor)
Average Flow Velocity Within the Gutter Section
 $V*d$ Product: Flow Velocity Times Gutter Flowline Depth
Slope-Based Depth Safety Reduction Factor for Major & Minor ($d \geq 6"$) Storm
Max Flow Based on Allowable Depth (Safety Factor Applied)
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)
Resultant Flow Depth at Street Crown (Safety Factor Applied)

	Minor Storm	Major Storm	
T_{TH}	17.0	26.6	ft
T_{XTH}	15.0	24.6	ft
E_o	0.349	0.220	
Q_{XTH}	6.7	25.0	cfs
Q_X	6.7	23.0	cfs
Q_W	3.6	7.1	cfs
Q_{BACK}	0.0	1.2	cfs
Q	10.3	31.3	cfs
V	4.7	6.1	fps
$V*d$	2.2	4.0	
R	1.00	1.00	
Q_d	10.3	31.3	cfs
d	5.60	7.90	inches
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

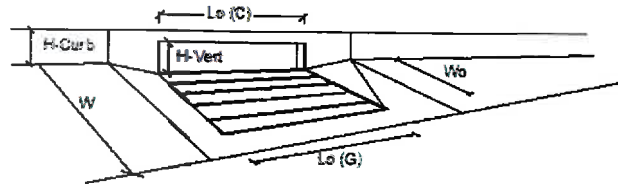
	Minor Storm	Major Storm	
Q_{allow}	10.3	31.3	cfs

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

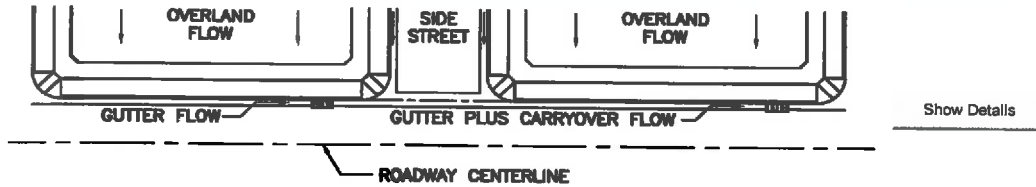
Project: PAINT BRUSH HILLS FILING NO. 14
Inlet ID: AT-GRADE INLET "DP37"



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)	N_o =	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)	$C_r G$ =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	$C_r C$ =	0.10	0.10	
Street Hydraulics: OK - $Q < \text{maximum allowable from sheet 'Q-Allow'}$				
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_i/Q_o =	$C\%$ =	100	88	%

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



Design Flow: ONLY if already determined through other methods: (local peak flow for 1/2 of street OR grass-lined channel):		Minor Storm *Q _{Known} = <u>6.0</u> cfs	Major Storm <u>14.9</u> cfs	← FILL IN THIS SECTION OR... ← FILL IN THE SECTIONS BELOW.
* 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):				
Site Type: <input type="radio"/> Site is Urban <input type="radio"/> Site is Non-Urban	Flows Developed For: <input type="radio"/> Street Inlets <input type="radio"/> Area Inlets in a Medial	Subcatchment Area = <u> </u> Acres Percent Imperviousness = <u> </u> % NRCS Soil Type = <u> </u> A, B, C, or D		
		Slope (ft/ft) <u> </u> Length (ft) <u> </u> Overland Flow = <u> </u> Channel Flow = <u> </u>		
Rainfall Information: Intensity i (in/hr) = $C_1 \cdot P_1 / (C_2 + T_p)^{C_3}$				
		Design Storm Return Period, T_r = <u> </u> years Return Period One-Hour Precipitation, P_1 = <u> </u> inches C_1 = <u> </u> C_2 = <u> </u> C_3 = <u> </u> User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C = <u> </u> User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 = <u> </u> Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b = <u>0.0</u> cfs		
		Total Design Peak Flow, Q = <u>6.0</u> cfs	<u>14.9</u> cfs	

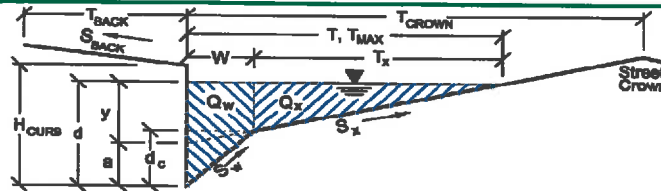
ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

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

Project:
inlet ID:

PAINT BRUSH HILLS FILING NO. 14

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)

$n_{STREET} = 0.020$

Max. Allowable Spread for Minor & Major Storm

Minor Storm 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

Water Depth without Gutter Depression (Eq. ST-2)

Minor Storm Major Storm
 $y = 4.08$ 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

Theoretical Water Spread

Minor Storm Major Storm
 $T_{TH} = 17.0$ 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 ($d \geq 6"$) 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 Allowable Capacity is based on Spread Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

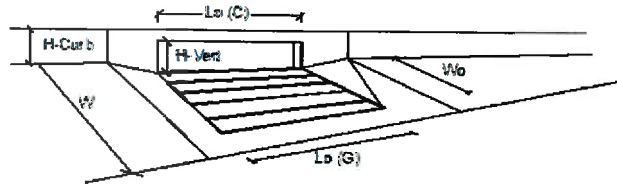
Minor Storm Major Storm
 $Q_{allow} = 8.8$ 26.7 cfs

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'

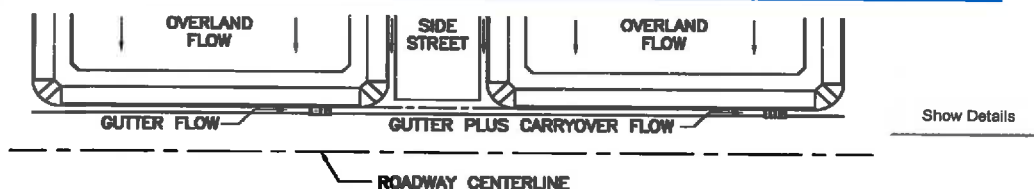
INLET ON A CONTINUOUS GRADE

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')	B _{LOCAL} =	3.0	3.0	inches	
Total Number of Units in the Inlet (Grate or Curb Opening)	N _o =	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 _r -G =	N/A	N/A		
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C _r -C =	0.10	0.10		
Street Hydraulics: OK - Q < maximum allowable from sheet 'Q-Allow'					
Total Inlet Interception Capacity	Q _i =	6.95	12.44	cfs	
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q _o =	0.0	2.4	cfs	
Capture Percentage = Q _i /Q _o =	C% =	100	84	%	

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



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

* $Q_{Known} =$

Minor Storm	Major Storm
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.**

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

Site Type:

☐ Site Is Urban

☐ Site Is Non-Urban

Flows Developed For:

☐ Street Inlets

☐ Area Inlets in a Media

Subcatchment Area = Acres

Percent Imperviousness = %

NRCS Soil Type = A, B, C, or D

Slope (ft/ft) Length (ft)

Overland Flow =

Channel Flow =

Rainfall Information: Intensity I (inch/hr) = $C_1 \cdot P_1 / (C_2 + 1) \cdot C_3$

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), $C_5 =$

Minor Storm	Major Storm
<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>

Bypass (Carry-Over) Flow from upstream Subcatchments, $Q_b =$

0.0	0.0
-----	-----

 cfs

Total Design Peak Flow, $Q =$

6.2	27.7
-----	------

 cfs

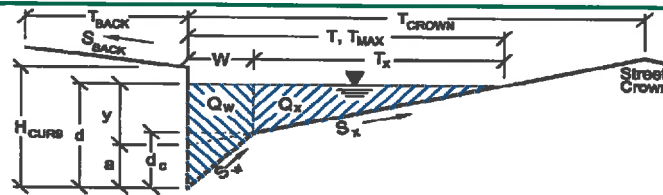
ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

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

Project:
Inlet ID:

PAINT BRUSH HILLS FILING NO. 14

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)

$n_{STREET} = 0.020$

Max. Allowable Spread for Minor & Major Storm

Minor Storm 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

Water Depth without Gutter Depression (Eq. ST-2)

Minor Storm Major Storm

$y = 4.08$ 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

$Q_T = \text{SUMP}$ 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

Theoretical Water Spread

Minor Storm Major Storm

$T_{TH} = 17.0$ 26.6 ft

Theoretical Spread for Discharge outside the Gutter Section W ($T - W$)

$T_{XTH} = 15.0$ 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_{XTH}

$Q_{XTH} = 0.0$ 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

$R = \text{SUMP}$ SUMP

Max Flow Based on Allowable Depth (Safety Factor Applied)

$Q_d = \text{SUMP}$ 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

$Q_{allow} = \text{SUMP}$ 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'

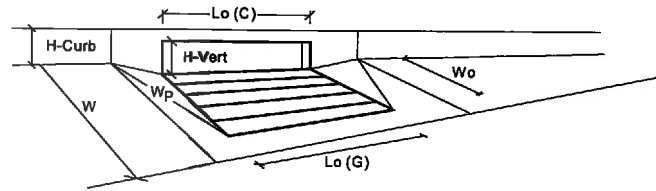
INLET IN A SUMP OR SAG LOCATION

Project =

PAINT BRUSH HILLS FILING NO. 14

Inlet ID =

SUMP INLET DP15



Design Information (input)

Type of Inlet

Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')

Number of Unit Inlets (Grate or Curb Opening)

Water Depth at Flowline (outside of local depression)

Grate Information

Length of a Unit Grate

Width of a Unit Grate

Area Opening Ratio for a Grate (typical values 0.15-0.90)

Clogging Factor for a Single Grate (typical value 0.50 - 0.70)

Grate Weir Coefficient (typical value 2.15 - 3.60)

Grate Orifice Coefficient (typical value 0.60 - 0.80)

Curb Opening Information

Length of a Unit Curb Opening

Height of Vertical Curb Opening in Inches

Height of Curb Orifice Throat in Inches

Angle of Throat (see USDCM Figure ST-5)

Side Width for Depression Pan (typically the gutter width of 2 feet)

Clogging Factor for a Single Curb Opening (typical value 0.10)

Curb Opening Weir Coefficient (typical value 2.3-3.7)

Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)

Total Inlet Interception Capacity (assumes clogged condition)

Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)

	MINOR	MAJOR	
Inlet Type =	CDOT Type R Curb Opening		
B_{local} =	3.00	3.00	inches
N_o =	4.0	4	
Ponding Depth =	5.8	7.9	inches

☒ Override Depths

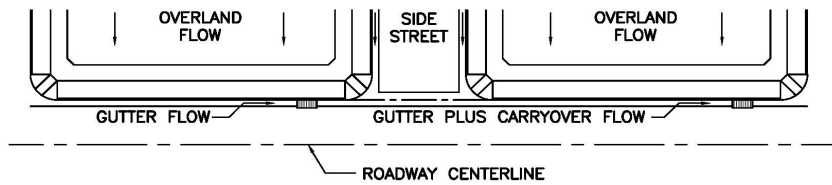
	MINOR	MAJOR	
$L_o (G)$ =	N/A	N/A	feet
W_o =	N/A	N/A	feet
A_{ratio} =	N/A	N/A	
$C_r (G)$ =	N/A	N/A	
$C_w (G)$ =	N/A	N/A	
$C_o (G)$ =	N/A	N/A	

	MINOR	MAJOR	
$L_o (C)$ =	5.00	5.00	feet
H_{vert} =	6.00	6.00	inches
H_{throat} =	6.00	6.00	inches
Theta =	63.40	63.40	degrees
W_p =	2.00	2.00	feet
$C_r (C)$ =	0.10	0.10	
$C_w (C)$ =	3.60	3.60	
$C_o (C)$ =	0.67	0.67	

	MINOR	MAJOR	
Q_a =	15.0	36.7	cfs
$Q_{PEAK REQUIRED}$ =	6.2	27.7	cfs

**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



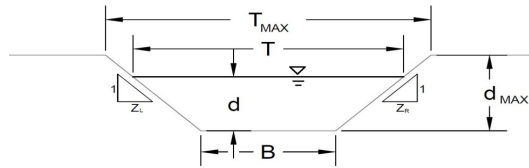
Show Details

Design Flow: ONLY if already determined through other methods: (local peak flow for 1/2 of street OR grass-lined channel):		Minor Storm *Q _{known} = <u>5.6</u>	Major Storm <u>20.8</u> cfs	<--- FILL IN THIS SECTION OR... FILL IN THE SECTIONS BELOW. <---
* 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):				
You cannot enter values for Q and use the Q calculator at the same time				
Site Type: <input checked="" type="radio"/> Site is Urban <input type="radio"/> Site is Non-Urban	Flows Developed For: <input type="radio"/> Street Inlets <input checked="" type="radio"/> Area Inlets in a Medial	Subcatchment Area = <u> </u> Acres Percent Imperviousness = <u> </u> % NRCS Soil Type = <u> </u> A, B, C, or D		
		Slope (ft/ft) Length (ft) Overland Flow = <u> </u> <u> </u> Channel Flow = <u> </u> <u> </u>		
Rainfall Information: Intensity I (inch/hr) = $C_1 \cdot P_1 / (C_2 + I_c)^{C_3}$				
Design Storm Return Period, T _r = <u> </u> years Return Period One-Hour Precipitation, P ₁ = <u> </u> inches C ₁ = <u> </u> C ₂ = <u> </u> C ₃ = <u> </u>		Minor Storm <u> </u> <u> </u> <u> </u> <u> </u> <u> </u>	Major Storm <u> </u> <u> </u> <u> </u> <u> </u> <u> </u>	
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C = <u> </u> User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C ₅ = <u> </u>				
Bypass (Carry-Over) Flow from upstream Subcatchments, Q _b = <u> </u>		0.0	0.0	cfs
Total Design Peak Flow, Q = <u> </u>		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)

Manning's n (Leave cell D16 blank to manually enter an n value)

Channel Invert Slope

Bottom Width

Left Side Slope

Right Side Slope

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

A, B, C, D or E

E
see details below
$S_0 = 0.0348$ ft/ft
B = 2.00 ft
Z1 = 3.00 ft/ft
Z2 = 3.00 ft/ft

Choose One:

- ☒ Sandy
☐ Non-Sandy

Max. Allowable Top Width of Channel for Minor & Major Storm

Max. Allowable Water Depth in Channel for Minor & Major Storm

	Minor Storm	Major Storm	
$T_{MAX} =$	5.00	6.80	feet
$d_{MAX} =$	0.46	0.78	feet

Maximum Channel Capacity Based On Allowable Top Width

Max. Allowable Top Width

Water Depth

Flow Area

Wetted Perimeter

Hydraulic Radius

Manning's n based on NRCS Vegetal Retardance

Flow Velocity

Velocity-Depth Product

Hydraulic Depth

Froude Number

Max. Flow Based On Allowable Top Width

	Minor Storm	Major Storm	
$T_{MAX} =$	5.00	6.80	ft
d =	0.50	0.80	ft
A =	1.75	3.52	sq ft
P =	5.16	7.06	ft
R =	0.34	0.50	ft
n =	0.035	0.028	
V =	3.91	6.27	fps
VR =	1.33	3.13	ft ² /s
D =	0.35	0.52	ft
Fr =	1.17	1.54	
$Q_T =$	6.85	22.07	cfs

Maximum Channel Capacity Based On Allowable Water Depth

Max. Allowable Water Depth

Top Width

Flow Area

Wetted Perimeter

Hydraulic Radius

Manning's n based on NRCS Vegetal Retardance

Flow Velocity

Velocity-Depth Product

Hydraulic Depth

Froude Number

Max. Flow Based On Allowable Water Depth

	Minor Storm	Major Storm	
$d_{MAX} =$	0.46	0.78	feet
T =	4.76	6.68	feet
A =	1.55	3.39	square feet
P =	4.91	6.93	feet
R =	0.32	0.49	feet
n =	0.036	0.028	
V =	3.63	6.16	fps
VR =	1.15	3.01	ft ² /s
D =	0.33	0.51	feet
Fr =	1.12	1.52	
$Q_d =$	5.64	20.84	cfs

Allowable Channel Capacity Based On Channel Geometry

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

	Minor Storm	Major Storm	
$Q_{allow} =$	5.64	20.84	cfs
$d_{allow} =$	0.46	0.78	ft

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow

Water Depth

Top Width

Flow Area

Wetted Perimeter

Hydraulic Radius

Manning's n based on NRCS Vegetal Retardance

Flow Velocity

Velocity-Depth Product

Hydraulic Depth

Froude Number

	Minor Storm	Major Storm	
$Q_o =$	5.60	20.80	cfs
d =	0.46	0.78	feet
T =	4.75	6.68	feet
A =	1.55	3.38	square feet
P =	4.90	6.93	feet
R =	0.32	0.49	feet
n =	0.036	0.028	
V =	3.62	6.15	fps
VR =	1.14	3.00	ft ² /s
D =	0.33	0.51	feet
Fr =	1.12	1.52	

Warning 03

Warning 04

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)

Width of Grate

Length of Grate

Open Area Ratio

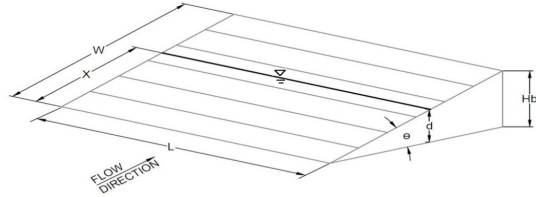
Height of Inclined Grate

Clogging Factor

Grate Discharge Coefficient

Orifice Coefficient

Weir Coefficient



θ =	0.10	degrees
W =	3.00	feet
L =	3.00	feet
A _{RATIO} =	0.70	
H _B =	0.01	feet
C _f =	0.50	
C _d =	0.84	
C _o =	0.56	
C _w =	1.79	

Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)

	MINOR	MAJOR
d =	1.46	1.78

Grate Capacity as a Weir

Submerged Side Weir Length

Inclined Side Weir Flow

Base Weir Flow

Interception without Clogging

Interception with Clogging

X =	3.00	3.00	feet
Q _{we} =	16.56	22.32	cfs
Q _{wb} =	23.71	31.95	cfs
Q _{wi} =	56.83	76.59	cfs
Q _{wb} =	28.41	38.29	cfs

Grate Capacity as an Orifice

Interception without Clogging

Interception with Clogging

Q _{oi} =	48.78	53.87	cfs
Q _{osi} =	24.39	26.94	cfs

Total Inlet Interception Capacity (assumes clogged condition)

Inlet Capacity IS GOOD for Minor and Major Storms (> Q PEAK)

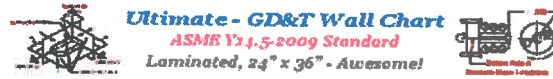
Q _a =	24.39	26.94	cfs
Bypassed Flow, Q _b =	0.00	0.00	cfs
Capture Percentage = Q _a /Q _o = C%	100	100	%

Warning 03: Velocity exceeds USDCM Volume I recommendation.

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

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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 = 17 in

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

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

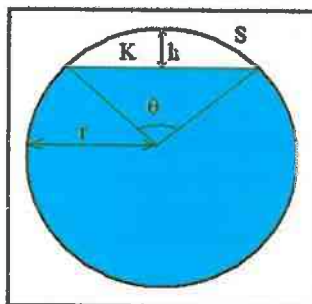
Pipe Diameter, D = 1.5 ft
Pipe Radius, r = 0.75 ft

Circ. Segment Height, h = 0.083 ft

Central Angle, θ = 0.95 radians
Cross-Sect. Area, A = 1.73 ft²

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)

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

$$V = Q/A$$

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

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

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

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

PR1 Q100= 13.7 CFS

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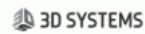
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Partially FULL Pipe Flow Calculator and Equations

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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** = in
 Depth of flow, **y** = in

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

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

Calculations

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

Calculations

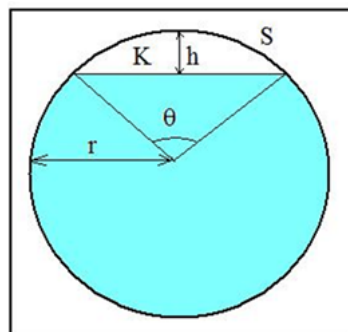
Pipe Diameter, **D** = ft
 Pipe Radius, **r** = ft

Circ. Segment Height, **h** = ft

Central Angle, **q** = radians
 Cross-Section Area, **A** = ft²

Wetted Perimeter, **P** = ft
 Hydraulic Radius, **R** = ft
 Discharge, **Q** = cfs
 Ave. Velocity, **V** = ft/sec

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



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 $0.5 \leq y/D \leq 1$)

