

**Colorado Springs Airport  
Filing No. 1F  
Integration Loop Phase 4**

**October 31, 2022**

**Final Drainage Report**

**Prepared For:**



**Prepared By:**



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## SIGNATURE PAGE

### Colorado Springs Airport Filing 1F, Integration Loop Phase 4

#### **ENGINEER'S STATEMENT**

This report and plan for the drainage design of **COSA Filing 1F, Integration Loop Phase 4** was prepared by me (or under my direct supervision) and is correct to the best of my knowledge and belief. Said report and plan has been prepared in accordance with the City of Colorado Springs Drainage Criteria Manual and is in conformity with the master plan of the drainage basin. I understand that the City of Colorado Springs does not and will not assume liability for drainage facilities designed by others. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

\_\_\_\_\_  
Jeffrey M. Mohr, P.E.

\_\_\_\_\_  
Date

Registered Professional Engineer State of Colorado No. 46411

#### **DEVELOPER'S STATEMENT**

Colorado Springs Airport hereby certifies that the drainage facilities for **COSA Filing 1F, Integration Loop Phase 4** shall be constructed according to the design presented in this report. I understand that the City of Colorado Springs does not and will not assume liability for the drainage facilities designed and/or certified by my engineer and that are submitted to the City of Colorado Springs pursuant to section 7.7.906 of the City Code; and cannot, on behalf of **COSA Filing 1F, Integration Loop Phase 4**, guarantee that final drainage design review will absolve Colorado Springs Airport and/or their successors and/or assigns of future liability for improper design. I further understand that approval of the final plat does not imply approval of my engineer's drainage design.

\_\_\_\_\_  
Colorado Springs Airport

Name of Developer

\_\_\_\_\_  
Authorized Signature

\_\_\_\_\_  
Date

\_\_\_\_\_  
Troy Stover

Printed Name

\_\_\_\_\_  
Assistant Director of Aviation

Title

7770 Milton E. Proby Pkwy, Suite 50

\_\_\_\_\_  
Colorado Springs, CO 80916

Address

#### **CITY OF COLORADO SPRINGS STATEMENT**

Filed in accordance with section 7.7.906 of the Code of the City of Colorado Springs, 2001, as amended.

\_\_\_\_\_  
For the City Engineer

\_\_\_\_\_  
Date

Conditions:

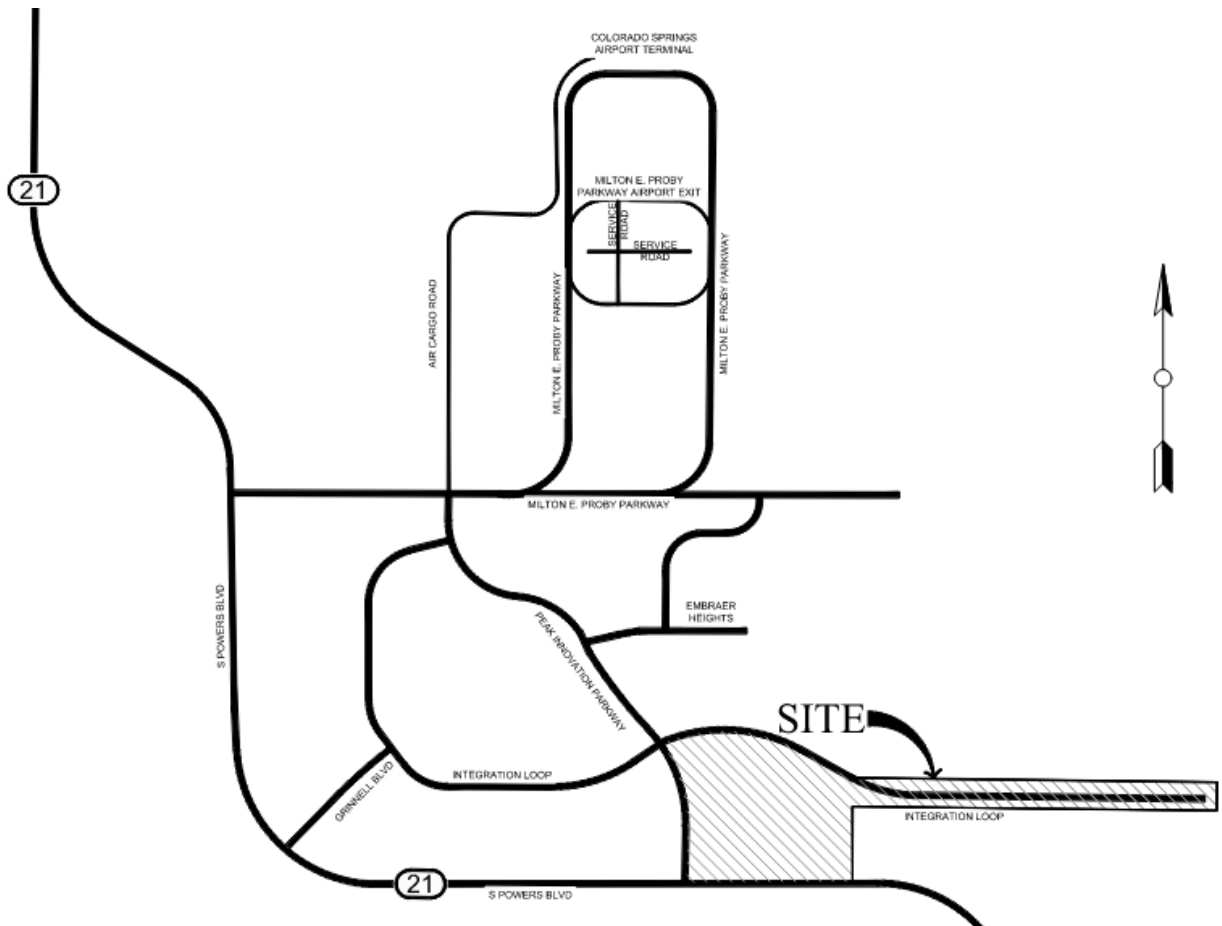
## INTRODUCTION

This Final Drainage Report (Report) for Colorado Springs Airport (COSA) Filing 1F, Integration Loop Phase 4 has been prepared in association with the Roadway CDs, the Permanent Control Measure (Plan), the Grading and Erosion Control (GEC) Plan, and the City Stormwater Management plan (CSWMP). The intent of this Report is to provide a basis of design, calculate design runoff, size stormwater infrastructure, and provide supporting drainage calculations.

### Project Location

The Project is located in Section 5 of Township 15 South, Range 65 West of the 6<sup>th</sup> Principal Meridian, located in the City of Colorado Springs, County of El Paso, State of Colorado. More specifically, the Project is located south of the Colorado Springs Airport terminal and is bordered by Integration Loop to the north, Peak Innovation Parkway to the west, South Powers Boulevard to the south, and undeveloped land to the east. A vicinity map is included as Figure 1 below.

Figure 1 - Vicinity Map (Not to Scale)



## Project Description

The Project proposes to build infrastructure on a portion of Lot 7, Colorado Springs Airport Filing No. 1F and within the Integration Loop roadway that will support future development within COSA Filing No. 1F. No subdivision is being proposed with the Project. The Project will construct detention and water quality Pond 705, approximately 2,900 LF of Integration Loop, open space trails, and utilities to serve future development. Approximately 44.3 acres will be disturbed by the Project. Drainage improvements constructed with the Project includes swales, storm drain infrastructure, and Pond 705.

## Site Description

The Project is generally undeveloped and slopes south towards South Powers Boulevard at varying slopes of 1%-5%. Existing vegetation consists primarily of native grasses.

As designated in the Natural Resources Conservation Services NRCS Soil Report in Appendix F, Site soils are classified as Type A and Type B soils. The site consists of approximately 75% Type A soils and 25% Type B soils.

Per Flood Insurance Rate Map Number 08041C0764G, effective December 7, 2018, the Project is located outside of the 0.2% annual chance floodplain. The FIRM Map is included in Appendix F.

The Project is not located within a Streamside zone.

There are no jurisdictional wetlands located within the Project area.

There are no irrigation facilities located within the Project area.

## Design Criteria

The methods used, and information provided with this Report have been prepared in accordance with the following design criteria:

- 1) City of Colorado Springs Drainage Criteria Manual Volume 1 (Last revised January 2021) & 2 (Last revised December 2020) and 11 policy clarifications (COCS Standards).
- 2) Mile High Flood District's (MHFD) Urban Storm Drainage Criteria Manual, Latest Revision/Updates (MHFD Standards)
- 3) Federal Aviation Administration (FAA) Advisory Circular No 150/5200-33B (FAA-AC)
  - Note: This site is in a special airport district and therefore subject to drainage criteria set by the FAA-AC. Note that FAA-AC requires a maximum drain time of 48 hours for all design storms at all stormwater facilities.

## Design Criteria Variances

A variance request has been made for the following:

1. A variance from the City's 72-hour draw down time for the excess urban runoff volume (EURV).

## Erosion Control Plan

A Grading and Erosion Control Plan and City Stormwater management Plan has been prepared by Enertia Consulting Group, LLC for the project.

## Drainage & Bridge Fees

Per the 1991 Big Johnson Reservoir/Crews Gulch DBPS, the Colorado Springs Airport is exempt from drainage basin fees within the Big Johnson Drainage Basin. This Project falls within the Big Johnson Drainage Basin.

## Cost Estimate

All proposed stormwater infrastructure is private and non-reimbursable. A stormwater construction cost estimate is provided in Appendix F.

# HISTORIC DRAINAGE CONDITIONS

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## Relevant Drainage Studies

- A Drainage Basin Planning Study titled “Big Johnson/Crews Gulch” prepared by Kiowa Engineering Corporation, dated September 1991, was prepared for this watershed. The Project is within the area of this study.
- A Final Drainage Report titled “Colorado Springs Airport Business Park Defense Access Road Project” (DAR FDR) prepared by CH2MHill, dated March 2011, was prepared for Peak Innovation Parkway (formerly Cresterra Parkway).
  - The Powers Pond was designed and constructed with the DAR FDR. The Project proposes to remove the Powers Pond and reroute all tributary flows to Pond 705.
- A Final Drainage Report titled “Colorado Springs Airport Integration Phase 3” (Phase 3 FDR) prepared by Enertia Consulting Group, dated September 28, 2022 and approved on October 19, 2022 was prepared for the COSA Filing 1F subdivision.
  - Ponds 701 and 702 were designed and constructed with the Phase 3 FDR. The Project proposes to remove Pond 702 and reroute all tributary flows to Pond 705.
- A Final Drainage Report titled “Colorado Springs Airport Ponds 500 & 600” (Ponds 500 & 600 FDR) prepared by Enertia Consulting Group, dated **September 28, 2022** and approved on **October 22, 2022** is adjacent to the Project.
- A Master Development Drainage Plan (MDDP) titled “Colorado Springs Airport Peak Innovation Park” prepared by Enginuity Engineering Solutions (Enginuity), dated August 2020, approved September 16, 2020, and amended (1<sup>st</sup> Amendment) September 28, 2021, was prepared for the Peak Innovation Park development. The Project is within the MDDP study area and must conform with the following criteria:
  - Pond 705 will provide regional detention for the Project and will be constructed with the Project. Per the MDDP, Pond 705 has a 100-year allowable release rate of 412 CFS and outfalls to DP700, an 8’x8’ RCBC.

## Hydrologic Analysis Criteria

Undeveloped conditions were analyzed in accordance with COCS Standards and MHFD Standards for the:

- **Major Event** (100-year, 1-hour)
- **Minor Event** (5-year, 1-hour)

Hydrologic design criteria for the Project’s historic condition is discussed below and associated calculations are included in Appendix B. The rational method was used to calculate basin peak flows.

Table 1 includes a summary of the criteria and resources used in preparation of the hydrologic analysis.

**Table 1 - Hydrologic (Rational Method) Analysis Parameters**

Parameter	Value	Unit	Reference
Time of Concentration, T <sub>c</sub>	-	min.	Sheet SF-2
Runoff Coefficient, C	-	-	COCS DCM Vol I, Chapter 6, Tbl 6-6*
1-hr Point Rainfall, P <sub>1</sub> (5-Year)	1.50	inches	COCS DCM Vol I, Chapter 6, Tbl 6-2
1-hr Point Rainfall, P <sub>1</sub> (100-Year)	2.52	inches	COCS DCM Vol I, Chapter 6, Tbl 6-2
Rainfall Intensity, I	-	-	COCS DCM Vol I, Chapter 6, Fig 6-5
Storm Runoff, Q	-	cfs	Q = CIA
*For impervious values not listed in Tbl 6-6, runoff coefficients were determined using a best fit polynomial formula derived using all applicable values from Tbl 6-6. The equation derivation can be found in Appendix B.			

### Historic Drainage Patterns

The Project falls within the Big Johnson major basin. Historically, the Project drains south to the north right-of-way of South Powers Boulevard. A portion of the Project area is conveyed by existing stormwater infrastructure in Peak Innovation Parkway to the existing Powers Pond. From here, it is conveyed under South Powers Boulevard by an existing 60" CMP culvert. A portion of the Project contains a manmade channel that receives flows from existing Pond 700 and overland flows from surrounding undeveloped areas. The channel conveys flows south where they are conveyed under South Powers Boulevard by an existing 8'x8' RCBC. The remainder of the Project area is conveyed overland to an existing naturally occurring sump. Should this sump overtop, flows are conveyed to the channel described above and conveyed under South Powers Boulevard by the existing 8'x8' RCBC. After flows are conveyed under South Powers Boulevard, they continue south where they are conveyed by naturally created drainageways to the Big Johnson Reservoir.

### Historic Drainage Basins

The Project is located within the Big Johnson drainage basin. A Historic Conditions Drainage Map is included in Appendix A. **All storm infrastructure is privately owned and maintained unless otherwise noted.**

**Basin A1** is 8.2 acres of existing Peak Innovation Parkway with a calculated imperviousness of 44%. Flows from Basin A1 are conveyed via curb and gutter to a series of existing CDOT Type R inlets within Peak Innovation Parkway where flows of  $Q_5 = 8.0$  CFS and  $Q_{100} = 21.5$  CFS are conveyed by existing stormwater infrastructure in Peak Innovation Parkway to the existing Powers Pond.

The Project proposes to remove the Powers Pond and route flows to Pond 705, a regional water quality and detention pond constructed with the Project.

**Basin A2** is 6.5 acres of existing Peak Innovation Parkway with a calculated imperviousness of 48%. Flows from Basin A2 are conveyed via curb and gutter to a series of existing CDOT Type R inlets within Peak Innovation Parkway where flows of  $Q_5 = 6.9$  CFS and  $Q_{100} = 17.9$  CFS are conveyed by existing stormwater infrastructure in Peak Innovation Parkway to the existing Powers Pond.

The Project proposes to remove the Powers Pond and route flows to Pond 705, a regional water quality and detention pond constructed with the Project.

**Basin A3** is 9.1 acres of open space with a regional trail and a calculated imperviousness of 5%. Basin A3 was analyzed in the Ponds 500 & 600 FDR and conveys flows of  $Q_5 = 3.3$  CFS and  $Q_{100} = 19.3$  CFS to the existing Powers Pond.

The Project proposes to remove the Powers Pond and route flows to Pond 705, a regional water quality and detention pond constructed with the Project.

**Basin A4** is 1.4 acres of Peak Innovation Parkway and South Powers Boulevard with a calculated imperviousness of 43%. Flows from Basin A4 are conveyed via curb and gutter to an existing CDOT 10' Type R inlet within Peak Innovation Parkway. Basin A4 conveys flows of  $Q_5 = 1.9$  CFS and  $Q_{100} = 5.1$  CFS to the existing Powers Pond.

The Project proposes to remove the Powers Detention Pond and route flows to Pond 705, a regional water quality and detention pond constructed with the Project.

**Basin A5** is 2.4 acres of Peak Innovation Parkway and South Powers Boulevard with a calculated imperviousness of 80%. Flows from Basin A5 are conveyed via curb and gutter to an existing CDOT 15' and 20' Type R inlets within Peak Innovation Parkway. Basin A5 conveys flows of  $Q_5 = 7.5$  CFS and  $Q_{100} = 14.7$  CFS to the existing Powers Detention Pond.

The Project proposes to remove the Powers Detention Pond and route flows to Pond 705, a regional water quality and detention pond constructed with the Project.

**Basin X1** is 9.1 acres of open space and the existing Powers Detention Pond with an assumed imperviousness of 2%. Flows of  $Q_5 = 1.6$  CFS and  $Q_{100} = 10.5$  CFS are routed to and detained by the existing Powers Detention Pond.

The Project proposes to remove the Powers Detention Pond and route flows to Pond 705, a regional water quality and detention pond constructed with the Project.

**Basin X2** is 181.4 acres of open space with an assumed imperviousness of 2%. Flows of  $Q_5 = 8.8$  CFS and  $Q_{100} = 57.6$  CFS are routed to DP700, an 8'x8' RCBC.

**Basin X701** is 9.6 acres of existing Integration Loop and existing Pond 701, with a calculated imperviousness of 48.3%. Basin X701 was analyzed in the Phase 3 FDR and its sub-basins were not delineated and analyzed as part of this report. Infrastructure within Basin X701 conveys flows of  $Q_5 = 7.5$  CFS and  $Q_{100} = 27.0$  CFS to Pond 701, where they are conveyed south by existing storm infrastructure to DP700, an 8'x8' RCBC.

**Basin X702** is 10.6 acres of existing Integration Loop, existing Logistics Point, Lot 4 COSA Filing 1F, and existing Pond 702, with a calculated imperviousness of 68.1%. Basin X702 was analyzed in the Phase 3 FDR and its sub-basins were not delineated and analyzed as part of this report.

Infrastructure within Basin X702 conveys flows of  $Q_5 = 13.5$  CFS and  $Q_{100} = 38.0$  CFS to Pond 702, where they are conveyed south by existing storm infrastructure to DP700, an 8'x8' RCBC. open space with an assumed imperviousness of 2%.

The Project proposes to remove Pond 702 and route flows to Pond 705, a regional water quality and detention pond constructed with the Project.

Tables 2 below provides a historic basin summary for the 5-year (minor) and 100-year (major) events.

EX BASIN SUMMARY				
Basin	Area (acres)	Impervious Percentage	Q5 (cfs)	Q100 (cfs)
A1	8.2	44%	8.0	21.5
A2	6.5	48%	6.9	17.9
A3	9.1	5%	3.3	19.3
A4	1.4	43%	1.9	5.1
A5	2.4	80%	7.5	14.7
X1	9.1	2%	1.6	10.5
X2	181.4	2%	8.8	57.6
X701	9.6	48%	#N/A	#N/A
X702	10.6	68%	#N/A	#N/A

## DEVELOPED DRAINAGE CONDITIONS

### Hydrologic Design Criteria

Developed conditions were analyzed in accordance with COCS Standards and MHFD Standards for the:

- **Major Event** (100-year, 1-hour)
- **Minor Event** (5-year, 1-hour)

Hydrologic design criteria for the Project's developed condition is discussed below and associated calculations are included in Appendix B. The rational method was used to calculate basin peak flows.

Table 1 above includes a summary of the criteria and resources used in preparation of the hydrologic analysis.

### Proposed Basins and Drainage Patterns

Per the MDDP, the Project primarily lies in developed Basins 700, 705, and a portion of developed Basin 600 that historically flowed to the Powers Pond. As stated above, the Project proposed to remove the Powers Pond and will route this tributary area to Pond 705 constructed with the Project. Pond 705 will outfall to the existing 8'x8' RCBC described above, where they are conveyed under South Powers



Boulevard and continue south where they are conveyed by naturally created drainageways to the Big Johnson Reservoir.

The MDDP Future Condition Hydrology Map is provided in Appendix A. The proposed sub-basins are delineated based on site layout, grading design, inlet locations, and planned land uses. A Developed Conditions Drainage Map for the Project is included in Appendix A. **All storm infrastructure is privately owned and maintained unless otherwise noted.**

#### *Pond 705 Basins*

The sub-basins described below will be treated and detained by Pond 705. Pond 705 discharges to an existing 8'x8' RCBC that conveys flows under S Powers Boulevard and overland by naturally created drainageways to the Big Johnson Reservoir.

**Basin A1** is 8.2 acres of existing Peak Innovation Parkway with a calculated imperviousness of 44.3%. Flows from Basin A1 are conveyed via curb and gutter to a series of existing CDOT Type R inlets within Peak Innovation Parkway where flows of  $Q_5 = 8.0$  CFS and  $Q_{100} = 21.5$  CFS are conveyed by existing stormwater infrastructure in Peak Innovation Parkway to DPA12, an existing 6' cylindrical manhole. Flows are then conveyed to Pond 705 at FOREBAY-1.0 via STM-1.0. The existing infrastructure in Peak Innovation Parkway was analyzed in the DAR FDR and no new flows are introduced to the previously designed system.

**Basin A2** is 6.2 acres of existing Peak Innovation Parkway with a calculated imperviousness of 47.7%. Flows from Basin A2 are conveyed via curb and gutter to a series of existing CDOT Type R inlets within Peak Innovation Parkway where flows of  $Q_5 = 6.9$  CFS and  $Q_{100} = 17.9$  CFS are conveyed by existing stormwater infrastructure in Peak Innovation Parkway to DPA12, an existing 6' cylindrical manhole. Flows are then conveyed to Pond 705 at FOREBAY-1.0 via STM-1.0. The existing infrastructure in Peak Innovation Parkway was analyzed in the DAR FDR and no new flows are introduced to the previously designed system.

**Basin A3** is 9.1 acres of open space with a regional trail and a calculated imperviousness of 4.8%. Basin A3 was analyzed in the Ponds 500 & 600 FDR and conveys flows of  $Q_5 = 3.3$  CFS and  $Q_{100} = 19.3$  CFS to Pond 705 at FOREBAY-1.0 via STM-1.1. Results from the Pond 500 & 600 FDR analysis are included in Appendix F.

**Basin A4** is 1.4 acres of Peak Innovation Parkway and South Powers Boulevard with a calculated imperviousness of 42.9%. Flows from Basin A4 are conveyed via curb and gutter to DPA4, an existing CDOT 10' Type R inlet within Peak Innovation Parkway. Basin A4 conveys flows of  $Q_5 = 1.9$  CFS and  $Q_{100} = 5.1$  CFS to Pond 705 at FOREBAY-1.0 via STM-1.1.

**Basin A5** is 2.4 acres of Peak Innovation Parkway and South Powers Boulevard with a calculated imperviousness of 80.2%. Flows from Basin A5 are conveyed via curb and gutter to DPA5, existing CDOT 15' and 20' Type R inlets within Peak Innovation Parkway. Basin A5 conveys flows of  $Q_5 = 7.5$  CFS and  $Q_{100} = 14.7$  CFS to Pond 705 at FOREBAY-1.0 via STM-1.1.

**Basin A6** is 3.1 acres of open space with a regional trail and a calculated imperviousness of 17.3%. Flows from Basin A6 are conveyed overland to CB-1.2, a 6' CDOT Type D inlet. Flows of  $Q_5 = 1.5$  CFS and  $Q_{100} = 6.0$  CFS are then conveyed to Pond 705 at FOREBAY-1.0 via STM-1.0.

**Basin A7** is 0.8 acres of open space and a small building that houses a sanitary sewer lift station with a calculated imperviousness of 27.0%. Flows of  $Q_5 = 0.6$  CFS and  $Q_{100} = 1.9$  CFS are conveyed overland to SWALE 12, captured by CB-1.1, a 6' CDOT manhole with a grated top, and conveyed to Pond 705 at FOREBAY-1.0 via STM-1.0.

**Basin A8** is 4.6 acres of open space with a regional trail and a calculated imperviousness of 2.9%. Flows of  $Q_5 = 1.3$  CFS and  $Q_{100} = 8.2$  CFS are conveyed overland to SWALE 9, where they are conveyed by a 24" RCP culvert to SWALE 11 in Basin A9. Flows are then captured by CB-1.0, a CDOT Type D inlet, and conveyed to Pond 705 at FOREBAY-1.0 via STM-1.0.

**Basin A9** is 1.9 acres of open space with a regional trail and a calculated imperviousness of 12.4%. Flows of  $Q_5 = 1.0$  CFS and  $Q_{100} = 4.5$  CFS are conveyed to SWALE 11, where they are captured by CB-1.0, a CDOT Type D inlet, and conveyed to Pond 705 at FOREBAY-1.0 via STM-1.0. Basin A9 receives flows of  $Q_5 = 1.3$  CFS and  $Q_{100} = 8.2$  CFS from Basin A8 and conveys them to Pond 705 as described above.

**Basin B1** is a 5.3-acre future development basin with an assigned imperviousness of 75%. Flows from Basin B1 will be conveyed by storm infrastructure designed and constructed with the future development to STUB-2.0, a 24" RCP stub constructed with the Project. Flows of  $Q_5 = 13.4$  CFS and  $Q_{100} = 27.4$  CFS are conveyed to Pond 705 at FOREBAY-3.0 via STM-3.0. Basin B1 is tributary to STM-2.0 and meets STM-3.0 at SDMH-3.0, upstream of Pond 705.

**Basin B2** is 9.7 acres of open space with a regional trail and a calculated imperviousness of 3.6%. Flows are conveyed south overland to SWALE 1 or east overland to SWALE 6. Flows are then captured by CB-2.0, a CDOT Type D inlet and conveyed to Pond 705 at FOREBAY-3.0 via STM-3.0. Basin B2 is tributary to STM-2.0 and meets STM-3.0 at SDMH-3.0, upstream of Pond 705.

**Basin B3** is a 6.2-acre future development basin with an assigned imperviousness of 75%. Flows from Basin B3 will be conveyed by storm infrastructure designed and constructed with the future development to STUB-2.1, a 30" RCP stub constructed with the Project. Flows of  $Q_5 = 15.6$  CFS and  $Q_{100} = 31.9$  CFS are conveyed to Pond 705 at FOREBAY-3.0 via STM-3.0. Basin B3 is tributary to STM-2.2 and meets STM-3.0 at SDMH-3.0, upstream of Pond 705.

**Basin C1** is 10.6 acres of open space with an assigned imperviousness of 2%. Basin C1 conveys flows of  $Q_5 = 1.8$  CFS and  $Q_{100} = 12.0$  CFS to SWALE C1, where they are captured by CB-3.9, a CDOT Type D inlet, and conveyed to Pond 705 at FOREBAY-3.0 via STM-3.0.

**Basin C2** is 1.9 acres of Integration Loop roadway with a calculated imperviousness of 75%. Basin C2 conveys flows of  $Q_5 = 4.0$  CFS and  $Q_{100} = 8.3$  CFS via curb and gutter to CB-3.8, a CDOT 10' Type R on-grade inlet. Flows are then conveyed to Pond 705 at FOREBAY-3.0 via STM-3.0.

**Basin C3** is 1.8 acres of Integration Loop roadway with a calculated imperviousness of 75%. Basin C3 conveys flows of  $Q_5 = 3.8$  CFS and  $Q_{100} = 7.9$  CFS via curb and gutter to CB-3.10, a CDOT 10' Type R on-grade inlet. Flows are then conveyed to Pond 705 at FOREBAY-3.0 via STM-3.0.

**Basin C4** is 32.7 acres of open space with an assigned imperviousness of 2%. Basin C4 conveys flows of  $Q_5 = 5.0$  CFS and  $Q_{100} = 33.1$  CFS to SWALE C4, where they are captured by CB-3.7, a CDOT Type D inlet, and conveyed to Pond 705 at FOREBAY-3.0 via STM-3.0.

**Basin C5** is a 12.3-acre future development basin with an assigned imperviousness of 80.4%. Flows from Basin C5 will be conveyed by storm infrastructure designed and constructed with the future development to CB-3.5, a CDOT Type D inlet. Flows of  $Q_5 = 34.4$  CFS and  $Q_{100} = 67.9$  CFS are conveyed to Pond 705 at FOREBAY-3.0 via STM-3.0.

**Basin C6** is 2.4 acres of Integration Loop roadway with a calculated imperviousness of 75%. Basin C6 conveys flows of  $Q_5 = 5.4$  CFS and  $Q_{100} = 11.1$  CFS via curb and gutter to CB-3.4, a CDOT 10' Type R sump inlet. Flows are then conveyed to Pond 705 at FOREBAY-3.0 via STM-3.0.

**Basin C7** is 2.3 acres of Integration Loop roadway with a calculated imperviousness of 75%. Basin C7 conveys flows of  $Q_5 = 5.1$  CFS and  $Q_{100} = 10.5$  CFS via curb and gutter to CB-3.6, a CDOT 10' Type R sump inlet. Flows are then conveyed to Pond 705 at FOREBAY-3.0 via STM-3.0.

**Basin C8** is 2.1 acres of open space with an assigned imperviousness of 2%. Basin C9 conveys flows of  $Q_5 = 0.9$  CFS and  $Q_{100} = 5.9$  CFS to SWALE 4, where they are captured by CB-3.3, a CDOT Type D inlet, and conveyed to Pond 705 at FOREBAY-3.0 via STM-3.0.

**Basin C9** is 1.0 acres of open space with an assigned imperviousness of 2%. Basin C10 conveys flows of  $Q_5 = 0.3$  CFS and  $Q_{100} = 2.2$  CFS to SWALE 5, where they are captured by CB-3.2, a CDOT Type D inlet, and conveyed to Pond 705 at FOREBAY-3.0 via STM-3.0.

**Basin C10** is 13.0 acres of open space with a regional trail and a calculated imperviousness of 4%. Basin C11 conveys flows of  $Q_5 = 5.3$  CFS and  $Q_{100} = 28.2$  CFS to SWALE 2, where they are captured by CB-3.1, a CDOT Type D inlet, and conveyed to Pond 705 at FOREBAY-3.0 via STM-3.0.

**Basin C11** is 4.0 acres of open space with a regional trail and a calculated imperviousness of 16.6%. Basin C11 conveys flows of  $Q_5 = 2.0$  CFS and  $Q_{100} = 13.7$  CFS to SWALE 7, where they are captured by CB-3.0, a CDOT Type D inlet, and conveyed to Pond 705 at FOREBAY-3.0 via STM-3.0.

**Basin D1** is a 56.8-acre future development basin with an assigned imperviousness of 80%. Flows from Basin D1 will be conveyed by storm infrastructure designed and constructed with the future development to STUB-4.0, a 60" RCP stub constructed with the Project. Flows of  $Q_5 = 139.2$  CFS and  $Q_{100} = 275.5$  CFS are conveyed to Pond 705 at FOREBAY-4.0 via STM-4.0.