PR2 Q100= 65.3 CFS

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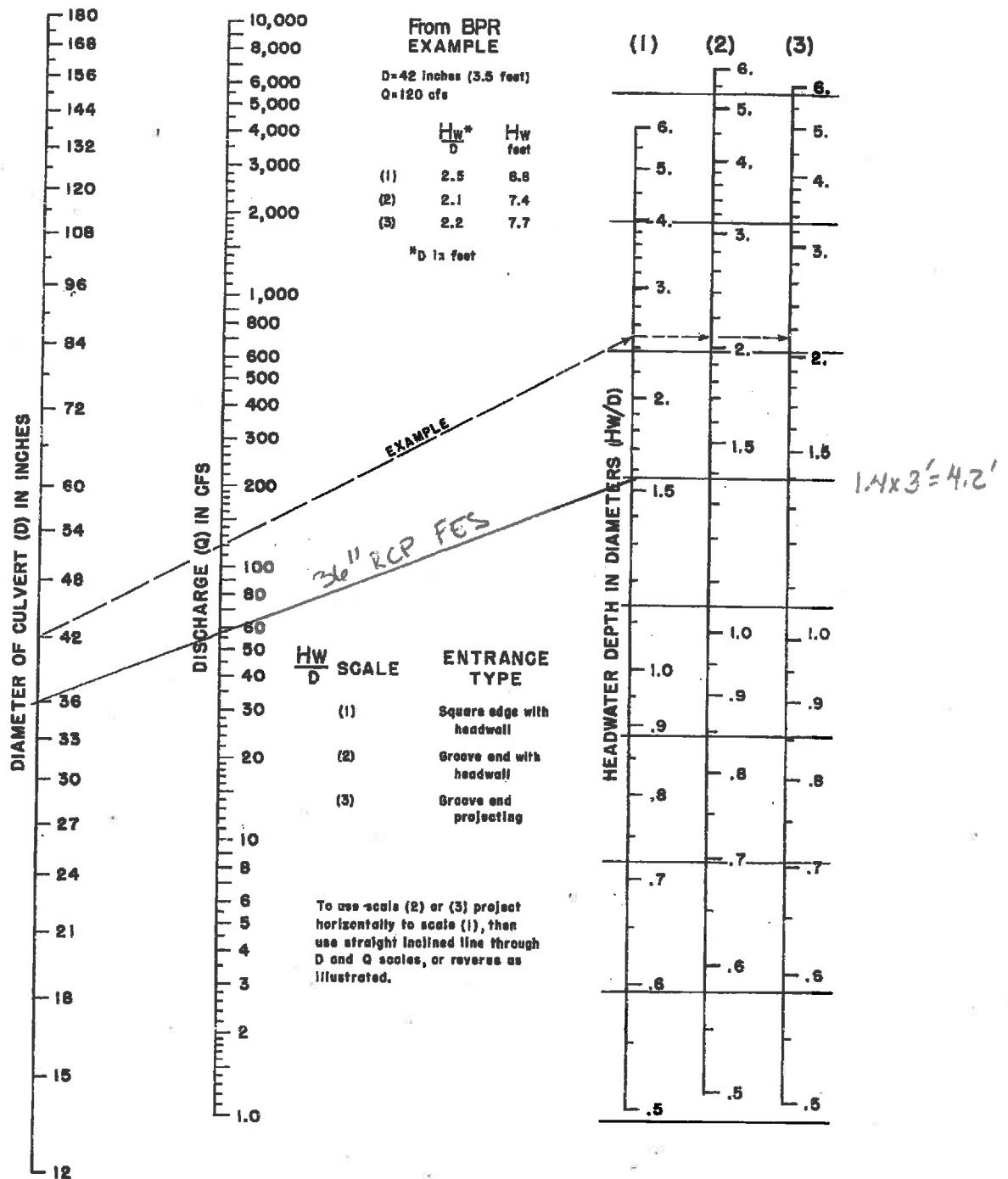


Figure CU-9—Inlet Control Nomograph—Example

DP3 Q100= 58.1 CFS

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Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
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Instructions: Enter values in blue boxes. Calculations in yellow

Inputs

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

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

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

Calculations

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

Calculations

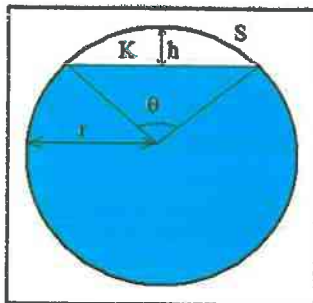
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Section. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

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



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 $0.5 \leq y/D \leq 1$)

PR3 Q100= 74.0 CFS

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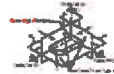
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Partially Full Pipe Flow Calculations - U.S. Units

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 = in
Depth of flow, y = in

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

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

Calculations

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

Calculations

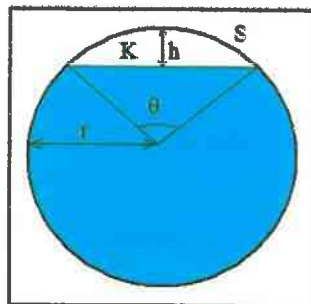
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Sect. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

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



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 $0.5 \leq y/D \leq 1$)

PR4 Q100= 2.7 CFS

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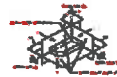
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Instructions: Enter values in blue boxes. Calculations in yellow

Inputs

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

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

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

Calculations

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

Calculations

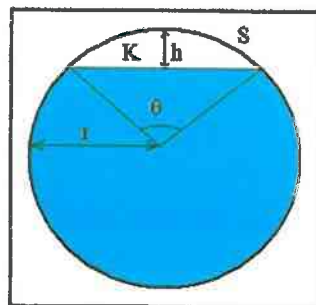
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Sect. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

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



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 $0.5 \leq y/D \leq 1$)

PR5 Q100= 76.0 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** = in
 Depth of flow, **y** = in

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

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

Calculations

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

Calculations

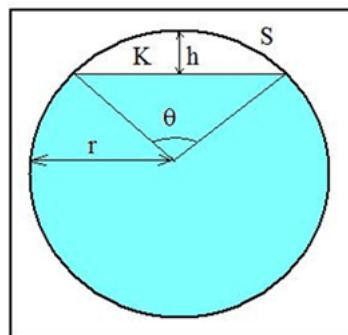
Pipe Diameter, **D** = ft
 Pipe Radius, **r** = ft

Circ. Segment Height, **h** = ft

Central Angle, **q** = radians
 Cross-Section Area, **A** = ft²

Wetted Perimeter, **P** = ft
 Hydraulic Radius, **R** = ft
 Discharge, **Q** = cfs
 Ave. Velocity, **V** = ft/sec

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



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 $0.5 \leq y/D \leq 1$)

**PR7 & PR8 Q100=22.2 CFS
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Inputs

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

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

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

Calculations

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

Calculations

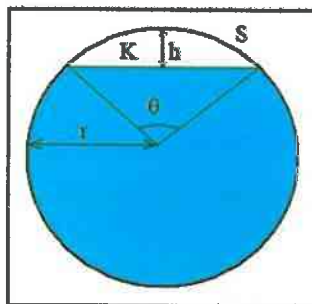
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Sect. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

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



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$r = D/2$$

$$h = 2r - y$$

(hydraulic radius)

$$R = A/P$$

(Manning Equation)

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

$$V = Q/A$$

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

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

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

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

PR9 Q100= 117.8 CFS

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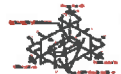
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Partially Full Pipe Flow Calculator and Equations

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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 = in
Depth of flow, y = in
(must have $y \geq D/2$)

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

Calculations

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

Calculations

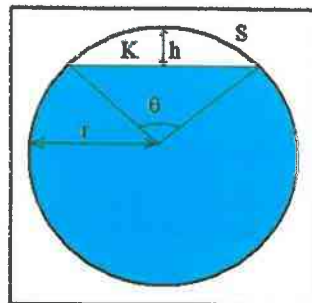
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Sect. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

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



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$r = D/2$$

$$h = 2r - y$$

(hydraulic radius)

$$R = A/P$$

(Manning Equation)

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

$$V = Q/A$$

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

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

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

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

**PR10 & PR11 Q100= 13.7 CFS
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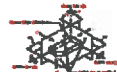
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Partially Full Pipe Flow Calculations - U.S. Units

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 = in
Depth of flow, y = in

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

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

Calculations

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

Calculations

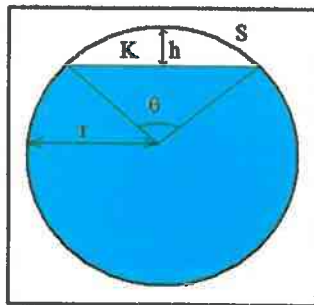
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Sect. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

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



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 $0.5 \leq y/D \leq 1$)

PR12 Q100= 142.5 CFS

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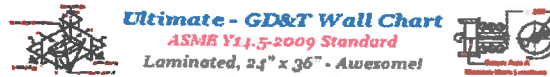
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This engineering calculator determines the Flow within a partially full pipe using the Manning equation. This calculator can also be used for uniform flow in a pipe, but the Manning roughness coefficient needs to be considered to be variable, dependent 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 $y \geq D/2$)

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

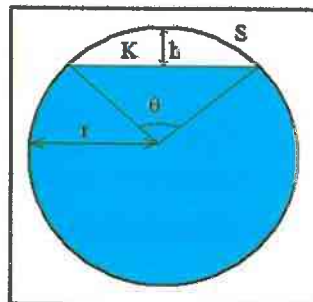
Pipe Diameter, D = 1.5 ft
Pipe Radius, r = 0.75 ft

Circ. Segment Height, h = 0.083 ft

Central Angle, θ = 0.95 radians
Cross-Sept. Area, A = 1.73 ft²

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)

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

$$V = Q/A$$

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

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

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

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

PR13 Q100= 14.0 CFS

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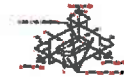
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Ultimate - GD&T Wall Chart
ASME Y14.5-2009 Standard
Laminated, 24" x 36" - Awesome!



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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 = in
Depth of flow, y = in
(must have $y \geq D/2$)

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

Calculations

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

Calculations

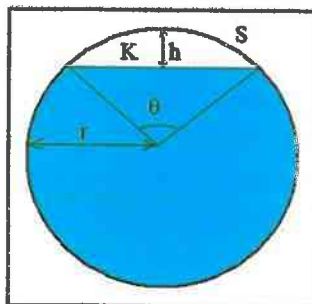
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Sect. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

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



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$r = D/2$$

$$h = 2r - y$$

$$(\text{hydraulic radius})$$

$$R = A/P$$

$$(\text{Manning Equation})$$

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

$$V = Q/A$$

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

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

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

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

PR14 Q100= 27.9 CFS

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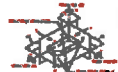
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This engineering calculator determines the Flow within a partially full pipe using the Manning equation. This calculator can also be used for uniform flow in a pipe, but the Manning roughness coefficient needs to be considered to be variable, dependent 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 $y \geq D/2$)

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

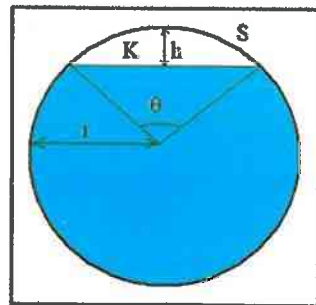
Pipe Diameter, D = 2.5 ft
Pipe Radius, r = 1.25 ft

Circ. Segment Height, h = 0.750 ft

Central Angle, θ = 2.32 radians
Cross-Section 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)

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

$$V = Q/A$$

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

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

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

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

#PR38 Q100= 27.9 CFS

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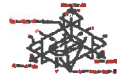
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Partially Full Pipe Flow Calculations - U.S. Units

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 = in
Depth of flow, y = in

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

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

Calculations

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

Calculations

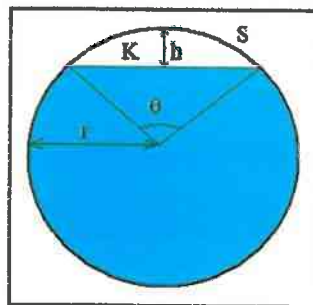
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Sect. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

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



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 $0.5 \leq y/D \leq 1$)

#PR15 Q100= 13.5 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 = in
Depth of flow, y = in

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

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

Calculations

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

Calculations

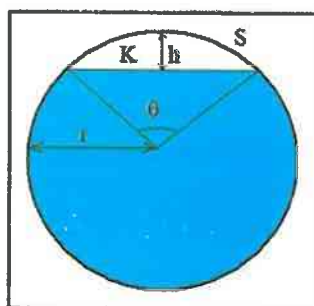
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Sect. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

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



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 $0.5 \leq y/D \leq 1$)

#PR16 Q100= 39.7 CFS

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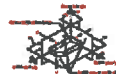
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Partially Full Pipe Flow Calculations - U.S. Units

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 = in
Depth of flow, y = in

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

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

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

Calculations

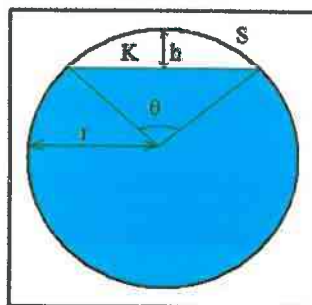
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Section. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

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



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$r = D/2$$

$$h = 2r - y$$

$$\text{(hydraulic radius)}$$

$$R = A/P$$

$$\text{(Manning Equation)}$$

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

$$V = Q/A$$

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

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

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

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

#PR39 Q100= 13.0 CFS

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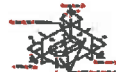
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Partially Full Pipe Flow Calculator and Equations

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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 = in
Depth of flow, y = in

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

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

Calculations

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

Calculations

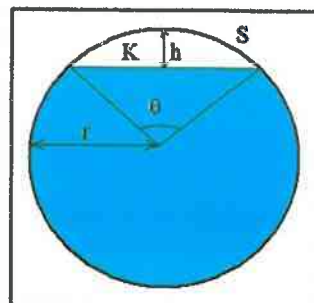
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Sect. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

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



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 $0.5 \leq y/D \leq 1$)

#PR17 Q100= 51.3 CFS

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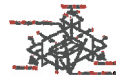
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Partially Full Pipe Flow Calculator and Equations

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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 = in
Depth of flow, y = in
(must have $y \geq D/2$)

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

Calculations

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

Calculations

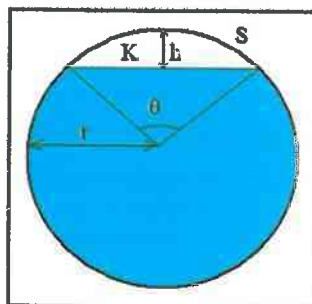
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Sect. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

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



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} : $n/n_{full} = 1.25 - (y/D) - 0.5 \log R$ ($0.5 \leq y/D \leq 1$)

PR18 Q100= 12.4 CFS

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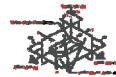
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Partially Full Pipe Flow Calculator and Equations

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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 = in
Depth of flow, y = in
(must have $y \geq D/2$)

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

Calculations

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

Calculations

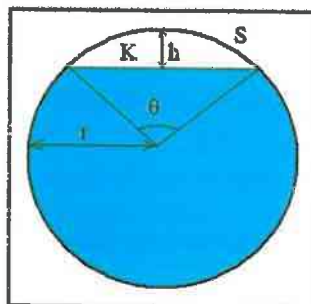
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Sect. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

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



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 $0.5 \leq y/D \leq 1$)

PR19 Q100= 24.8 CFS

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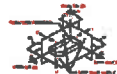
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Partially Full Pipe Flow Calculator and Equations

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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 = in
Depth of flow, y = in

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

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

Calculations

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

Calculations

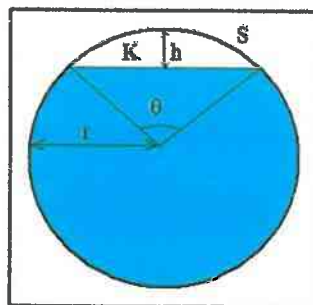
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Sect. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

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



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$r = D/2$$

$$h = 2r - y$$

$$(\text{hydraulic radius})$$

$$R = A/P$$

$$(\text{Manning Equation})$$

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

$$V = Q/A$$

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

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

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

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

PR20 Q100= 75.3 CFS

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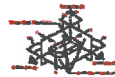
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This engineering calculator determines the Flow within a partially full pipe using the Manning equation. This calculator can also be used for uniform flow in a pipe, but the Manning roughness coefficient needs to be considered to be variable, dependent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

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

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

Calculations

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

Calculations

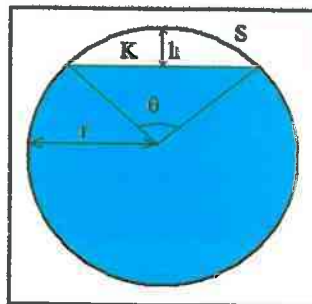
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Sect. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

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



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 $0.5 \leq y/D \leq 1$)

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 = in
Depth of flow, y = in

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

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

Calculations

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

Calculations

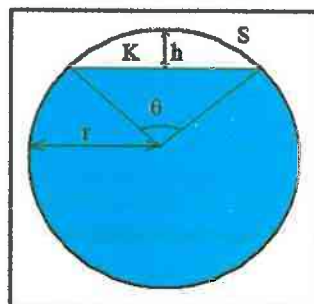
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Sect. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

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



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$r = D/2$$

$$h = 2r - y$$

(hydraulic radius)

$$R = A/P$$

(Manning Equation)

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

$$V = Q/A$$

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

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

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

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

PR22 Q100= 27.7 CFS

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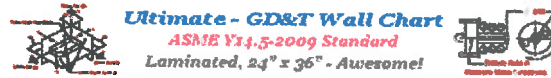
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Partially Full Pipe Flow Calculator and Equations

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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 = in
Depth of flow, y = in

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

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

Calculations

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

Calculations

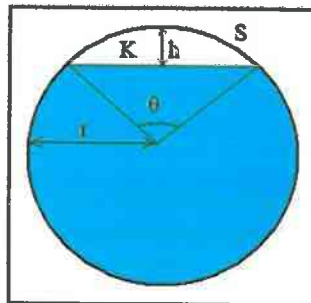
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, α = radians
Cross-Section. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

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



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 $0.5 \leq y/D \leq 1$)

PR23 Q100= 55.4 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 full) 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** = in
 Depth of flow, **y** = in

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

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

Calculations

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

Calculations

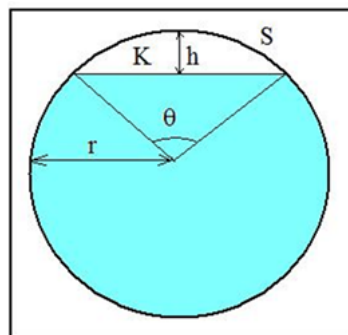
Pipe Diameter, **D** = ft
 Pipe Radius, **r** = ft

Circ. Segment Height, **h** = ft

Central Angle, **q** = radians
 Cross-Section Area, **A** = ft²

Wetted Perimeter, **P** = ft
 Hydraulic Radius, **R** = ft
 Discharge, **Q** = cfs
 Ave. Velocity, **V** = ft/sec

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



Partially Full Pipe Flow Parameters
 (More Than Half Full)

$$r = D/2$$

$$h = 2r - y$$

(hydraulic radius)

$$R = A/P$$

(Manning Equation)

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

$$V = Q/A$$

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

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

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

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

PR24 Q100= 269.3 CFS

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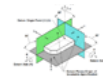
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Geometric Boundaries IV Based on ASME Y14.5-2018



Partially FULL Pipe Flow Calculator and Equations

[Fluid Flow Table of Contents](#)
[Hydraulic and Pneumatic Knowledge](#)
[Fluid Power Equipment](#)

This engineering calculator determines the Flow within a partially full pipe (&e1/2 full) 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** = in
Depth of flow, **y** = in

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

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

Calculations

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

Calculations

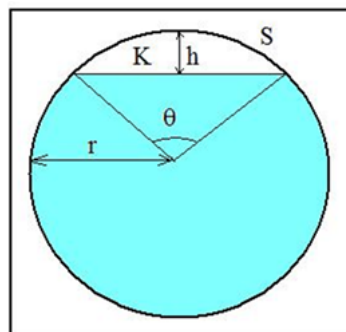
Pipe Diameter, **D** = ft
Pipe Radius, **r** = ft

Circ. Segment Height, **h** = ft

Central Angle, **q** = radians
Cross-Section Area, **A** = ft²

Wetted Perimeter, **P** = ft
Hydraulic Radius, **R** = ft
Discharge, **Q** = cfs
Ave. Velocity, **V** = ft/sec

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



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 $0.5 \leq y/D \leq 1$)

PR25 Q100= 20.8 CFS

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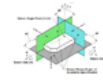
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Geometric Boundaries IV Based on ASME Y14.5-2018



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Depth of flow, **y** = in

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

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roughness, **n_{full}** =
Channel bottom
slope, **S** = ft/ft

Calculations

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

Calculations

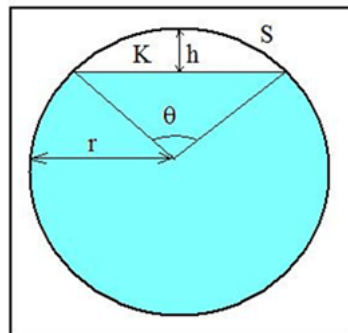
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(More Than Half Full)

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(hydraulic radius)

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

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

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

PR26 Q100= 287.3 CFS

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Partially FULL Pipe Flow Calculator and Equations

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[Hydraulic and Pneumatic Knowledge](#)
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Partially Full Pipe Flow Calculations - U.S. Units

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 Depth of flow, **y** = in

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

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

Calculations

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

Calculations

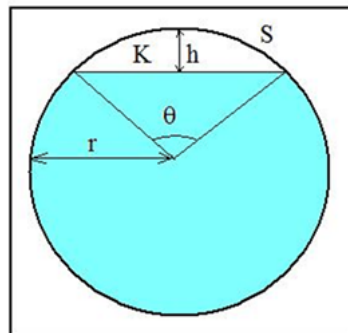
Pipe Diameter, **D** = ft
 Pipe Radius, **r** = ft

Circ. Segment Height, **h** = ft

Central Angle, **q** = radians
 Cross-Section Area, **A** = ft²

Wetted Perimeter, **P** = ft
 Hydraulic Radius, **R** = ft
 Discharge, **Q** = cfs
 Ave. Velocity, **V** = ft/sec

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



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

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

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

#PR27 Q100= 92.8 CFS

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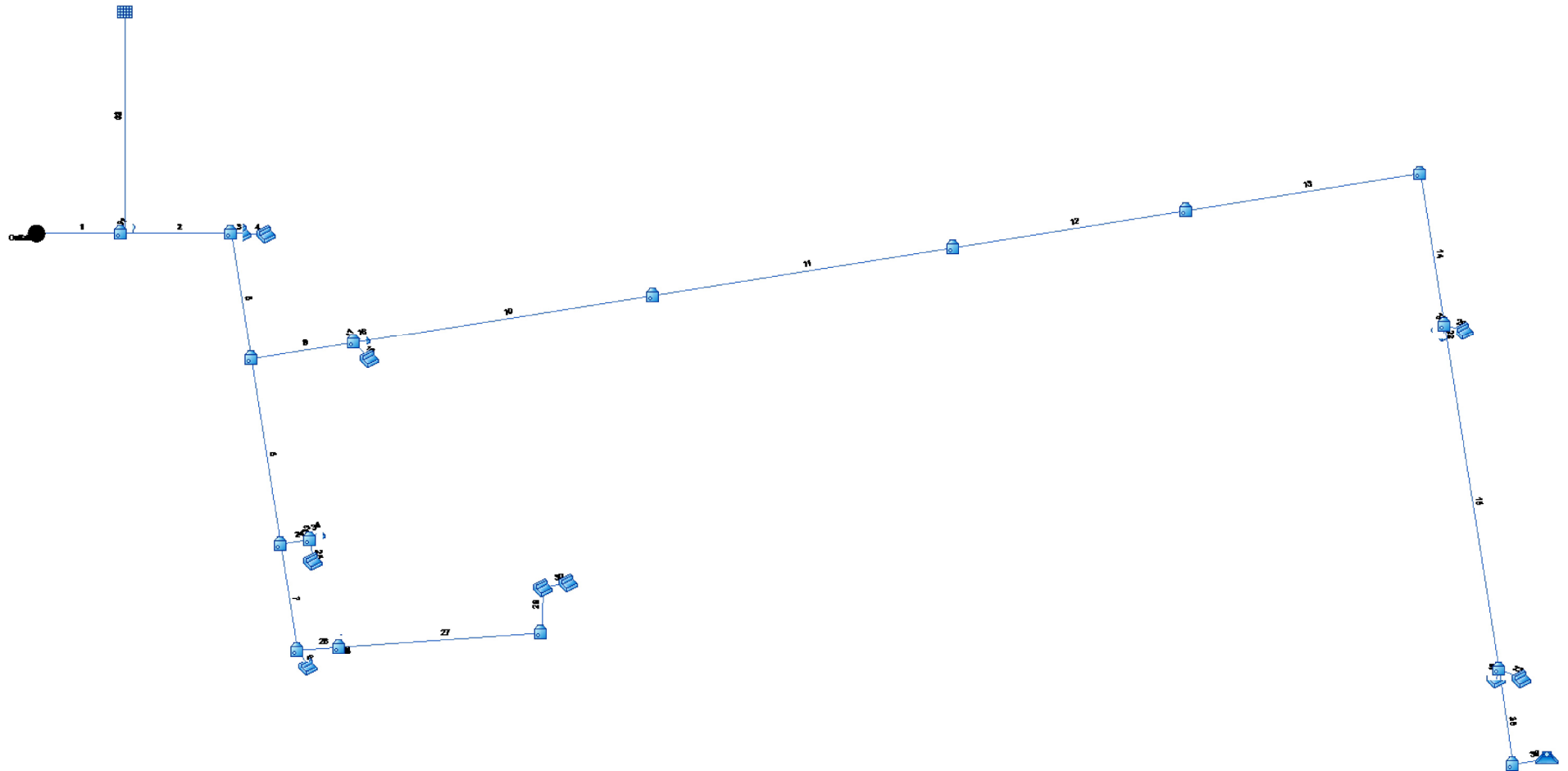
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STORM 1, 2, 3, 4, 4A, 5, 7 & 9 incl LATERALS INDEX MAP



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	287.20	7191.76	7192.37	0.50	7197.26	7198.15	1.70	7199.86	12.09	121.710	5.65	
2	Storm 1(2)	Cir	MH	0.99 z	0.013	269.20	7192.87	7202.30	5.95	7199.86	7206.83	n/a	7206.83	14.05	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	7209.67	7.84	14.400	1.73	
4	Storm 1	Cir	Generic	1.00	0.013	27.70	7205.17	7206.51	3.79	7210.13	7210.29	0.50	7210.79	5.64	35.350	0.61	
5	Storm 2	Cir	MH	1.00 z	0.013	214.40	7202.80	7205.94	1.72	7207.23	7210.06	n/a	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	13.00	7218.58	7219.65	3.74	7221.71	7221.81	0.27	7222.07	4.14	28.586	2.01	
9	Storm 3	Cir	MH	0.89 z	0.013	142.40	7206.44	7208.80	1.58	7211.13	7212.33	2.04	7212.33	11.73	149.360	3.83	
10	Storm 3	Cir	MH	0.15 z	0.013	117.70	7209.10	7217.15	1.85	7213.25	7220.42	n/a	7220.42	10.04	435.420	3.58	
11	Storm 3	Cir	MH	0.15 z	0.013	117.70	7217.45	7225.32	1.81	7220.84	7228.59	n/a	7228.59	10.54	435.420	3.87	
12	Storm 3	Cir	MH	0.15 z	0.013	117.70	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	117.70	7240.89	7246.33	1.60	7244.29	7249.60	n/a	7249.60	10.53	339.480	6.89	
14	Storm 3	Cir	MH	0.92	0.013	117.70	7246.63	7247.95	0.60	7250.16	7251.48	1.44	7252.92	10.02	219.470	2.34	
15	Storm 3	Cir	MH	0.88	0.013	75.90	7248.25	7251.41	0.63	7253.91	7255.20	0.52	7255.72	6.10	502.070	2.74	
16	Storm 4	Cir	Generic	1.00	0.013	2.70	7253.93	7254.75	5.60	7256.27	7256.28	0.04	7256.32	1.53	14.630	2.33	
17	Storm 3_Lat 1	Cir	None	0.89	0.013	13.70	7211.10	7211.21	2.51	7213.68	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	7213.68	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	7254.77	7.07	30.230	0.48	
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	7255.18	7.07	8.000	0.28	
23	Storm 4	Cir	Generic	1.00	0.013	10.40	7253.93	7254.27	0.97	7255.77	7256.12	0.54	7256.65	5.89	34.960	1.64	