**Basin D2** is 4.4 acres of open space with an assigned imperviousness of 2%. Basin D2 conveys flows of  $Q_5 = 1.4$  CFS and  $Q_{100} = 9.1$  CFS to SWALE 8, where they are captured by CB-4.0, a CDOT Type D inlet, and conveyed to Pond 705 at FOREBAY-4.0 via STM-4.0.

**Basin P1** is 1.1 acres of open space and regional trail adjacent to Pond 705 with a calculated imperviousness of 22.8%. Basin P1 conveys flows of  $Q_5 = 0.9$  CFS and  $Q_{100} = 3.2$  CFS to SWALE 13, where they are conveyed Pond 705 via a Type X riprap rundown.

**Basin P2** is 4.4 acres of Pond 705 with an assigned imperviousness of 2% that contributes inflows of  $Q_5 = 1.6$  CFS and  $Q_{100} = 10.8$  CFS to Pond 705.

**Basin I1** is 6.6 acres of Lot 4 COSA Filing 1F with an assigned imperviousness of 75%. Basin I1 was analyzed in the Phase 3 FDR and contributes flows of  $Q_5 = 16.1$  CFS and  $Q_{100} = 33.0$  CFS to DPI1, an existing CDOT Type D inlet that captures and conveys flows to Pond 705 at FOREBAY-3.0 via STM-3.0.

**Basin I2** is 1.0 acre of Logistics Point roadway with a calculated imperviousness of 75.3%. Basin I2 was analyzed in the Phase 3 FDR and contributes flows of  $Q_5 = 2.5$  CFS and  $Q_{100} = 5.0$  CFS at DPI2, where they are conveyed by a concrete pan and then curb and gutter to Integration Loop roadway in Basin C6, where they are conveyed to Pond 705 at FOREBAY-3.0 via STM-3.0 as described above.

**Basin I3** is 1.0 acre of Integration Loop roadway with a calculated imperviousness of 77.1%. Basin I3 was analyzed in the Phase 3 FDR and contributes flows of  $Q_5 = 2.6$  CFS and  $Q_{100} = 5.3$  CFS to DPI3, an existing CDOT 5' Type R inlet. Flows are then conveyed to Pond 705 at FOREBAY-3.0 via STM-3.0.

**Basin I4** is 1.3 acres of Integration Loop roadway with a calculated imperviousness of 74.4%. Basin I4 was analyzed in the Phase 3 FDR and contributes flows of  $Q_5 = 2.9$  CFS and  $Q_{100} = 6.0$  CFS to DPI4, an existing CDOT 5' Type R inlet. Flows are then conveyed to Pond 705 at FOREBAY-3.0 via STM-3.0.

#### *Undetained Basins*

**Basin UD1** is 9.8 acres of existing South Powers Boulevard and open space with a calculated imperviousness of 17.4%. Basin UD1 will convey flows of  $Q_5 = 3.5$  CFS and  $Q_{100} = 14.0$  CFS overland to SWALE 14, where they are captured by CB-6.0, an 8' CDOT manhole with a grated top. Basin UD1 cannot practically be conveyed to Pond 705. Pond 705 will overdetain for Basin UD1 and the 100-year release rate will be reduced by  $Q_{100} = 14.0$  CFS to account for Basin UD1. The portion of Basin UD1 that contains the existing impervious surfaces of South Powers Boulevard will flow over a grass buffer before being captured by CB-6.0. This is discussed in further detail below in the Four Step Process section.

The total acreage tributary to Pond 705 is 229.8 acres with a composite imperviousness of 41% which is below MDDP criteria.

Table 4 below provides a design point summary for the 5-year and 100-year storms. Flows were routed in two different ways:

- **Overland** flows were calculated using the SF-3 5 YR and SF-3 100 YR spreadsheets.
- **Storm Drain** flows were calculated using Hydraflow Storm Sewers for AutoCAD Civil 3D 2019, described in a subsequent section.

## DRAINAGE FACILITY DESIGN

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### **Gutter and Inlets**

The Project gutter and storm drain inlets were designed per COCS Standards for the major and minor events using the MHFD gutter and inlet capacity spreadsheets. The following is a summary of the road capacity requirements for arterial roadways:

In the **Major Event** flow may spread to the ROW. To be conservative, this Report only allows flow to the back of treelawn and does not allow overtopping of the street crown.

In the **Minor Event** there shall be no curb overtopping. Flow spread must leave a minimum 10-foot lane free of water, 5-feet either side of the road crown.

Storm drain inlets were sized and located to meet the above criteria. Bypass flows were determined for on grade inlets and added to the downstream inlet.

Results of the gutter and storm drain inlets analysis are provided in Appendix D.

## Storm Drain

The Project storm drain system was designed per the COCS Standards and MHFD Standards for the major and minor events using Hydraflow Storm Sewers for AutoCAD Civil 3D 2019. A duplicate model analysis was run with Hydraflow and UD-Sewer (2009) to demonstrate that the results of the two models are consistent and in compliance with COCS Standards. Hydraflow uses the Standard Step Method to calculate the hydraulic grade line. Head losses due to friction are calculated using Manning's Equation. The following is a summary of the storm drain design criteria.

In the **Major Event** the hydraulic grade line can rise above the top of the storm drain pipe and surcharge the system but must be maintained at least 1 foot below the finished grade elevation.

In the **Minor Event** the hydraulic grade line (HGL) must be maintained below the top of pipe.

All proposed storm drain pipes are calculated using a Manning's Roughness coefficient of 0.013. Specific discussion of the storm drain systems are included below:

### STM-1.0

Basins A1-A9 are tributary to STM-1.0. Stormwater from these basins is captured by inlets and conveyed to Pond 705 at **DPXX**.

### STM-2.0

Basins B1-B3 are tributary to STM-2.0. STM-2.0. Stormwater from these basins is captured by inlets and storm stubs and conveyed to Pond 705 at **DPXX**.

### STM-3.0

Basins C1-C12 and B1-B3 are tributary to STM-3.0. Stormwater from these basins is captured by inlets and storm stubs and conveyed to Pond 705 at **DPXX**.

### STM-4.0

Basins D1 & D1 are tributary to STM-4.0. Stormwater from these basins is captured by inlets and storm stubs and conveyed to Pond 705 at **DPXX**.

### STM-5.0

No project basins are tributary to STM-5.0, a 36" RCP bypass from the upstream outfalls of Pond 700 and 701. These flows historically discharged to an open channel that conveyed flows to the existing 8'x8' RCBC, where they were conveyed under South Powers Boulevard. The Project proposed to intercept the 36" RCP bypass upstream from where it historically discharged and route flows around Pond 705 to the existing 8'x8' RCBC.

### STM-705

Basins A1-A9, B1-B3, C1-C12, D1-D2, P1-P2, UD1, and the outfalls of Ponds 700 and 701 are tributary to STM-705, the Project's outfall to the Big Johnson Reservoir. Stormwater is conveyed to SDMH-705, a

CDOT Box Base manhole that ties into the existing 8'x8' RCBC described above. From SDMH-705, flows are conveyed under South Powers Boulevard and continue south where they are conveyed by naturally created drainageways to the Big Johnson Reservoir.

### Four Step Process

The City of Colorado Springs requires the "Four Step Process" for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainageways, and implementing long-term source controls. The Four Step Process, and how it was used in the design of this Project, is summarized below:

#### **Step 1:** *Employ volume reduction practices*

*Applicable sites must meet one of the following standards:*

- *Minimum volume reduction through infiltration, evaporation, and evapotranspiration.*
  - *For the 2-year rainfall event, a minimum of 4%, or*
  - *For WQCV event, minimum of 10%*
- *At least 20-percent of the imperviousness areas are disconnected and drain through a receiving pervious area comprising of at least 10-percent of the disconnected impervious area.*

The proposed Project will meet the required standards of Step 1.

#### **Step 2:** *Treat and slowly release the WQCV.*

Stormwater runoff generated from the Project will be treated by water quality and detention Pond 705. Pond 705 is an extended detention basin that provides a slow release of the WQCV of at least 40-hours.

#### **Step 3:** *Stabilize stream channels.*

Pond 705 outfalls to an existing 8'x8' RCBC that conveys flows under South Powers Boulevard, where they continue south and are conveyed by naturally created drainageways to the Big Johnson Reservoir. The Project proposes to reduce peak flows to the 8'x8' RCBC below historic peak flows. Areas downstream of the 8'x8' RCBC will be further assessed and stabilized as necessary.

#### **Step 4:** *Implement source controls.*

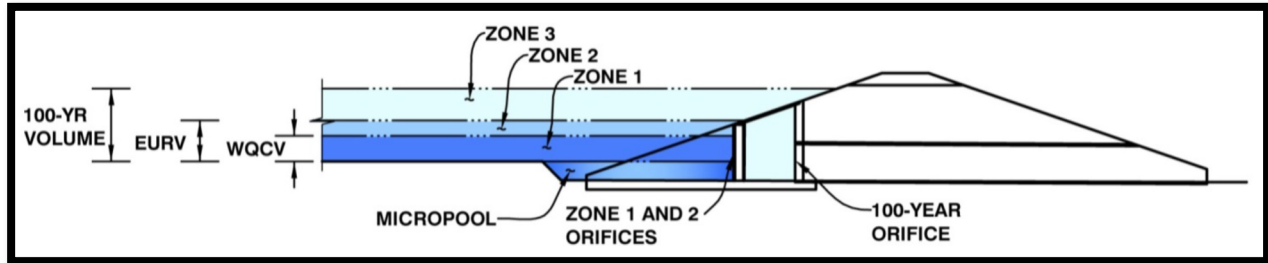
All source controls are identified in the "City Stormwater Management Plan" and "Grading and Erosion Control Plans" prepared by Enertia Consulting Group. We anticipate the need for minimal source control BMPs due to the scope of the Project. Examples of source control BMPs that may be needed are Landscape Maintenance, Street Sweeping and Cleaning, and Storm Drain System Cleaning. It is not anticipated that there will be any outdoor storage areas.

### Stormwater Detention and Water Quality

Stormwater detention and water quality is provided for the Project. The proposed detention and water quality pond (Pond 705) shall be provided in accordance with the COCS and MHFD criteria. **Pond 705 will be privately owned and maintained.**

Pond 705 is an extended detention basin (EDB) designed per the full spectrum detention design process as outlined in Volume 2 and 3 of the MHFD Manual. Full spectrum design includes three zones: water quality capture volume (WQCV), excess urban runoff volume (EURV) and the 100-year volume. Figure 2 below illustrates the three zones. The volume for each of these zones is stored for a period of time and released at a controlled rate. A description of Pond 705 is provided below:

**FIGURE 2 – EXTENDED DETENTION BASIN COMBINED WITH FULL SPECTRUM DETENTION**



#### *Pond 705*

Pond 705 is designed as follows:

- Pond 705 is sized for Project Basins A1-A9, B1-B3, C1-C12, D1-D2, and P1-P2. Pond 705 is sized for 229.8 acres with an imperviousness of 41%.
- Pond 705 was sized using the MHFD spreadsheet UD-Detention Version 4.06. Pond 705 is sized for the following volume requirements:
  - WQCV = 3.49 acre-feet
  - EURV = 10.19 acre-feet
  - 100-YR Volume = 19.38 acre-feet
- The outlet structure was sized using UD-Detention Version 4.06 and is based on the COCS “Outlet Structure with Parallel Wingwalls and Flush Bar Grating” (Figure 13-10 of the COCS Drainage Manual).
  - The structure includes an orifice plate with multiple orifices sized to limit the WQ drain time to around 40 hours and limit the EURV (in conjunction with the 100-year event) to less than 48 hours.
- The peak 100-year inflow to Pond 705 was estimated to be 505.4 CFS by UD-Detention.
- The 100-year release rate from Pond 705 is 105.7 CFS. The allowable release rate specified for Pond 705 in the MDDP is 412 CFS. An orifice plate is provided to limit the release at the outlet pipe to below the allowed 100-year rate.
- Concrete forebays are provided at the STM-1.0, STM-3.0 and STM-4.0 outfalls to Pond 705.
  - STM-1.0 outfalls into Forebay-1.0, an Integral Forebay (Figure 13-9 of the COCS Standards) to provide a volume of 3% of the WQCV tributary to STM-1.0. A 7.4” notch is provided in the forebay to discharge 2% of the 100-year peak discharge.
  - STM-3.0 outfalls into Forebay-3.0, an Integral Forebay (Figure 13-9 of the COCS Standards) to provide a volume of 3% of the WQCV tributary to STM-3.0. An 8.6” notch is provided in the forebay to discharge 2% of the 100-year peak discharge.
  - STM-4.0 outfalls into Forebay-4.0, which utilizes a US Bureau of Reclamation Type VI Impact Stilling Basin (Figure 9-45 of the MHFD Standards Vol 2) for energy dissipation and a concrete forebay with 1’-4” high walls to provide a volume of 3% of the WQCV tributary to STM-4.0. A 1’-2.5” notch is provided in the forebay to discharge 2% of the 100-year peak discharge.



- The trickle channels are sized to convey 2% of the 100-year peak discharge into the Pond.
- An emergency spillway is provided adjacent to the outlet structure. The spillway conveys emergency flows to CB-705, an inlet in a sump. The spillway is sized for the peak 100-year undetained flow. It has an 80-foot wide crest and is 2.5-feet deep, with 10:1 side slopes. The spillway crest, side slopes, and downstream embankment are armored with 36-inch thick Type-H soil riprap. A 3-foot concrete crest wall is provided at the downstream end of the spillway in accordance with COCS criteria. CB-705 has been sized with a 50% clogging factor to capture the 100-year undetained flow from Pond 705 and the 100-year flow from Basin UD1.

In accordance with the new Colorado Revised Statute (CRS) 37-92-602 (8), effective August 5, 2015, a Stormwater Detention and Infiltration Design Data Sheet shall be provided for all proposed detention ponds. This spreadsheet must be provided to COCS prior to acceptance of Pond 705.

Results of the Pond Analysis are included in Appendix E of this Report.

## CONCLUSION

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The analysis in this Report outlines the final drainage design associated with the Colorado Springs Airport Filing 1F Integration Loop Phase 4 Project. Drainage improvements include stormwater conveyance infrastructure and detention and water quality pond, Pond 705. This Final Drainage Report has been prepared in accordance with the following criteria:

- City of Colorado Springs Standards and Specifications (COCS Standards)
- Mile High Flood District Criteria Manual (MHFD Standards)
- Federal Aviation Administration Advisory Circular No 150/5200-33B (FAA-AC).

### Summary of Results

The following conclusions can be made from this Report:

- The Project conforms to the MDDP by releasing the 100-year storm from Pond 705 at a lower rate than what was calculated and approved in the MDDP.
- Site runoff, storm drains and appurtenances associated with the proposed project will not adversely affect the downstream and surrounding developments.
- There is detention proposed with this Project. Pond 705 is an EDB designed per COCS and MHFD Standards. A variance request is requested to allow for a 48-hour drain time as required by the FAA.

## REFERENCES

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1. "Drainage Criteria Manual Volume 1", City of Colorado Springs Engineering Division, May 2014.
2. "Drainage Criteria Manual Volume 2", City of Colorado Springs Engineering Division, May 2014.
3. "Drainage Criteria Manual Policy Clarifications 1 – 11", City of Colorado Springs Engineering Division, January 9, 2017 – August 23, 2017
4. "Urban Storm Drainage Criteria Manual, Volume 1, 2 & 3", MHFD, Latest Revisions / Updates.



5. "FEMA Flood Insurance Rate Maps Map Number 08041C0764G", FEMA, Effective: December 7, 2018.
6. "Windmill Gulch Drainage Basin Planning Study", Wilson and Company, January 1991 (last revised February 1992).
7. "Colorado Springs Airport in the Windmill Gulch and Big Johnson Drainage Basin(s)", CH2MHill, June 2005.
8. "Hydraulic Grade Line Calculation Reference" Hydraflow Storm Sewers (Appendix C)
9. "FAA Advisory Circular No 150/5200-33B", FAA, August 28, 2007.

# Appendix A

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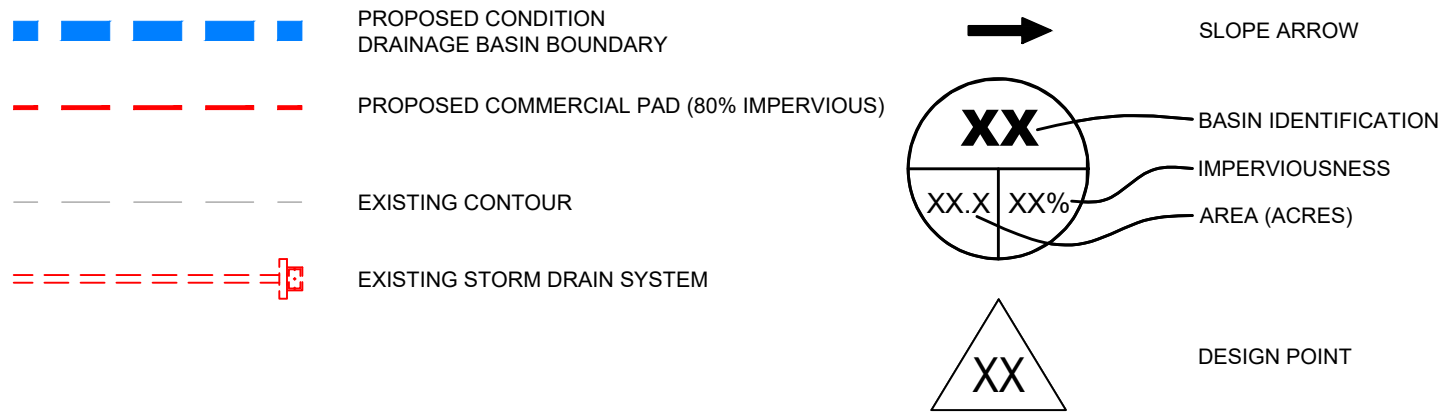
Project Figures

## Project Drainage Area Maps

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LEGEND

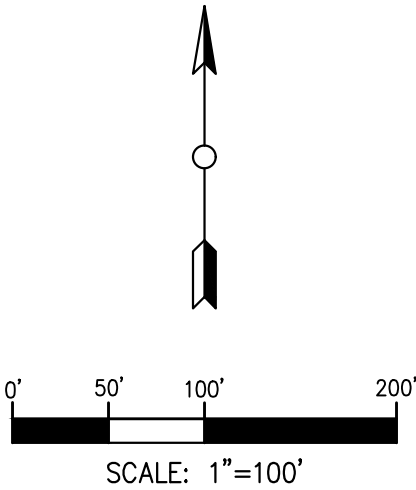
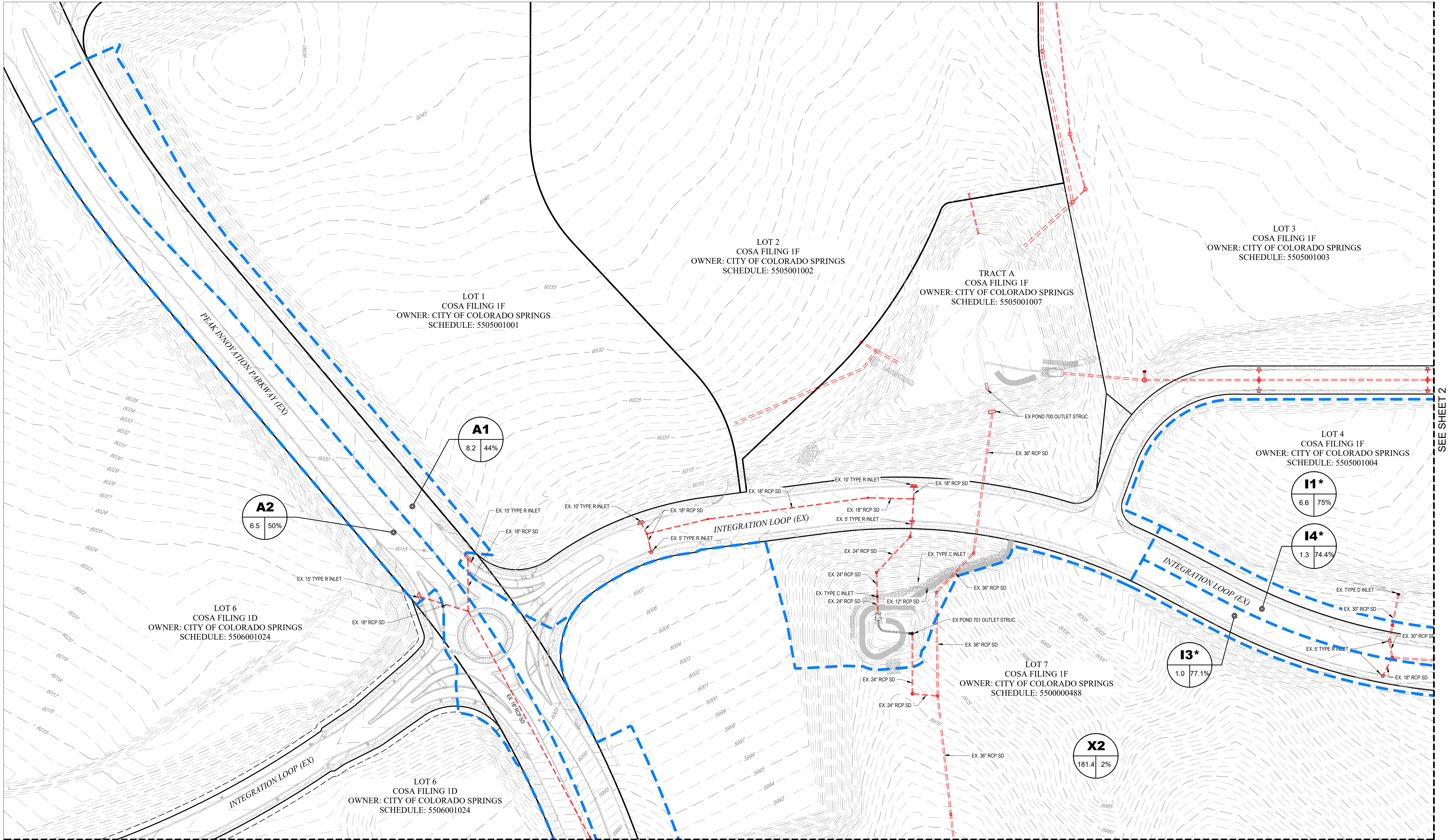


NOTES

1. ALL EXISTING STORM INFRASTRUCTURE IN POWERS BLVD IS PUBLICLY OWNED AND MAINTAINED.
2. ALL EXISTING STORM INFRASTRUCTURE WITHIN PEAK INNOVATION PARK IS PRIVATELY OWNED AND MAINTAINED.

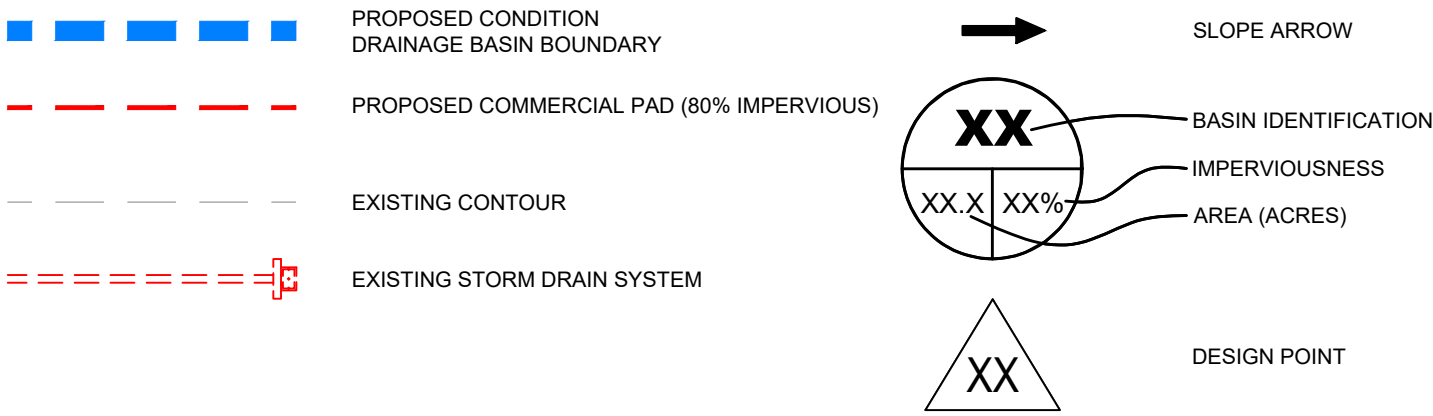
EX BASIN SUMMARY						
Basin	Area (acres)	Impervious Percentage	Q <sub>s</sub> (cfs)	Q <sub>100</sub> (cfs)	Q <sub>s</sub> (cfs/acre)	Q <sub>100</sub> (cfs/acre)
A1	8.2	44%	8.0	21.5	1.0	2.6
A2	6.5	48%	6.9	17.9	1.1	2.7
A3	9.1	5%	3.3	19.3	0.4	2.1
A4	1.4	43%	1.9	5.1	1.4	3.7
A5	2.4	80%	7.5	14.7	3.1	6.1
X1	9.1	2%	1.6	10.5	0.2	1.2
X2	181.4	2%	8.8	57.6	0.0	0.3
I1	6.6	75%	16.1	33.0	2.4	5.0
I2	1.0	75%	2.4	4.9	2.4	4.9
I3	1.0	77%	2.5	5.0	2.5	5.0
I4	1.3	74%	3.2	6.5	2.4	5.0
I5	2.2	21%	2.2	8.1	1.0	3.7

COLORADO SPRINGS AIRPORT  
FILING NO. 1F  
INTEGRATION PHASE 4FINAL  
DRAINAGE REPORT  
HISTORIC CONDITIONS MAP  
SHEET 1 OF 4





LEGEND

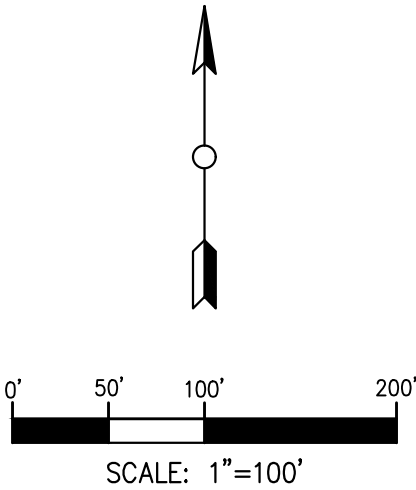
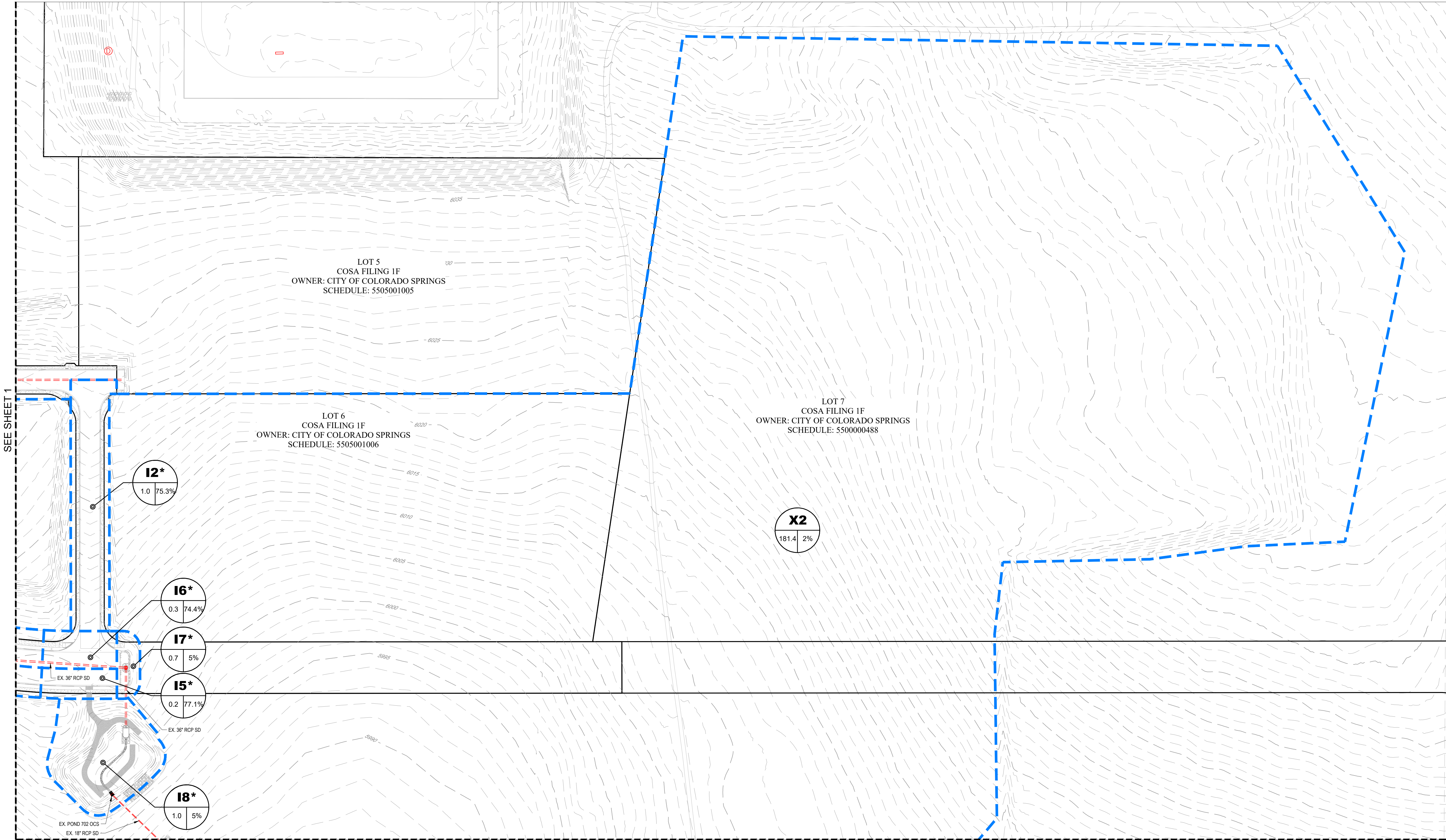