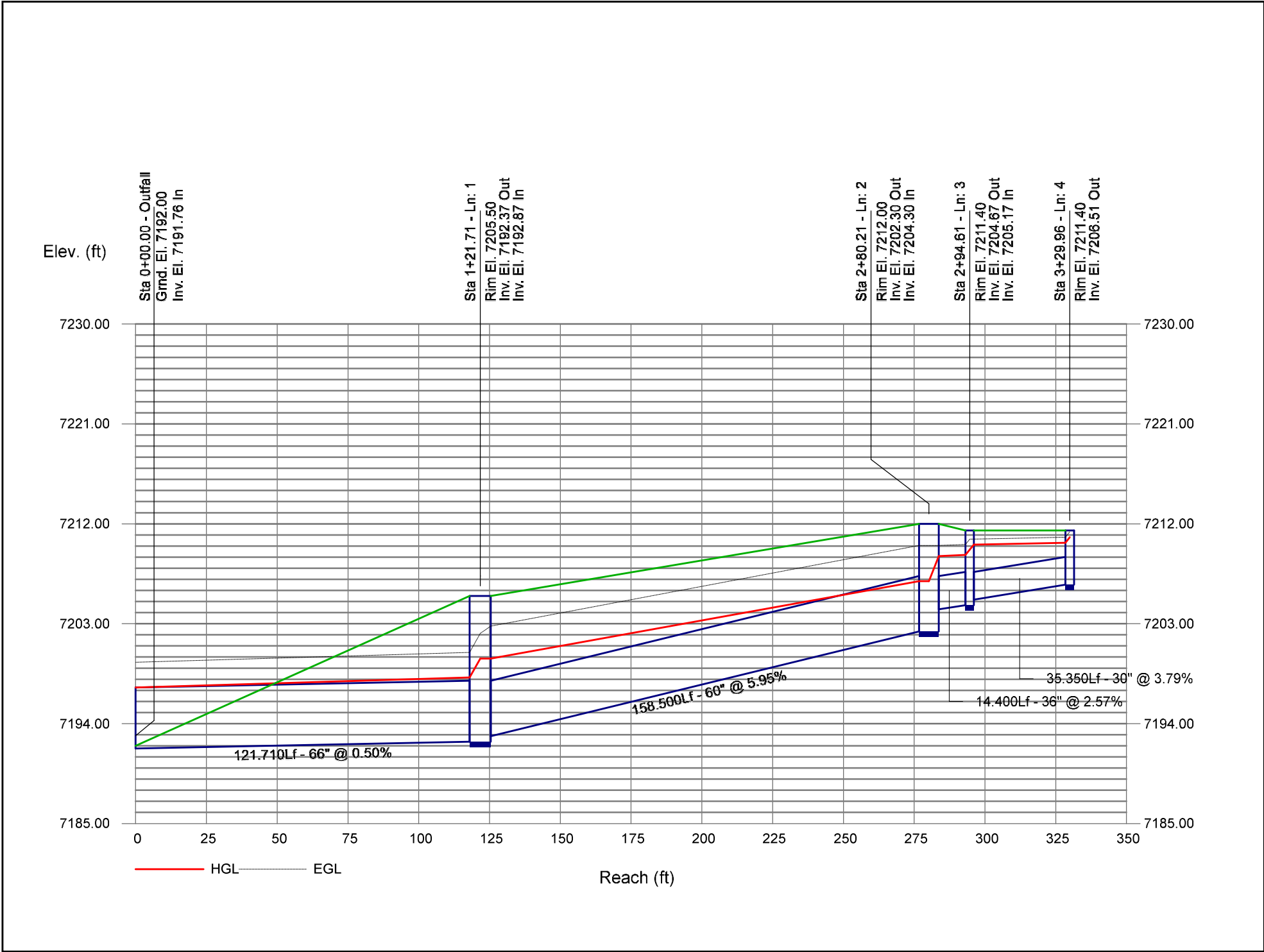
Project File: Storm Main System.stm

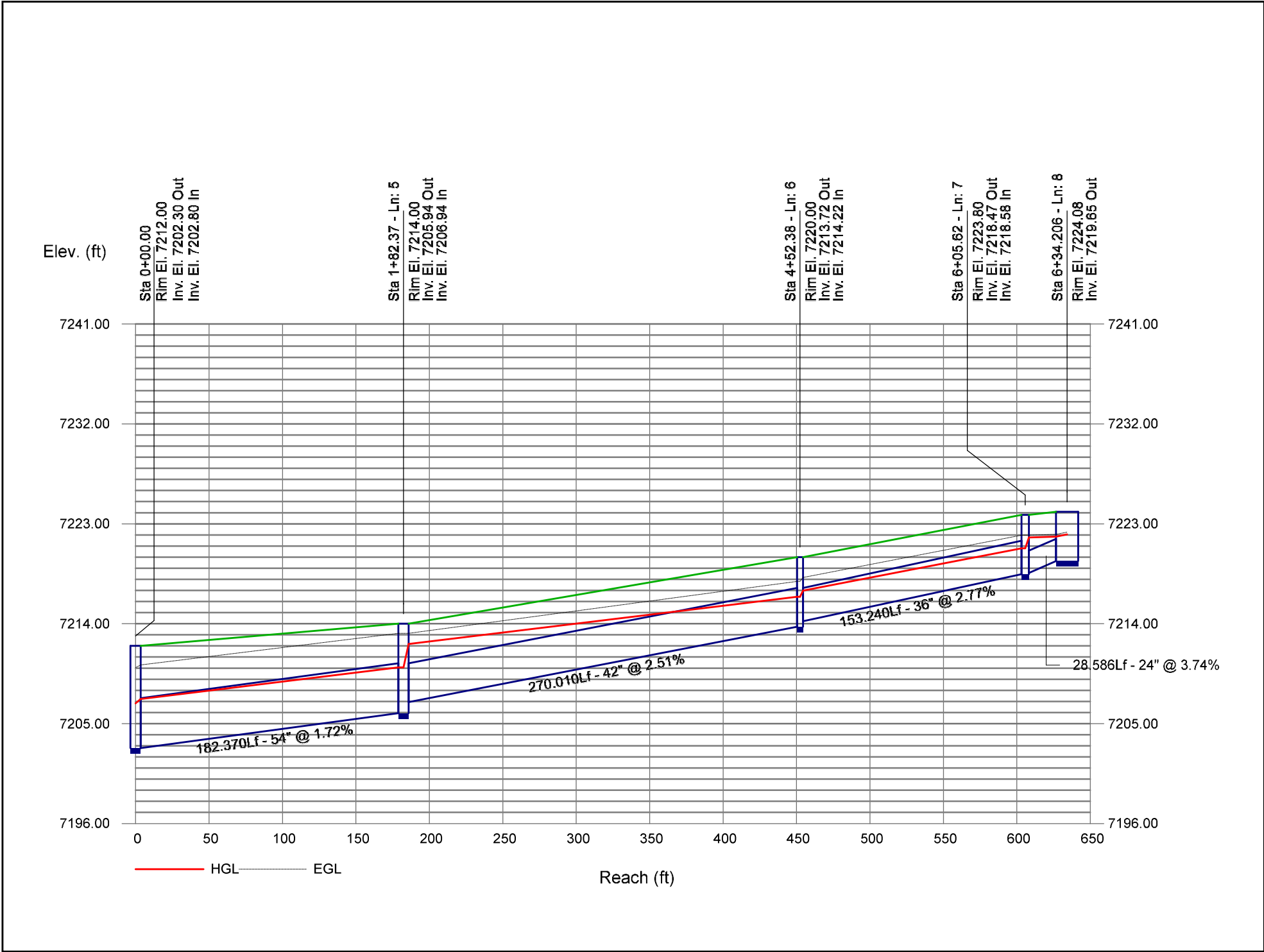
Number of lines: 36

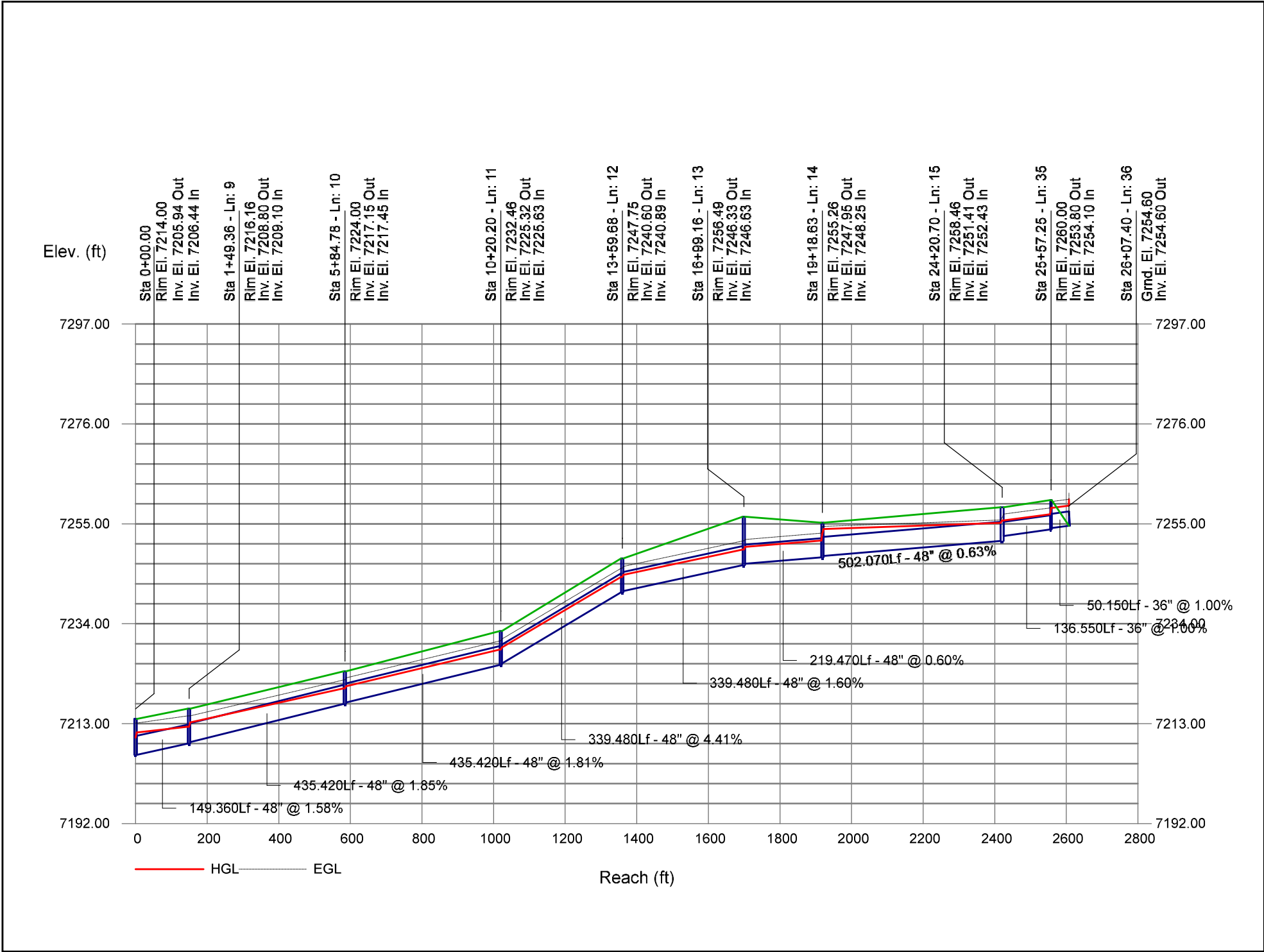
Date: 3/3/2021

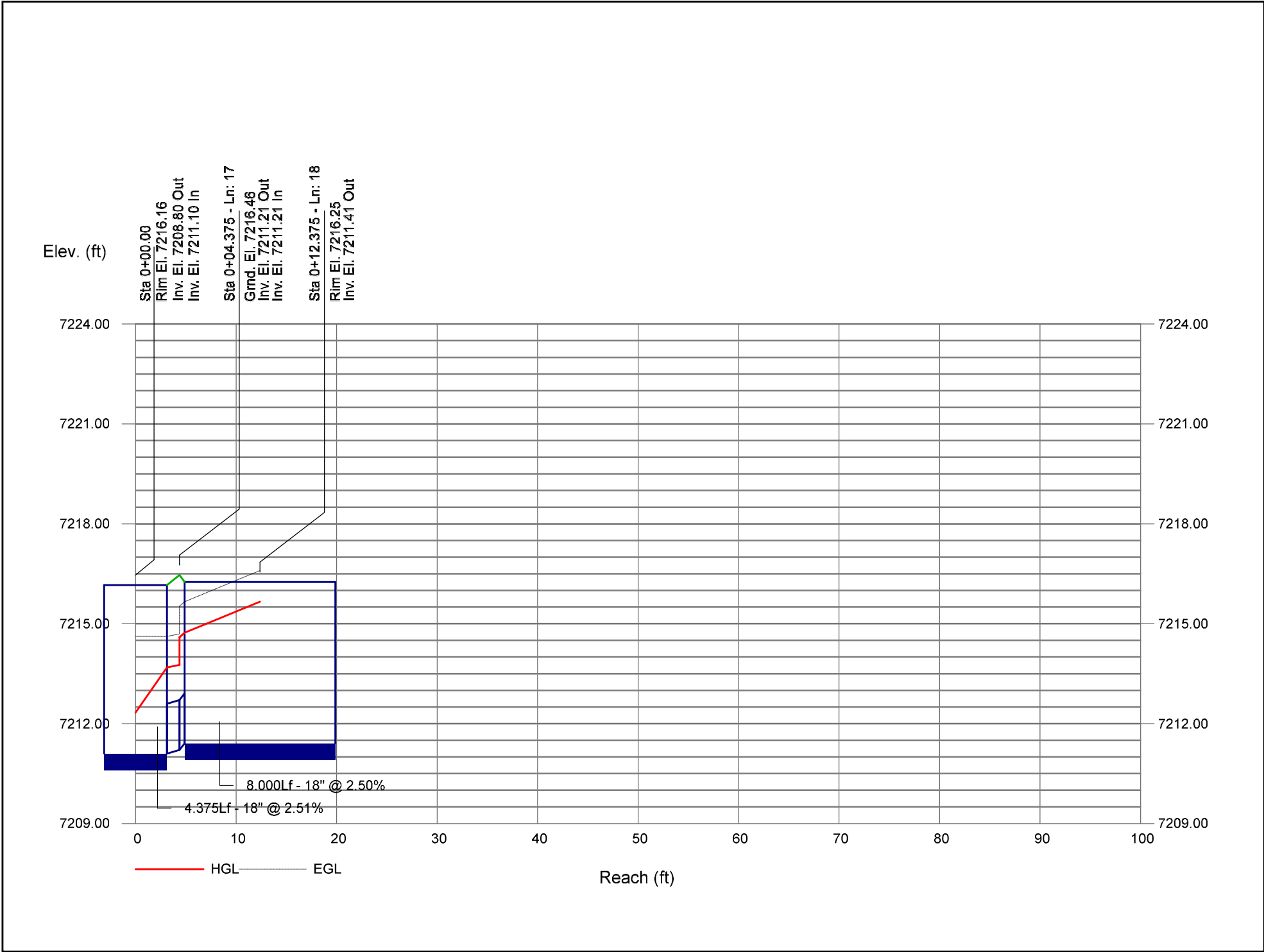
NOTES: ** Critical depth

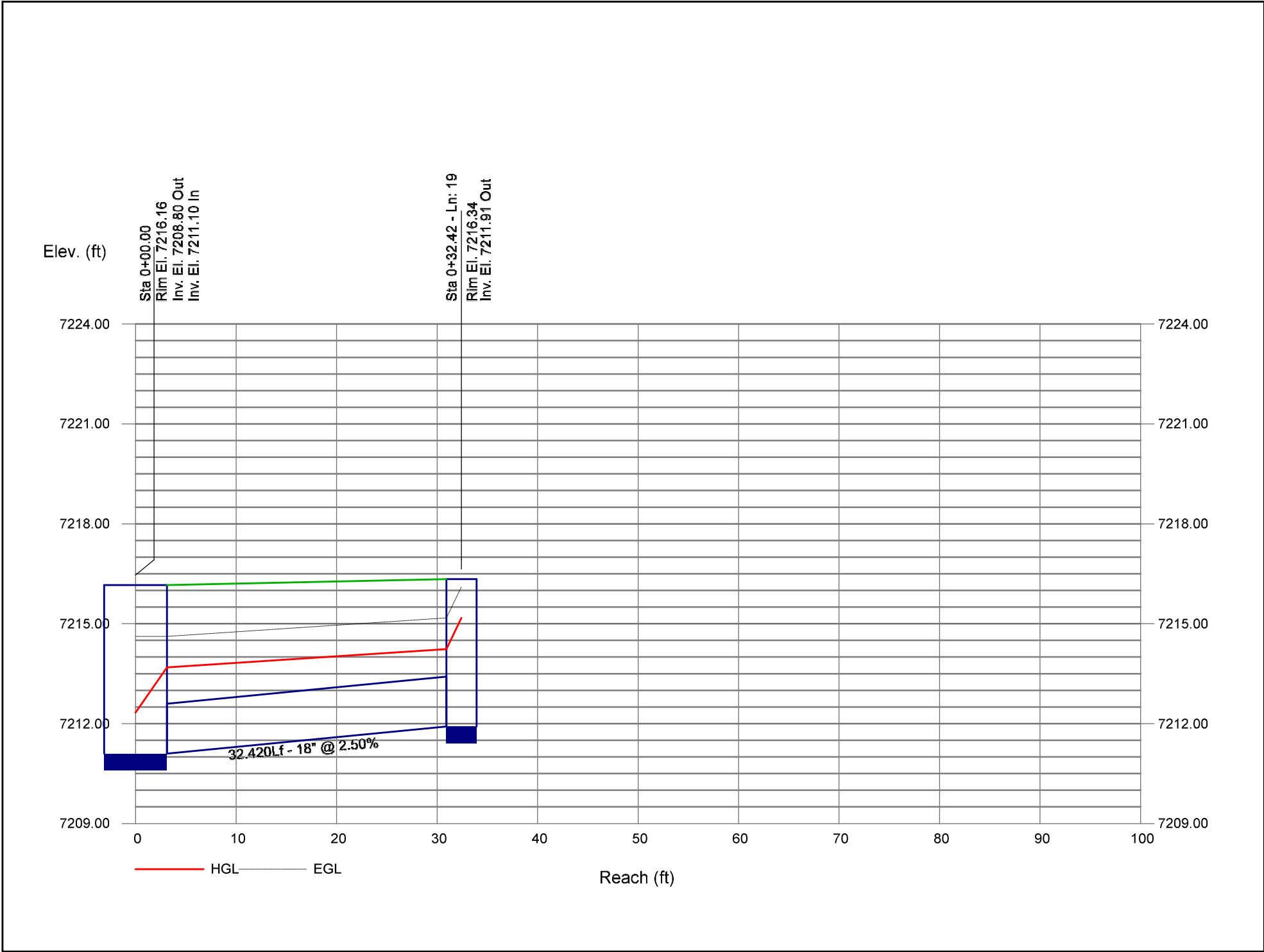
Line No.	Line ID	Line Type	Junct Type	J-Loss Coeff	n-val Pipe	Flow Rate	Invert Dn	Invert Up	Line Slope	HGL Dn	HGL Up	Minor Loss	HGL Jnct	Vel Ave	Line Length	Rim-Hw	
						(cfs)	(ft)	(ft)	(%)	(ft)	(ft)	(ft)	(ft)	(ft/s)	(ft)	(ft)	
24	Storm 5	Cir	MH	1.00	0.013	24.80	7214.72	7215.24	1.23	7217.28	7217.33	0.50	7217.83	5.35	42.170	2.65	
25	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	
26	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	
27	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	
28	Storm 6	Cir	Generic	1.00	0.013	13.50	7219.99	7220.09	1.94	7223.51	7223.52	0.29	7223.81	4.30	5.130	0.69	
29	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	
30	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	
31	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	
32	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	
33	STRM 5 LAT1	Cir	None	0.75	0.013	12.40	7216.24	7216.29	0.92	7217.83	7217.90	0.57	7218.48	7.02	5.390	2.22	
34	STRM 5 LAT1 (2)	Cir	Generic	1.00	0.013	12.40	7216.29	7216.37	1.00	7218.48	7218.59	0.77	7219.36	7.02	8.000	1.41	
35	Storm 3	Cir	MH	1.00	0.013	65.30	7252.43	7253.80	1.00	7255.72	7257.03	1.33	7258.36	9.24	136.550	1.64	
36	Storm 3	Cir	Hdwall	1.00	0.013	65.30	7254.10	7254.60	1.00	7258.36	7258.84	1.33	7260.17	9.24	50.150	-5.56	
Project File: Storm Main System.stm												Number of lines: 36			Date: 3/3/2021		
NOTES: ** Critical depth																	