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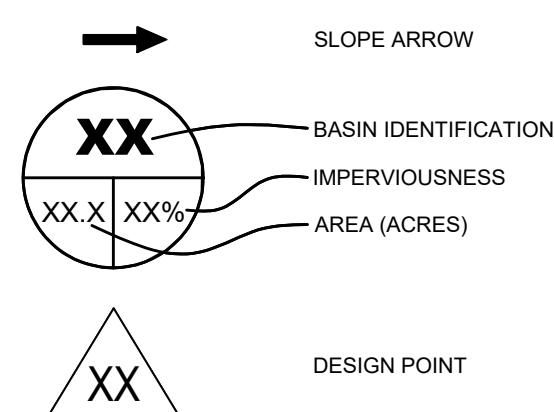
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SHEET 2 OF 4





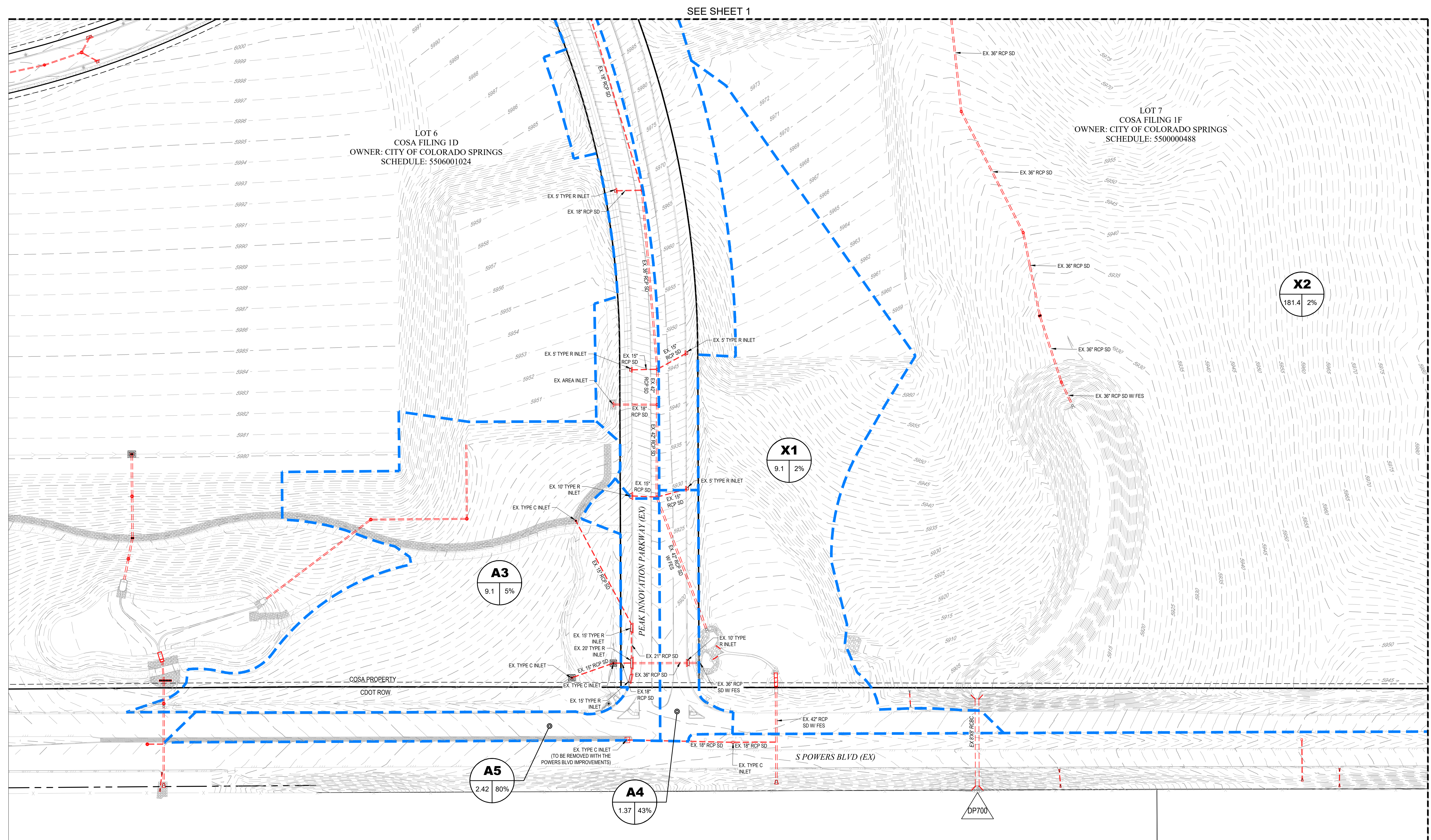
 PROPOSED CONDITION DRAINAGE BASIN BOUNDARY  
 PROPOSED COMMERCIAL PAD  
 EXISTING CONTOUR  
 EXISTING STORM DRAIN SYSTEM



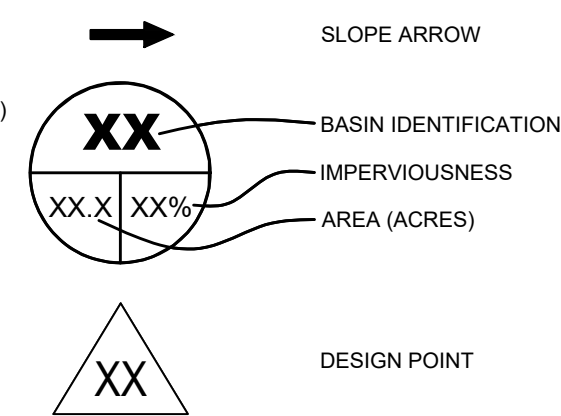
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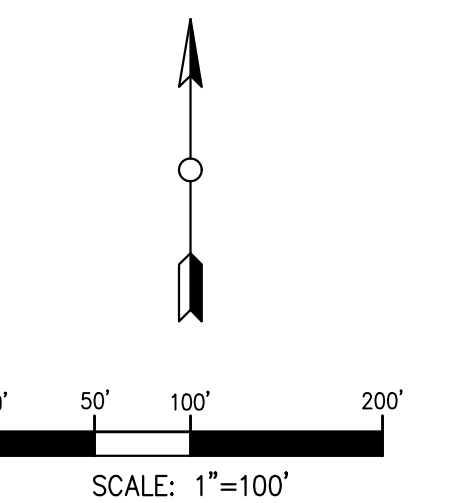
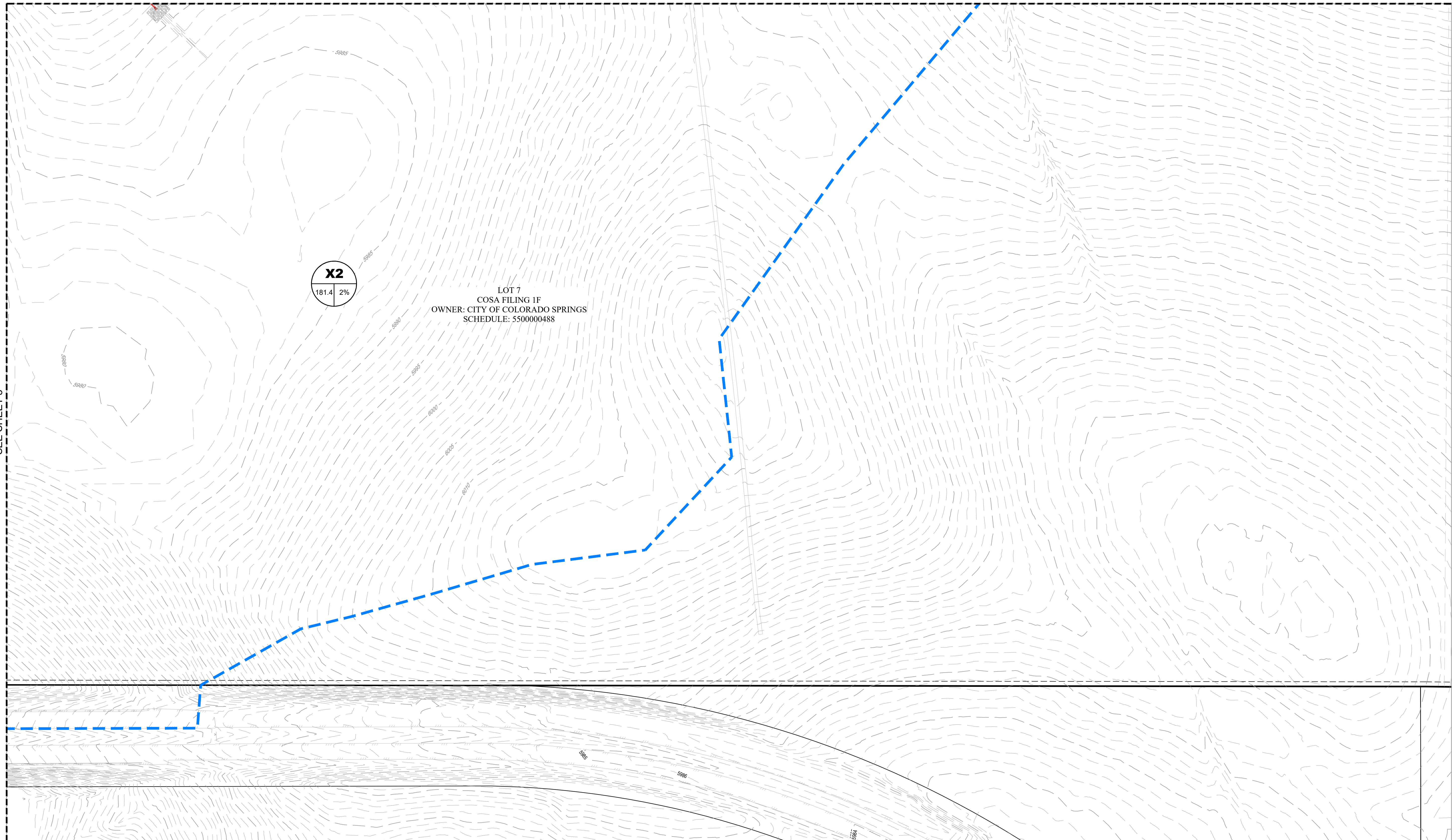


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SEE SHEET 2

SEE SHEET 3





COLORADO SPRINGS AIRPORT  
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DRAINAGE REPORT  
DEVELOPED CONDITIONS MAP  
SHEET 2 OF 4

LEGEND

PROPOSED CONDITION  
DRAINAGE BASIN BOUNDARY

PROPOSED COMMERCIAL PAD (80% IMPERVIOUS)

PROPOSED CONTOUR

EXISTING CONTOUR

PROPOSED STORM DRAIN SYSTEM

EXISTING STORM DRAIN SYSTEM

→

SLOPE AREA

XX

XX.X

XX%

BASIN IDENTIFICATION

IMPERVIOUSNESS

AREA (ACRES)

XX

DESIGN POINT

NOTES

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3.

ALL PROPOSED STORM INFRASTRUCTURE IS PRIVATELY OWNED AND MAINTAINED.

4.

ALL MANHOLES ARE TO BE CONSTRUCTED PER CDOT STANDARDS AND SPECIFICATIONS.

0' 50' 100' 200'

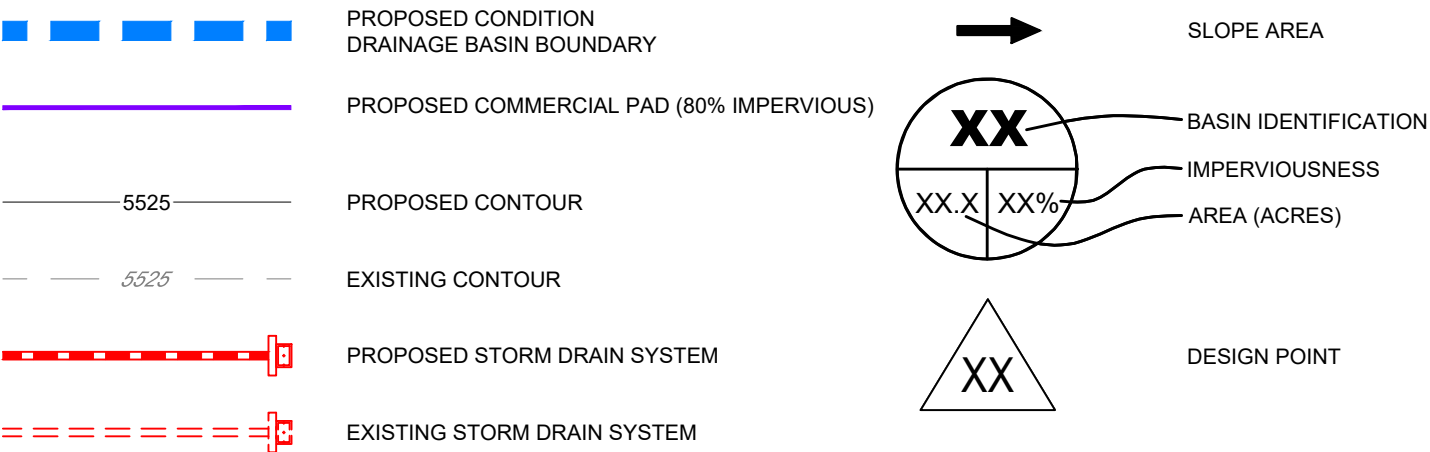
SCALE: 1"=100'

The map displays the developed conditions for the Colorado Springs Airport Filing No. 1F, Integration Phase 4. It shows three lots: Lot 5 (COSA FILING 1F, OWNER: CITY OF COLORADO SPRINGS, SCHEDULE: 5505001005), Lot 6 (COSA FILING 1F, OWNER: CITY OF COLORADO SPRINGS, SCHEDULE: 5505001006), and Lot 7 (COSA FILING 1F, OWNER: CITY OF COLORADO SPRINGS, SCHEDULE: 5500000488). The map includes topographic contours, proposed and existing storm drain systems, and various infrastructure elements like manholes (SDMH), catch basins (CB), and swales. Drainage basins C1 through C7 are identified with their respective areas and impervious percentages. A legend in the top left corner defines the symbols used. Notes at the top center provide additional context. A north arrow and scale bar are located in the top right corner. The map is labeled 'SHEET 2 OF 4' and includes references to 'SEE SHEET 1' and 'SEE SHEET 4'.

BASIN SUMMARY				
Basin	Area (acres)	Impervious Percentage	Q <sub>s</sub> (cfs)	Q <sub>100</sub> (cfs)
A1	8.2	44.3%	8.0	21.5
A2	6.5	47.7%	6.9	17.9
A3	9.1	4.8%	3.3	19.3
A4	1.4	42.9%	1.9	5.1
A5	2.4	80.2%	7.5	14.7
A6	3.1	17.3%	1.5	6.0
A7	0.8	27.0%	0.6	1.9
A8	4.6	2.9%	1.3	8.2
A9	1.9	12.4%	1.0	4.5
B1	5.3	75.0%	13.4	27.4
B2	9.7	3.6%	2.3	14.1
B3	6.2	75.0%	15.6	31.9
C1	10.6	2.0%	1.8	12.0
C2	1.9	75.0%	4.0	8.3
C3	1.8	75.0%	3.8	7.9
C4	32.7	2.0%	5.0	33.1
C5	12.3	80.4%	34.4	67.9
C6	2.4	75.0%	5.4	11.1
C7	2.3	75.0%	5.1	10.5
C8	2.1	2.0%	0.9	5.9
C9	1.0	2.0%	0.3	2.2
C10	13.0	7.1%	5.3	28.2
C11	4.0	16.6%	2.0	13.7
D1	56.8	80.0%	139.2	275.5
D2	4.4	2.0%	1.4	9.1
P1	1.1	22.8%	0.9	3.2
P2	4.4	2.0%	1.6	10.8
UD1	9.8	17.4%	3.5	14.0



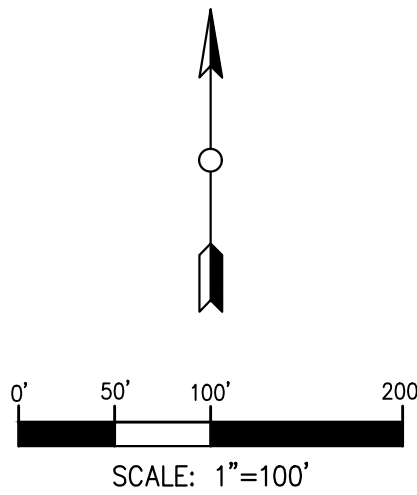
LEGEND



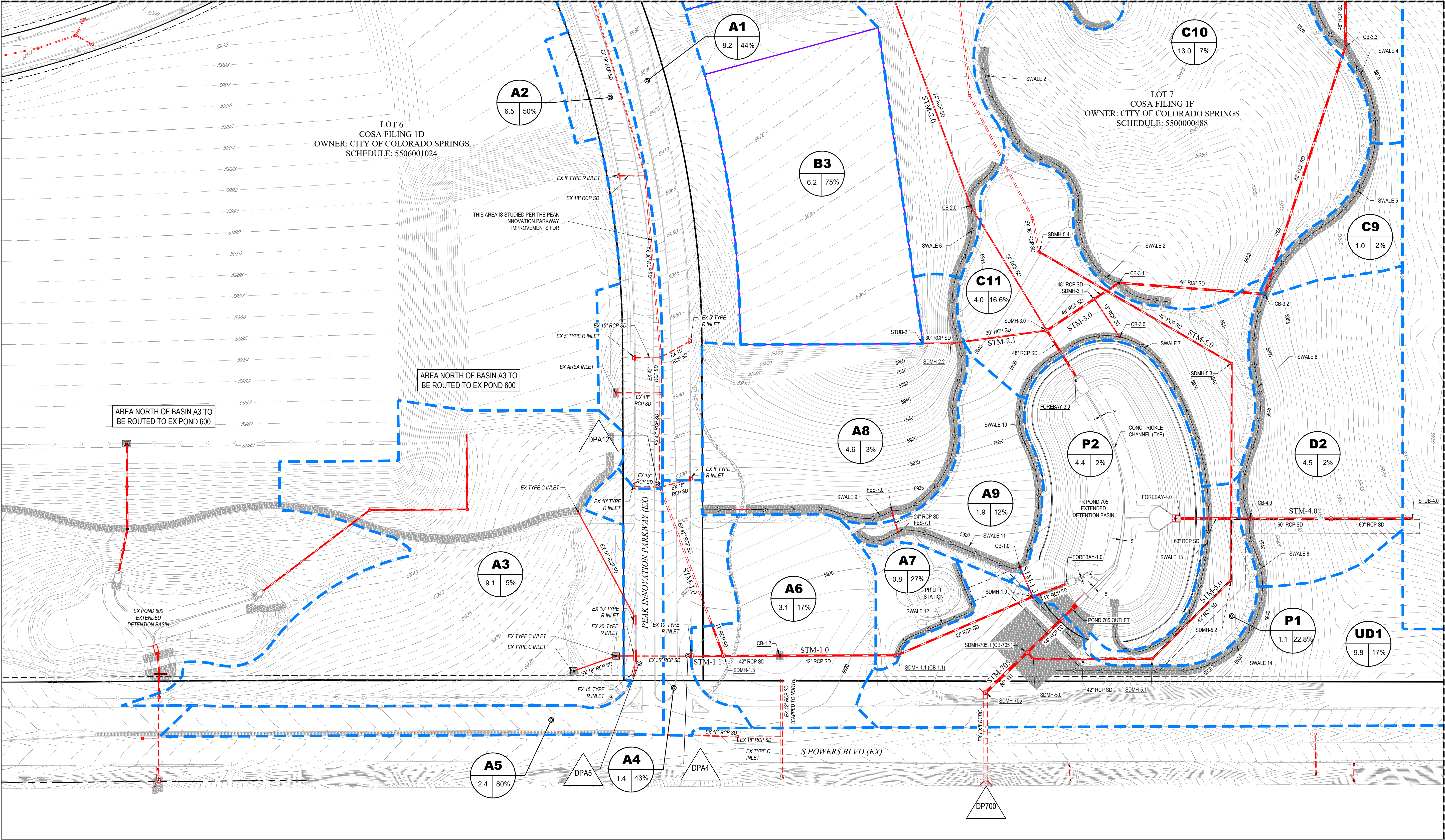
NOTES

1. ALL EXISTING STORM INFRASTRUCTURE IN POWERS BLVD IS PUBLICLY OWNED AND MAINTAINED.
2. ALL EXISTING STORM INFRASTRUCTURE WITHIN PEAK INNOVATION PARK IS PRIVATELY OWNED AND MAINTAINED.
3. ALL PROPOSED STORM INFRASTRUCTURE IS PRIVATELY OWNED AND MAINTAINED.
4. ALL MANHOLES ARE TO BE CONSTRUCTED PER CDOT STANDARDS AND SPECIFICATIONS.

COLORADO SPRINGS AIRPORT  
FILING NO. 1F  
INTEGRATION PHASE 4FINAL  
DRAINAGE REPORT  
DEVELOPED CONDITIONS MAP  
SHEET 3 OF 4



SEE SHEET 1

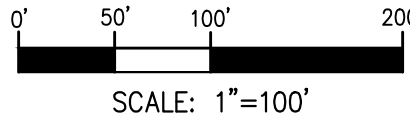


BASIN SUMMARY				
Basin	Area (acres)	Impervious Percentage	Qs (cfs)	Q100 (cfs)
A1	8.2	44.3%	8.0	21.5
A2	6.5	47.7%	6.9	17.9
A3	9.1	4.8%	3.3	19.3
A4	1.4	42.9%	1.9	5.1
A5	2.4	80.2%	7.5	14.7
A6	3.1	17.3%	1.5	6.0
A7	0.8	27.0%	0.6	1.9
A8	4.6	2.9%	1.3	8.2
A9	1.9	12.4%	1.0	4.5
B1	5.3	75.0%	13.4	27.4
B2	9.7	3.6%	2.3	14.1
B3	6.2	75.0%	15.6	31.9
C1	10.6	2.0%	1.8	12.0
C2	1.9	75.0%	4.0	8.3
C3	1.8	75.0%	3.8	7.9
C4	32.7	2.0%	5.0	33.1
C5	12.3	80.4%	34.4	67.9
C6	2.4	75.0%	5.4	11.1
C7	2.3	75.0%	5.1	10.5
C8	2.1	2.0%	0.9	5.9
C9	1.0	2.0%	0.3	2.2
C10	13.0	7.1%	5.3	28.2
C11	4.0	16.6%	2.0	13.7
D1	56.8	80.0%	139.2	275.5
D2	4.4	2.0%	1.4	9.1
P1	1.1	22.8%	0.9	3.2
P2	4.4	2.0%	1.6	10.8
UD1	9.8	17.4%	3.5	14.0

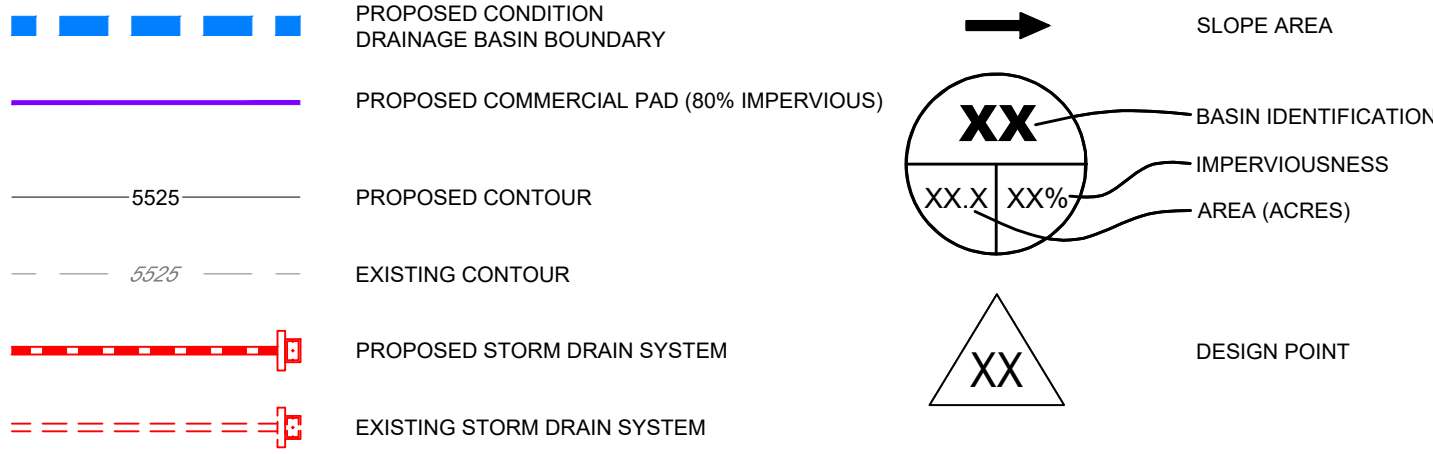
SEE SHEET 4



COLORADO SPRINGS AIRPORT  
FILING NO. 1F  
INTEGRATION PHASE 4FINAL  
DRAINAGE REPORT  
DEVELOPED CONDITIONS MAP

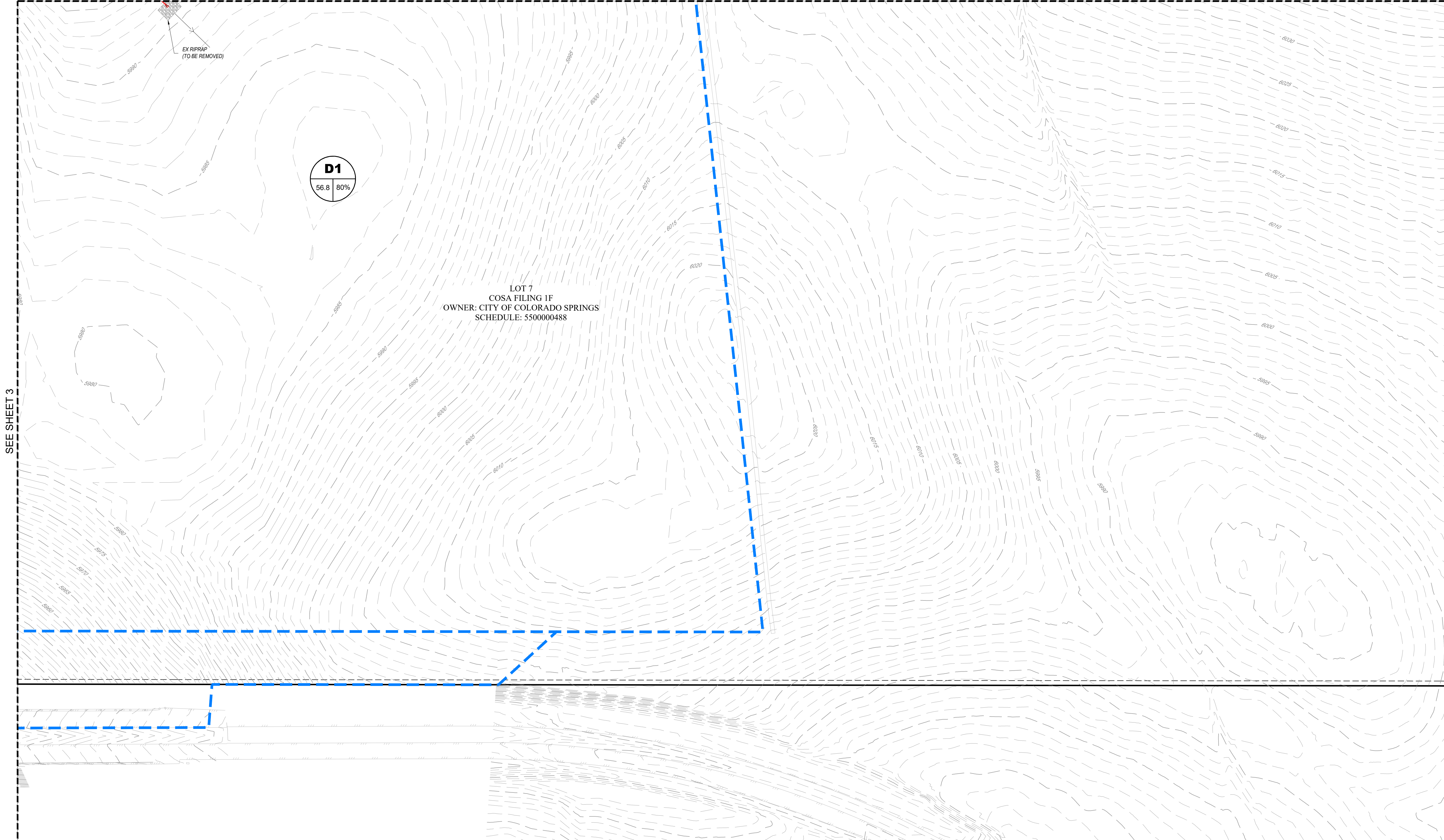


## LEGEND



## NOTES

1. ALL EXISTING STORM INFRASTRUCTURE IN POWERS BLVD IS PUBLICLY OWNED AND MAINTAINED.
2. ALL EXISTING STORM INFRASTRUCTURE WITHIN PEAK INNOVATION PARK IS PRIVATELY OWNED AND MAINTAINED.
3. ALL PROPOSED STORM INFRASTRUCTURE IS PRIVATELY OWNED AND MAINTAINED.
4. ALL MANHOLES ARE TO BE CONSTRUCTED PER CDOT STANDARDS AND SPECIFICATIONS.