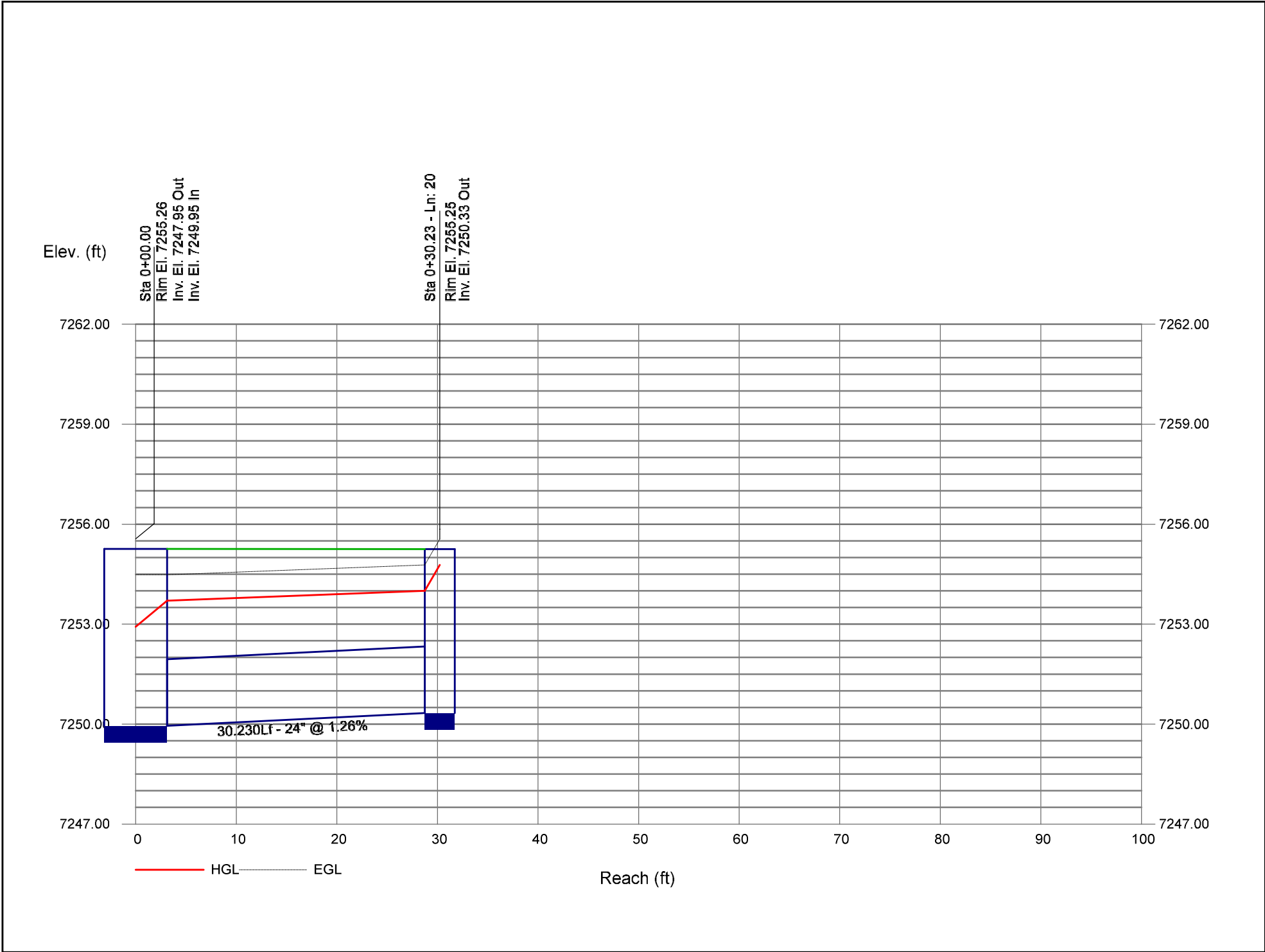


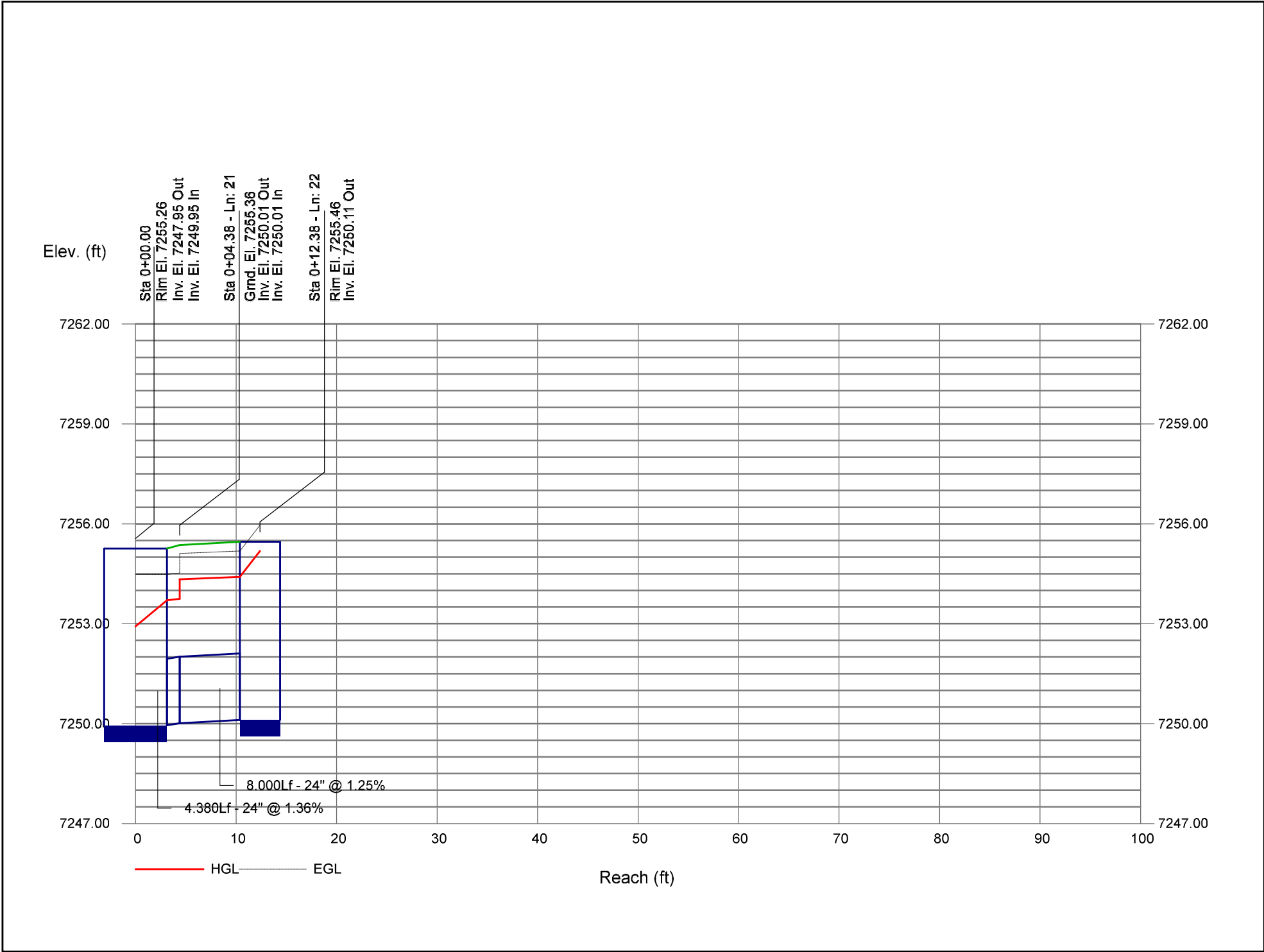


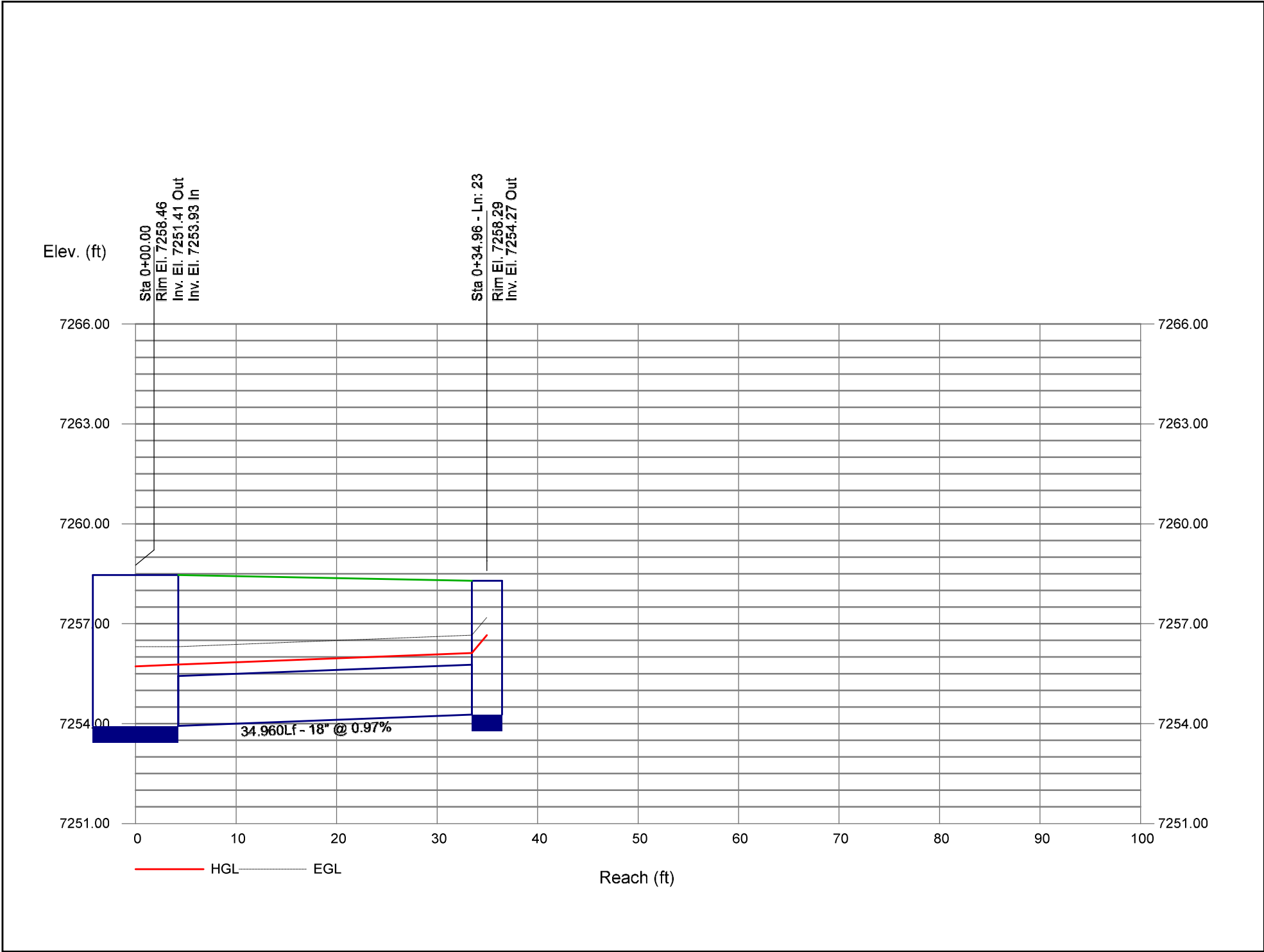


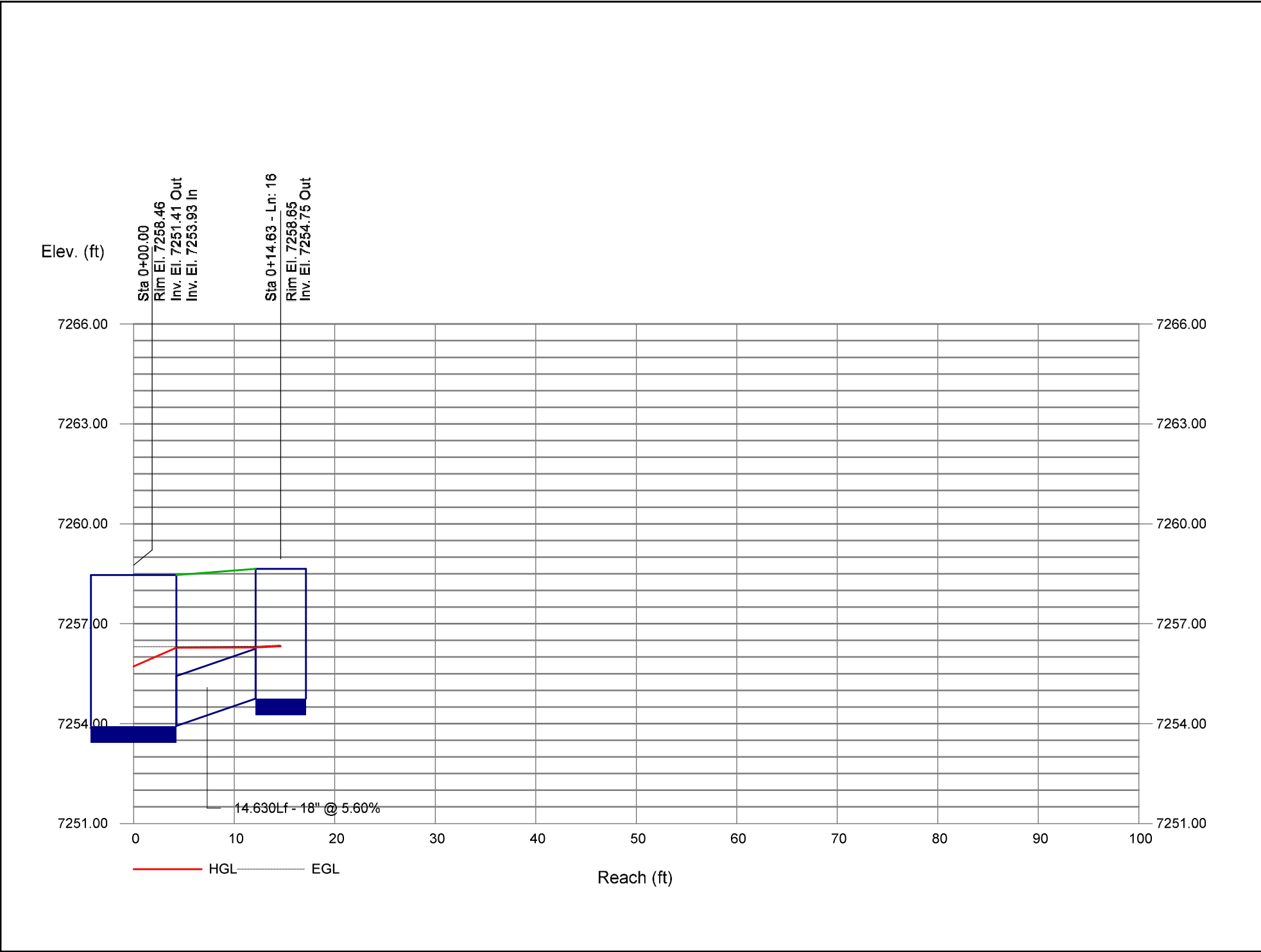


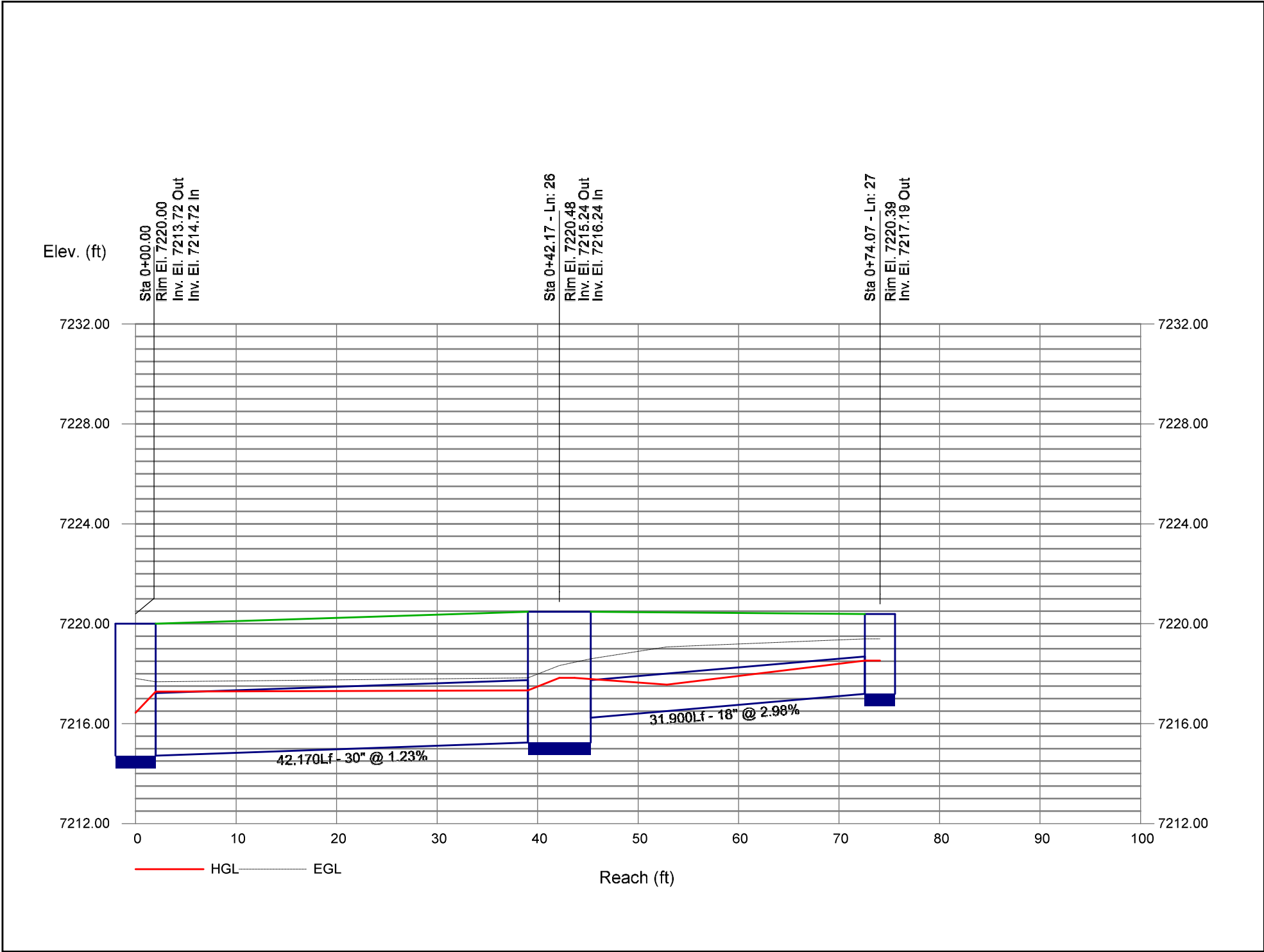


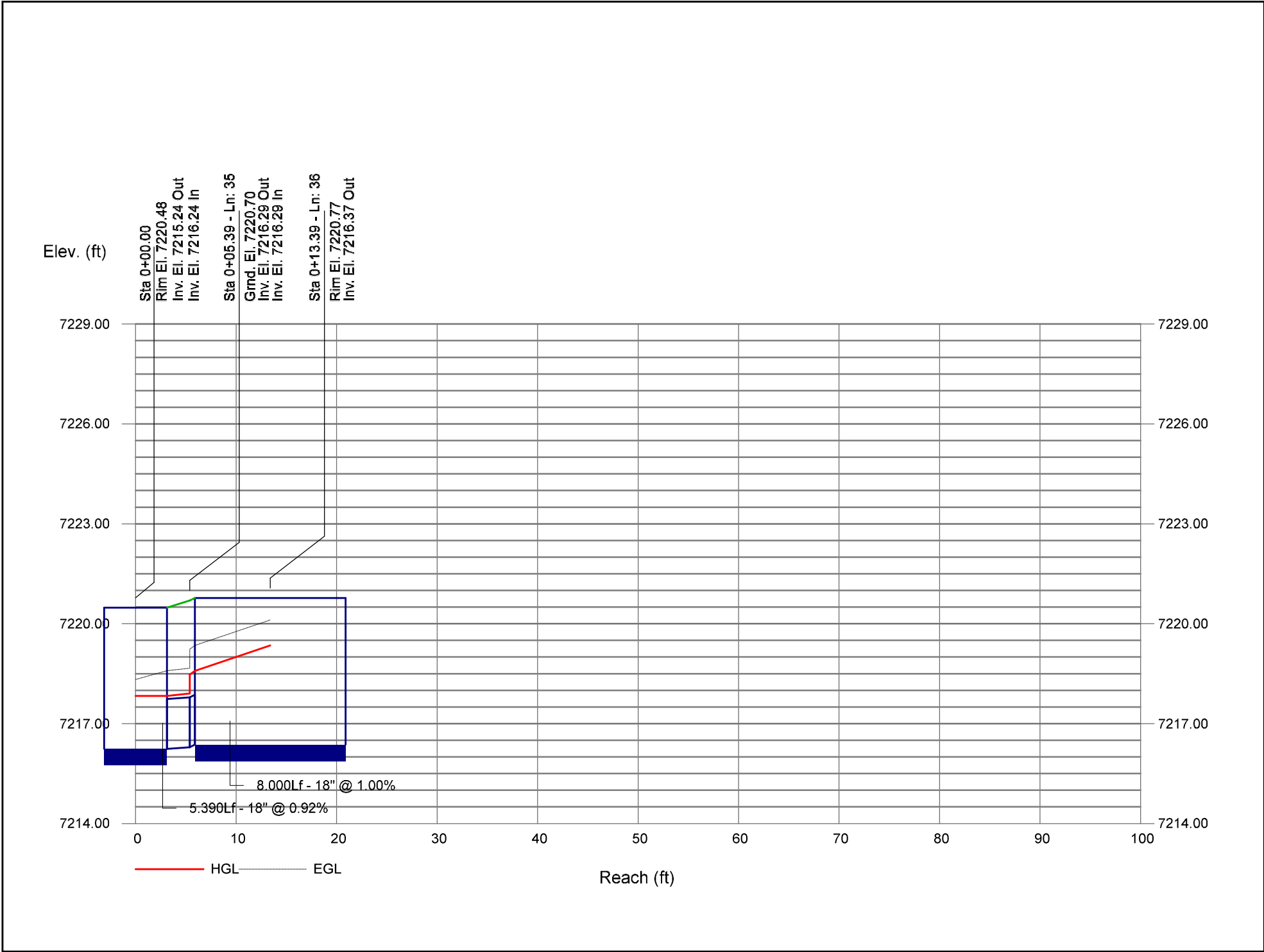


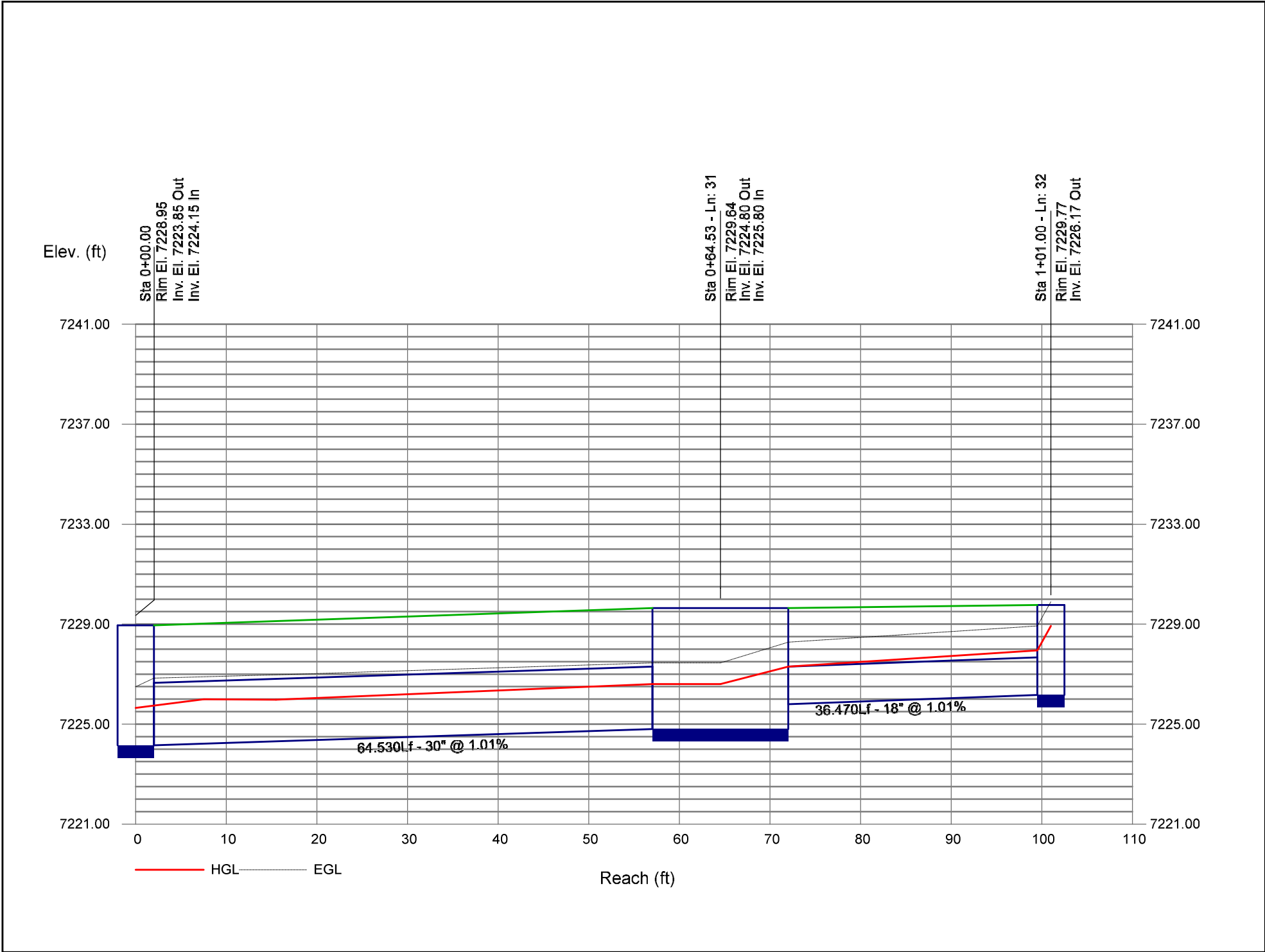


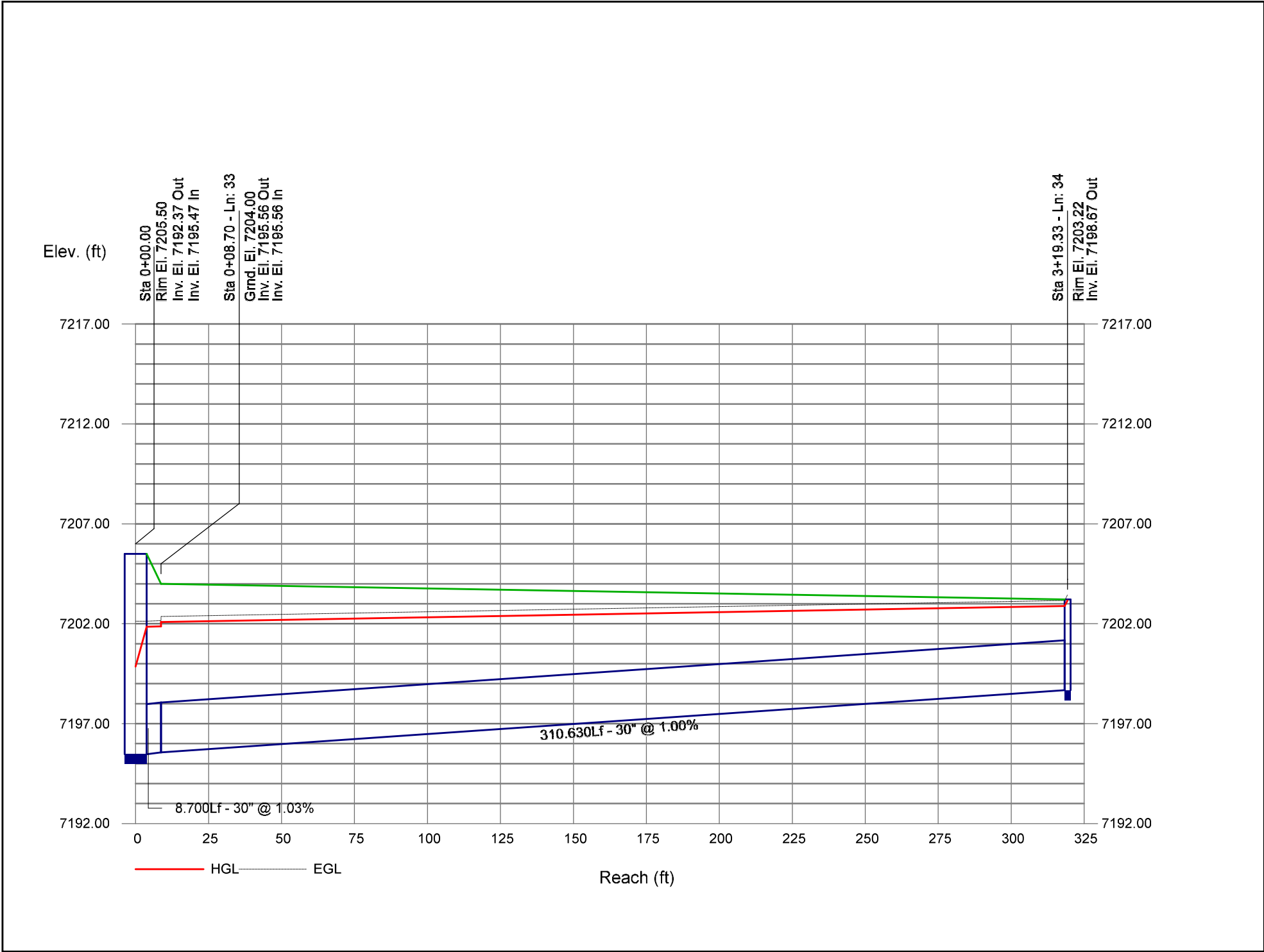








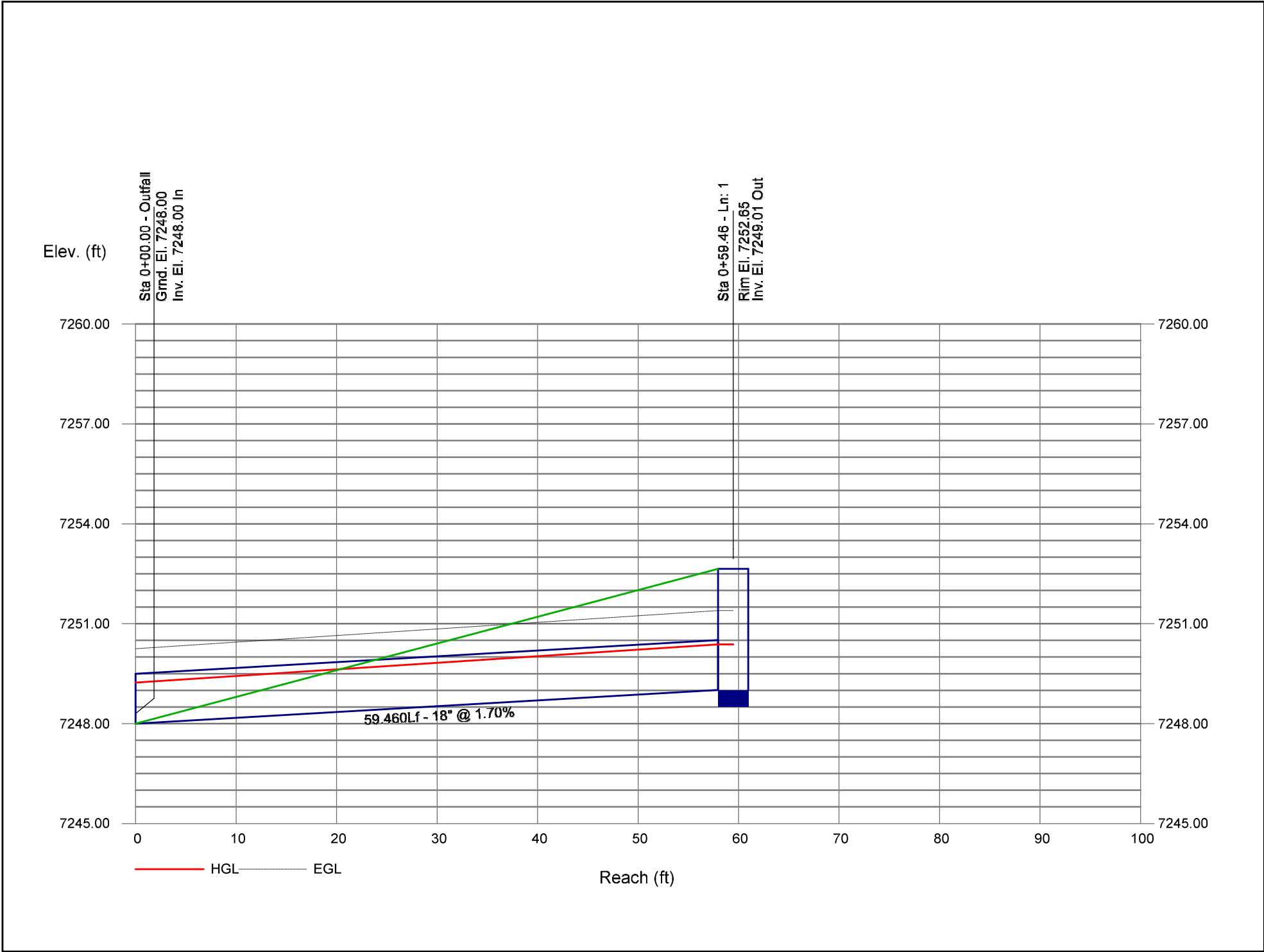




STORM 8 PIPE RUN INDEX MAP



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 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																	

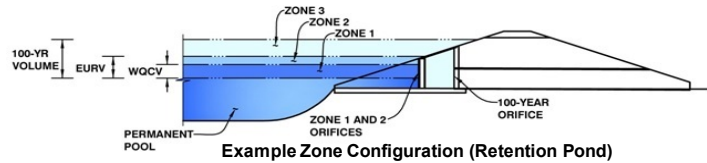


Weighted Percent Imperviousness of PBH Filing 14				
Contributing Basins	Area (Acres)	C_s	Impervious % (I)	(Acres)*(I)
**OSI	4.44	0.30	40	177.60
A	0.52	0.18	16	8.32
B	8.31	0.20	20	166.17
B1	0.92	0.16	13	12.00
C	11.50	0.26	32	368.00
D	5.20	0.20	20	104.00
E	0.49	0.90	100	49.00
F	1.61	0.30	40	64.40
G	12.20	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			

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

MHFD-Detention, Version 4.03 (May 2020)

Basin ID: FSD Pond C



Selected BMP Type =	EDB	
Watershed Area =	137.58	acres
Watershed Length =	3,440	ft
Length to Centroid =	2,149	ft
Watershed Slope =	0.025	ft/ft
Imperviousness =	32.80%	percent
Hydrologic Soil Group A =	0.0%	percent
Hydrologic Soil Group B =	100.0%	percent
Hydrologic Soil Groups C/D =	0.0%	percent
Detention Time =	40.0	hours
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.

Water Quality Capture Volume (WQCV) =	1.834	acre-feet
Excess Urban Runoff Volume (EURV) =	4.664	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	4.688	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	7.414	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	9.906	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	13.603	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	16.440	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	20.186	acre-feet
500-yr Runoff Volume (P1 = 3.14 in.) =	27.480	acre-feet
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

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	

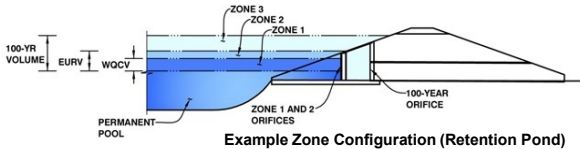
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DETENTION BASIN OUTLET STRUCTURE DESIGN

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)

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

Calculated Parameters for Underdrain
Underdrain Orifice Area = ft²
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)

Invert of Lowest Orifice = 0.00 ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate = 5.56 ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing = 22.20 inches
Orifice Plate: Orifice Area per Row = 6.62 sq. inches (use rectangular openings)

Calculated Parameters for Plate
WQ Orifice Area per Row = 4.597E-02 ft²
Elliptical Half-Width = N/A feet
Elliptical Slot Centroid = N/A feet
Elliptical Slot Area = N/A ft²

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)

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

Calculated Parameters for Vertical Orifice
Vertical Orifice Area = Not Selected Not Selected ft²
Vertical Orifice Centroid = Not Selected Not Selected feet

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

Overflow Weir Front Edge Height, H_o = 5.57 Not Selected ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length = 8.50 Not Selected feet
Overflow Weir Gate Slope = 0.00 Not Selected H:V
Horiz. Length of Weir Sides = 2.90 Not Selected feet
Overflow Gate Open Area % = 70% Not Selected %, gate open area/total area
Debris Clogging % = 50% Not Selected %

Calculated Parameters for Overflow Weir
Height of Gate Upper Edge, H_t = 5.57 Not Selected feet
Overflow Weir Slope Length = 2.90 Not Selected feet
Gate Open Area / 100-yr Orifice Area = 1.37 Not Selected
Overflow Gate Open Area w/o Debris = 17.26 Not Selected ft²
Overflow Gate Open Area w/ Debris = 8.63 Not Selected ft²

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

Depth to Invert of Outlet Pipe = 0.25 Not Selected ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter = 48.00 Not Selected inches
Restrictor Plate Height Above Pipe Invert = 48.00 Not Selected inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate
Outlet Orifice Area = 12.57 Not Selected ft²
Outlet Orifice Centroid = 2.00 Not Selected feet
Half-Central Angle of Restrictor Plate on Pipe = 3.14 Not Selected radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage = 8.97 ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length = 96.00 feet
Spillway End Slopes = 8.33 H:V
Freeboard above Max Water Surface = 1.00 feet

Calculated Parameters for Spillway
Spillway Design Flow Depth = 0.87 feet
Stage at Top of Freeboard = 10.84 feet
Basin Area at Top of Freeboard = 2.42 acres
Basin Volume at Top of Freeboard = 13.83 acre-ft

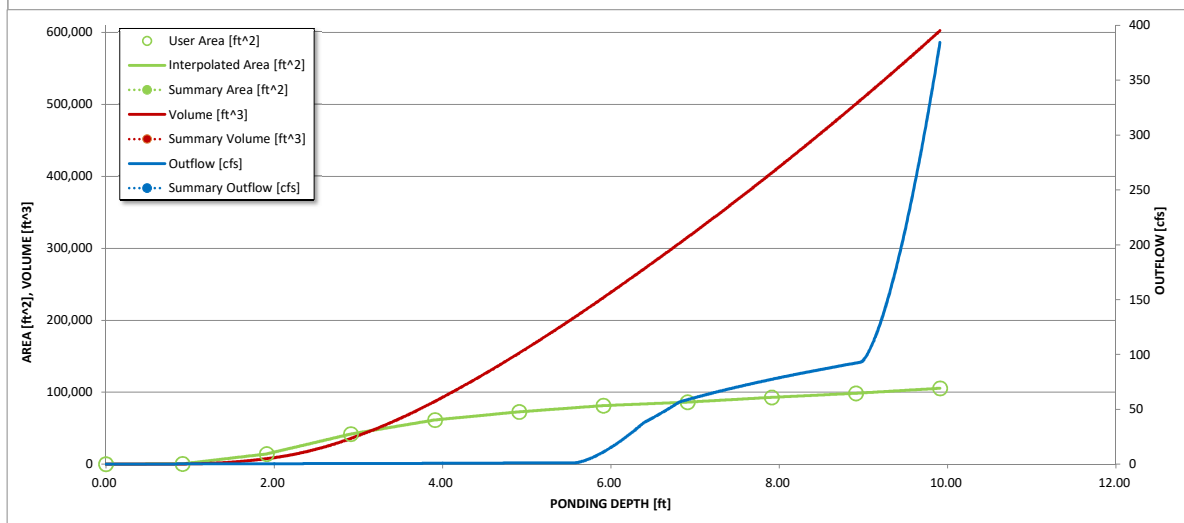
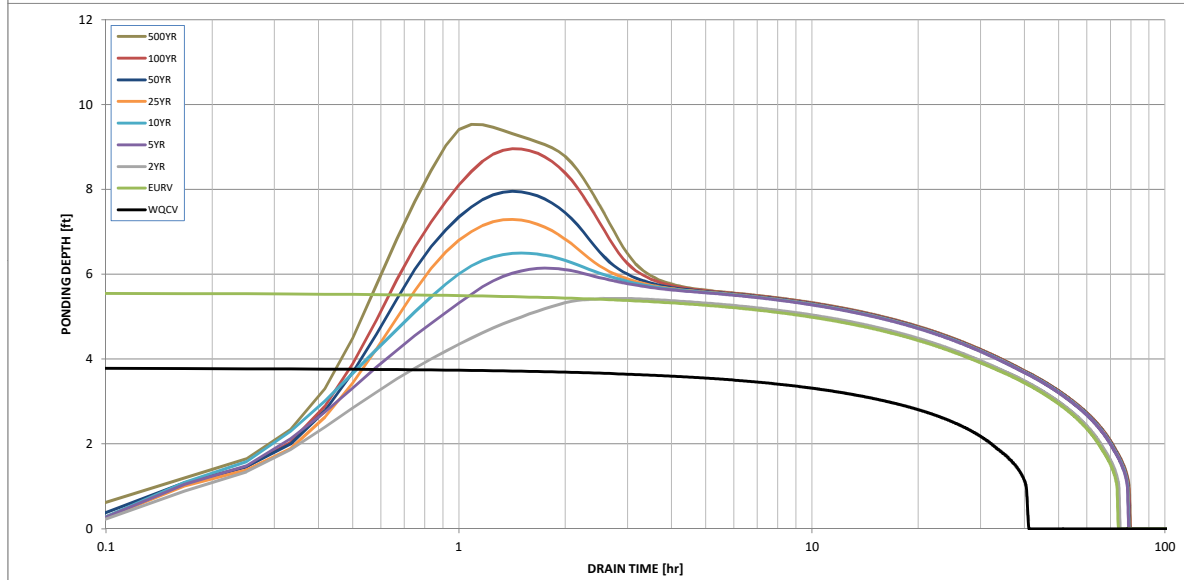
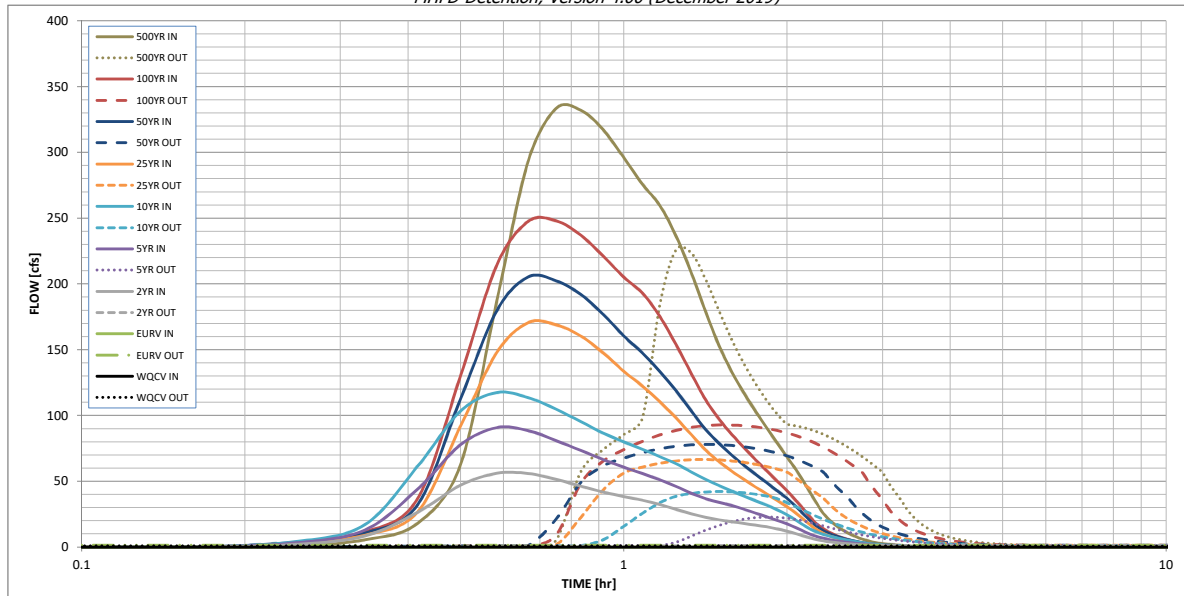
Routed Hydrograph Results

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

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
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 Gate 1 (fps) =	N/A	N/A	N/A	1.2	2.4	3.8	4.4	5.3	5.7
Max Velocity through Gate 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

Worksheet Protected

User Input: Watershed Characteristics

0.025

3440

137.58

32.8% percent

0.0%	percent
------	---------

100.0%	percent
--------	---------

0.0% percent

User Input

WQCV Treatment Method = Extended Detention

[illegible]

After completing and printing this worksheet to a pdf, go to:

<https://maperture.digitaldataservices.com/gvh/?viewer=cswdif>

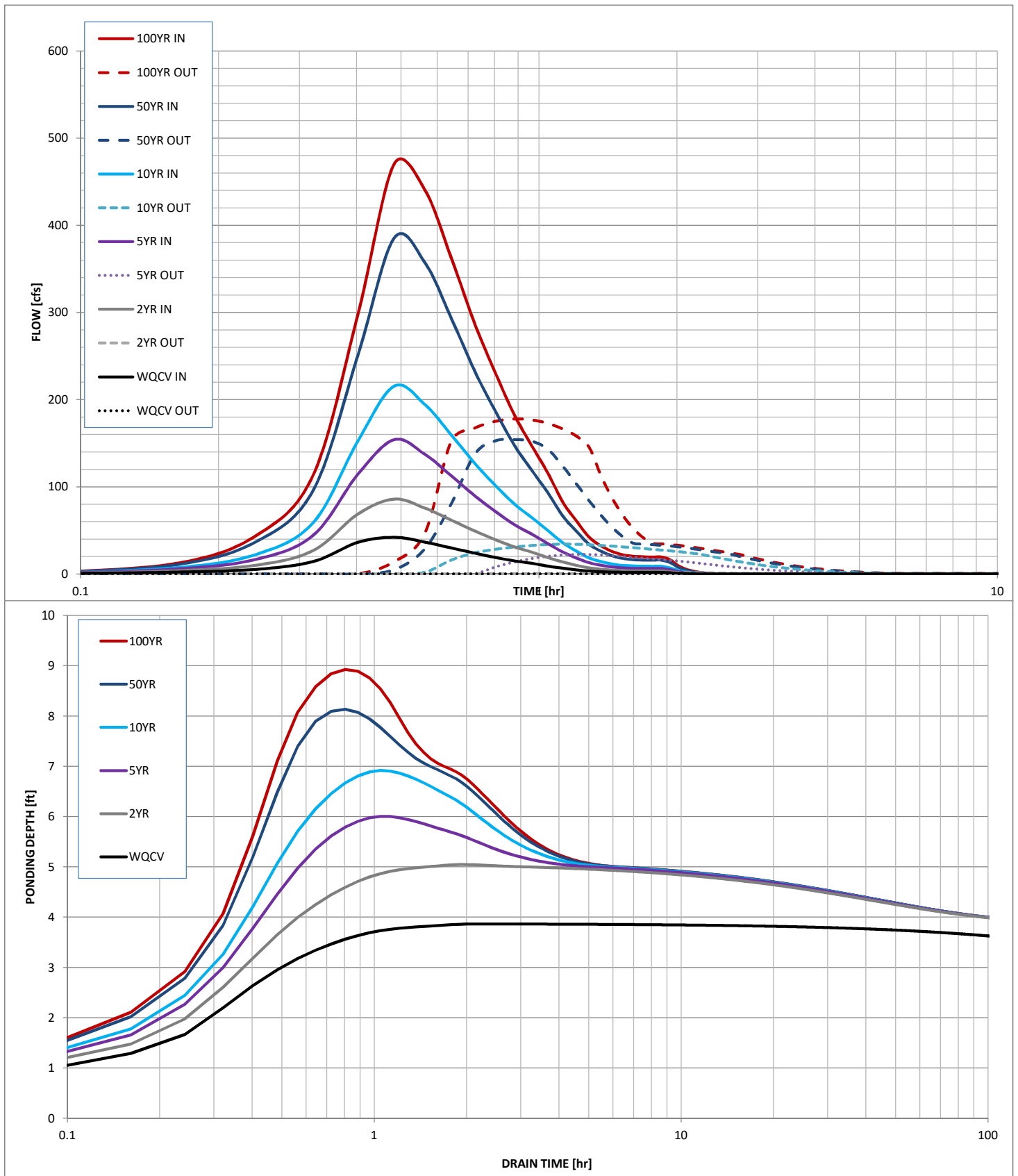
create a new stormwater facility, and

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 Poned 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		
<i>C</i>	3.00		L (ft)	H (ft)	Q (cfs)
<i>L</i>	96.00	ft	0.0	0.0	288.0
<i>H</i>	1.00	ft			
<i>Q</i>		cfs			

Total <i>Q</i>	307.99
-----------------------	---------------

Equation 12-20

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

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)

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

Equation 12-21

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

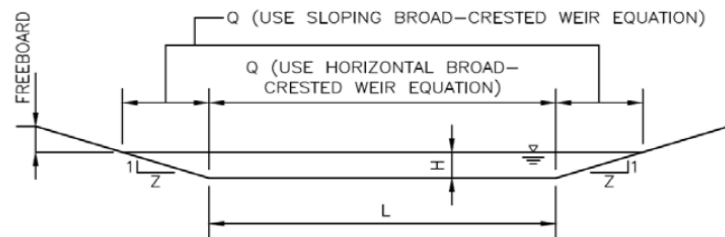
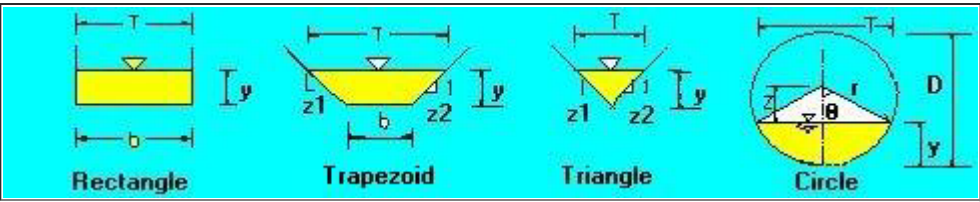


Figure 12-20. Sloping broad-crest weir

The open channel flow calculator			
Select Channel Type: Trapezoid ▼	 <div style="display: flex; justify-content: space-around; font-size: small;"> Rectangle Trapezoid Triangle Circle </div>		
Velocity(V)&Discharge(Q) ▼	Select unit system: Feet(ft) ▼		
Channel slope: <input type="text" value="0.33"/> <small>ft/ft</small>	Water depth(y): <input type="text" value="0.241"/> <small>ft</small>	Bottom width(b) <input type="text" value="96"/> <small>ft</small>	
Flow velocity <input type="text" value="13.0435"/> <small>ft/s</small>	LeftSlope (Z1): <input type="text" value="8.33"/> to 1 (H:V)	RightSlope (Z2): <input type="text" value="8.33"/> <small>to 1 (H:V)</small>	
Flow discharge <input type="text" value="308.0843"/> <small>ft^3/s</small>	Input n value <input type="text" value="0.025"/> or select n		
<input type="button" value="Calculate!"/>	Status: Calculation finished		<input type="button" value="Reset"/>
Wetted perimeter <input type="text" value="100.04"/> <small>ft</small>	Flow area <input type="text" value="23.62"/> <small>ft^2</small>	Top width(T) <input type="text" value="100.02"/> <small>ft</small>	
Specific energy <input type="text" value="2.88"/> <small>ft</small>	Froude number <input type="text" value="4.73"/>	Flow status <input type="text" value="Supercritical flow"/>	
Critical depth <input type="text" value="0.67"/> <small>ft</small>	Critical slope <input type="text" value="0.0105"/> <small>ft/ft</small>	Velocity head <input type="text" value="2.64"/> <small>ft</small>	

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POND C SPILLWAY RUNDOWN



PROJECT: PAINT BRUSH HELIX FILTRATION

DATE: _____

POND C SURCHARGE VOL.

ACRES 137.58 AC. WATERSHED IMPERVIOUS = 32.80%
TRIBUTARY IMPERVIOUS AREA $137.58 \text{ AC} \times 32.8\% = 45.12 \approx 45 \text{ AC.}$
FROM FIG 1 MICROPOOL SURFACE AREA = 180 SF DESIGN = 180 SF ACTUAL

MINIMUM FOREBAY VOLUME

$$3\% \text{ OF WQCV } 3\% \times 1839 \text{ AC-FT} \times \frac{4350 \text{ CU-FT}}{1 \text{ AC-FT}} = 2403 \text{ CU-FT}$$

$$2403 \text{ CU-FT} \div 15 \text{ FT} = 1602 \text{ SQ-FT DESIGN} \leq 1623 \text{ SQ-FT ACTUAL}$$

FOREBAY RELEASE & CONFIGURATION

PEAK 100 YEAR DISCHARGE $Q_{100} = 92.8 \text{ CFS} \times 2\% \text{ RELEASE} = 1.86 \text{ CFS}$
WEIR BOW $Q = CLH^{3/2}$ FOREBAY 1.5 FT DEEP?
 $Q = 3.0 (0.33') (1.5')^{3/2} = 1.82 \text{ CFS ACTUAL} \approx 1.86 \text{ CFS DESIGN}$

TRICKLE CHANNEL CAPACITY

$$\text{TRICKLE CHANNEL } 2' \times 6" \text{ H } Q = 3.0 (2') (6.5')^{3/2} = 2.12 \text{ CFS}$$

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 REBRAP TYPES FOR SPILLWAY PROTECTION (DSM, V.1)
UNIT DISCHARGE $306.7 \text{ CFS/96 FT} = 3.2$ 3:1 LONGITUDINAL SLOPE

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

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

Figure 13-12c. Emergency Spillway Protection

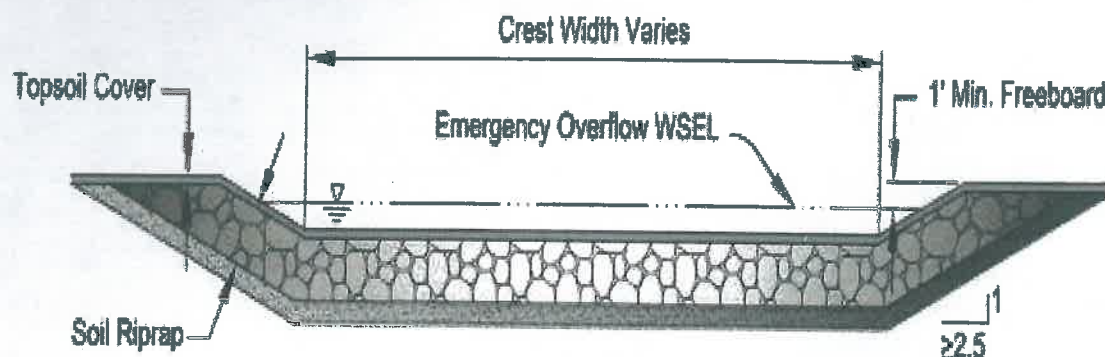
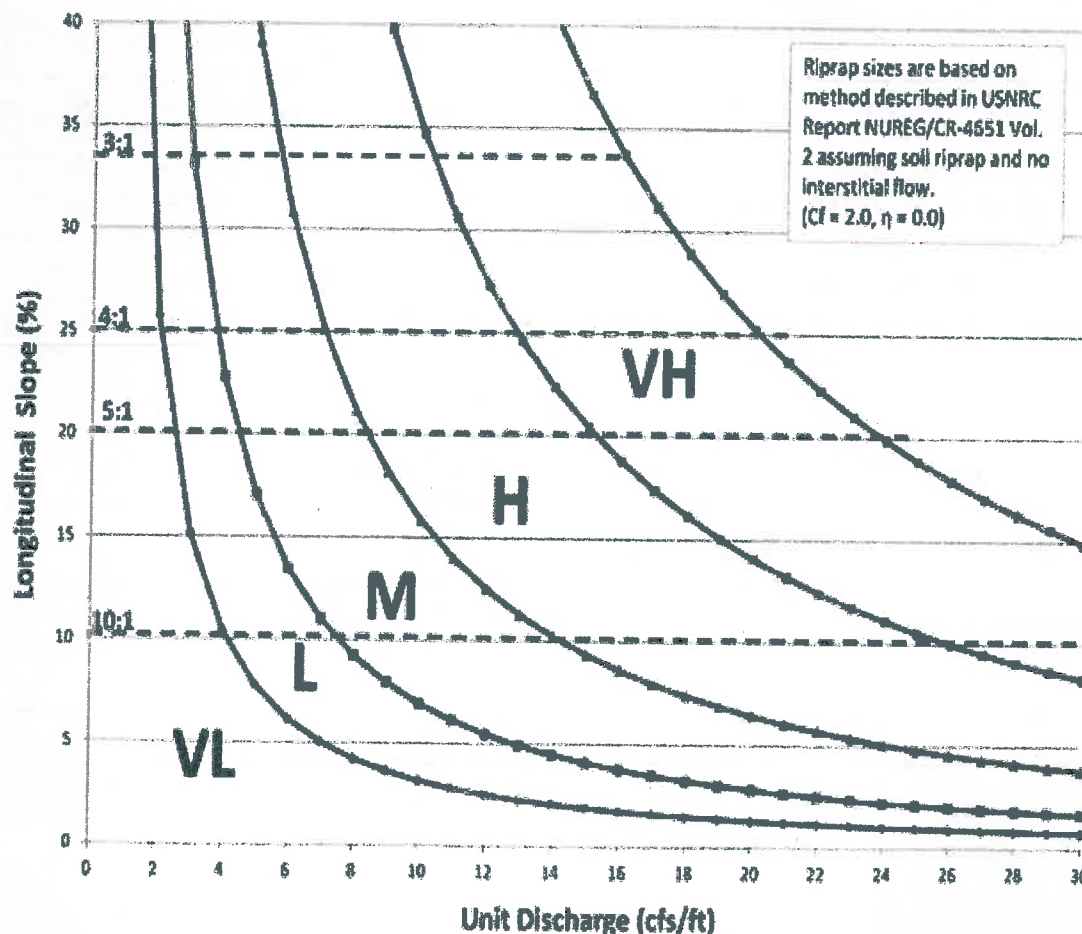


Figure 13-12d. Riprap Types for Emergency Spillway Protection



Micropool Surface Area, SA

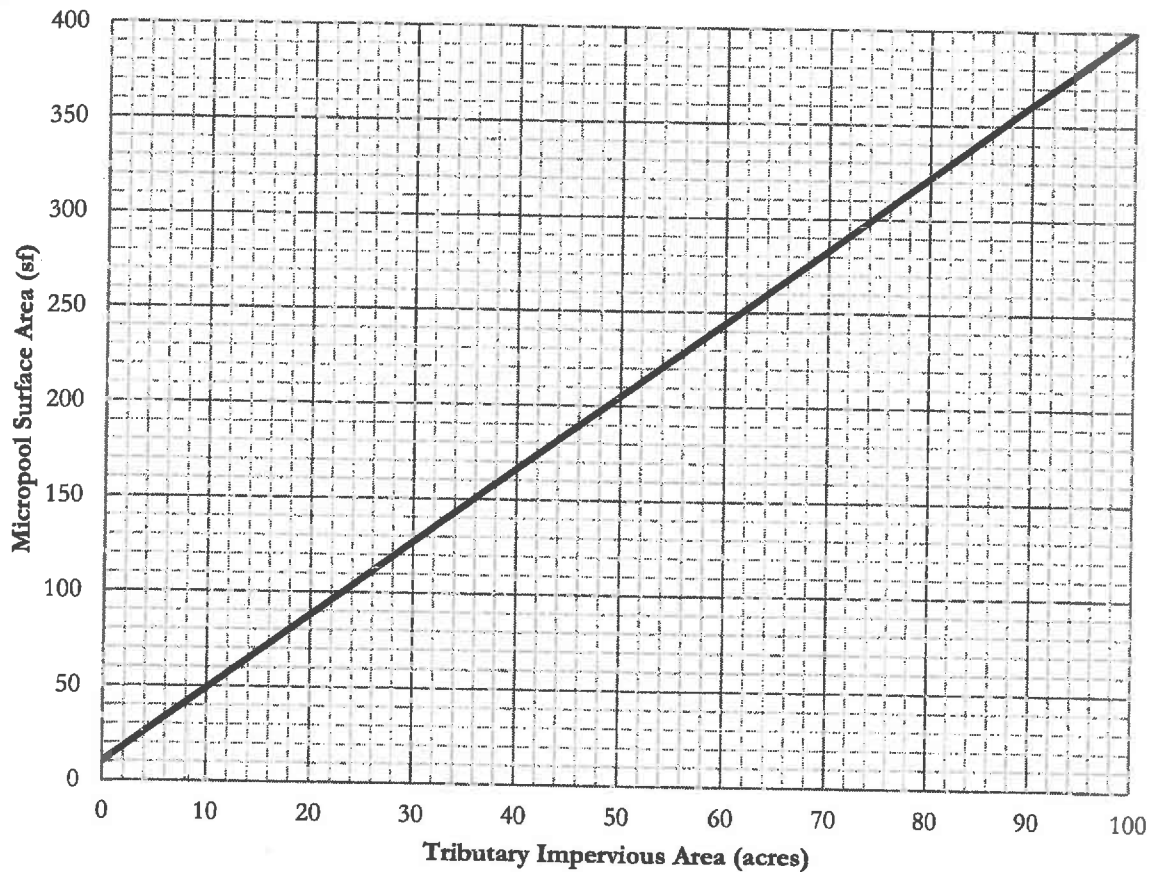


Figure 1 – Micropool Surface Area (SA) Determination Chart

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.