BASIN SUMMARY				
Basin	Area (acres)	Impervious Percentage	Qs (cfs)	Q100 (cfs)
A1	8.2	44.3%	8.0	21.5
A2	6.5	47.7%	6.9	17.9
A3	9.1	4.8%	3.3	9.1
A4	1.4	42.9%	1.9	5.3
A5	2.4	80.2%	7.5	14.7
A6	3.1	1.7%	1.5	6.0
A7	0.8	27.0%	0.6	1.9
A8	4.6	2.9%	1.3	4.2
A9	1.9	12.4%	1.0	4.5
B1	5.3	75.0%	13.4	27.4
B2	9.7	3.6%	2.3	14.1
B3	6.2	75.0%	15.6	31.9
C1	10.6	2.0%	1.8	12.0
C2	1.9	75.0%	4.0	8.3
C3	1.8	75.0%	3.8	7.9
C4	32.7	2.0%	5.0	33.1
C5	12.3	80.4%	34.4	67.9
C6	2.4	75.0%	5.4	11.1
C7	2.3	75.0%	5.1	10.5
C8	2.1	2.0%	0.9	5.9
C9	1.0	2.0%	0.3	2.2
C10	13.0	7.1%	5.3	28.2
C11	4.0	16.6%	2.0	13.7
D1	56.8	80.0%	139.2	275.5
D2	4.4	2.0%	1.4	9.1
P1	1.1	22.8%	0.9	3.2
P2	4.4	2.0%	1.6	10.8
UD1	9.8	17.4%	3.5	14.0



Legend:

- PROPOSED CONDITION DRAINAGE BASIN BOUNDARY
- PROPOSED COMMERCIAL PAD (80% IMPERVIOUS)
- 5525
- PROPOSED CONTOUR
- 5525
- EXISTING CONTOUR
- PROPOSED STORM DRAIN SYSTEM
- EXISTING STORM DRAIN SYSTEM
- SLOPE AREA
- BASIN IDENTIFICATION
- IMPERVIOUSNESS
- AREA (ACRES)
- DESIGN POINT

1. ALL EXISTING STORM INFRASTRUCTURE IN POWERS BLVD IS PUBLICLY OWNED AND MAINTAINED.
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3. ALL PROPOSED STORM INFRASTRUCTURE IS PRIVATELY OWNED AND MAINTAINED.
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BASIN SUMMARY				
Basin	Area (acres)	Impervious Percentage	Q <sub>s</sub> (cfs)	Q <sub>100</sub> (cfs)
A1	8.2	44.3%	8.0	21.5
A2	6.5	47.7%	6.9	17.9
A3	9.1	4.8%	3.3	19.3
A4	1.4	42.9%	1.9	5.1
A5	2.4	80.2%	7.5	14.7
A6	3.1	17.3%	1.5	6.0
A7	0.8	27.0%	0.6	1.9
A8	4.6	2.9%	1.3	8.2
A9	1.9	12.4%	1.0	4.5
B1	5.3	75.0%	13.4	27.4
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C2	1.9	75.0%	4.0	8.3
C3	1.8	75.0%	3.8	7.9
C4	32.7	2.0%	5.0	33.1
C5	12.3	80.4%	34.4	67.9
C6	2.4	75.0%	5.4	11.1
C7	2.3	75.0%	5.1	10.5
C8	2.1	2.0%	0.9	5.9
C9	1.0	2.0%	0.3	2.2
C10	13.0	7.1%	5.3	28.2
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D1	56.8	80.0%	139.2	275.5
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P1	1.1	22.8%	0.9	3.2
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UD1	9.8	17.4%	3.5	14.0

SEE SHEET 3



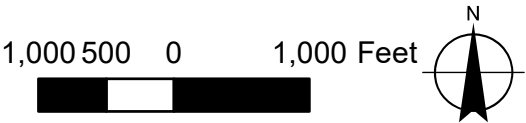
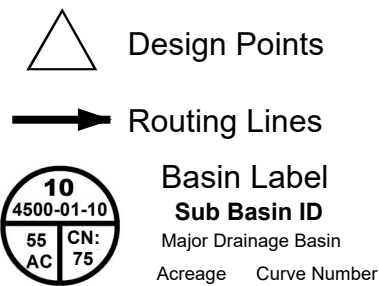
## MDDP Maps

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**COLORADO SPRINGS AIRPORT  
PEAK INNOVATION PARK  
FIGURE 4 - HISTORIC HYDROLOGY MAP  
Windmill Gulch and Big Johnson Drainage Basins**

**HEC-HMS/ SCS Method  
Modeling Elements**



**Features**

- Peak Innovation Boundary
- Airport Property Boundary
- Historic Sump
- Man-Made Sump
- Major Drainage Basins
- Sub Basins
- Existing Stormwater Utilities  
ALL STORM DRAIN SYSTEMS  
SHOWN ARE PUBLIC UTILITIES.

Engineering

**SUB-BASIN HYDROLOGIC SUMMARY TABLE**

HISTORIC CONDITIONS - WINDMILL GULCH AND BIG JOHNSON BASINS  
COSA: PEAK INNOVATION PARK

Catchment Name/ID	Area (acres)	Weighted Imperv. (%)	Peak Flow Rate			100-yr Runoff per Unit Area (cfs/acre)
			5-Yr (cfs)	10-Yr (cfs)	100-Yr (cfs)	
10	115	2.0	31	49	153	1.32
20	122	2.0	43	66	206	1.70
30	83	2.0	13	20	68	0.82
40	128	2.0	20	33	142	1.11
50	198	27.1	103	137	323	1.63
110	96	2.0	16	26	89	0.92
120	64	2.0	5	10	43	0.67
130	115	2.0	9	16	68	0.59
200	109	2.0	17	28	95	0.87
210	96	2.0	21	33	113	1.17
220	122	2.0	22	36	121	1.00
230	134	2.0	17	27	89	0.66
240	141	2.3	17	27	90	0.64
250	109	4.0	17	26	85	0.78
255	58	2.8	11	18	59	1.02
260	58	3.1	12	18	60	1.04
270	109	27.2	32	42	99	0.91
280	96	77.3	100	122	225	2.35
290	45	2.0	8	13	43	0.96
300	60	3.4	10	16	52	0.87
310	122	4.0	23	36	115	0.95
315	64	7.5	12	18	55	0.86
320	35	5.7	7	10	32	0.90

**DESIGN POINT HYDROLOGIC SUMMARY TABLE**

HISTORIC CONDITIONS - WINDMILL GULCH AND BIG JOHNSON BASINS  
COSA: PEAK INNOVATION PARK

Design Point	Peak Flow Rate		
	5-Yr (cfs)	10-Yr (cfs)	100-Yr (cfs)
DP1	26	45	184
DP3	17	28	95
DP4	188	264	721
DP5	156	213	545
DP6	133	175	406
DP8	12	18	60
DP9	0	0	1
DP10	50	80	269
DP12	17	26	84
DP20	31	49	153
DP21	138	196	533
DP22	13	20	68

**HISTORIC RETENTION BASINS**

VOLUME AND RELEASE RATES  
COSA: PEAK INNOVATION PARK

Basin ID	Retention Volume (AF)	10-Year Release (cfs)	100-Year Release (cfs)
Reservoir 250	2	26	85
Reservoir 270	149	0	1

#72  
(4) 24" x 38" HERCP  
Capacity: 108 cfs  
100-yr Flow: 95.2 cfs

#50  
(2) 8' x 6' RCBC  
Capacity: 860 cfs  
100-yr Flow: 721.3 cfs

Local roadway  
drainage culvert  
crossings (#45A,B,C).

#40  
(2) 8' x 3' RCBC  
Capacity: 300 cfs  
100-yr Flow: 184.4 cfs

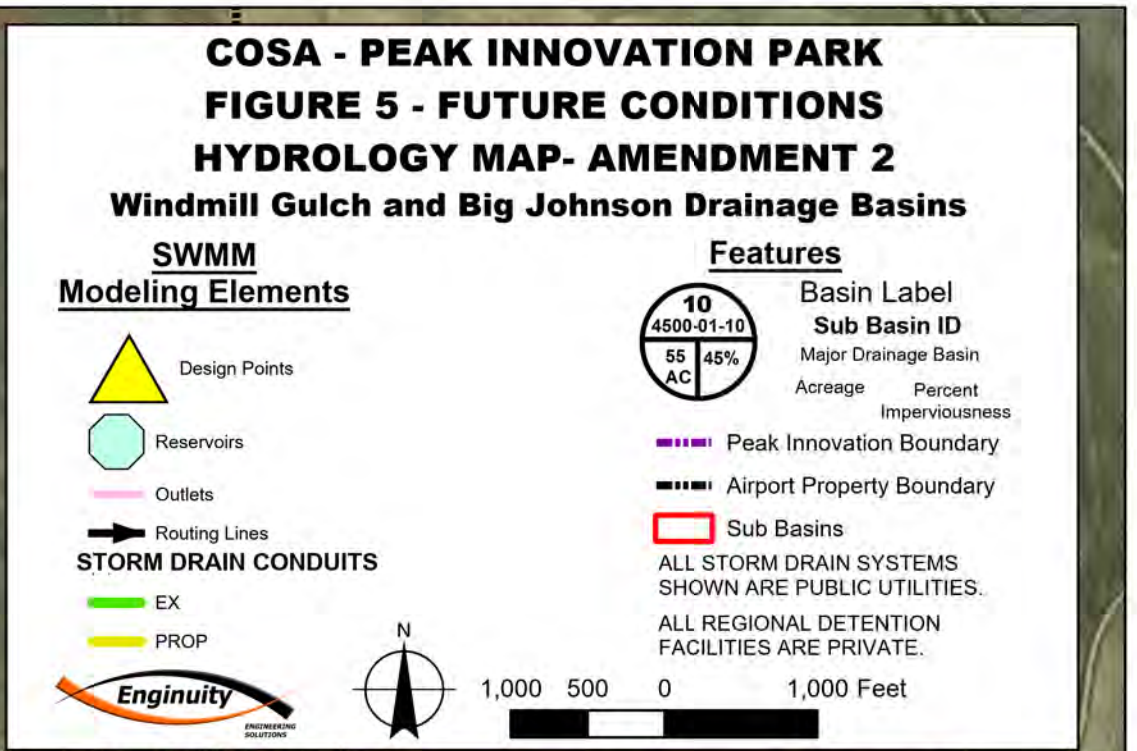
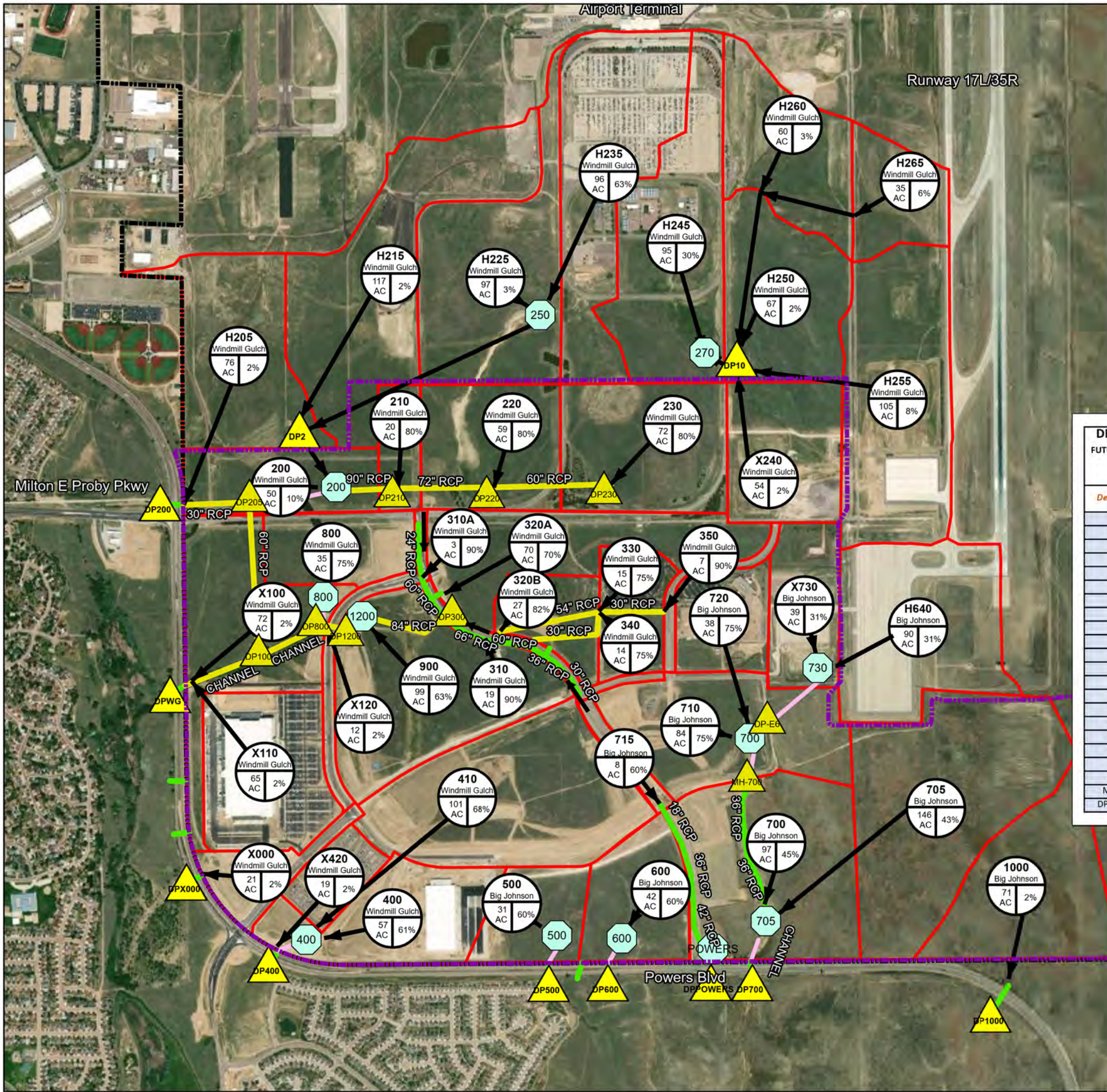
Local roadway  
drainage culvert  
crossings (#10A,B,C).

#10  
60" CMP  
Capacity: 144 cfs  
100-yr Flow: 152.5 cfs

#20  
8' x 8' RCBC  
Capacity: 605 cfs  
100-yr Flow: 532.7 cfs

#30  
8' x 6' RCBC  
Capacity: 425 cfs  
100-yr Flow: 68.3 cfs





DESIGN POINT HYDROLOGIC SUMMARY TABLE			
FUTURE CONDITIONS - WINDMILL GULCH AND BIG JOHNSON BASINS			
COSA: PEAK INNOVATION PARK			
Design Point	Peak Flow Rate		
	5-Yr (cfs)	10-Yr (cfs)	100-Yr (cfs)
DP2	117	158	388
DP10	106	144	291
DP100	118	139	293
DP200	30	38	101
DP205	53	61	89
DP210	199	244	453
DP220	186	228	422
DP230	107	131	244
DP300	220	270	501
DP400	38	67	154
DP500	8	9	19
DP600	3	5	34
DP700	101	136	414
DP800	89	106	247
DP900	72	87	189
DP1000	17	28	88
DP1200	71	86	213
DPX000	6	11	38
DP-E6	91	107	177
DPWG	136	165	407
MH-700-A	67	98	128
DPPOWERS*	-	37.9	76.2

\*Report Data - See Appendix

100-YEAR REGIONAL DETENTION		
VOLUME AND RELEASE RATES		
COSA: PEAK INNOVATION PARK		
Pond	Detention Volume (AF)	100-Year Release (cfs)
200	80.4	89
400	25.6	127
500	5.1	19
600	7.1	34
700	26.6	128
705	21.9	412
730	13.3	51
800	5.4	22
1200	39.9	213
POWERS*	7.13	76.2

\*Report Data - See Appendix

SUB-BASIN HYDROLOGIC SUMMARY TABLE						
FUTURE CONDITIONS - WINDMILL GULCH AND BIG JOHNSON BASINS						
COSA: PEAK INNOVATION PARK						
Catchment Name/ID	Area (acres)	Weighted Imperv. (%)	Peak Flow Rate			100-Yr Runoff per Unit Area (cfs/acre)
			5-Yr (cfs)	10-Yr (cfs)	100-Yr (cfs)	
X000	21	2	6	10	31	1.45
X100	72	2	16	26	87	1.21
X110	65	2	10	16	52	0.80
X120	13	2	1	2	10	0.76
X240	54	2	9	14	48	0.90
X420	19	2	8	11	22	1.20
X730	39	31	33	43	101	2.60
200	50	10	24	36	99	1.98
210	20	80	44	54	100	5.11
220	59	80	80	97	180	3.06
230	72	80	107	131	244	3.39
310	19	90	37	45	81	4.29
310A	3	90	8	10	18	5.41
320A	70	70	88	108	207	2.96
320B	27	82	49	59	109	4.05
330	15	75	20	24	45	3.03
340	14	75	20	24	45	3.23
350	7	90	17	21	37	5.27
400	57	64	67	84	165	2.90
410	101	61	117	145	279	2.78
500	31	60	51	64	126	4.00
600	42	60	58	76	151	3.60
700	97	45	118	151	314	3.24
705	146	43	159	205	440	3.02
710	84	75	121	149	241	2.87
715	8	60	12	15	29	3.77
720	38	75	57	70	131	3.43
800	35	75	82	101	189	5.38
900	99	67	127	158	311	3.15
1000	71	2	17	28	88	1.24
H205	76	2	11	17	57	0.75
H215	117	2	13	21	71	0.61
H225	97	3	16	25	83	0.85
H235	96	63	87	109	215	2.24
H245	95	30	38	51	119	1.25
H250	67	2	11	17	57	0.84
H255	105	8	17	25	74	0.71
H260	60	3	10	16	52	0.87
H265	35	6	7	10	32	0.90
H640	90	31	89	119	274	3.04



# Appendix B

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Hydrologic Calculations

**INTEGRATION LOOP PH3  
HISTORIC CONDITIONS IMPERVIOUSNESS SUMMARY**

**EXISTING BASIN CONDITION**

<b>Basin</b>	<b>Total Area</b>	<b>Composite Imperviousness</b>
	<b>(ac)</b>	<b>(%)</b>
A1	8.2	44%
A2	6.5	50%
A3	9.1	5%
A4	1.4	43%
A5	2.4	80%
X1	9.1	2%
X2	181.4	2%
I1	6.6	75%
I2	1.0	75%
I3	1.0	77%
I4	1.3	74%
I5	2.2	21%
<b>TOTAL</b>	<b>230.2</b>	<b>10%</b>



STANDARD FORM SF-2

TIME OF CONCENTRATION - HISTORIC CONDITIONS

BY: SWK

DATE: 26-Oct-22

CHECKED BY: EJD

PROJECT: INTEGRATION LOOP PH4

JOB NUMBER: FINAL DRAINAGE REPORT

NRCS SOIL TYPE: TYPE A

SUB-BASIN DATA			INITIAL TIME (T <sub>i</sub> ) (COCs Eq. 6-8)			TRAVEL TIME (T <sub>t</sub> ) (COCs Eq. 6-9)					T <sub>c</sub> URBANIZED CHECK (COCs Eq. 6-9 & 6-10)			FINAL T <sub>c</sub>	REMARKS	NRCS SOIL TYPES					COMPOSITE																						
BASIN	AREA ac	C <sub>s</sub>	LENGTH ft	SLOPE %	T <sub>i</sub>	LENGTH ft	SLOPE %	C <sub>v</sub>	VEL. fps	T <sub>t</sub>	COMP. T <sub>c</sub>	TOTAL LENGTH	SLOPE %	COMP. T <sub>c</sub>	MIN	Type A/B Area (SF)	Type C/D Area (SF)	% Type A/B	% Type C/D	Check	C <sub>5A/B</sub>	C <sub>100A/B</sub>	C <sub>5C/D</sub>	C <sub>100C/D</sub>	C <sub>5</sub>	C <sub>100</sub>	Imperv. %																
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)																												
EXISTING BASINS																																											
A1	8.2	0.32	CALACULATED A PART OF PEAK INNOVATION PARKWAYS ROADWAY IMPROVEMENTS FDR												20.3	(1)	357,358		100%	0%	100%	0.32	0.51	0.00	0.00	0.32	0.51	44%															
A2	6.5	0.34	CALACULATED A PART OF PEAK INNOVATION PARKWAYS ROADWAY IMPROVEMENTS FDR												19.3		284,168		100%	0%	100%	0.34	0.52	0.00	0.00	0.34	0.52	46%															
A3	9.1	0.11	CALACULATED A PART OF COSA - PONDS 500 & 600 FDR												16.5		395,812		100%	0%	100%	0.11	0.38	0.00	0.00	0.11	0.38	5%															
A4	1.4	0.31	CALACULATED A PART OF PEAK INNOVATION PARKWAYS ROADWAY IMPROVEMENTS FDR												8.5		59,625		100%	0%	100%	0.31	0.51	0.00	0.00	0.31	0.51	43%															
A5	2.4	0.60	CALACULATED A PART OF PEAK INNOVATION PARKWAYS ROADWAY IMPROVEMENTS FDR												5.0		105,560		100%	0%	100%	0.60	0.70	0.00	0.00	0.60	0.70	80%															
X1	9.1	0.09	300	3.1%	21.8	1171	4.9%	4.0	0.9	22.0	43.9	NON-URBANIZED		43.9		396,396		100%	0%	100%	0.09	0.36	0.00	0.00	0.09	0.36	2%																
X2	181.4	0.09	300	2.3%	24.2	4786	3.4%	5.0	0.9	86.2	110.4	NON-URBANIZED		110.4		7,901,784		100%	0%	100%	0.09	0.36	0.00	0.00	0.09	0.36	2%																
I1	6.6	0.54	CALACULATED A PART OF COSA - INTEGRATION LOOP PHASE 3												7.6		287,496		100%	0%	100%	0.54	0.66	0.00	0.00	0.54	0.66	75%															
I2	1.0	0.54	CALACULATED A PART OF COSA - INTEGRATION LOOP PHASE 4												8.4		43,560		100%	0%	100%	0.54	0.66	0.00	0.00	0.54	0.66	75%															
I3	1.0	0.56	CALACULATED A PART OF COSA - INTEGRATION LOOP PHASE 5												8.1		43,560		100%	0%	100%	0.56	0.67	0.00	0.00	0.56	0.67	77%															
I4	1.3	0.53	CALACULATED A PART OF COSA - INTEGRATION LOOP PHASE 5												7.3		56,628		100%	0%	100%	0.53	0.65	0.00	0.00	0.53	0.65	74%															
I5	2.2	0.20	CALACULATED A PART OF COSA - INTEGRATION LOOP PHASE 6												5.9		95,832		100%	0%	100%	0.20	0.44	0.00	0.00	0.20	0.44	21%															
<div><div><div>Equation Summary</div><div>(6) T<sub>i</sub> = (0.395(1.1 - C<sub>s</sub>)<sup>0.5</sup>) / S<sup>0.33</sup></div><div>(10) V = C * S<sup>0.5</sup></div><div>(11) T<sub>t</sub> = L / (60V)</div><div>(12) T<sub>c</sub> = T<sub>i</sub> + T<sub>t</sub></div><div>(15) T<sub>c</sub> = (L / 180) + 10</div></div><div><div>COCs Drainage Criteria Manual V1</div><div>Eq. 6-8</div><div>Eq. 6-9</div><div>Eq. 6-16</div><div>Eq. 6-7 (Use a Time of 5 if (12) produces lesser T<sub>c</sub>)</div><div>Eq. 6-10 (In urban catchments, choose the lesser of (12) and (15))</div></div><div><div>COCs Manual V1 - Table 6-7. Conveyance Coefficient, C<sub>v</sub></div><table><thead><tr><th>Type of Land Surface</th><th>Conveyance Factor, C<sub>v</sub></th></tr></thead><tbody><tr><td>Heavy meadow</td><td>2.5</td></tr><tr><td>Tillage/Field</td><td>5</td></tr><tr><td>Riprap (not buried)</td><td>6.5</td></tr><tr><td>Short Pasture and Lawns</td><td>7</td></tr><tr><td>Nearly Bare Ground</td><td>10</td></tr><tr><td>Grassed Waterway</td><td>15</td></tr><tr><td>Paved Areas</td><td>20</td></tr></tbody></table></div><div><div>REMARKS</div><div>(1) PER PEAK TECHNOLOGY CAMPUS FINAL DRAINAGE REPORT BY CLASSIC CONSULTING ENGINEERS &amp; SURVEYORS</div></div></div>																												Type of Land Surface	Conveyance Factor, C <sub>v</sub>	Heavy meadow	2.5	Tillage/Field	5	Riprap (not buried)	6.5	Short Pasture and Lawns	7	Nearly Bare Ground	10	Grassed Waterway	15	Paved Areas	20
Type of Land Surface	Conveyance Factor, C <sub>v</sub>																																										
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<p align="center"><b>STANDARD FORM SF-3</b>  <b>PEAK BASIN RUNOFF CALCULATIONS - HISTORIC CONDITIONS</b>  <b>(RATIONAL METHOD PROCEDURE)</b></p>		
<p>CALCULATED BY: <u>SWK</u></p> <p>DATE: <u>26-Oct-22</u></p> <p>CHECKED BY: <u>EJD</u></p>	<p>P<sub>1</sub>= 1.50</p>	<p>PROJECT: <u>INTEGRATION LOOP PH4</u></p> <p>JOB NUMBER: <u>FINAL DRAINAGE REPORT</u></p> <p>DESIGN STORM: <u>5-YEAR</u></p>

DESIGN STORM: 5-YEAR[illegible]

<p align="center"><b>STANDARD FORM SF-3</b>  <b>PEAK BASIN RUNOFF CALCULATIONS - HISTORIC CONDITIONS</b>  <b>(RATIONAL METHOD PROCEDURE)</b></p>		
<p>CALCULATED BY: <u>SWK</u></p> <p>DATE: <u>26-Oct-22</u></p> <p>CHECKED BY: <u>EJD</u></p>	<p>P<sub>1</sub>=      2.52</p>	<p>PROJECT: <u>INTEGRATION LOOP PH4</u></p> <p>JOB NUMBER: <u>FINAL DRAINAGE REPORT</u></p> <p>DESIGN STORM: <u>5-YEAR</u></p>

DESIGN STORM: 5-YEAR[illegible]

**INTEGRATION LOOP PH4  
DEVELOPED CONDITIONS IMPERVIOUSNESS SUMMARY**

Basin	Total Area	Total Area	Paved Area	Roof Area	Concrete Walks	Gravel Path	Lawn/Open Space	Composite Imperviousness
	(ac)	(ac)	(ac)	(ac)	(ac)	(ac)	(ac)	(ac)
<b>PROPOSED ON-SITE BASIN CONDITION</b>								
A1	357,358	8.20	154,226	0	0	0	203,132	44%
A2	284,168	6.52	132,638	0	0	0	151,530	48%
A3	395,812	9.09	0	0	3,646	8,341	392,166	5%
A4	59,625	1.37	24,866	0	0	0	34,759	43%
A5	105,560	2.42	84,199	0	0	0	21,361	80%
A6	136,169	3.13	11,220	0	2,313	8,381	122,636	17%
A7	36,891	0.85	0	480	0	9,780	36,411	27%
A8	200,332	4.60	0	0	1,773	0	198,559	3%
A9	81,135	1.86	0	0	0	9,404	81,135	12%
<b>A Total</b>	<b>1,657,050</b>	<b>38.04</b>	<b>407,149</b>	<b>480</b>	<b>7,732</b>	<b>35,906</b>	<b>1,241,689</b>	<b>29%</b>
B1	232,488	5.34	174,366	0	0	0	58,122	75%
B2	423,742	9.73	6,785	0	0	0	416,957	4%
B3	270,252	6.20	202,689	0	0	0	67,563	75%
C1	461,640	10.60	0	0	0	0	461,640	2%
C2	81,589	1.87	44,872	0	12,346	0	24,371	75%
C3	77,884	1.79	44,561	0	7,371	0	25,952	75%
C4	1,424,952	32.71	0	0	0	0	1,424,952	2%
C5	536,723	12.32	429,378	0	0	0	107,345	80%
C6	104,985	2.41	78,739	0	0	0	26,246	75%
C7	98,796	2.27	74,097	0	0	0	24,699	75%
C8	90,739	2.08	0	0	0	0	90,739	2%
C9	45,513	1.04	0	0	0	0	45,513	2%
C10	568,259	13.05	0	0	0	32,169	568,259	7%
C11	174,201	4.00	0	0	0	28,338	174,201	17%
<b>B/C Total</b>	<b>4,591,763</b>	<b>105.41</b>	<b>1,055,487</b>	<b>0</b>	<b>19,717</b>	<b>60,507</b>	<b>3,516,559</b>	<b>26%</b>
D1	2,474,610	56.81	1,979,688	0	0	0	494,922	80%
D2	193,718	4.45	0	0	0	0	193,718	2%
<b>D Total</b>	<b>2,668,328</b>	<b>61.26</b>	<b>1,979,688</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>688,640</b>	<b>75%</b>
P1	47,417	1.09	0	0	0	10,954	47,417	23%
P2	190,887	4.38	0	0	0	0	190,887	2%
UD1	427,386	9.81	65,376	0	1,775	0	360,235	17%
<b>TOTAL</b>	<b>9,582,831</b>	<b>219.99</b>	<b>3,507,700</b>	<b>480</b>	<b>29,224</b>	<b>107,367</b>	<b>6,045,427</b>	<b>39%</b>

**UDFCD Table 6-3. Recommended Percentage Imperviousness Values**

<i>Land Use or Surface Characteristics</i>	<i>Percentage Imperviousness (%)</i>
Paved	100%
Roofs	90%
Walks	100%
Gravel Path	90%
Lawns	2%