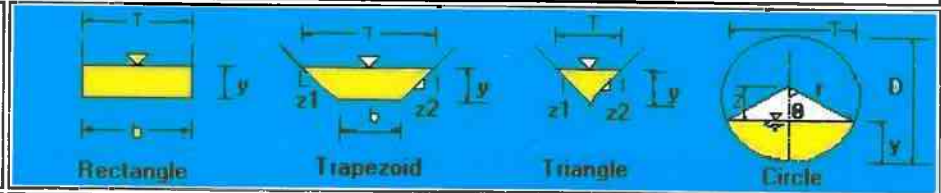
$$ISV = SA \times 4 \text{ inches}$$

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

ft³/s

Input n value: 0.013 or select n

Calculate!

Status: Calculation finished

Reset

Wetted perimeter: 3

ft

Flow area: 1

ft²

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

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LOW FLOW TRICKLE CHANNEL

PROJECT: PALM BRUSH HILLS FILING #1

DATE: _____

LOW TAILWATER RIP RAP BASIN PR 1
 $Q_{100} = 13.7 \text{ cfs}$ 18" RCP

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

FIG. 9-38 RIP RAP EROSION PROTECTION (UDFCD)

Y_e/D ASSUMED 0.4

$Q/D^{1.5} = 13.7/1.5^{1.5} = 7.46$
FROM FIG. 9-38 TYPE L RIP RAP $D_{50} = 9"$

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

LOW TAILWATER RIP RAP BASIN PR #27

$Q_{100} = 92.8 \text{ cfs}$ 48" RCP

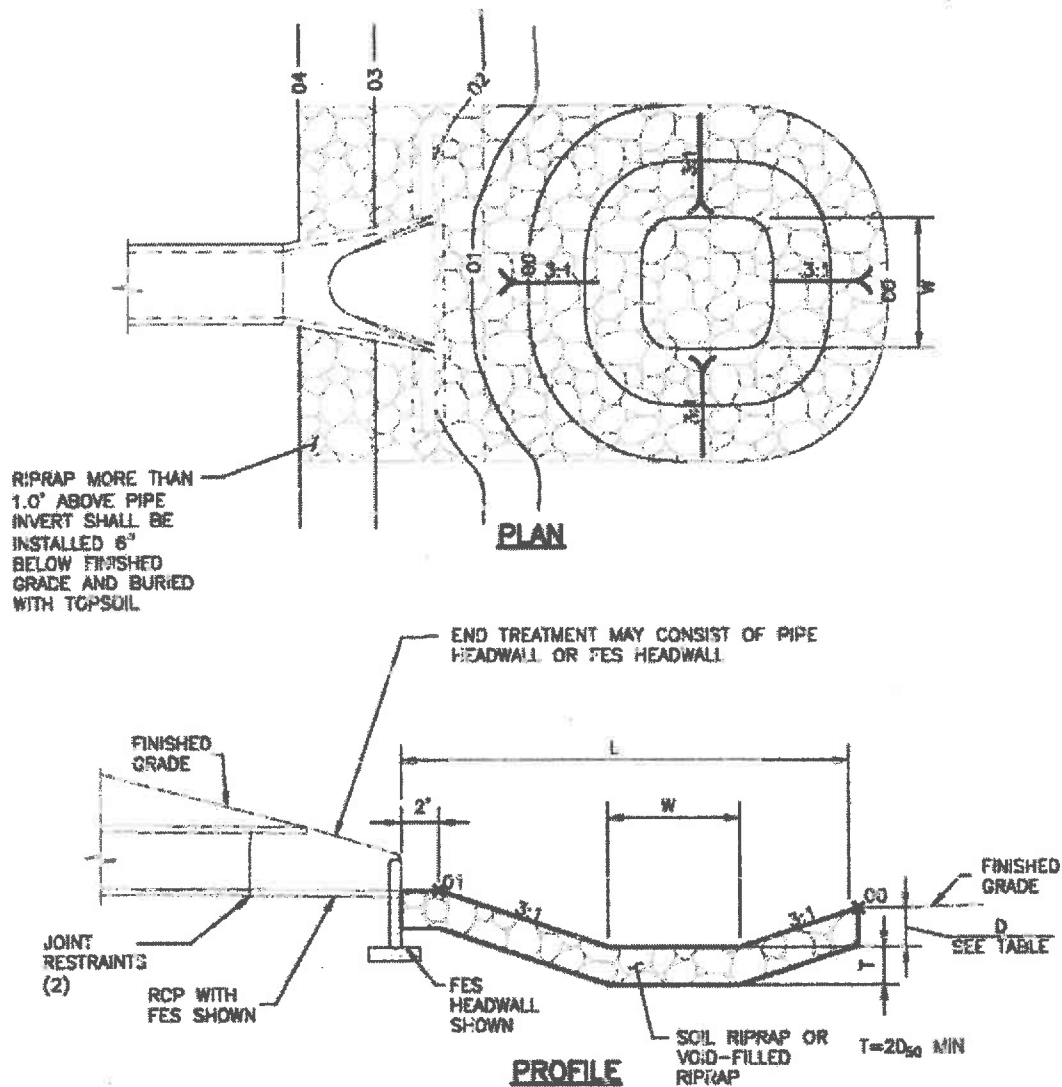
FIG. 9-37 LOW TAILWATER RIP RAP BASIN (UDFCD)
FOR 48" STORM PIPE 24' L x 19' W DESIGN
24' L x 19' W ACTUAL

FIG. 9-38 RIP RAP EROSION PROTECTION (UDFCD)

Y_e/D ASSUMED 0.4

$Q/D^{1.5} = 92.8 \text{ cfs} / 4^{1.5} = 11.6$
FROM FIG. 9-38 TYPE M $D_{50} = 12"$
 $2D_{50} = 2 \times 12" = 24" \text{ THICK}$

PER "PALM BRUSH HILLS FILING #1" CONSTRUCTION PLANS
EXISTING RIP RAP FOR OUTFALL 20' x 20' x 3' THICK ($D_{50} = 18"$)
EXISTING RIP RAP PAD IS IN GOOD PERFORMANCE.



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:

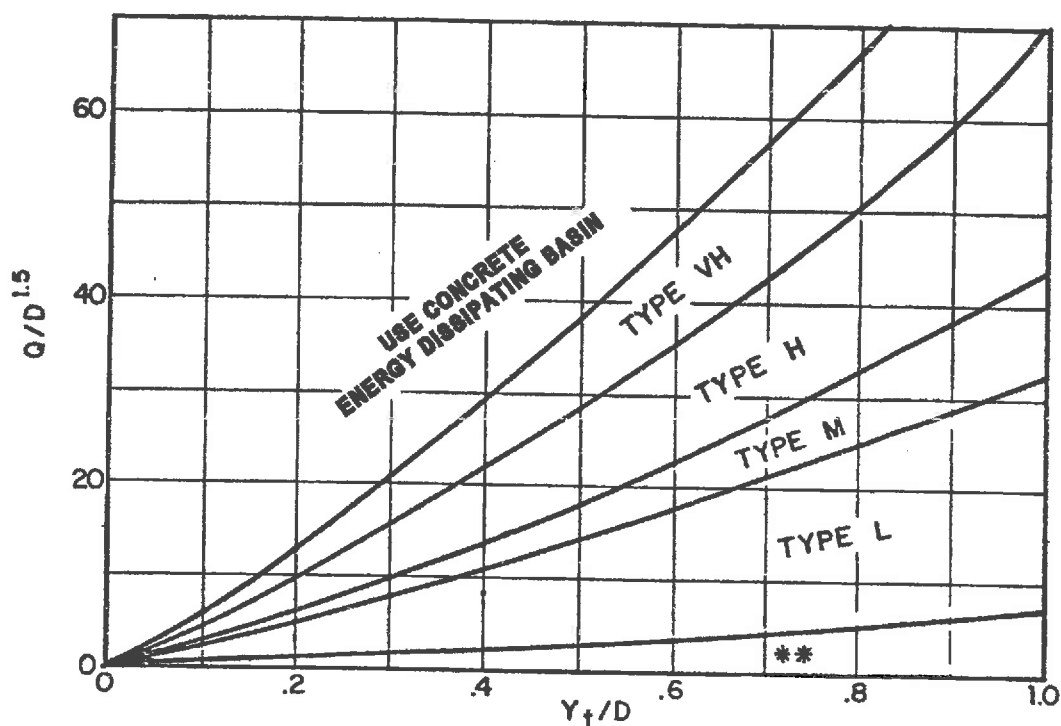
D_a = parameter to use in place of D in Figure 9-38 when flow is supercritical (ft)

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)

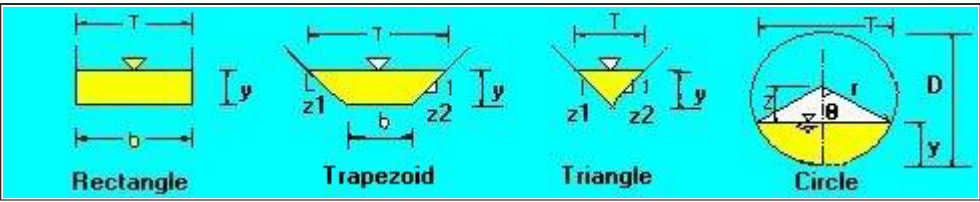
H = height of rectangular culvert (ft)

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



Use D_0 instead of D whenever flow is supercritical in the barrel.
 ** Use Type L for a distance of $3D$ downstream.

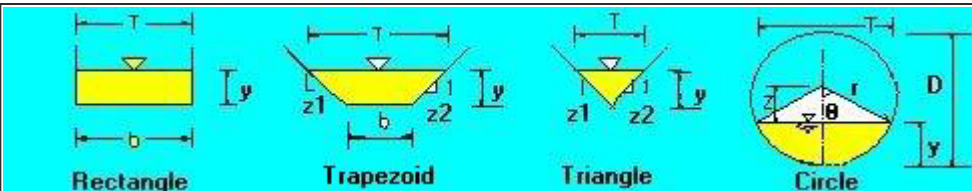
Figure 9-38. Riprap erosion protection at circular conduit outlet (valid for $Q/D^{2.5} \leq 6.0$)

The open channel flow calculator			
Select Channel Type: Trapezoid ▼	 <div style="display: flex; justify-content: space-around; font-size: small;"> Rectangle Trapezoid Triangle Circle </div>		
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	

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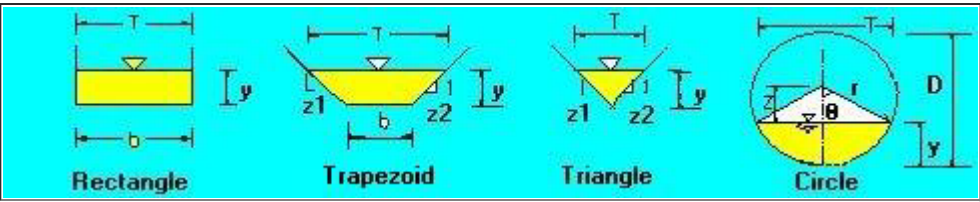
DP1 EXISTING SWALE Q100= 13.7 CFS

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

The open channel flow calculator					
Select Channel Type: Triangle ▼		 <div style="display: flex; justify-content: space-around; font-size: small;"> Rectangle Trapezoid Triangle Circle </div>			
Velocity(V)&Discharge(Q) ▼		Select unit system: Feet(ft) ▼			
Channel slope: .012 ft/ft		Water depth(y): 1.93 ft		Bottom W(b) 0 ft	
Flow velocity: 4.4509 ft/s		LeftSlope (Z1): 4 to 1 (H:V)		RightSlope (Z2): 4 to 1 (H:V)	
Flow discharge: 66.317 ft^3/s		Input n value: 0.035 or select n			
Calculate!		Status: Calculation finished		Reset	
Wetted perimeter: 15.92 ft		Flow area: 14.9 ft^2		Top width(T): 15.44 ft	
Specific energy: 2.24 ft		Froude number: 0.8		Flow status: Subcritical flow	
Critical depth: 1.76 ft		Critical slope: 0.0194 ft/ft		Velocity head: 0.31 ft	

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DP3 NATURAL CHANNEL $Q_{100}=65.3$ cfs
 SEE SC150 TURF REINFORCEMENT MAT

The open channel flow calculator			
Select Channel Type: Trapezoid ▼	 <div style="display: flex; justify-content: space-around; font-size: small;"> Rectangle Trapezoid Triangle Circle </div>		
Velocity(V)&Discharge(Q) ▼	Select unit system: Feet(ft) ▼		
Channel slope: <input type="text" value="0.0145"/> <small>ft/ft</small>	Water depth(y): <input type="text" value="0.91"/> <small>ft</small>	Bottom width(b) <input type="text" value="2"/> <small>ft</small>	
Flow velocity <input type="text" value="4.8339"/> <small>ft/s</small>	LeftSlope (Z1): <input type="text" value="3"/> to 1 (H:V)	RightSlope (Z2): <input type="text" value="3"/> to 1 (H:V)	
Flow discharge <input type="text" value="20.8065"/> <small>ft^3/s</small>	Input n value <input type="text" value="0.025"/> or select n		
<input type="button" value="Calculate!"/>	Status: Calculation finished		<input type="button" value="Reset"/>
Wetted perimeter <input type="text" value="7.76"/> <small>ft</small>	Flow area <input type="text" value="4.3"/> <small>ft^2</small>	Top width(T) <input type="text" value="7.46"/> <small>ft</small>	
Specific energy <input type="text" value="1.27"/> <small>ft</small>	Froude number <input type="text" value="1.12"/>	Flow status <input type="text" value="Supercritical flow"/>	
Critical depth <input type="text" value="0.97"/> <small>ft</small>	Critical slope <input type="text" value="0.0112"/> <small>ft/ft</small>	Velocity head <input type="text" value="0.36"/> <small>ft</small>	

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DP16 PROPOSED SWALE Q100= 20.8 CFS

**SEE TABLE 10-4 FOR MAXIMUM PERMISSIBLE
VELOCITIES 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.		



Material and Performance Specification Sheet

North American Green
14649 Highway 41 North
Evansville, IN 47725
800-772-2040
FAX: 812-867-0247
www.nagreen.com

A **tensar** Company

SC150 Erosion Control Blanket

The extended-term double net erosion control blanket shall be a machine-produced mat of 70% agricultural straw and 30% coconut fiber with a functional longevity of up to 24 months. (NOTE: functional longevity may vary depending upon climatic conditions, soil, geographical location, and elevation). The blanket shall be of consistent thickness with the straw and coconut evenly distributed over the entire area of the mat. The blanket shall be covered on the top side with a heavyweight photodegradable polypropylene netting having ultraviolet additives to delay breakdown and an approximate 0.63 x 0.63 (1.59 x 1.59 cm) mesh, and on the bottom side with a lightweight photodegradable polypropylene netting with an approximate 0.50 x 0.50 in (1.27 x 1.27 cm) mesh. The blanket shall be sewn together on 1.50 inch (3.81 cm) centers with degradable thread.

The SC150 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 713.17 as a type 3.B Extended-term Erosion Control Blanket*.

The SC150 is also available with the DOT System™, which consists of installation staple patterns clearly marked on the erosion control blanket with environmentally safe paint. The blanket 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 Fiber	0.35 lbs/yd ² (0.19 kg/m ²)
	30% Coconut Fiber	0.15 lbs/yd ² (0.08 kg/m ²)
Nettings	Top - Heavyweight photodegradable with UV additives	3.0 lb/1000 ft ² (1.47 kg/100 m ²)
	Bottom - Lightweight Photodegradable	1.5 lb/1000 ft ² (0.73 kg/100 m ²)
Thread	Degradable	

SC150 is available in the following standard roll sizes:

Width	6.67 ft (2.03 m)	16 ft (4.87 m)
Length	108 ft (32.92 m)	108 ft (32.92 m)
Weight ± 10%	44 lbs (19.95 kg)	105.6 lbs (47.9 kg)
Area	80.0 yd ² (66.9 m ²)	192 yd ² (165.5 m ²)

Index Value Properties:

Property	Test Method	Typical
Thickness	ASTM D6525	0.39 in (9.91 mm)
Resiliency	ECTC Guidelines	75%
Water Absorbency	ASTM D1117	285%
Mass/Unit Area	ASTM 6475	11.44 oz/yd ² (388 g/m ²)
Swell	ECTC Guidelines	30%
Smolder Resistance	ECTC Guidelines	Yes
Stiffness	ASTM D1388	1.11 oz-in
Light Penetration	ECTC Guidelines	8.7%
Tensile Strength - MD	ASTM D6818	146.6 lbs/ft (2.17 kN/m)
Elongation - MD	ASTM D6818	26.9%
Tensile Strength - TD	ASTM D6818	147.6 lbs/ft (2.19 kN/m)
Elongation - TD	ASTM D6818	25.2%

Bench Scale Testing* (NTPEP):

Test Method	Parameters	Results
ECTC Method 2 Rainfall	50 mm (2 in)/hr for 30 min	SLR** = 5.47
	100mm (4 in)/hr for 30 min	SLR** = 5.67
	150 mm (6 in)/hr for 30 min	SLR** = 5.88
ECTC Method 3 Shear Resistance	Shear at 0.50 inch soil loss	2.72 lbs/ft ²
ECTC Method 4 Germination	Top Soil, Fescue, 21 day incubation	538% 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	
Unvegetated Shear Stress	2.00 lbs/ft ² (96 Pa)
Unvegetated Velocity	8.00 ft/s (2.44 m/s)

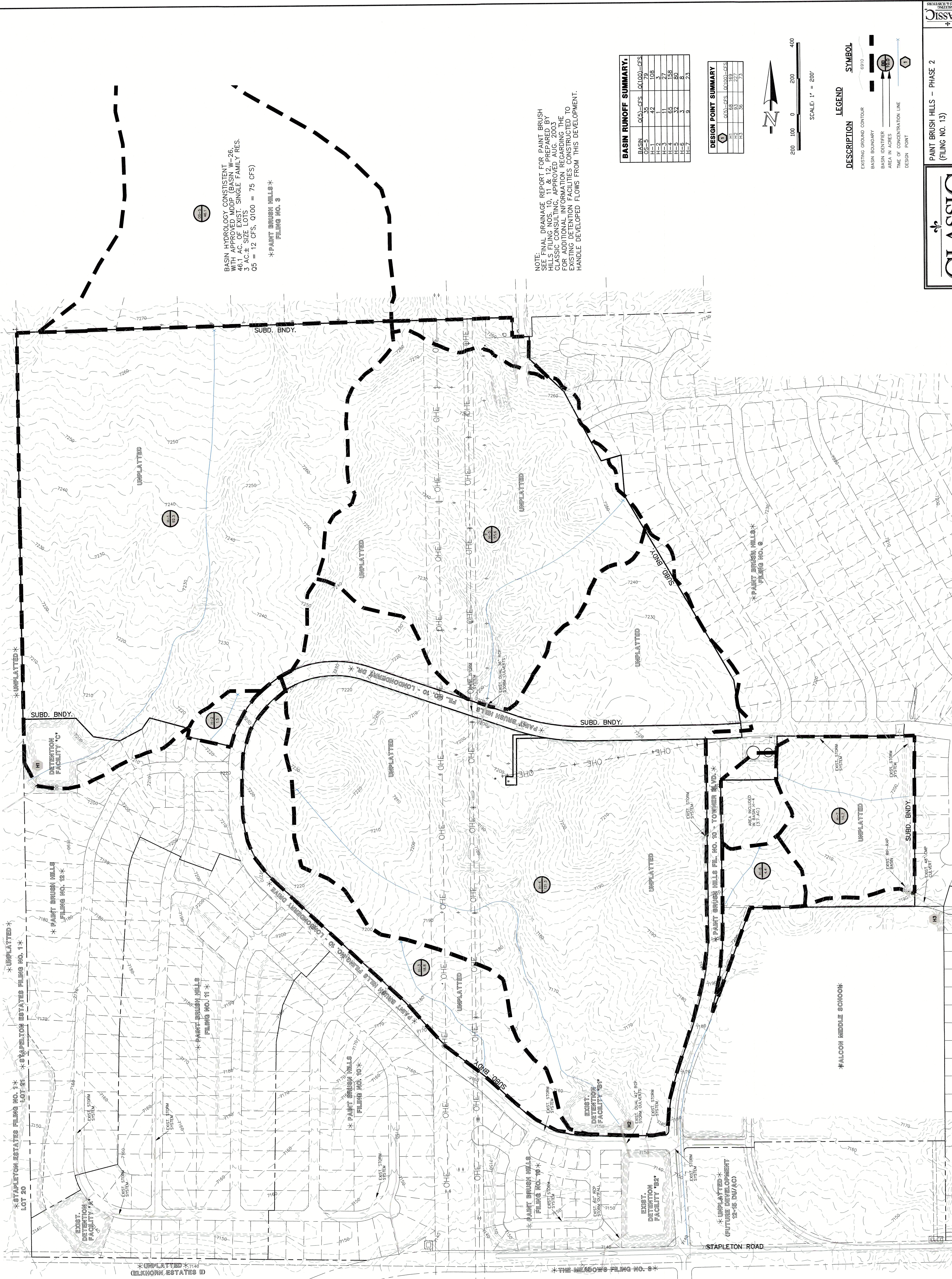
Slope Design Data: C Factors			
	Slope Gradients (S)		
Slope Length (L)	≤ 3:1	3:1 - 2:1	≥ 2:1
≤ 20 ft (6 m)	0.001	0.048	0.100
20-50 ft	0.051	0.079	0.145
≥ 50 ft (15.2 m)	0.10	0.110	0.190

Roughness Coefficients- Unveg.	
Flow Depth	Manning's n
≤ 0.50 ft (0.15 m)	0.050
0.50 - 2.0 ft	0.050 - 0.018
≥ 2.0 ft (0.60 m)	0.018



Product Participant of:

**PROPOSED AND EXISTING DRAINAGE MAP
& REFERENCE MAPS**



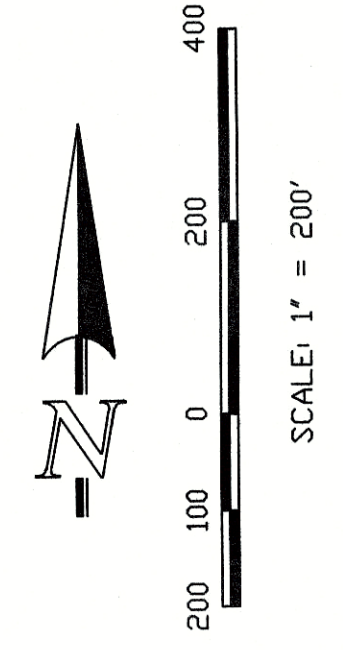
BASIN HYDROLOGY CONSTANT
WITH ADJUSTED MDDP (BASIN W-26,
46.1 AC OF EXIST. SINGLE FAMILY RES.
3 AC.± SIZE LOTS
Q5 = 12 CFS, Q100 = 75 CFS)

PAINT BRUSH HILLS
FILING NO. 3

NOTE:
SEE FINAL DRAINAGE REPORT FOR PAINT BRUSH
HILLS FILING NOS. 10, 11 & 12, PREPARED BY
CLASSIC CONSULTING, APPROVED AUG. 2007
FOR ADDITIONAL INFORMATION REGARDING THE
EXISTING DETENTION FACILITIES AND THE
HANDLE DEVELOPED FLOWS FROM THIS DEVELOPMENT.

BASIN RUNOFF SUMMARY.		
BASIN	Q(CS)-CFS	Q(100)-CFS
OS-5	35	79
H-1	42	108
H-2	11	27
H-4	65	158
H-5	32	80
H-7	9	23

DESIGN POINT SUMMARY		
DESIGN POINT	Q(CS)-CFS	Q(100)-CFS
1	83	207
2	93	227
3	113	286



DESCRIPTION	SYMBOL
EXISTING GROUND CONTOUR	6910
BASIN BOUNDARY	---
BASIN IDENTIFIER	○
AREA IN ACRES	100
TIME OF CONCENTRATION LINE	---
DESIGN POINT	△

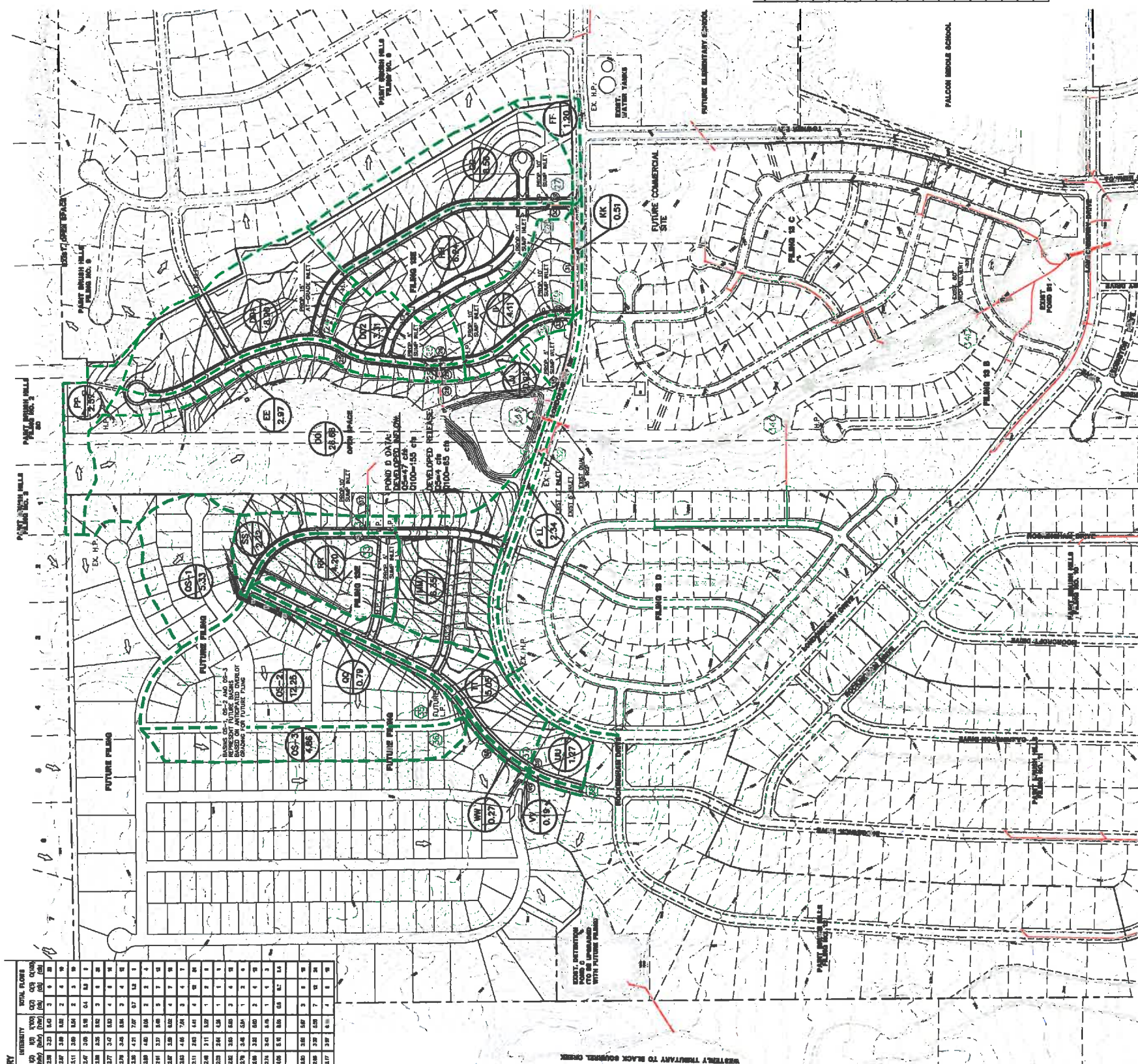
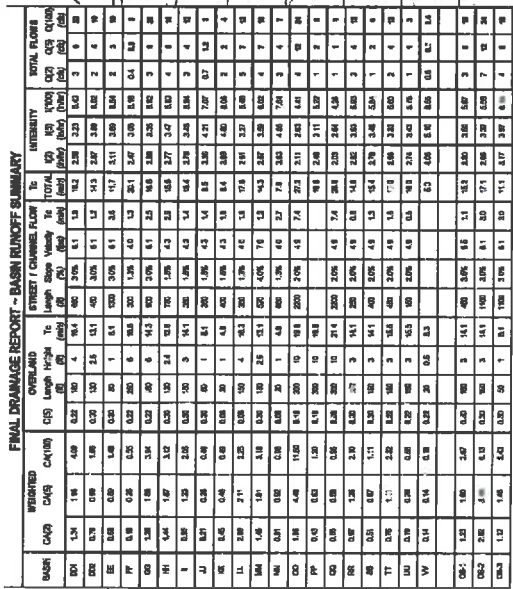
CLASSICSM
CONSULTING
ENGINEERS & SURVEYORS

6335 Corporate Drive, Suite 101
Colorado Springs, Colorado 80919
(719) 785-0790
(719) 785-0798 (fax)

PAINT BRUSH HILLS - PHASE 2
(FILING NO. 13)

FINAL DRAINAGE REPORT
HISTORIC CONDITIONS DRAINAGE MAP

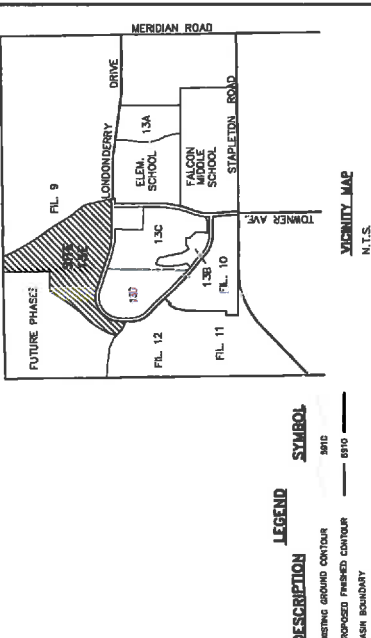
DESIGNED BY: MAM SCALE: DATE: 8/20/12
DRAWN BY: MAM (H) 1"= 200' SHEET: 1 OF 2
CHECKED BY: (V) 1"= N/A JOB NO.: 2053.21



FINAL DRAINAGE REPORT – SURFACE ROUTING SUMMARY										
Design Profile(s)	Contributing Basin	Equivalent Catchment Area(s)	Mainstem Tc	Incumbency			Flow			
				Qp	Q100	Q50	Q100	Q50	Q100	
24	D01	1.08	4.05	58.2	3.25	5.0	8	22	100% SCS Type II	
25	D02, D03	0.89	3.01	31.9	3.9	3	15	50% Type II Ramp		
26	DE	0.89	3.08	14.8	3.9	8.0	3	10% Type II Ramp		
27	DE	EE		11.7	3.9	8.0	3	10% Type II Ramp		
27	DL, FF	2.15	4.48	28.1	3.08	5.3	7	20% Type II Ramp		
28	HH	1.07	3.13	55.1	3.47	8.0	8	10% Type II Ramp		
29	A, HC	1.11	2.58	18.4	3.48	6.0	16	10% Type II Ramp		
30	J	0.25	0.48	9.4	4.21	2.67	1	3% Type II Ramp		
31	LL, MM	4.01	5.42	19.2	3.37	6.9	13	50, 22% Type II		
32	NN	0.92	0.98	7.9	4.35	2.68	4	7% Type II Ramp		
33	NN	1.38	5.19	14.3	3.93	6.01	4	12% Type II Ramp		
34	RR, DP-1	2.27	3.71	58.3	3.49	6.71	8	50% Type II Ramp		
34A	Total Inflow to Pond 1	57.04	35.33	32.2	2.93	4.41	47	100%		
35	OO, OO-2	4.25	6.71	91.1	3.88	6.88	14	38% Type II Ramp		
36	OO-3	1.48	2.43	11.1	3.67	6.88	4	10% Type II Ramp		
37	TT	1.11	2.33	10.3	3.88	6.88	4	10% Type II Ramp		
38	UU, VV and DP-3P Flowing	0.42	0.88	9.2	3.32	4.27	1	40% SCS		

FINAL DAMAGE REPORT - PIPE ROUTING SUMMARY										
Pipe Size	Contributing Station	Estimated Damage			Intensity			Flow		
		CAS	COV(%)	Tc	Q(%)	Q(%)	Q(%)	Q(%)	Q(%)	Pressure (ftH2O)
26	DP15 Pump	1.82	2.1%	98.2	1.23	0.0	5	18	30' H2O	
28	DP25	0.88	3.0%	96.7	1.0	1.8	3	16	20' H2O	
27	PR101 PUMP	2.88	8.1%	98.0	1.88	1.8	0	21	30' H2O	
27	DP101 PUMP	1.86	7.2%	98.2	1.86	1.8	13	20	30' H2O	
29	DP27	2.16	4.4%	98.1	1.88	0.8	7	23	20' H2O	
30	DP28	1.87	3.1%	98.5	1.9	1.8	0	18	20' H2O	
31	PR101 PUMP	4.02	7.8%	97.8	1.88	1.05	11	23	30' H2O	
32	DP29	1.88	2.84	98.4	1.8	0.8	0	18	20' H2O	
33	DP30	0.58	0.4%	98.5	1.85	1.85	1	3	10' H2O	
34	PR 101 PUMP	1.87	3.0%	98.8	1.22	0.3	7	07	20' H2O	
35	PR101 PUMP	3.88	10.8%	98.3	1.8	1.45	18	23	30' H2O	
36	DP 30	1.86	2.16	98.3	1.83	1.83	4	12	20' H2O	
37	DP34 PUMP	2.45	6.1%	96.5	1.88	1.87	13	30	30' H2O	
38	PR101 PUMP	5.71	8.22	97.2	1.81	0.66	19	81	30' H2O	
39	PR101 PUMP	1.11	2.07	97.8	1.83	0.88	4	03	20' H2O	
40	PR 101 PUMP	8.82	11.28	97.8	1.88	0.46	22	02	20' H2O	

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 0530F AND 08041C 05375, WITH EFFECTIVE DATES OF MARCH 17, 1997 (SEE APPENDIX).



NOTES:
THIS MAP IS FOR DRAINAGE PURPOSES ONLY.
SEE GRADING PLAN FOR APPROPRIATE GRADING
INFORMATION.

POND D DESIGN DATA:
 TRIBUTARY ACREAGE = 78.53
 WQCV REQ. = 0.88 AC-FT

POND D STRUCTURE DESIGN DATA:

**48 HOURS BEFORE YOU DIG,
CALL UTILITY LOCATORS
1-800-822-1987**

CITY OF COLORADO SPRINGS DEPT. OF UTILITIES
GAS, ELECTRIC, WATER AND WASTEWATER

[illegible]

REVIEW: _____ DATE _____

PREPARED UNDER MY DIRECT SUPERVISION FOR AND ON BEHALF OF
CLASSIC CONSULTING ENGINEERS AND SURVEYORS, L.L.C.

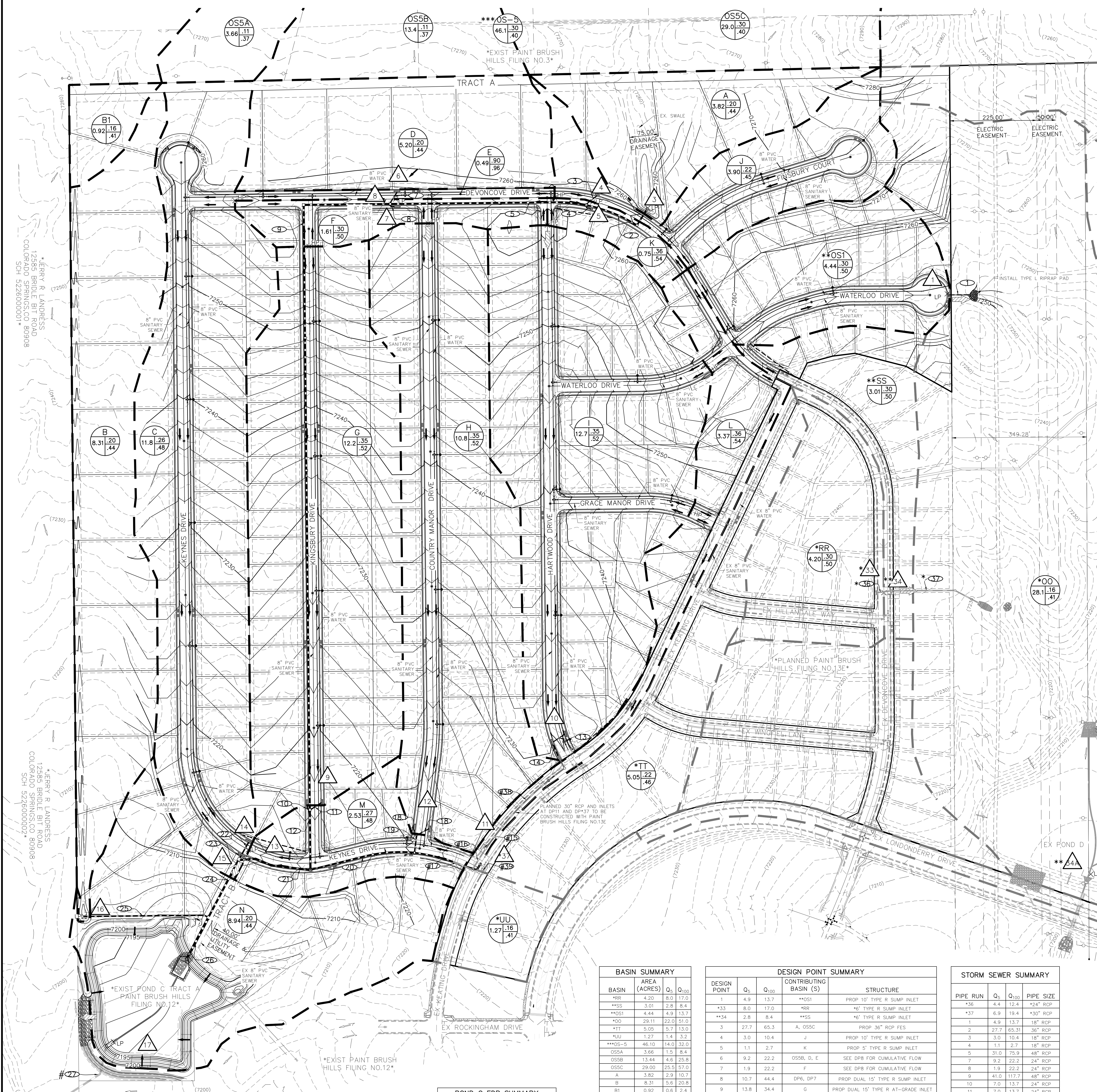
JAMES A. WHORTON, COLORADO P.E. 30715

CLASSIC
CONSULTING
ENGINEERS & SURVEYORS
Castro Avenue, Suite 200
(719) 335-3790

BRUSH HILLS NO. 13E DRAINAGE REPORT FED CONDITIONS DRAINAGE MAP	BY	MAW	SCALE	DATE	2/12/18
	TY	MAW	(H) 1" = 200'	SHEET	2 OF 2

PAINT BRUSH HILLS FILING NO. 14
COUNTY OF EL PASO, STATE OF COLORADO
PROPOSED DRAINAGE MAP

MARCH 2021



LEGEND

- BASIN DESIGNATION
- ACRES
- PIPE RUN REFERENCE LABEL
- SURFACE DESIGN POINT
- BASIN BOUNDARY
- EXISTING BASIN BOUNDARY
- EXISTING CONTOUR
- PROP CONTOUR
- PROP FENCE
- EX STORM SEWER PIPE
- STORM SEWER PIPE
- FLARED END SECTION
- CROSSSPAN
- INLET/OUTLET STRUCTURE
- EXISTING FLOW DIRECTION
- EMERGENCY OVERFLOW DIRECTION
- PROPOSED FLOW DIRECTION
- HIGH POINT
- LOW POINT
- RIPRAP
- EROSION CONTROL BLANKET

POND C EDB SUMMARY

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

BASIN SUMMARY

BASIN	AREA (ACRES)	Q _s	Q ₁₀₀
*RR	4.20	8.0	17.0
**SS	3.01	2.8	8.4
**S3	4.44	4.9	13.7
**34	2.8	8.4	22.0
*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	3.82	2.9	10.7
B	8.31	5.8	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	3.90	3.0	10.4
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 _s	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	27.7	65.3	A, OS5C	PROP 36" RCP FES
4	3.0	10.4	J	PROP 10" TYPE R SUMP INLET
5	1.1	2.7	K	PROP 8" 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 AT-GRADE 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 INLET
13	2.1	21.3	M, FLOWBY DP9, FLOWBY 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	108.8	306.5	N, PR26	EX POND C

STORM SEWER SUMMARY

PIPE RUN	Q _s	Q ₁₀₀	PIPE SIZE
*35	4.4	12.4	*24" RCP
*37	6.9	19.4	*30" RCP
1	4.9	13.7	18" RCP
2	27.7	65.3	36" RCP
3	3.0	10.4	18" RCP
4	1.1	2.7	18" RCP
5	31.0	75.9	48" RCP
7	9.2	22.2	24" RCP
8	1.9	22.2	24" RCP
9	41.0	117.7	48" RCP
10	7.0	13.7	24" RCP
11	7.0	13.7	24" RCP
12	53.7	142.4	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	6.0	12.4	18" RCP
19	11.9	24.8	30" RCP
20	34.4	75.3	42" RCP
21	86.6	214.4	54" RCP
22	6.1	27.7	30" RCP
23	12.3	55.4	36" RCP
24	98.8	269.2	60" RCP
25	5.6	20.8	30" RCP
26	103.6	287.2	66" RCP
*27	22.6	92.8	EX 48" RCP

*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.13F) 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

COMMENT ADDRESSED.
REVISED ALL SHEETS.

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 final drainage report
Unresolved. The note still references the PDR



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'	DATE: 03/04/2021
DESIGNED BY: GT	VERTICAL: N/A	SHEET 1 OF 1
DRAWN BY: CMN		FDM
CHECKED BY: VAS		



FOR BURIED UTILITY INFORMATION
48 HRS BEFORE YOU DIG
CALL 1-800-922-1987

Drairage V_3.pdf Markup Summary


dsdlaforce (11)

Since this is a combined PDR/FDR. Address the review 2 comments to the drainage report uploaded with the final plat application.

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Since this is a combined PDR/FDR. Address the review 2 comments to the drainage report uploaded with the final plat application.

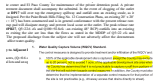



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100% of the development site must be treated for water quality. Provide permanent stormwater quality control measure for basin B.


Review 2. Unresolved. See ECM Appendix I Section I.7.1.B and Section I.7.1.C.1.a for exclusion from permanent WQ. Update the narrative to explain/identify the relevant exclusion from permanent water quality. If no exclusion is applicable then original comment remains.

Review 3. Unresolved. Contact the review engineer (Gilbert LaForce) if you require clarification regarding review 2 comments. 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: Image
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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. Unresolved. Update narrative to describe the mitigation proposed.




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

Review 2. Unresolved. Read Step 4 and revise the narrative appropriately. See snippet below.

Review 3. Unresolved. Contact the review engineer if you require clarification. Attached is a snippet from a similar project with no planned industrial or commercial site. If there are specialized BMPs, then update the narrative to describe said BMPs.




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Subject: Image
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RY AND STORM SEWER F
DATED FEB. 2018
JUNE 2008
DATE RECEIVED

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Subject: Callout
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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. The note still references the PDR