STANDARD FORM SF-2																												
TIME OF CONCENTRATION - DEVELOPED CONDITIONS																												
BY: SWK		PROJECT: INTEGRATION LOOP PH4																										
DATE: 26-Oct-22		JOB NUMBER: FINAL DRAINAGE REPORT																										
CHECKED BY: EJD		NRCS SOIL TYPE: TYPE A/B																										
SUB-BASIN DATA			INITIAL TIME (Ti) (COCS Eq. 6-8)			TRAVEL TIME (Ti) (COCS Eq. 6-9)					Tc URBANIZED CHECK (COCS Eq. 6-9 & 6-10)					FINAL Tc	REMARKS	NRCS SOIL TYPES					COMPOSITE					
BASIN	AREA ac	Cs	LENGTH ft	SLOPE %	Ti	LENGTH ft	SLOPE %	Cv	VEL fps	Ti	COMP. Tc	TOTAL LENGTH	SLOPE %	COMP. Tc	MIN		Type A/B Area (SF)	Type C/D Area (SF)	% Type A/B	% Type C/D	Check	CsA/B	C100A/B	C5C/D	C100C/D	Cs	C100	Improv. %
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)													
A1	8.2	0.32	CALCULATED A PART OF PEAK INNOVATION PARKWAYS ROADWAY IMPROVEMENTS FDR												20.3	(1)	357,358		100%	0%	100%	0.32	0.51	0.00	0.00	0.32	0.51	44%
A2	6.5	0.34	CALCULATED A PART OF PEAK INNOVATION PARKWAYS ROADWAY IMPROVEMENTS FDR												19.3		284,168		100%	0%	100%	0.34	0.52	0.00	0.00	0.34	0.52	48%
A3	9.1	0.11	CALCULATED A PART OF COSA - PONDS 500 & 600 FDR												16.5		395,812		100%	0%	100%	0.11	0.38	0.00	0.00	0.11	0.38	5%
A4	1.4	0.31	CALCULATED A PART OF PEAK INNOVATION PARKWAYS ROADWAY IMPROVEMENTS FDR												8.5		59,625		100%	0%	100%	0.31	0.51	0.00	0.00	0.31	0.51	43%
A5	2.4	0.60	CALCULATED A PART OF PEAK INNOVATION PARKWAYS ROADWAY IMPROVEMENTS FDR												5.0		105,560		100%	0%	100%	0.60	0.70	0.00	0.00	0.60	0.70	80%
A6	3.1	0.18	300	3.2%	19.8	210	1.0%	5.0	0.5	7.0	26.8	Undeveloped				26.8	136,169		100%	0%	100%	0.18	0.43	0.00	0.00	0.18	0.43	17%
A7	0.8	0.23	109	1.8%	13.6	297	1.0%	5.0	0.5	9.9	23.5	Undeveloped				23.5	36,891		100%	0%	100%	0.23	0.46	0.00	0.00	0.23	0.46	27%
A8	4.6	0.10	272	4.8%	18.0	170	1.5%	5.0	0.6	4.6	22.6	Undeveloped				22.6	200,332		100%	0%	100%	0.10	0.37	0.00	0.00	0.10	0.37	3%
A9	1.9	0.15	124	5.6%	10.9	170	1.5%	5.0	0.6	4.6	15.5	Undeveloped				15.5	81,135		100%	0%	100%	0.15	0.41	0.00	0.00	0.15	0.41	12%
B1	5.3	0.54	ASSUMED TC OF 7.0												7.0		232,488		100%	0%	100%	0.54	0.66	0.00	0.00	0.54	0.66	75%
B2	9.7	0.10	300	9.4%	15.0	940	3.1%	5.0	0.9	17.8	32.8	Undeveloped				32.8	423,742		100%	0%	100%	0.10	0.37	0.00	0.00	0.10	0.37	4%
B3	6.2	0.54	ASSUMED TC OF 7.0												7.0		270,252		100%	0%	100%	0.54	0.66	0.00	0.00	0.54	0.66	75%
C1	10.6	0.09	300	3.3%	21.5	1,291	3.3%	5.0	0.9	23.7	45.2	Undeveloped				45.2	461,640		100%	0%	100%	0.09	0.36	0.00	0.00	0.09	0.36	2%
C2	1.9	0.54	41	2.0%	5.2	1,221	3.2%	20.0	3.6	5.7	10.9	1,262.0	3.2%	17.0	10.9	81,589		100%	0%	100%	0.54	0.66	0.00	0.00	0.54	0.66	75%	
C3	1.8	0.54	41	2.0%	5.2	1,221	3.2%	20.0	3.6	5.7	10.9	1,262.0	3.2%	17.0	10.9	77,884		100%	0%	100%	0.54	0.66	0.00	0.00	0.54	0.66	75%	
C4	32.7	0.09	300	3.3%	21.5	1,638	3.3%	5.0	0.9	30.1	51.5	Undeveloped				51.5	1,424,952		100%	0%	100%	0.09	0.36	0.00	0.00	0.09	0.36	2%
C5	12.3	0.60	ASSUMED TC OF 7.0												7.0		536,723		100%	0%	100%	0.60	0.70	0.00	0.00	0.60	0.70	80%
C6	2.4	0.54	67	3.6%	5.5	794	2.4%	20.0	3.1	4.3	9.8	861.0	2.5%	14.8	9.8	104,985		100%	0%	100%	0.54	0.66	0.00	0.00	0.54	0.66	75%	
C7	2.3	0.54	67	3.6%	5.5	794	2.4%	21.0	3.3	4.1	9.6	861.0	2.5%	14.8	9.6	98,796		100%	0%	100%	0.54	0.66	0.00	0.00	0.54	0.66	75%	
C8	2.1	0.09	ASSUMED TC OF 7.0												7.0		90,739		100%	0%	100%	0.09	0.36	0.00	0.00	0.09	0.36	2%
C9	1.0	0.09	240	8.8%	13.9	89	5.0%	5.0	1.1	1.3	15.2	Undeveloped				15.2	45,513		100%	0%	100%	0.09	0.36	0.00	0.00	0.09	0.36	2%
C10	13.0	0.12	300	6.1%	17.0	1	5.0%	5.0	1.1	0.0	17.0	Undeveloped				17.0	568,259		100%	0%	100%	0.12	0.39	0.00	0.00	0.12	0.39	7%
C11	4.0	0.18	300	3.1%	20.0	116	1.3%	5.0	0.6	3.4	23.4	Undeveloped				23.4	174,201		100%	0%	100%	0.18	0.43	0.00	0.00	0.18	0.43	17%
D1	56.8	0.59	ASSUMED TC OF 10.0												10.0		2,474,610		100%	0%	100%	0.59	0.70	0.00	0.00	0.59	0.70	80%
D2	4.4	0.09	300	10.2%	14.8	89	3.2%	5.0	0.9	1.7	16.4	Undeveloped				16.4	193,718		100%	0%	100%	0.09	0.36	0.00	0.00	0.09	0.36	2%
P1	1.1	0.21	112	11.3%	7.7	304	5.1%	5.0	1.1	4.5	12.2	Undeveloped				12.2	47,417		100%	0%	100%	0.21	0.45	0.00	0.00	0.21	0.45	23%
P2	4.4	0.09	72	3.5%	10.3	1	3.5%	5.0	0.9	0.0	10.3	Undeveloped				10.3	190,887		100%	0%	100%	0.09	0.36	0.00	0.00	0.09	0.36	2%
UD1	9.8	0.18	294	10.0%	13.4	1,742	4.1%	5.0	1.0	28.7	42.0	Undeveloped				42.0	427,386		100%	0%	100%	0.18	0.43	0.00	0.00	0.18	0.43	17%
Equation Summary			COCS Manual V1 - Table 6-7: Conveyance Coefficient, Cc										REMARKS															
(6) Ti = (0.395(1.1-Cs) <sup>1.49</sup> )/S <sup>0.33</sup>			Type of Land Surface										(1) PER PEAK TECHNOLOGY CAMPUS FINAL DRAINAGE REPORT BY CLASSIC CONSULTING															
(10) V = Cc*S <sup>0.55</sup>			Conveyance Factor, Cc										ENGINEERS & SURVEYORS															
Eq 6-9			Heavy meadow																									
Eq 6-9 (Use of Time of 5 if (12) produces lesser Tc)			Tillage/Field																									
			Riprap (not buried)																									
			Short Pasture and Lawns																									
			Nearly Bare Ground																									
			Grassed Waterway																									
			Paved Areas																									
(15) Tc = (L/180)+10																												

<p align="center"><b>STANDARD FORM SF-3</b>  <b>PEAK BASIN RUNOFF CALCULATIONS - DEVELOPED CONDITIONS</b>  <b>(RATIONAL METHOD PROCEDURE)</b></p>		<p><b>PROJECT:</b> INTEGRATION LOOP PH4</p>
<p><b>CALCULATED BY:</b> SWK</p>	<p><b>P<sub>1</sub>=</b> 1.50</p>	<p><b>JOB NUMBER:</b> DRAINAGE REPORT</p>
<p><b>DATE:</b> 26-Oct-22</p>		<p><b>DESIGN STORM:</b> 5-YEAR</p>
<p><b>CHECKED BY:</b> EJD</p>		

[illegible]

<p align="center"><b>STANDARD FORM SF-3</b>  <b>PEAK BASIN RUNOFF CALCULATIONS - DEVELOPED CONDITIONS</b>  <b>(RATIONAL METHOD PROCEDURE)</b></p>		<p><b>PROJECT:</b> INTEGRATION LOOP PH4</p>
<p><b>CALCULATED BY:</b> SWK</p>	<p><b>P<sub>1</sub>=</b> 1.50</p>	<p><b>JOB NUMBER:</b> DRAINAGE REPORT</p>
<p><b>DATE:</b> 26-Oct-22</p>		<p><b>DESIGN STORM:</b> 5-YEAR</p>
<p><b>CHECKED BY:</b> EJD</p>		

CHECKED BY: EJD

DESIGN STORM: 5-YEAR[illegible]

<p align="center">STANDARD FORM SF-3</p> <p align="center">PEAK BASIN RUNOFF CALCULATIONS - DEVELOPED CONDITIONS</p> <p align="center">(RATIONAL METHOD PROCEDURE)</p>		<p>PROJECT: INTEGRATION LOOP PH4</p> <p>JOB NUMBER: DRAINAGE REPORT</p> <p>DESIGN STORM: 100-YEAR</p>
<p>CALCULATED BY: <u>SWK</u></p> <p>DATE: <u>26-Oct-22</u></p> <p>CHECKED BY: <u>EJD</u></p>	<p>P<sub>1</sub>= 2.52</p>	

[illegible]



<p align="center">STANDARD FORM SF-3</p> <p align="center">PEAK BASIN RUNOFF CALCULATIONS - DEVELOPED CONDITIONS</p> <p align="center">(RATIONAL METHOD PROCEDURE)</p>		<p>PROJECT: INTEGRATION LOOP PH4</p> <p>JOB NUMBER: DRAINAGE REPORT</p> <p>DESIGN STORM: 100-YEAR</p>
<p>CALCULATED BY: SWK</p> <p>DATE: 26-Oct-22</p> <p>CHECKED BY: EJD</p>	<p><math>P_1 = 2.52</math></p>	

DESIGN STORM: 100-YEAR[illegible]

<p align="center"><b>STANDARD FORM SF-3</b>  <b>PEAK BASIN RUNOFF CALCULATIONS - DEVELOPED CONDITIONS</b>  <b>(RATIONAL METHOD PROCEDURE)</b></p>		
<p>CALCULATED BY: <u>SWK</u></p> <p>DATE: <u>26-Oct-22</u></p> <p>CHECKED BY: <u>EJD</u></p>	<p><math>P_1 =</math>    2.52</p>	<p>PROJECT: <u>INTEGRATION LOOP PH4</u></p> <p>JOB NUMBER: <u>DRAINAGE REPORT</u></p> <p>DESIGN STORM: <u>100-YEAR</u></p>

[illegible]

<p align="center"><b>STANDARD FORM SF-3</b>  <b>PEAK BASIN RUNOFF CALCULATIONS - DEVELOPED CONDITIONS</b>  <b>(RATIONAL METHOD PROCEDURE)</b></p>		<p>PROJECT: INTEGRATION LOOP PH4</p>
<p>CALCULATED BY: <u>SWK</u></p>	<p>P<sub>1</sub>= 2.52</p>	<p>JOB NUMBER: <u>DRAINAGE REPORT</u></p>
<p>DATE: <u>26-Oct-22</u></p>		<p>DESIGN STORM: <u>100-YEAR</u></p>
<p>CHECKED BY: <u>EJD</u></p>		

CHECKED BY: EJD

DESIGN STORM: 100-YEAR

[illegible]

# Appendix C

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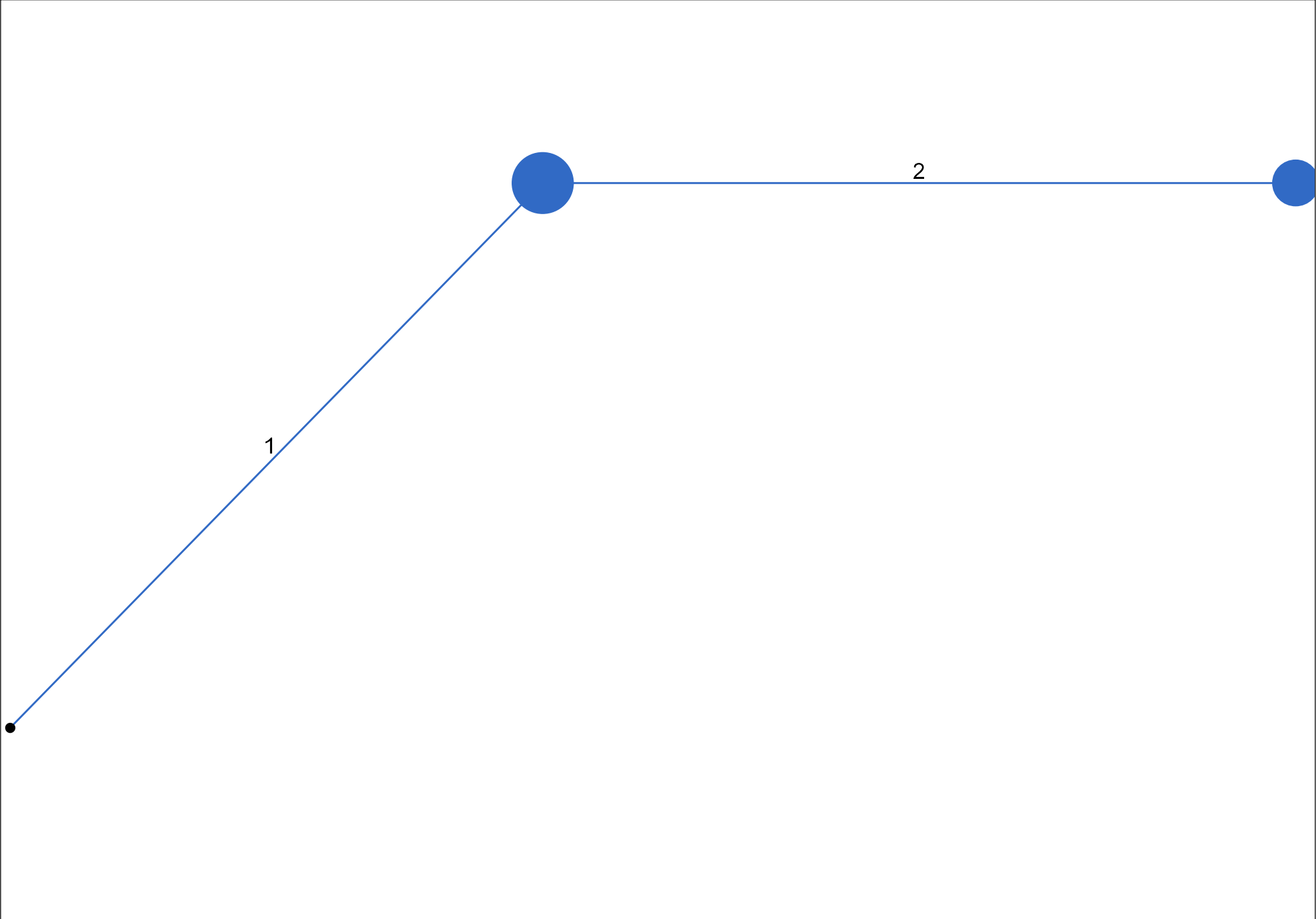
Storm Drain & Swale Calculations

## Duplicate Analysis

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Duplicate analysis is provided to demonstrate that the results of the Hydraflow and UD-Sewer models are consistent and in compliance with COCS Standards.

# Hydraflow Storm Sewers Extension for Autodesk® Civil 3D® Plan



Project File: DUPLICATE ANALYSIS - 5 YEAR.stm	Number of lines: 2	Date: 3/19/2019
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# Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	Pipe - (17)	10.01	18	Cir	50.000	93.80	94.30	1.000	95.04	95.52	n/a	95.52 j	End	Manhole
2	Pipe - (16)	10.08	18	Cir	50.000	94.50	95.00	1.000	95.68	96.22	n/a	96.22	1	Manhole
Project File: DUPLICATE ANALYSIS - 5 YEAR.stm									Number of lines: 2			Run Date: 3/19/2019		
NOTES: Return period = 5 Yrs. ; j - Line contains hyd. jump.														

# Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
(1)	(in) (2)	(cfs) (3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(K) (23)	(ft) (24)
1	18	10.01	93.80	95.04	1.24	1.54	6.41	0.66	95.70	0.000	50.000	94.30	95.52 j	1.22**	1.54	6.51	0.66	96.18	0.000	0.000	n/a	0.75	n/a
2	18	10.08	94.50	95.68	1.18*	1.49	6.77	0.66	96.34	0.000	50.000	95.00	96.22	1.22**	1.54	6.54	0.66	96.89	0.000	0.000	n/a	1.00	n/a
Project File: DUPLICATE ANALYSIS - 5 YEAR.stm														Number of lines: 2					Run Date: 3/19/2019				
Notes: * depth assumed; ** Critical depth.; j-Line contains hyd. jump ; c = cir e = ellip b = box																							



## General Procedure:

Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

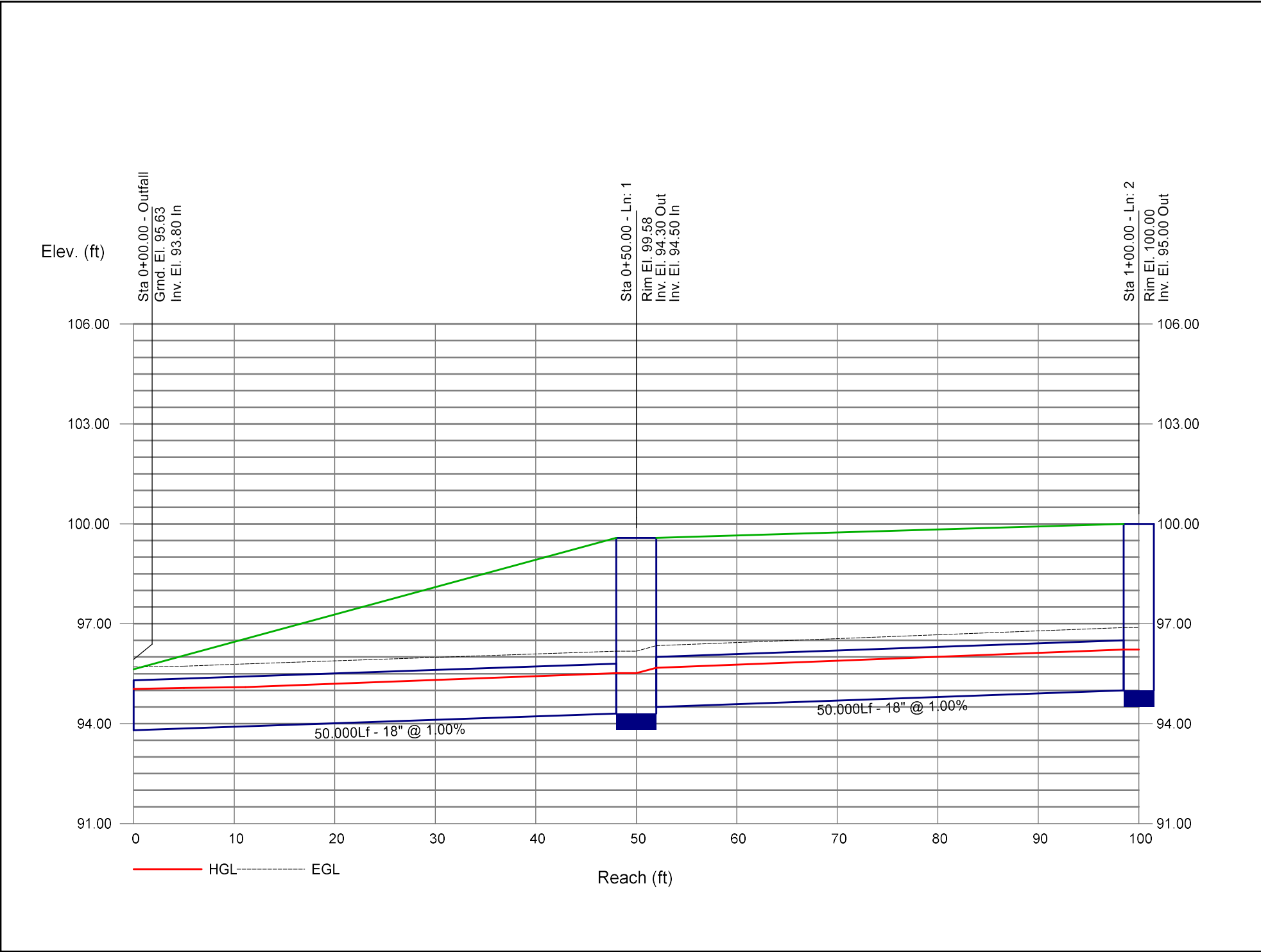
Col. 21 The average of the downstream and upstream friction slopes.

Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

Storm Sewer Profile



# **COLORADO SPRINGS AIRPORT – FILING NO. 1C**

## **FINAL DRAINAGE REPORT**

### **UD SEWER DUPLICATE ANALYSIS RESULTS**

## **System Input Summary**

### **Rainfall Parameters**

**Rainfall Return Period:** 5

**Rainfall Calculation Method:** Table

<b>Time</b>	<b>Intensity</b>
<b>5</b>	5.20
<b>10</b>	4.10
<b>20</b>	3.10
<b>30</b>	2.50
<b>40</b>	2.00
<b>60</b>	1.50
<b>120</b>	0.40

### **Rational Method Constraints**

**Minimum Urban Runoff Coeff.:** 0.20

**Maximum Rural Overland Len. (ft):** 500

**Maximum Urban Overland Len. (ft):** 300

**Used UDFCD Tc. Maximum:** Yes

### **Sizer Constraints**

**Minimum Sewer Size (in):** 18.00

**Maximum Depth to Rise Ratio:** 0.90

**Maximum Flow Velocity (fps):** 18.0

**Minimum Flow Velocity (fps):** 2.0

### **Backwater Calculations:**

**Tailwater Elevation (ft):** 0.00

## Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	Ground Elevation (ft)	Total Known Flow (cfs)	Local Contribution (cfs)	Drainage Area (Ac.)	Runoff Coefficient	5yr Coefficient	Overland Length (ft)	Overland Slope (%)	Gutter Length (ft)	Gutter Velocity (fps)
OUTFALL	95.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH	99.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CB	100.00	0.00	0.00	3.00	0.65	0.65	10.00	1.00	10.00	2.00

## Manhole Output Summary:

Element Name	Local Contribution					Total Design Flow				Comment
	Overland Time (min)	Gutter Time (min)	Basin Tc (min)	Intensity (in/hr)	Local Contribution (cfs)	Coefficient Area	Intensity (in/hr)	Manhole Tc (min)	Peak Flow (cfs)	
OUTFALL	0.00	0.00	0.00	0.00	0.00	1.95	5.20	5.00	10.14	
MH	0.00	0.00	0.00	0.00	0.00	1.95	5.20	5.00	10.14	
CB	2.57	0.08	5.00	5.20	10.14	1.95	5.20	5.00	10.14	Used Minimum Tc

## Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	Sewer Length (ft)	Downstream Invert (ft)	Slope (%)	Upstream Invert (ft)	Manning's n	Bend Loss	Lateral Loss	Cross Section	Rise (ft or in)	Span (ft or in)
MH	50.00	93.80	1.0	94.30	0.013	0.00	0.00	CIRCULAR	18.00 in	18.00 in
CB	50.00	94.50	1.0	95.00	0.013	0.05	0.00	CIRCULAR	18.00 in	18.00 in

## Sewer Flow Summary:

		Full Flow Capacity		Critical Flow		Normal Flow					
Element Name	Flow (cfs)	Velocity (fps)	Depth (in)	Velocity (fps)	Depth (in)	Velocity (fps)	Froude Number	Flow Condition	Flow (cfs)	Surcharged Length (ft)	Comment
MH	10.53	5.96	14.72	6.56	14.18	6.79	1.08	Supercritical	10.14	0.00	
CB	10.53	5.96	14.72	6.56	14.18	6.79	1.08	Supercritical	10.14	0.00	

- A Froude number of 0 indicates that pressurized flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

## Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	Peak Flow (cfs)	Cross Section	Rise	Span	Rise	Span	Rise	Span	Area (ft^2)	Comment
MH	10.14	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	
CB	10.14	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.
- Sewer sizes should not decrease downstream.
- All hydraulics were calculated using the 'Used' parameters.

## Grade Line Summary:

Tailwater Elevation (ft): 0.00

		Invert Elev.		Downstream Manhole Losses		HGL		EGL	
Element Name	Downstream (ft)	Upstream (ft)	Bend Loss (ft)	Lateral Loss (ft)	Downstream (ft)	Upstream (ft)	Downstream (ft)	Friction Loss (ft)	Upstream (ft)
MH	93.80	94.30	0.00	0.00	94.98	95.53	95.70	0.50	96.19
CB	94.50	95.00	0.03	0.00	95.68	96.23	96.40	0.50	96.89

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss =  $Bend\ K * V_{fi}^2 / (2 * g)$
- Lateral loss =  $V_{fo}^2 / (2 * g) - Junction\ Loss\ K * V_{fi}^2 / (2 * g)$ .
- Friction loss is always Upstream EGL - Downstream EGL.

## Excavation Estimate:

The trench side slope is 1.0 ft/ft

The minimum trench width is 2.00 ft

					Downstream			Upstream				
Element Name	Length (ft)	Wall (in)	Bedding (in)	Bottom Width (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Volume (cu. yd)	Comment
MH	50.00	2.50	4.00	4.92	0.00	2.37	0.12	10.06	5.82	3.57	42.87	Sewer Too Shallow
CB	50.00	2.50	4.00	4.92	9.66	5.62	3.37	9.50	5.54	3.29	60.89	

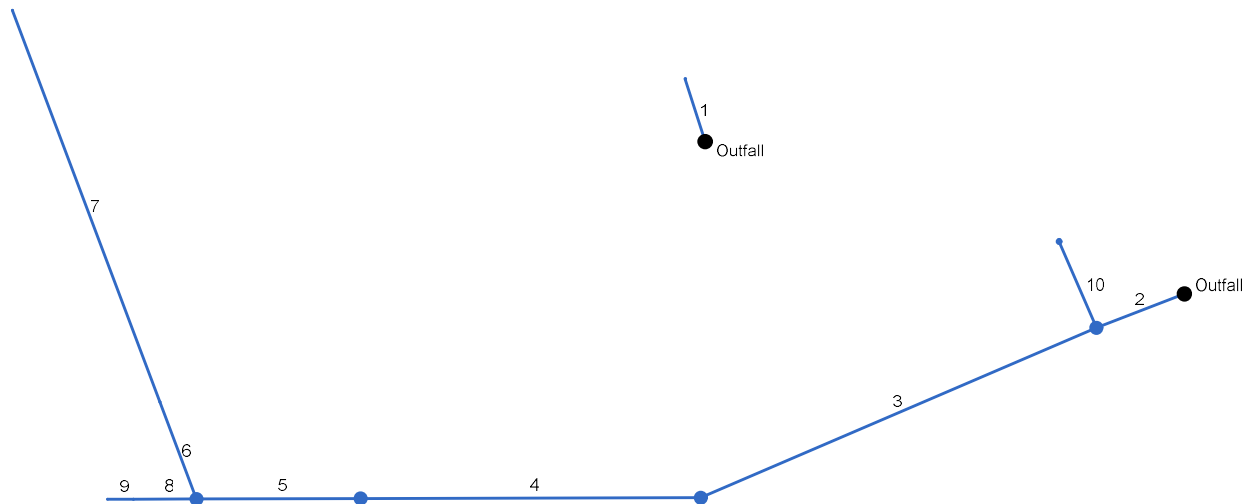
**Total earth volume for sewer trenches** = 104 cubic yards.

- The trench was estimated to have a bottom width equal to the outer pipe diameter plus 36 inches.
- If the calculated width of the trench bottom is less than the minimum acceptable width, the minimum acceptable width was used.
- The sewer wall thickness is equal to: (equivalent diameter in inches/12)+1 inches
- The sewer bedding thickness is equal to:
  - Four inches for pipes less than 33 inches.
  - Six inches for pipes less than 60 inches.
  - Eight inches for all larger sizes.

## STM-1.0-STM-1.2 Summary And Profile



# Hydraflow Storm Sewers Extension for Autodesk® Civil 3D® Plan



# Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	Pipe - (32)	1.36	24	Cir	47.404	5918.92	5919.40	1.013	5919.96	5919.80	n/a	5919.80	End	Manhole
2	Pipe - (30) (1)	30.21	42	Cir	67.409	5900.67	5901.34	0.994	5903.35	5903.04	n/a	5903.04	End	Manhole
3	Pipe - (30)	29.54	42	Cir	307.930	5901.84	5904.92	1.000	5903.14	5906.60	n/a	5906.60	2	Manhole
4	Pipe - (29) (1) (1)	29.95	42	Cir	243.177	5905.22	5907.65	0.999	5906.60	5909.34	n/a	5909.34	3	Manhole
5	Pipe - (29) (1)	30.26	42	Cir	117.273	5907.95	5910.89	2.507	5909.34	5912.59	0.63	5912.59	4	Manhole
6	Pipe - (31)	14.06	42	Cir	74.372	5911.19	5912.40	1.627	5912.59	5913.54	n/a	5913.54 j	5	None
7	Pipe - (57)	15.27	42	Cir	300.052	5912.40	5917.30	1.633	5913.54	5918.49	n/a	5918.49	6	None
8	Pipe - (28)	20.27	36	Cir	45.185	5911.85	5912.10	0.553	5913.19	5913.54	n/a	5913.54	5	None
9	Pipe - (56)	20.33	36	Cir	18.305	5912.10	5912.20	0.547	5913.54	5913.65	0.56	5913.65	8	None
10	Pipe - (46)	2.12	24	Cir	67.377	5902.84	5908.63	8.593	5903.08	5909.14	n/a	5909.14	2	Manhole
Project File: STM1.0 - 5YR.stm									Number of lines: 10			Run Date: 10/10/2022		
NOTES: Return period = 5 Yrs. ; j - Line contains hyd. jump.														

# Storm Sewer Tabulation

Station		Len  (ft)	Drng Area		Rnoff coeff  (C)	Area x C		Tc		Rain (I)  (in/hr)	Total flow  (cfs)	Cap full  (cfs)	Vel  (ft/s)	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line		Incr  (ac)	Total  (ac)		Incr  (min)	Syst  (min)	Size  (in)	Slope  (%)					Dn  (ft)	Up  (ft)	Dn  (ft)	Up  (ft)	Dn  (ft)	Up  (ft)			
1	End	47.404	4.60	4.60	0.10	0.46	0.46	22.6	22.6	3.0	1.36	22.76	1.92	24	1.01	5918.92	5919.40	5919.96	5919.80	5921.30	5921.78	Pipe - (32)
2	End	67.409	0.00	38.00	0.00	0.00	12.12	0.0	29.8	2.5	30.21	100.3	5.18	42	0.99	5900.67	5901.34	5903.35	5903.04	5905.82	5916.27	Pipe - (30) (1)
3	2	307.930	0.80	31.50	0.24	0.19	11.41	23.4	28.1	2.6	29.54	100.6	7.78	42	1.00	5901.84	5904.92	5903.14	5906.60	5916.27	5916.19	Pipe - (30)
4	3	243.177	3.10	30.70	0.18	0.56	11.21	26.8	26.8	2.7	29.95	100.6	7.52	42	1.00	5905.22	5907.65	5906.60	5909.34	5916.19	5915.31	Pipe - (29) (1) (1)
5	4	117.273	0.00	27.60	0.00	0.00	10.66	0.0	24.3	2.8	30.26	159.3	7.52	42	2.51	5907.95	5910.89	5909.34	5912.59	5915.31	5917.97	Pipe - (29) (1)
6	5	74.372	0.00	14.70	0.00	0.00	4.85	0.0	23.5	2.9	14.06	128.3	4.55	42	1.63	5911.19	5912.40	5912.59	5913.54	5917.97	5916.58	Pipe - (31)
7	6	300.052	14.70	14.70	0.33	4.85	4.85	20.3	20.3	3.1	15.27	128.6	5.46	42	1.63	5912.40	5917.30	5913.54	5918.49	5916.58	5929.58	Pipe - (57)
8	5	45.185	0.00	12.90	0.00	0.00	5.81	0.0	16.6	3.5	20.27	49.61	6.34	36	0.55	5911.85	5912.10	5913.19	5913.54	5917.97	5915.71	Pipe - (28)
9	8	18.305	12.90	12.90	0.45	5.81	5.81	16.5	16.5	3.5	20.33	49.32	6.03	36	0.55	5912.10	5912.20	5913.54	5913.65	5915.71	5918.88	Pipe - (56)
10	2	67.377	6.50	6.50	0.11	0.72	0.72	22.6	22.6	3.0	2.12	71.83	6.77	24	8.59	5902.84	5908.63	5903.08	5909.14	5916.27	5914.30	Pipe - (46)
Project File: STM1.0 - 5YR.stm																Number of lines: 10				Run Date: 10/10/2022		
NOTES:Intensity = 503.90 / (Inlet time + 28.20) ^ 1.31; Return period =Yrs. 5 ; c = cir e = ellip b = box																						

# Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev (ft)	HGL elev (ft)	Depth	Area	Vel	Vel head	EGL elev (ft)	Sf		Invert elev (ft)	HGL elev (ft)	Depth	Area	Vel	Vel head	EGL elev (ft)	Sf	Ave Sf	Enrgy loss		
(1)	(in) (2)	(cfs) (3)	(4)	(5)	(ft) (6)	(sqft) (7)	(ft/s) (8)	(ft) (9)	(ft) (10)	(%) (11)	(ft) (12)	(ft) (13)	(ft) (14)	(ft) (15)	(sqft) (16)	(ft/s) (17)	(ft) (18)	(ft) (19)	(%) (20)	(%) (21)	(ft) (22)	(K) (23)	(ft) (24)
1	24	1.36	5918.92	5919.96	1.04	0.45	0.83	0.14	5920.10	0.000	47.404	5919.40	5919.80	0.40**	0.45	3.02	0.14	5919.94	0.000	0.000	n/a	1.00	n/a
2	42	30.21	5900.67	5903.35	2.68	4.62	3.82	0.66	5904.01	0.000	67.409	5901.34	5903.04	1.70**	4.62	6.53	0.66	5903.70	0.000	0.000	n/a	1.00	n/a
3	42	29.54	5901.84	5903.14	1.30*	3.25	9.08	0.65	5903.79	0.000	307.930	5904.92	5906.60	1.68**	4.55	6.49	0.65	5907.25	0.000	0.000	n/a	0.45	n/a
4	42	29.95	5905.22	5906.60	1.38	3.51	8.52	0.66	5907.26	0.000	243.177	5907.65	5909.34	1.69**	4.60	6.51	0.66	5910.00	0.000	0.000	n/a	0.15	n/a
5	42	30.26	5907.95	5909.34	1.39	3.55	8.51	0.66	5910.00	0.000	117.273	5910.89	5912.59	1.70**	4.63	6.54	0.66	5913.25	0.000	0.000	n/a	0.95	0.63
6	42	14.06	5911.19	5912.59	1.40	2.72	3.92	0.42	5913.01	0.000	74.372	5912.40	5913.54 j	1.14**	2.72	5.17	0.42	5913.96	0.000	0.000	n/a	0.15	0.06
7	42	15.27	5912.40	5913.54	1.14	2.72	5.62	0.44	5913.98	0.000	300.052	5917.30	5918.49	1.19**	2.88	5.30	0.44	5918.93	0.000	0.000	n/a	1.00	n/a
8	36	20.27	5911.85	5913.19	1.34*	3.04	6.66	0.56	5913.75	0.000	45.185	5912.10	5913.54	1.44**	3.37	6.02	0.56	5914.11	0.000	0.000	n/a	0.15	n/a
9	36	20.33	5912.10	5913.54	1.44	3.37	6.04	0.56	5914.11	0.000	18.305	5912.20	5913.65	1.45**	3.37	6.03	0.56	5914.21	0.000	0.000	n/a	1.00	0.56
10	24	2.12	5902.84	5903.08	0.24*	0.21	10.15	0.18	5903.26	0.000	67.377	5908.63	5909.14	0.50**	0.62	3.40	0.18	5909.32	0.000	0.000	n/a	1.00	n/a
Project File: STM1.0 - 5YR.stm														Number of lines: 10					Run Date: 10/10/2022				
Notes: * depth assumed; ** Critical depth.; j-Line contains hyd. jump ; c = cir e = ellip b = box																							

## General Procedure:

Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

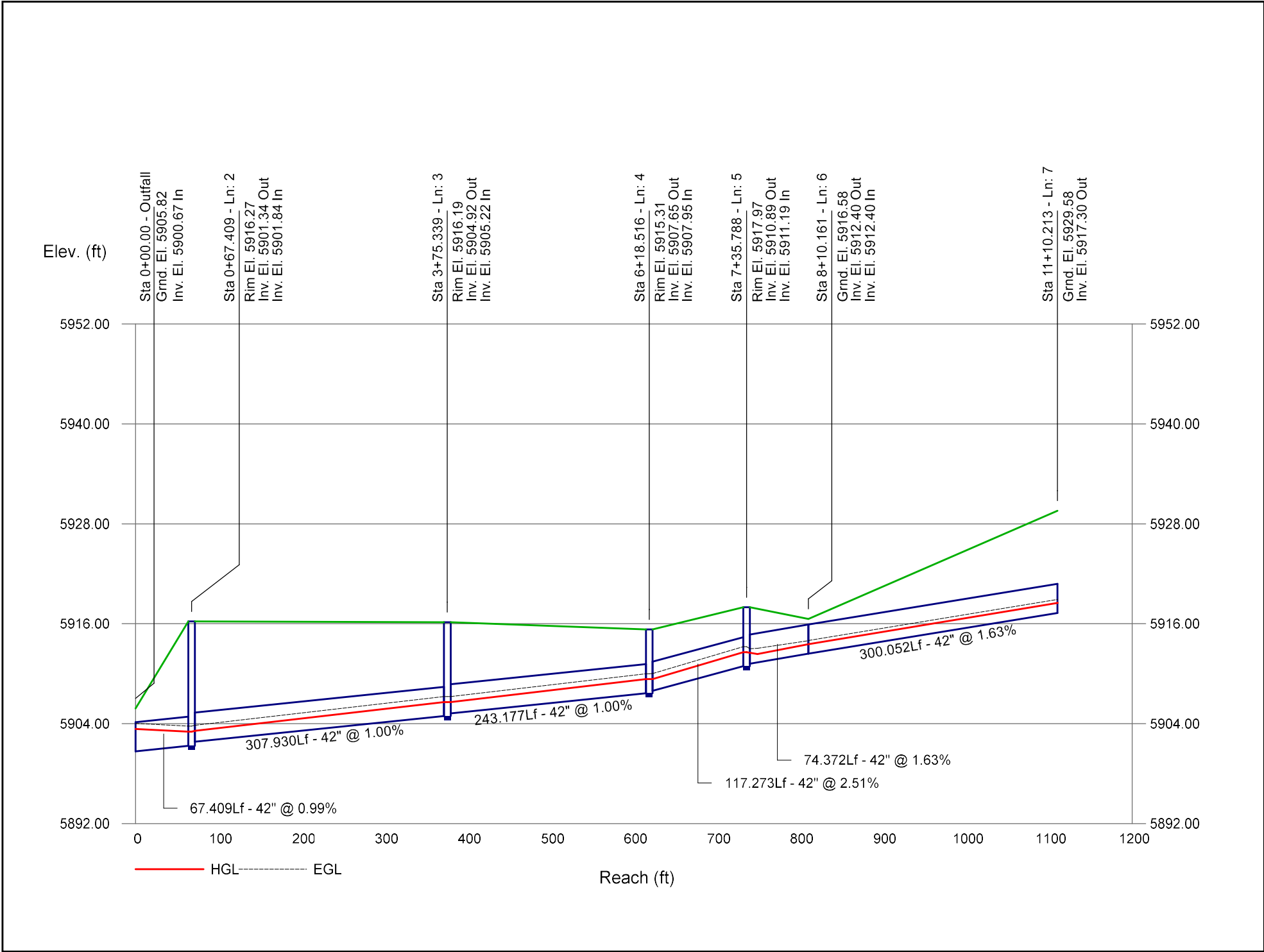
Col. 21 The average of the downstream and upstream friction slopes.

Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

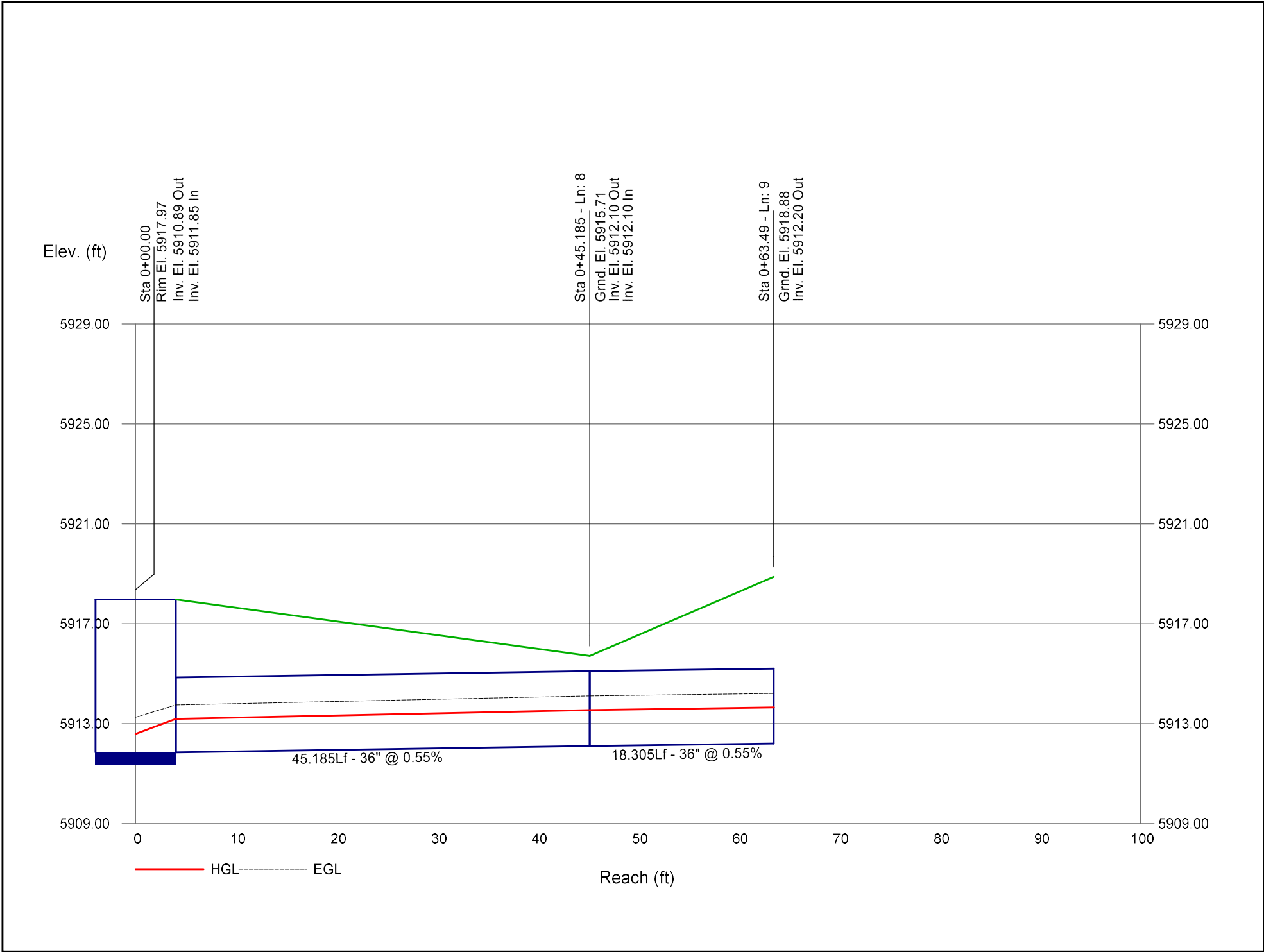
Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

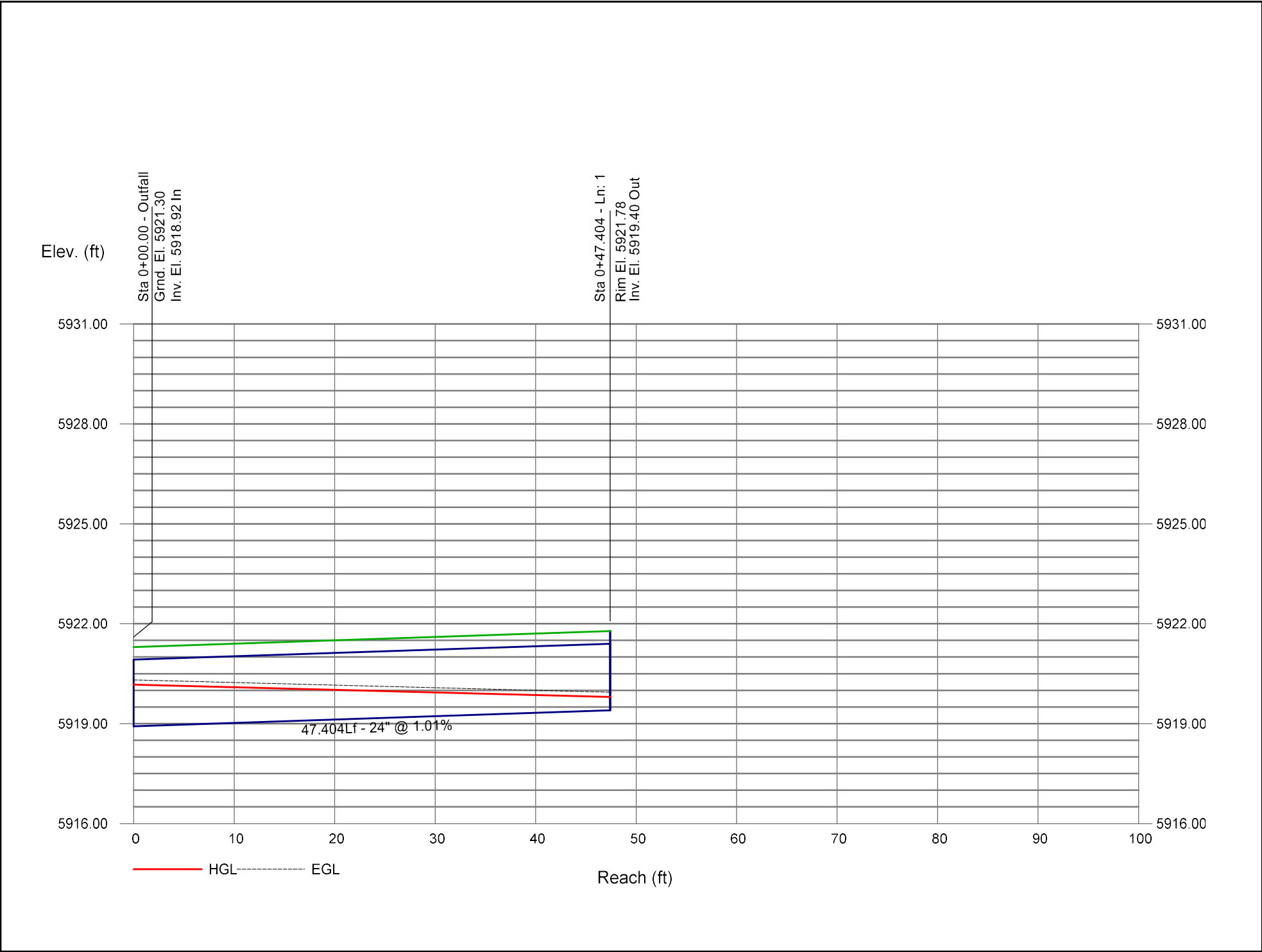
Storm Sewer Profile



Storm Sewer Profile

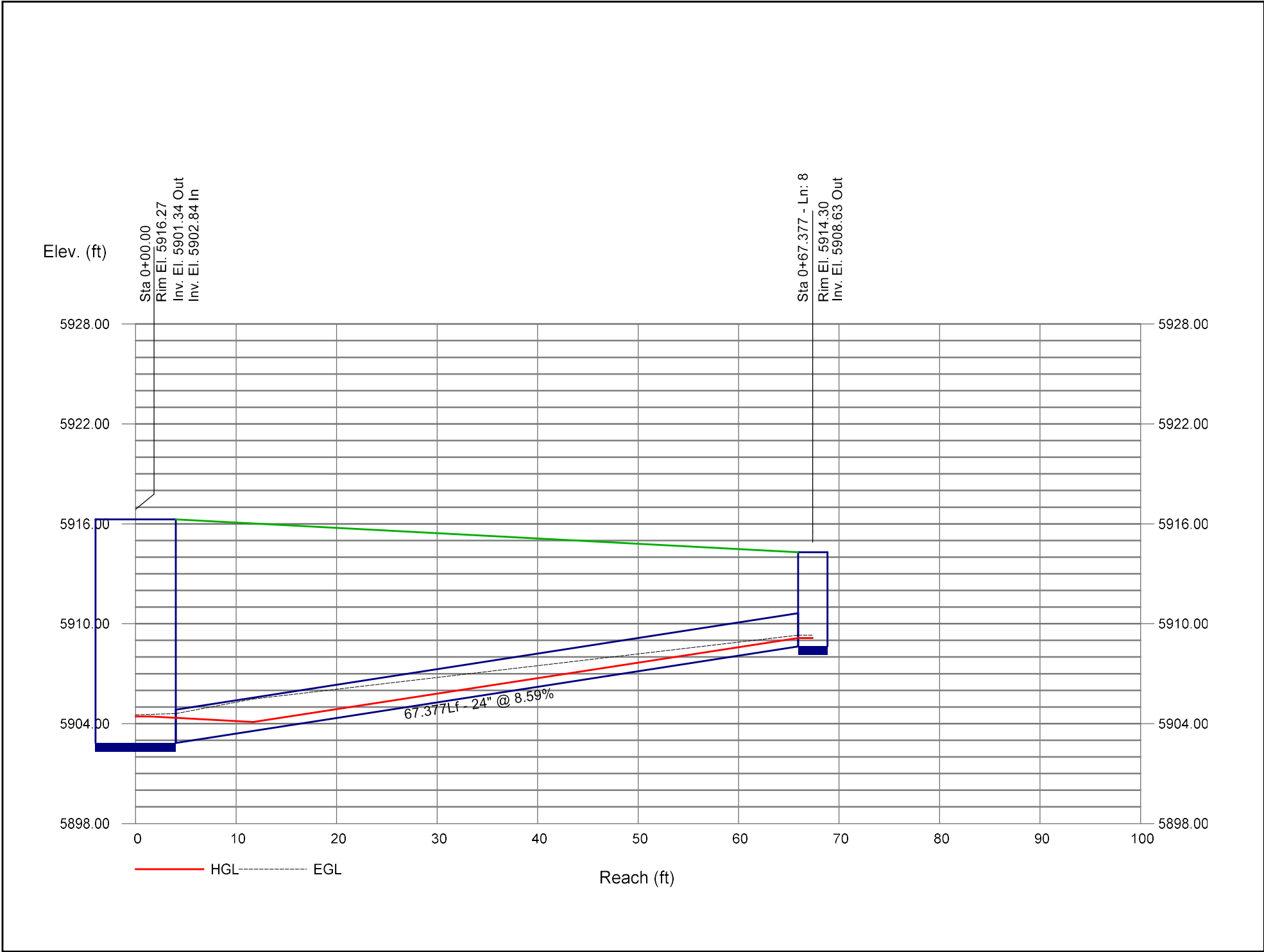


Storm Sewer Profile

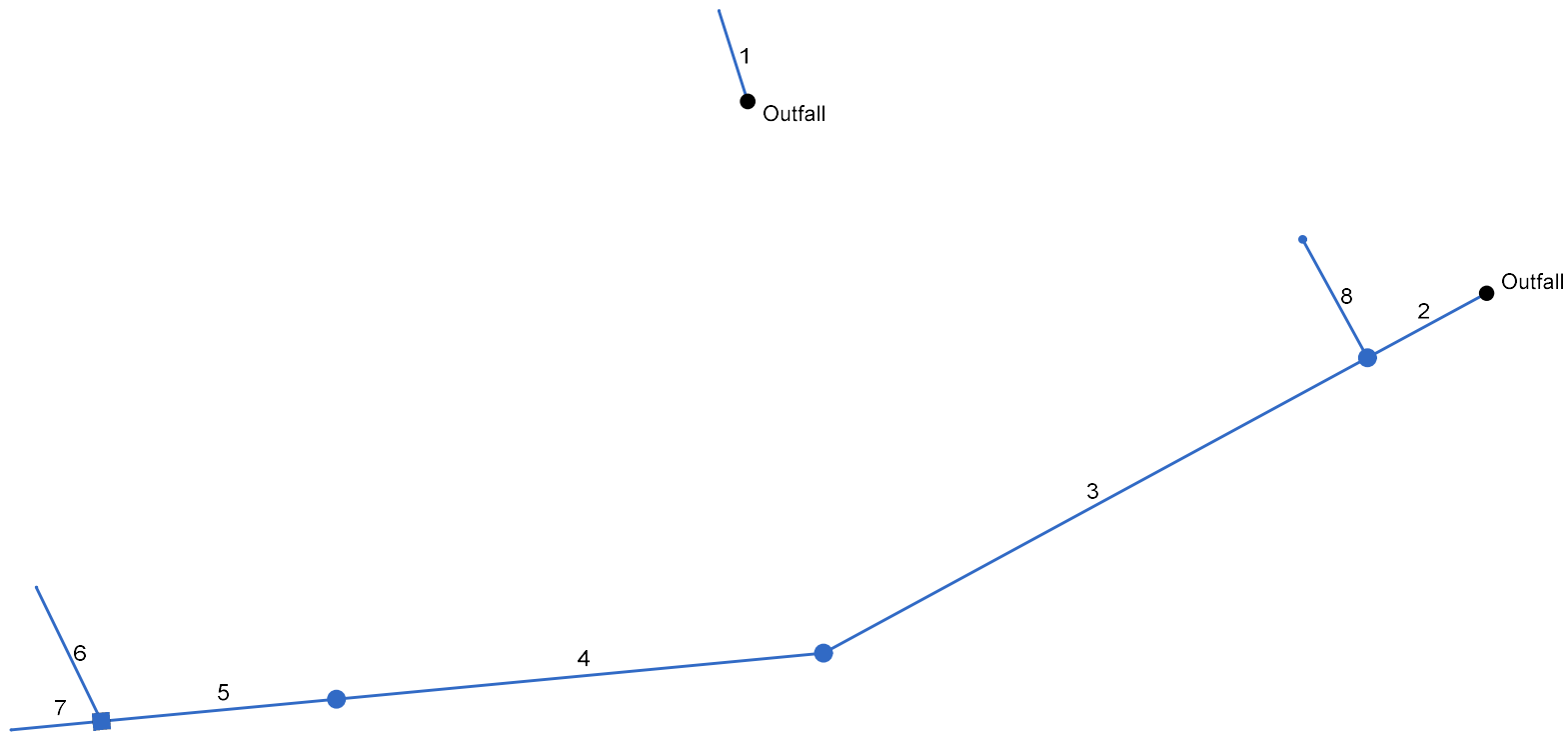




Storm Sewer Profile



# Hydraflow Storm Sewers Extension for Autodesk® Civil 3D® Plan



# Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	Pipe - (32)	8.46	24	Cir	47.404	5918.92	5919.40	1.013	5920.17	5920.44	n/a	5920.44 j	End	Manhole
2	Pipe - (30) (1)	75.73	42	Cir	67.410	5900.67	5901.34	0.994	5904.31	5904.61	1.02	5905.63	End	Manhole
3	Pipe - (30)	66.17	42	Cir	307.930	5901.84	5904.92	1.000	5905.63	5907.47	n/a	5907.47	2	Manhole
4	Pipe - (29) (1) (1)	66.11	42	Cir	243.177	5905.22	5907.65	0.999	5907.47	5910.20	0.18	5910.20	3	Manhole
5	Pipe - (29) (1)	76.01	42	Cir	117.273	5907.95	5910.89	2.507	5910.20	5913.62	1.32	5913.62	4	Manhole
6	Pipe - (31)	42.72	42	Cir	74.372	5911.19	5912.40	1.627	5913.62	5914.43	n/a	5914.43 j	5	None
7	Pipe - (28)	34.89	36	Cir	45.185	5911.85	5912.10	0.553	5913.62	5914.02	n/a	5914.02	5	None
8	Pipe - (46)	12.27	24	Cir	67.377	5902.84	5908.63	8.593	5905.63	5909.89	n/a	5909.89 j	2	Manhole
Project File: STM1.0 - 100YR.stm									Number of lines: 8			Run Date: 10/10/2022		
NOTES: Return period = 100 Yrs. ; j - Line contains hyd. jump.														

# Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line		Incr	Total		Incr	Total	Inlet	Syst					Size	Slope	Dn	Up	Dn	Up	Dn	Up	
		(ft)	(ac)	(ac)	(C)			(min)	(min)	(in/hr)	(cfs)	(cfs)	(ft/s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
1	End	47.404	4.60	4.60	0.37	1.70	1.70	22.6	22.6	5.0	8.46	22.76	4.62	24	1.01	5918.92	5919.40	5920.17	5920.44	5921.30	5921.78	Pipe - (32)
2	End	67.410	0.00	37.67	0.00	0.00	17.45	0.0	28.1	4.3	75.73	100.3	7.98	42	0.99	5900.67	5901.34	5904.31	5904.61	5905.82	5916.27	Pipe - (30) (1)
3	2	307.930	0.47	31.17	0.47	0.22	14.98	16.9	27.4	4.4	66.17	100.6	7.85	42	1.00	5901.84	5904.92	5905.63	5907.47	5916.27	5916.19	Pipe - (30)
4	3	243.177	3.10	30.70	0.43	1.33	14.76	26.8	26.8	4.5	66.11	100.6	9.47	42	1.00	5905.22	5907.65	5907.47	5910.20	5916.19	5915.31	Pipe - (29) (1) (1)
5	4	117.273	0.00	27.60	0.00	0.00	13.43	0.0	17.8	5.7	76.01	159.3	10.55	42	2.51	5907.95	5910.89	5910.20	5913.62	5915.31	5917.97	Pipe - (29) (1)
6	5	74.372	14.40	14.40	0.52	7.49	7.49	17.5	17.5	5.7	42.72	139.0	6.68	42	1.63	5911.19	5912.40	5913.62	5914.43	5917.97	5916.58	Pipe - (31)
7	5	45.185	13.20	13.20	0.45	5.94	5.94	16.5	16.5	5.9	34.89	53.74	7.69	36	0.55	5911.85	5912.10	5913.62	5914.02	5917.97	5915.71	Pipe - (28)
8	2	67.377	6.50	6.50	0.38	2.47	2.47	22.6	22.6	5.0	12.27	66.30	4.90	24	8.59	5902.84	5908.63	5905.63	5909.89	5916.27	5914.30	Pipe - (46)
Project File: STM1.0 - 100YR.stm																Number of lines: 8				Run Date: 10/10/2022		
NOTES:Intensity = 790.75 / (Inlet time + 27.70) ^ 1.29; Return period =Yrs. 100 ; c = cir e = ellip b = box																						

# Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
(1)	(in) (2)	(cfs) (3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(ft) (12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1	24	8.46	5918.92	5920.17	1.25	1.64	4.09	0.41	5920.58	0.000	47.404	5919.40	5920.44 j	1.04**	1.64	5.15	0.41	5920.85	0.000	0.000	n/a	1.00	n/a
2	42	75.73	5900.67	5904.31	3.50	9.62	7.87	0.96	5905.27	0.567	67.410	5901.34	5904.61	3.27	9.35	8.10	1.02	5905.63	0.490	0.528	0.356	1.00	1.02
3	42	66.17	5901.84	5905.63	3.50	7.50	6.88	0.74	5906.37	0.433	307.930	5904.92	5907.47	2.55**	7.50	8.82	1.21	5908.68	0.559	0.496	n/a	0.45	n/a
4	42	66.11	5905.22	5907.47	2.25	6.53	10.13	1.21	5908.68	0.000	243.177	5907.65	5910.20	2.55**	7.50	8.81	1.21	5911.41	0.000	0.000	n/a	0.15	0.18
5	42	76.01	5907.95	5910.20	2.25	6.52	11.65	1.39	5911.59	0.000	117.273	5910.89	5913.62	2.73**	8.04	9.45	1.39	5915.01	0.000	0.000	n/a	0.95	1.32
6	42	42.72	5911.19	5913.62	2.43	5.80	6.00	0.84	5914.46	0.000	74.372	5912.40	5914.43 j	2.03**	5.80	7.37	0.84	5915.28	0.000	0.000	n/a	1.00	n/a
7	36	34.89	5911.85	5913.62	1.77	4.33	8.06	0.83	5914.45	0.000	45.185	5912.10	5914.02	1.92**	4.77	7.31	0.83	5914.85	0.000	0.000	n/a	1.00	n/a
8	24	12.27	5902.84	5905.63	2.00	2.08	3.91	0.24	5905.87	0.295	67.377	5908.63	5909.89 j	1.26**	2.08	5.90	0.54	5910.43	0.566	0.430	n/a	1.00	0.54
Project File: STM1.0 - 100YR.stm														Number of lines: 8					Run Date: 10/10/2022				
Notes: ; ** Critical depth.; j-Line contains hyd. jump ; c = cir e = ellip b = box																							

## General Procedure:

Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

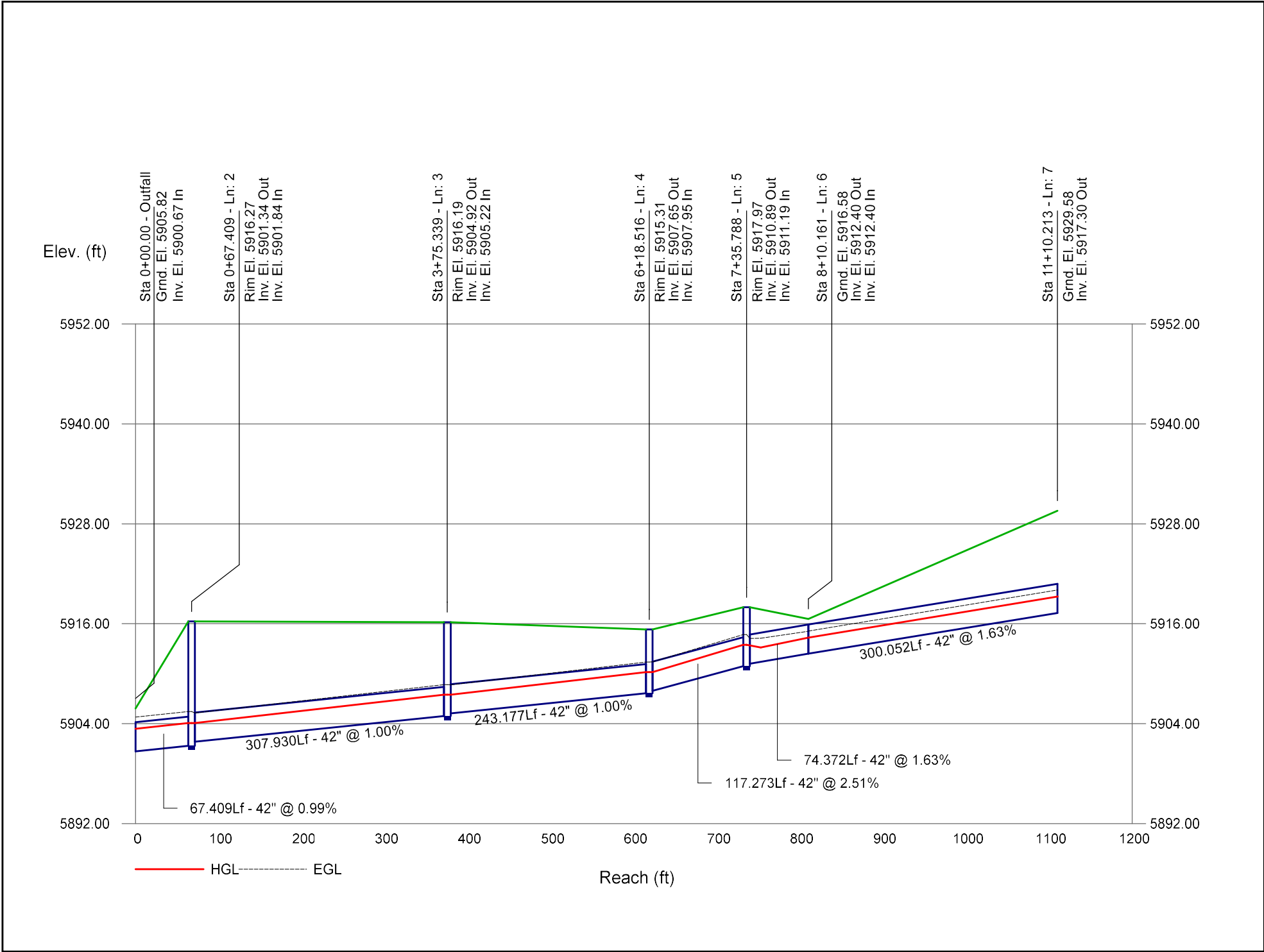
Col. 21 The average of the downstream and upstream friction slopes.

Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

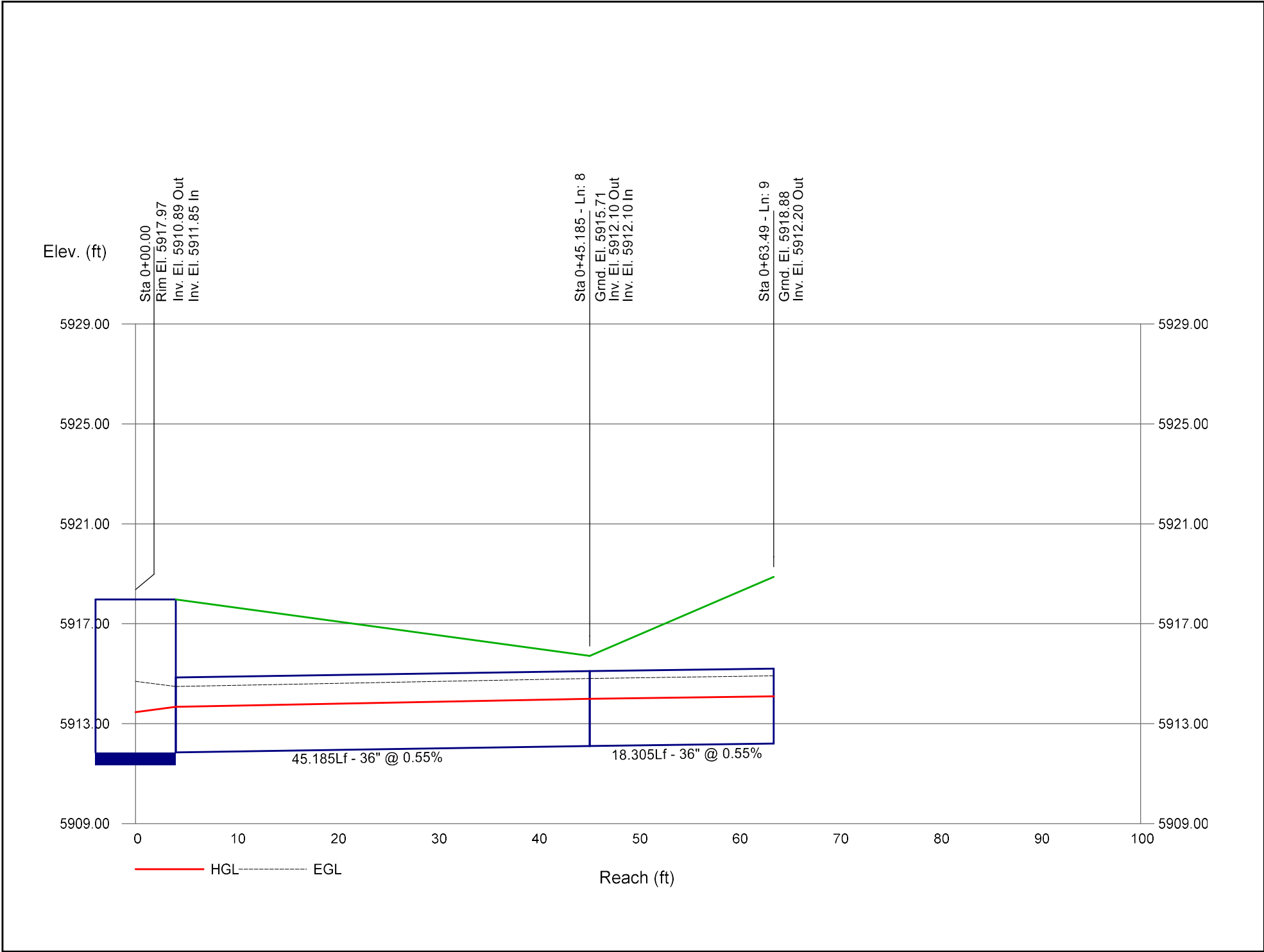
Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

Storm Sewer Profile

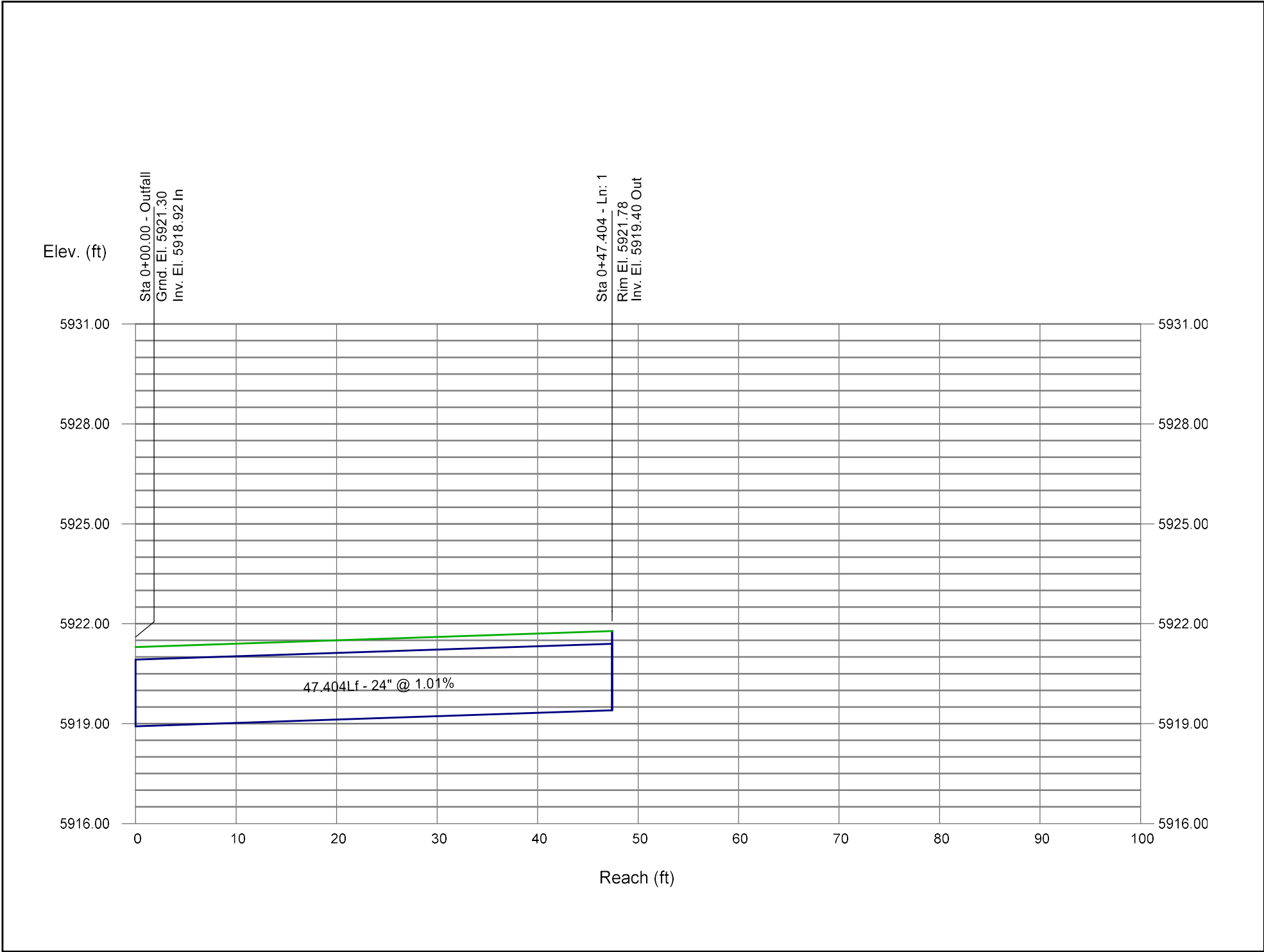


Storm Sewer Profile

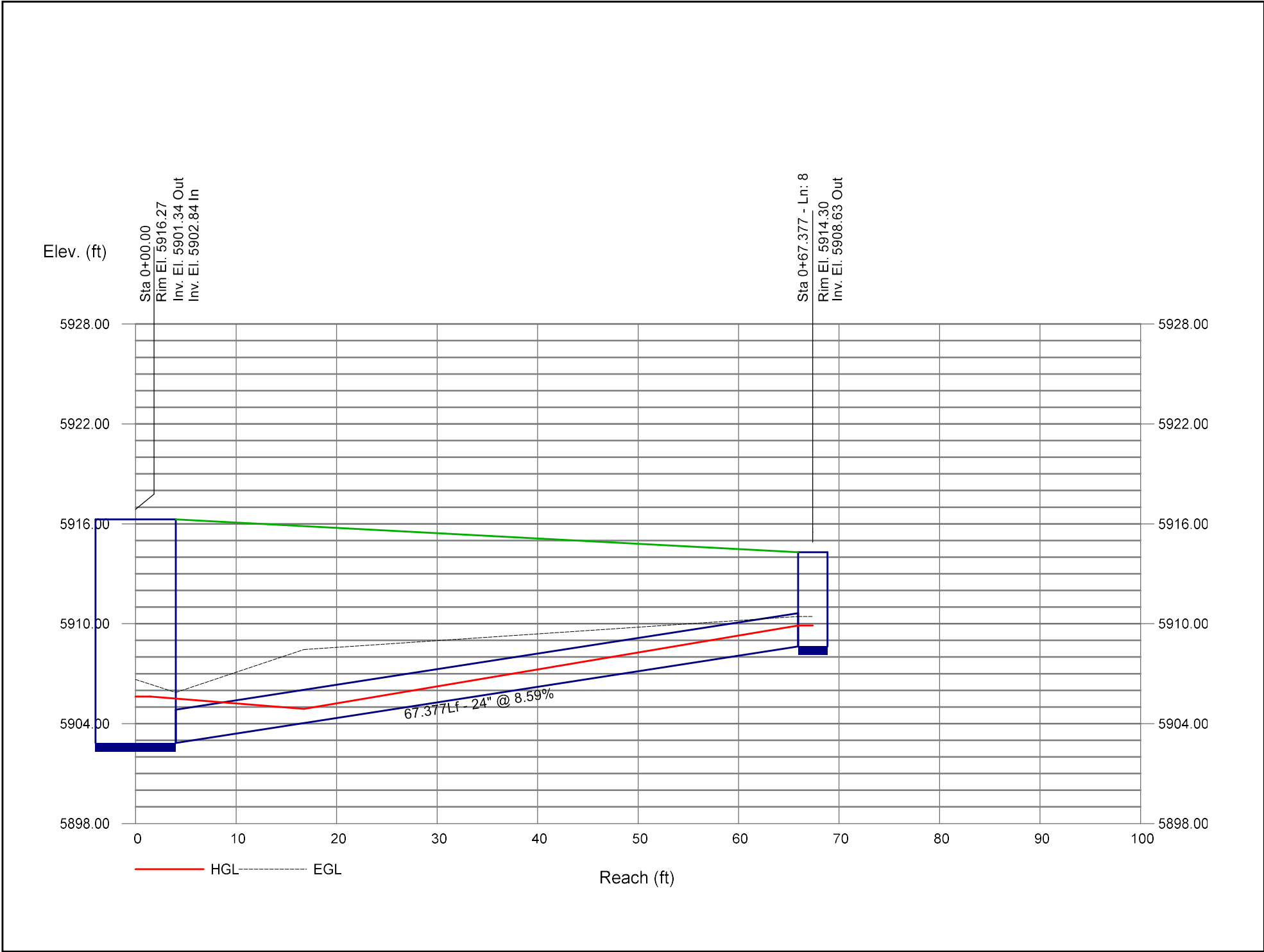




Storm Sewer Profile



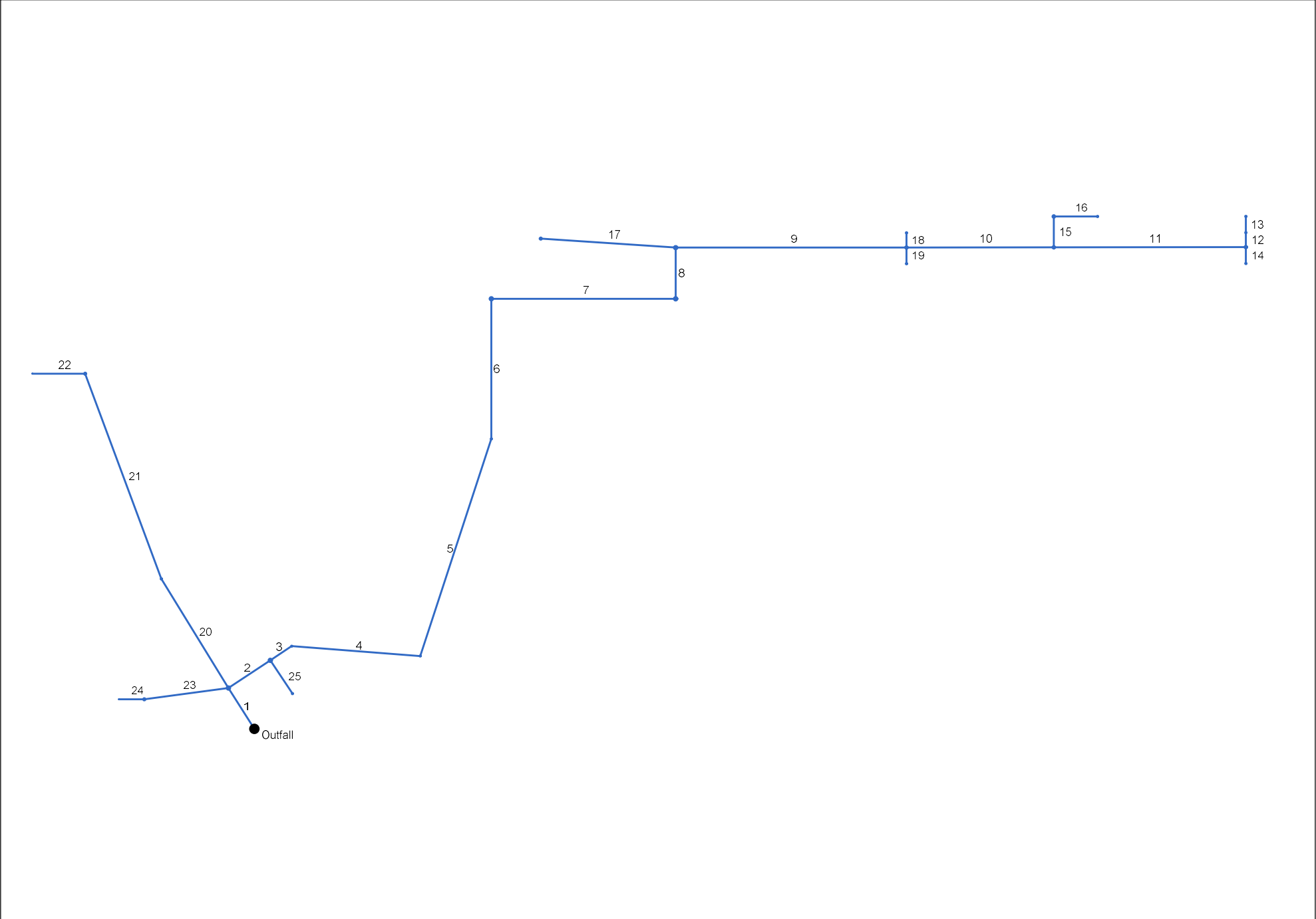
Storm Sewer Profile



# STM-2.0, STM-2.1 & STM-3.0-STM-3.4 Summary And Profile

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# Hydraflow Storm Sewers Extension for Autodesk® Civil 3D® Plan



Project File: STM2.0 & STM3.0 - 5YR.stm	Number of lines: 25	Date: 10/28/2022
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# Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	Pipe - (17) (1)	35.91	48	Cir	114.660	5902.37	5909.25	6.000	5903.23	5911.03	n/a	5911.03	End	Manhole
2	Pipe - (35) (1)	27.79	48	Cir	118.607	5916.15	5917.34	1.003	5917.34	5918.90	0.58	5918.90	1	Manhole
3	Pipe - (35)	27.37	48	Cir	60.761	5917.64	5918.25	1.004	5918.90	5919.80	0.39	5919.80	2	Manhole
4	Pipe - (55)	26.26	48	Cir	304.454	5918.35	5942.40	7.899	5919.80	5943.91	n/a	5943.91	3	Manhole
5	Pipe - (54)	27.52	48	Cir	541.840	5942.70	5960.95	3.368	5943.91	5962.50	0.21	5962.50	4	Manhole
6	Pipe - (53)	28.16	48	Cir	332.408	5961.25	5980.18	5.695	5962.50	5981.75	0.59	5981.75	5	Manhole
7	Pipe - (52)	29.34	48	Cir	435.462	5980.48	5982.66	0.501	5981.95	5984.26	n/a	5984.26	6	Manhole
8	Pipe - (51)	29.69	48	Cir	121.238	5982.96	5983.57	0.503	5984.38	5985.18	n/a	5985.18	7	Manhole
9	Pipe - (50)	23.76	48	Cir	545.335	5983.87	5986.60	0.501	5985.19	5988.04	n/a	5988.04	8	Manhole
10	Pipe - (49)	21.04	48	Cir	348.174	5986.90	5993.49	1.893	5988.04	5994.84	0.50	5994.84	9	Manhole
11	Pipe - (48)	5.25	30	Cir	453.666	5994.99	6007.77	2.817	5995.46	6008.53	n/a	6008.53	10	Manhole
12	Pipe - (61)	3.55	24	Cir	34.551	6008.27	6008.62	1.013	6008.81	6009.28	0.04	6009.28	11	Manhole
13	Pipe - (68)	1.75	24	Cir	38.500	6008.92	6009.30	0.987	6009.30	6009.76	n/a	6009.76	12	Manhole
14	Pipe - (62)	4.06	18	Cir	38.449	6008.77	6010.46	4.395	6009.21	6011.23	0.31	6011.23	11	Manhole
15	Pipe - (60)	16.67	48	Cir	73.054	5993.79	5994.52	0.999	5994.84	5995.72	0.43	5995.72	10	Manhole
16	Pipe - (70)	4.84	24	Cir	103.148	5996.52	5999.97	3.345	5996.98	6000.74	n/a	6000.74	15	Manhole
17	Pipe - (69)	25.59	36	Cir	319.210	5992.28	5996.11	1.200	5993.51	5997.74	0.66	5997.74	8	Manhole
18	Pipe - (58)	5.61	30	Cir	34.551	5988.10	5988.80	2.025	5988.62	5989.58	n/a	5989.58	9	Manhole
19	Pipe - (59)	5.38	24	Cir	38.449	5988.80	5990.27	3.824	5989.27	5991.09	0.31	5991.09	9	Manhole
20	Pipe - (42)	8.94	24	Cir	303.547	5918.15	5935.25	5.633	5918.70	5936.32	n/a	5936.32	1	Manhole
21	Pipe - (41)	13.46	24	Cir	518.760	5935.45	5959.05	4.549	5936.32	5960.37	n/a	5960.37	20	Manhole
22	Pipe - (40)	13.70	24	Cir	125.000	5959.25	5971.75	10.000	5960.37	5973.08	n/a	5973.08	21	None
23	Pipe - (17)	15.84	30	Cir	200.580	5917.65	5930.10	6.205	5918.32	5931.44	0.09	5931.44	1	Manhole
24	Pipe - (23)	16.03	30	Cir	60.000	5937.70	5940.80	5.166	5938.37	5942.15	n/a	5942.15	23	None

Project File: STM2.0 & STM3.0 - 5YR.stm

Number of lines: 25

Run Date: 10/28/2022

NOTES: Return period = 5 Yrs.

# Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
25	Pipe - (63)	2.06	18	Cir	94.812	5920.34	5923.66	3.502	5920.66	5924.20	0.20	5924.20	2	Manhole
Project File: STM2.0 & STM3.0 - 5YR.stm									Number of lines: 25			Run Date: 10/28/2022		
NOTES: Return period = 5 Yrs.														

# Storm Sewer Inlet Time Tabulation

Line No.	Line ID	Tc Method	Sheet Flow					Shallow Concentrated Flow					Channel Flow							Total
			n-Value	flow Length (ft)	2-yr 24h P (in)	Land Slope (%)	Travel Time (min)	flow Length (ft)	Water Slope (%)	Surf Descr	Ave Vel (ft/s)	Travel Time (min)	X-sec Area (sqft)	Wetted Perim (ft)	Chan Slope (%)	n-Value	Vel	flow Length (ft)	Travel Time (min)	Travel Time (min)
1	Pipe - (17) (1)	User																		0.00
2	Pipe - (35) (1)	User																		0.00
3	Pipe - (35)	User																		24.70
4	Pipe - (55)	User																		17.50
5	Pipe - (54)	User																		15.20
6	Pipe - (53)	User																		0.00
7	Pipe - (52)	User																		0.00
8	Pipe - (51)	User																		0.00
9	Pipe - (50)	User																		0.00
10	Pipe - (49)	User																		0.00
11	Pipe - (48)	User																		0.00
12	Pipe - (61)	User																		10.90
13	Pipe - (68)	User																		45.20
14	Pipe - (62)	User																		10.90
15	Pipe - (60)	User																		7.00
16	Pipe - (70)	User																		51.50
17	Pipe - (69)	User																		7.00
18	Pipe - (58)	User																		9.80
19	Pipe - (59)	User																		9.80
20	Pipe - (42)	User																		32.80
21	Pipe - (41)	User																		0.00
22	Pipe - (40)	User																		7.00
23	Pipe - (17)	User																		0.00
24	Pipe - (23)	User																		7.00
Project File: STM2.0 & STM3.0 - 5YR.stm					Min. Tc used for intensity calculations = 5 min							Number of lines: 25				Date: 10/28/2022				

# Storm Sewer Inlet Time Tabulation

Line No.	Line ID	Tc Method	Sheet Flow					Shallow Concentrated Flow					Channel Flow								Total Travel Time (min)
			n-Value	flow Length (ft)	2-yr 24h P (in)	Land Slope (%)	Travel Time (min)	flow Length (ft)	Water Slope (%)	Surf Descr	Ave Vel (ft/s)	Travel Time (min)	X-sec Area (sqft)	Wetted Perim (ft)	Chan Slope (%)	n-Value	Vel	flow Length (ft)	Travel Time (min)		
25	Pipe - (63)	User																		10.00	
Project File: STM2.0 & STM3.0 - 5YR.stm					Min. Tc used for intensity calculations = 5 min					Number of lines: 25					Date: 10/28/2022						



# Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
	(in)	(cfs)									(ft)											(K)	(ft)
1	48	35.91	5902.37	5903.23	0.86	2.00	17.99	0.68	5903.92	0.000	114.66	5909.25	5911.03	1.78**	5.42	6.63	0.68	5911.72	0.000	0.000	n/a	1.00	n/a
2	48	27.79	5916.15	5917.34	1.19*	3.14	8.84	0.58	5917.93	0.000	118.60	5917.34	5918.90	1.56**	4.54	6.12	0.58	5919.48	0.000	0.000	n/a	1.00	0.58
3	48	27.37	5917.64	5918.90	1.26	3.39	8.07	0.58	5919.48	0.000	60.76	5918.25	5919.80	1.55**	4.49	6.10	0.58	5920.38	0.000	0.000	n/a	0.67	0.39
4	48	26.26	5918.35	5919.80	1.45	4.10	6.40	0.56	5920.36	0.000	304.45	5942.40	5943.91	1.51**	4.36	6.02	0.56	5944.48	0.000	0.000	n/a	0.98	n/a
5	48	27.52	5942.70	5943.91	1.21	3.22	8.54	0.58	5944.49	0.000	541.84	5960.95	5962.50	1.55**	4.51	6.11	0.58	5963.08	0.000	0.000	n/a	0.36	0.21
6	48	28.16	5961.25	5962.50	1.25	3.36	8.37	0.59	5963.09	0.000	332.40	5980.18	5981.75	1.57**	4.58	6.15	0.59	5982.34	0.000	0.000	n/a	1.00	0.59
7	48	29.34	5980.48	5981.95	1.47*	4.19	7.00	0.60	5982.56	0.000	435.46	5982.66	5984.26	1.60**	4.71	6.23	0.60	5984.87	0.000	0.000	n/a	1.00	n/a
8	48	29.69	5982.96	5984.38	1.42*	3.99	7.44	0.61	5984.99	0.000	121.23	5983.57	5985.18	1.61**	4.75	6.25	0.61	5985.79	0.000	0.000	n/a	1.00	n/a
9	48	23.76	5983.87	5985.19	1.32*	3.60	6.60	0.53	5985.72	0.000	545.33	5986.60	5988.04	1.44**	4.07	5.85	0.53	5988.57	0.000	0.000	n/a	1.00	n/a
10	48	21.04	5986.90	5988.04	1.14	2.95	7.14	0.50	5988.53	0.000	348.17	5993.49	5994.84	1.35**	3.73	5.64	0.50	5995.34	0.000	0.000	n/a	1.00	0.50
11	30	5.25	5994.99	5995.46	0.47*	0.64	8.26	0.27	5995.73	0.000	453.66	6007.77	6008.53	0.76**	1.25	4.20	0.27	6008.80	0.000	0.000	n/a	1.00	n/a
12	24	3.55	6008.27	6008.81	0.53*	0.67	5.26	0.24	6009.05	0.000	34.55	6008.62	6009.28	0.66**	0.90	3.94	0.24	6009.52	0.000	0.000	n/a	0.15	0.04
13	24	1.75	6008.92	6009.30	0.38*	0.41	4.24	0.16	6009.46	0.000	38.50	6009.30	6009.76	0.46**	0.54	3.22	0.16	6009.92	0.000	0.000	n/a	1.00	n/a
14	18	4.06	6008.77	6009.21	0.44*	0.43	9.50	0.31	6009.51	0.000	38.44	6010.46	6011.23	0.77**	0.91	4.44	0.31	6011.54	0.000	0.000	n/a	1.00	0.31
15	48	16.67	5993.79	5994.84	1.05	2.63	6.34	0.43	5995.27	0.000	73.05	5994.52	5995.72	1.20**	3.16	5.28	0.43	5996.15	0.000	0.000	n/a	1.00	0.43
16	24	4.84	5996.52	5996.98	0.46*	0.55	8.80	0.29	5997.27	0.000	103.14	5999.97	6000.74	0.77**	1.12	4.31	0.29	6001.03	0.000	0.000	n/a	1.00	n/a
17	36	25.59	5992.28	5993.51	1.23*	2.72	9.42	0.66	5994.17	0.000	319.21	5996.11	5997.74	1.63**	3.93	6.51	0.66	5998.40	0.000	0.000	n/a	1.00	0.66
18	30	5.61	5988.10	5988.62	0.52*	0.75	7.51	0.28	5988.91	0.000	34.55	5988.80	5989.58	0.78**	1.31	4.28	0.28	5989.87	0.000	0.000	n/a	1.00	n/a
19	24	5.38	5988.80	5989.27	0.47*	0.56	9.52	0.31	5989.58	0.000	38.44	5990.27	5991.09	0.82**	1.21	4.45	0.31	5991.40	0.000	0.000	n/a	1.00	0.31
20	24	8.94	5918.15	5918.70	0.55*	0.71	12.66	0.43	5919.13	0.000	303.54	5935.25	5936.32	1.07**	1.70	5.25	0.43	5936.74	0.000	0.000	n/a	0.23	n/a
21	24	13.46	5935.45	5936.32	0.87	1.30	10.33	0.58	5936.90	0.000	518.76	5959.05	5960.37	1.32**	2.20	6.12	0.58	5960.95	0.000	0.000	n/a	0.95	n/a
22	24	13.70	5959.25	5960.37	1.12	1.81	7.57	0.59	5960.96	0.000	125.00	5971.75	5973.08	1.33**	2.22	6.17	0.59	5973.67	0.000	0.000	n/a	1.00	n/a

Project File: STM2.0 & STM3.0 - 5YR.stm

Number of lines: 25

Run Date: 10/28/2022

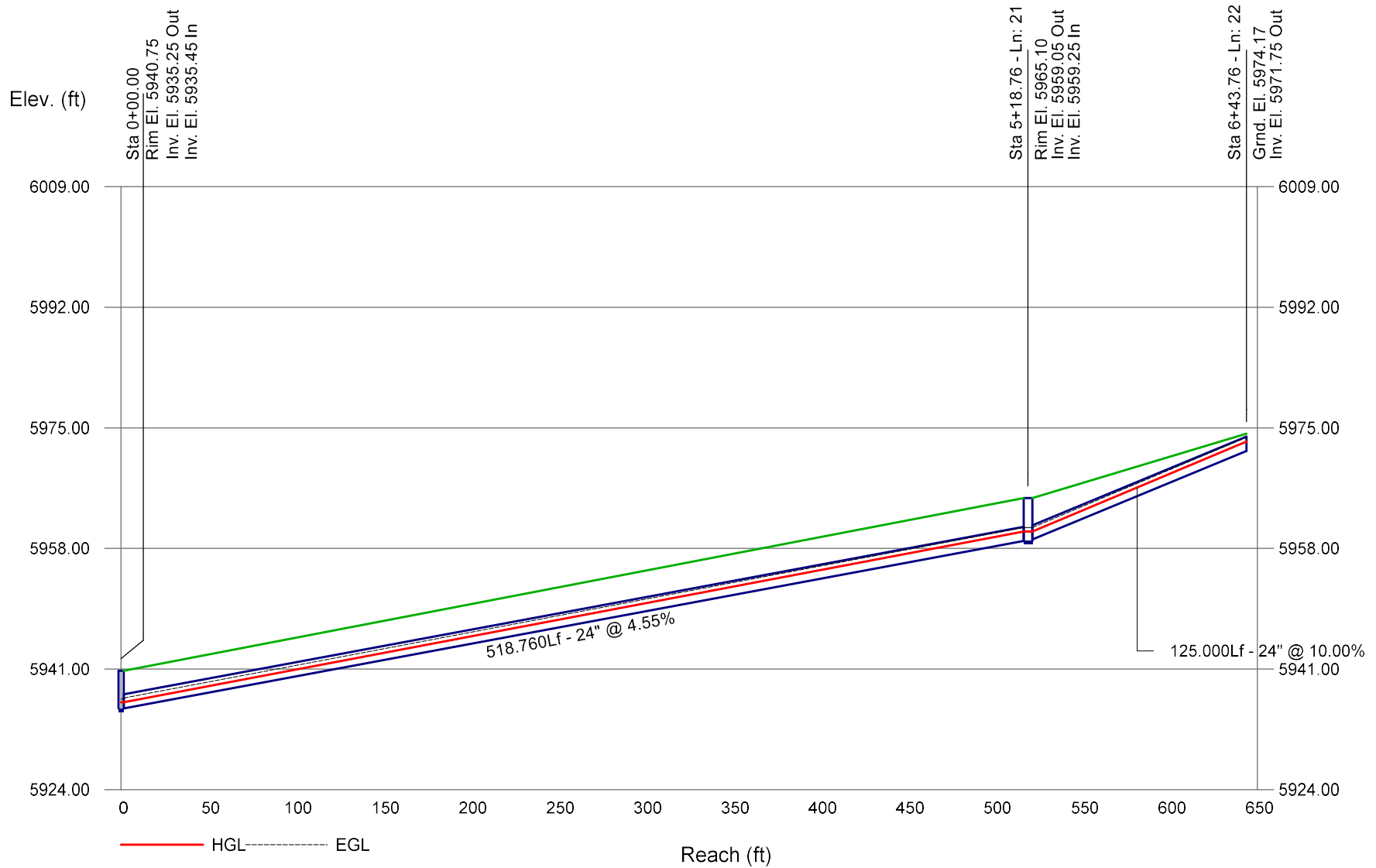
Notes: \* depth assumed; \*\* Critical depth. ; c = cir e = ellip b = box

# Hydraulic Grade Line Computations

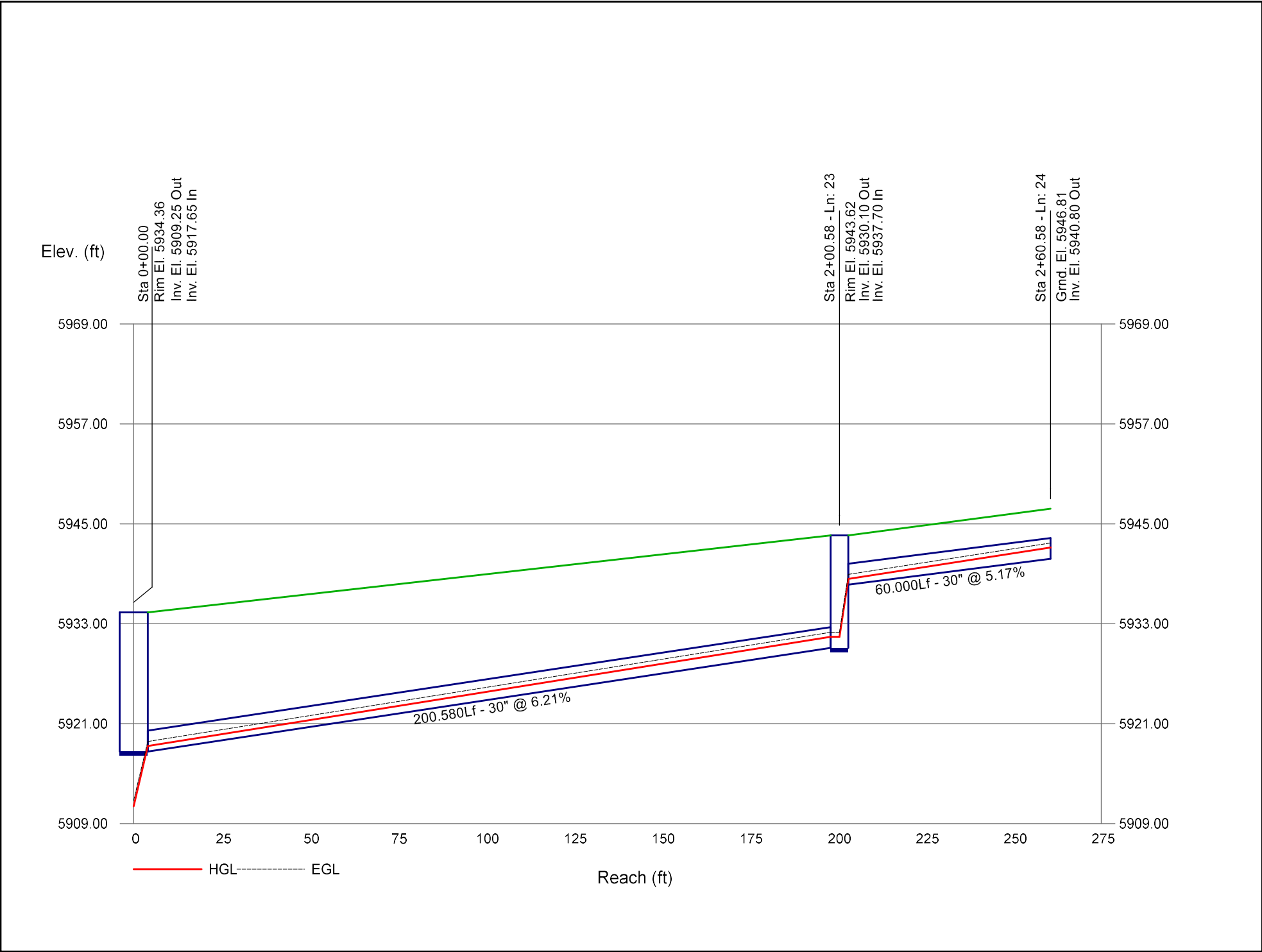
Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
(in)	(cfs)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(K)	(ft)	
23	30	15.84	5917.65	5918.32	0.67*	1.05	15.10	0.54	5918.86	0.000	200.58	5930.10	5931.44	1.34**	2.69	5.90	0.54	5931.98	0.000	0.000	n/a	0.17	0.09
24	30	16.03	5937.70	5938.37	0.67*	1.07	15.04	0.55	5938.92	0.000	60.000	5940.80	5942.15	1.35**	2.71	5.92	0.55	5942.70	0.000	0.000	n/a	1.00	n/a
25	18	2.06	5920.34	5920.66	0.32*	0.27	7.64	0.20	5920.86	0.000	94.812	5923.66	5924.20	0.54**	0.58	3.59	0.20	5924.40	0.000	0.000	n/a	1.00	0.20

# Storm Sewer Profile

Proj. file: STM2.0 & STM3.0 - 5YR.stm

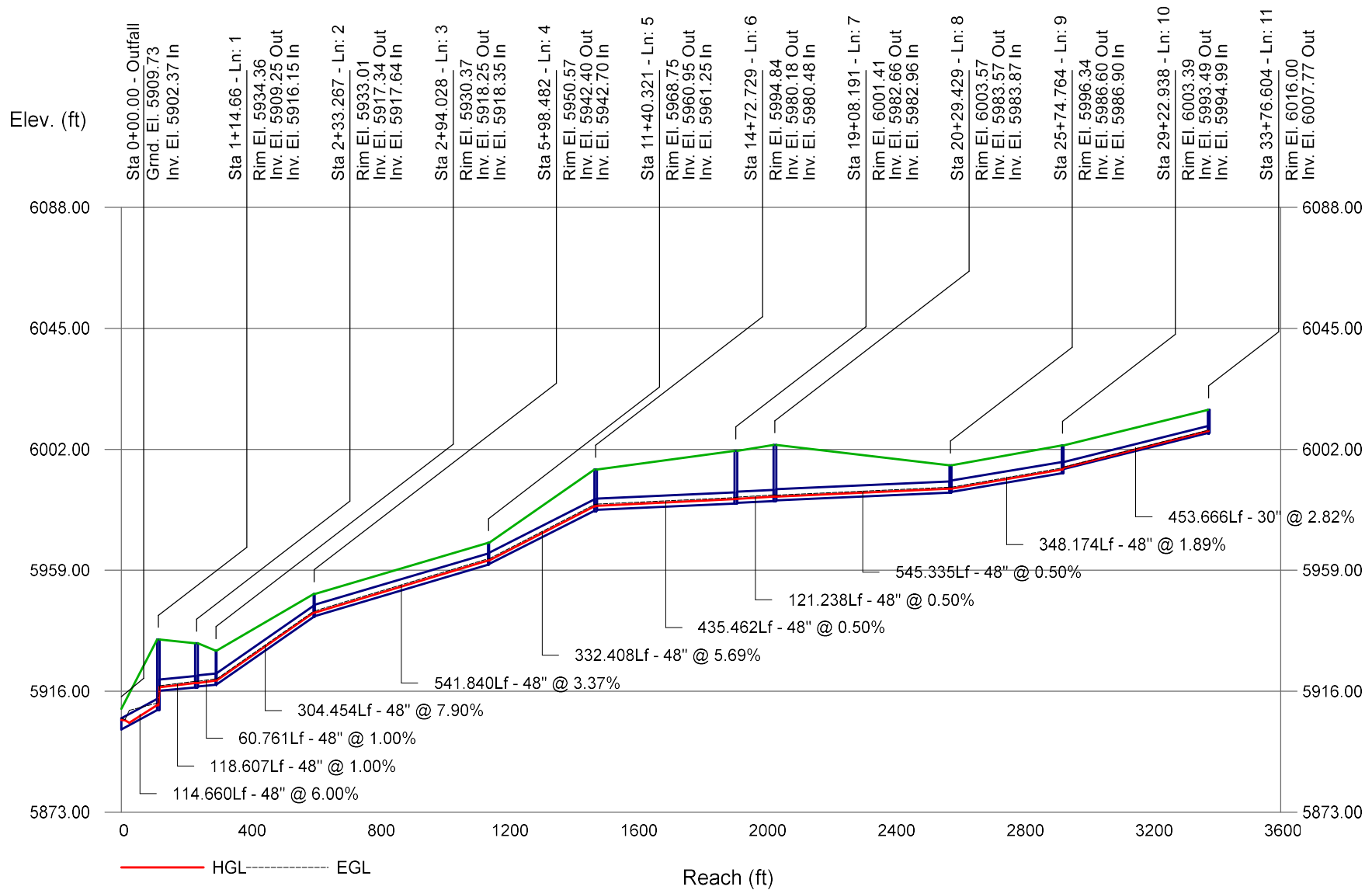


Storm Sewer Profile

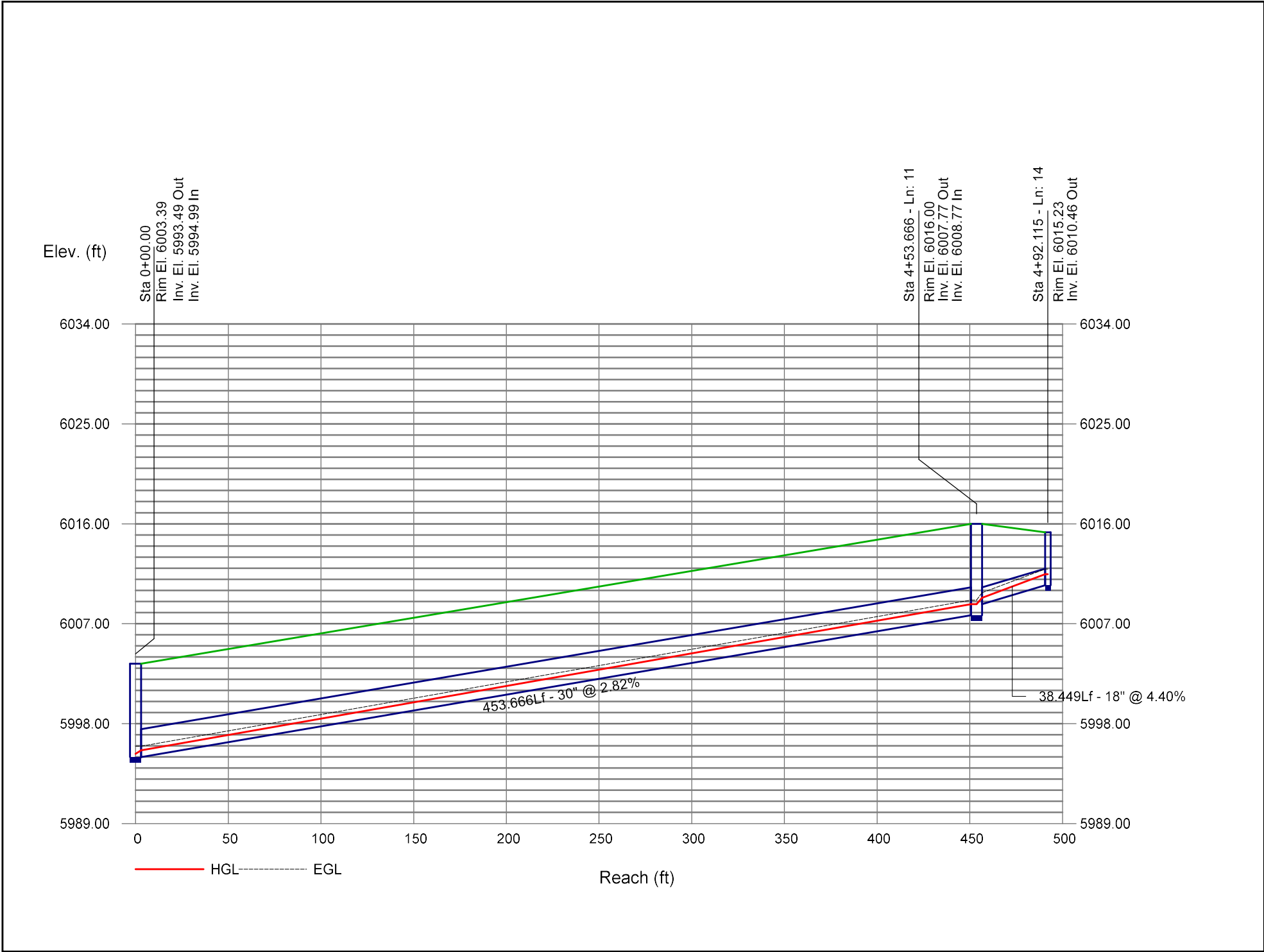


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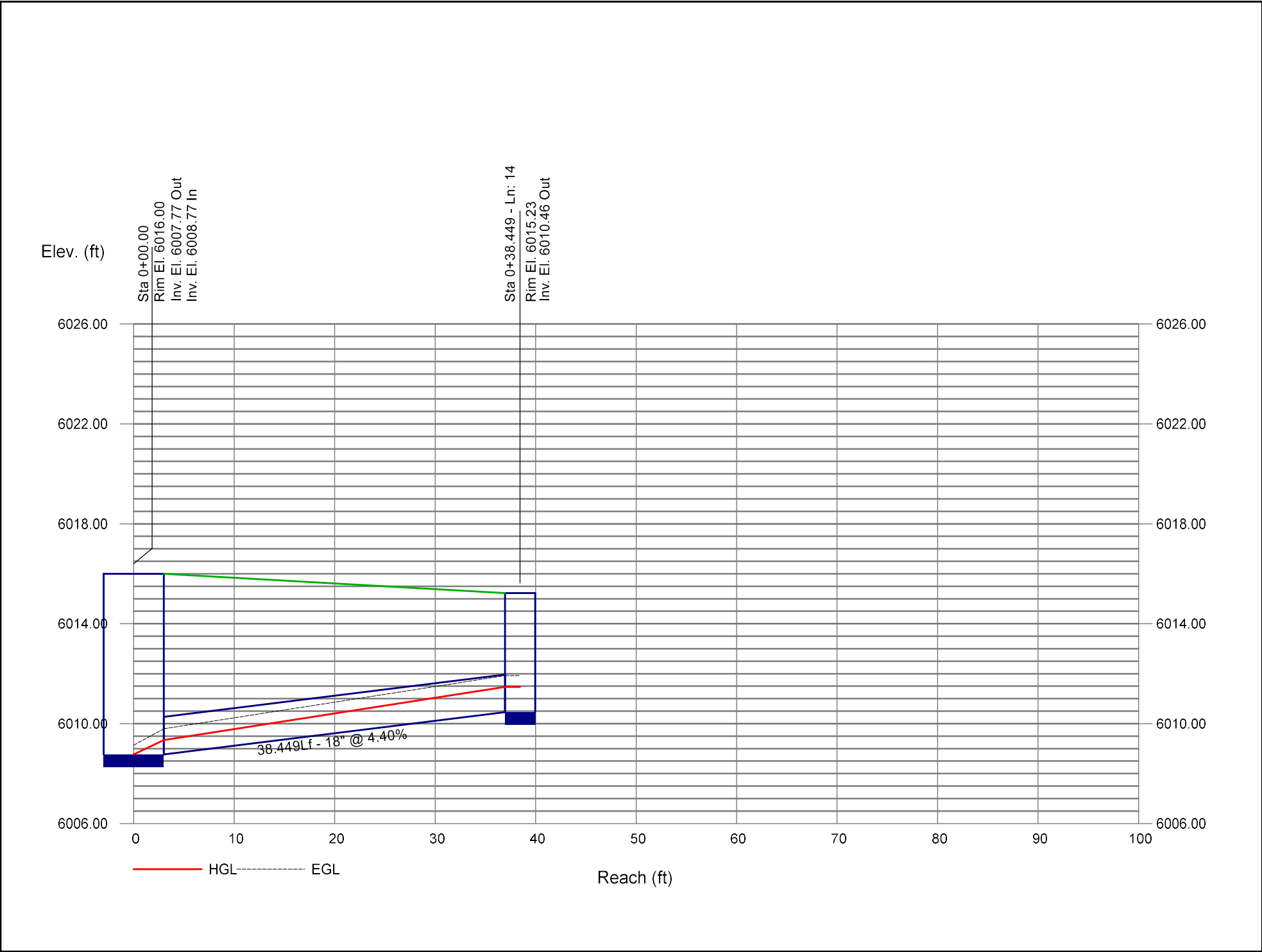
Proj. file: STM2.0 & STM3.0 - 5YR.stm



Storm Sewer Profile

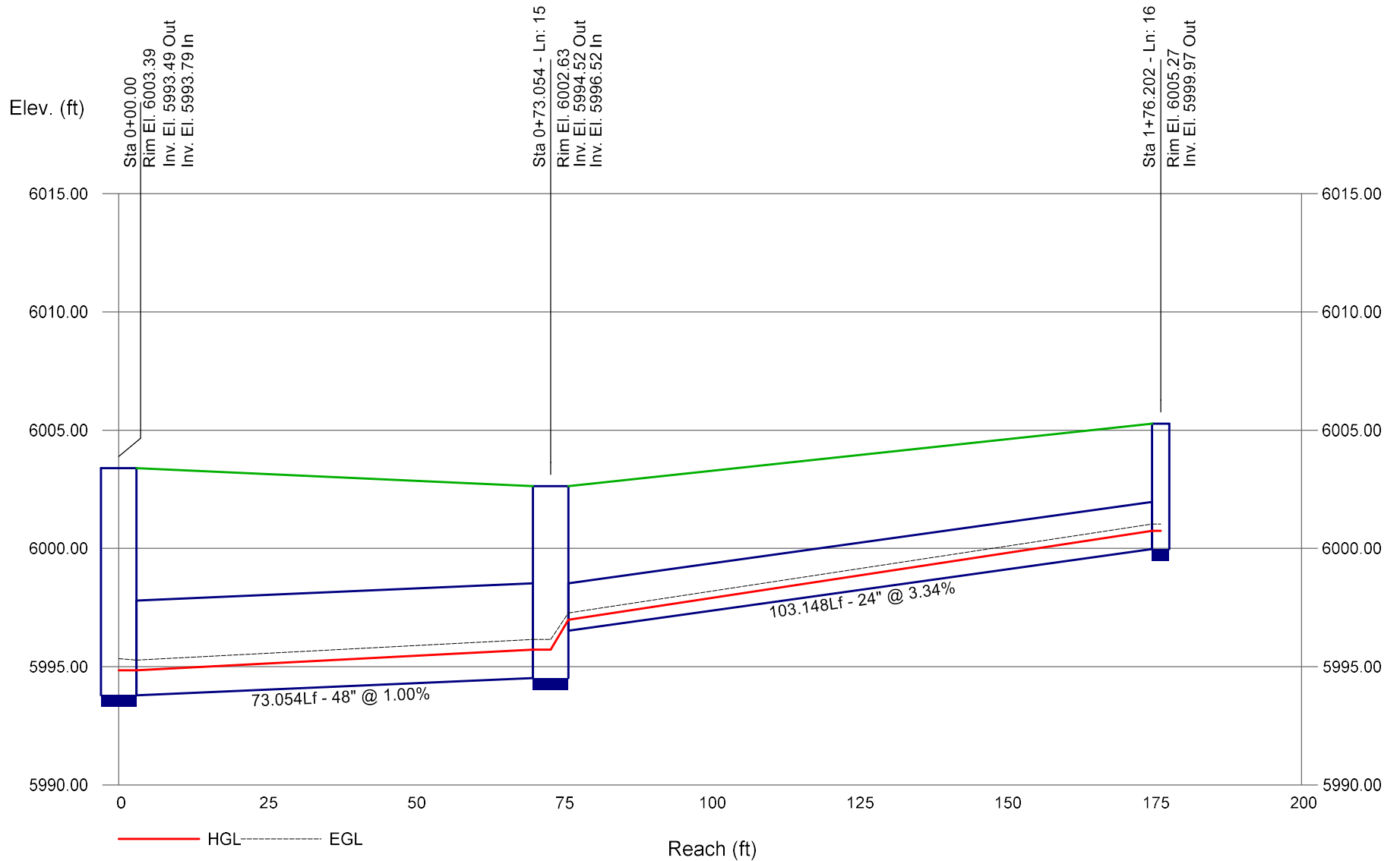


Storm Sewer Profile



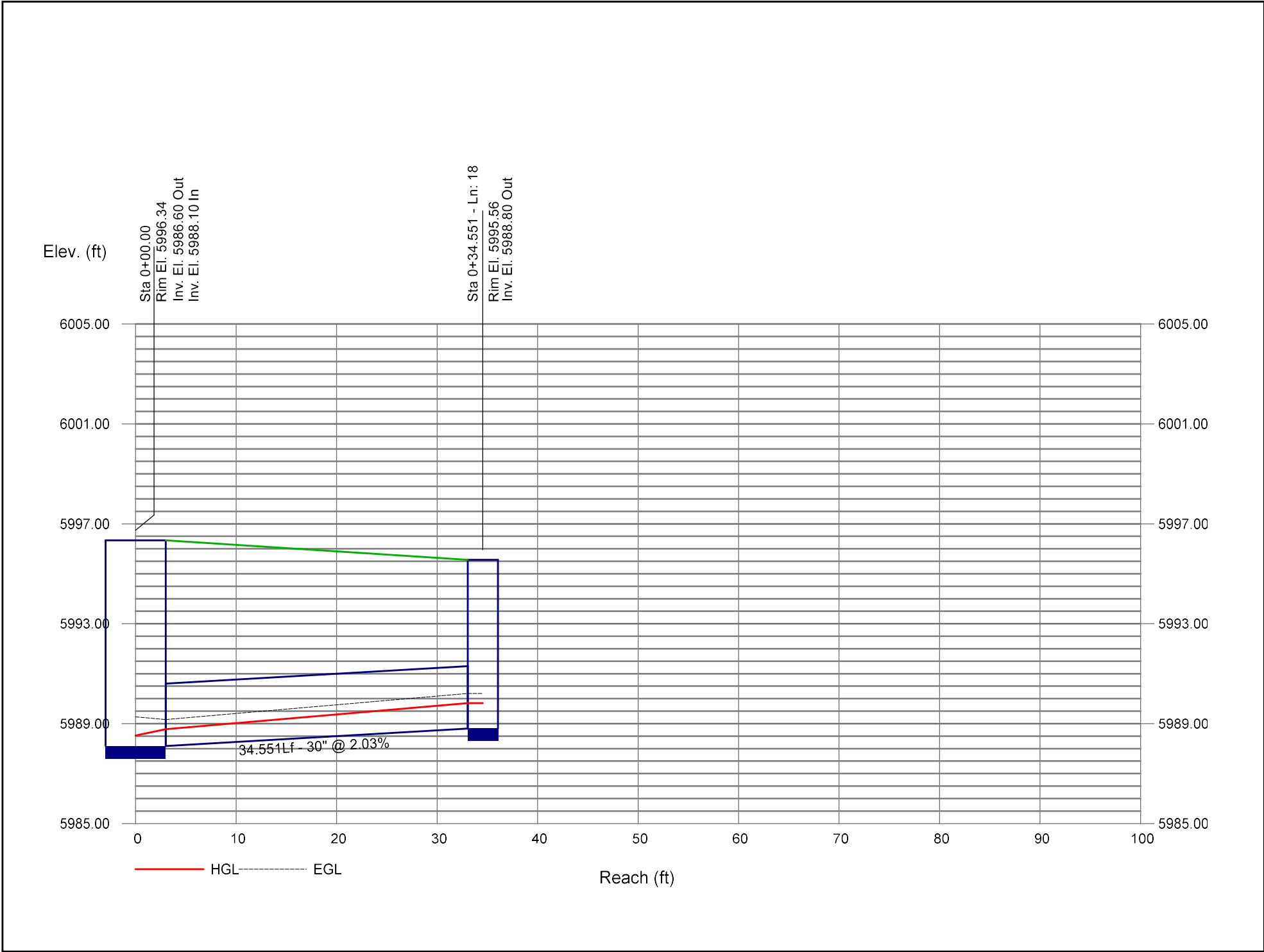
# Storm Sewer Profile

Proj. file: STM2.0 & STM3.0 - 5YR.stm

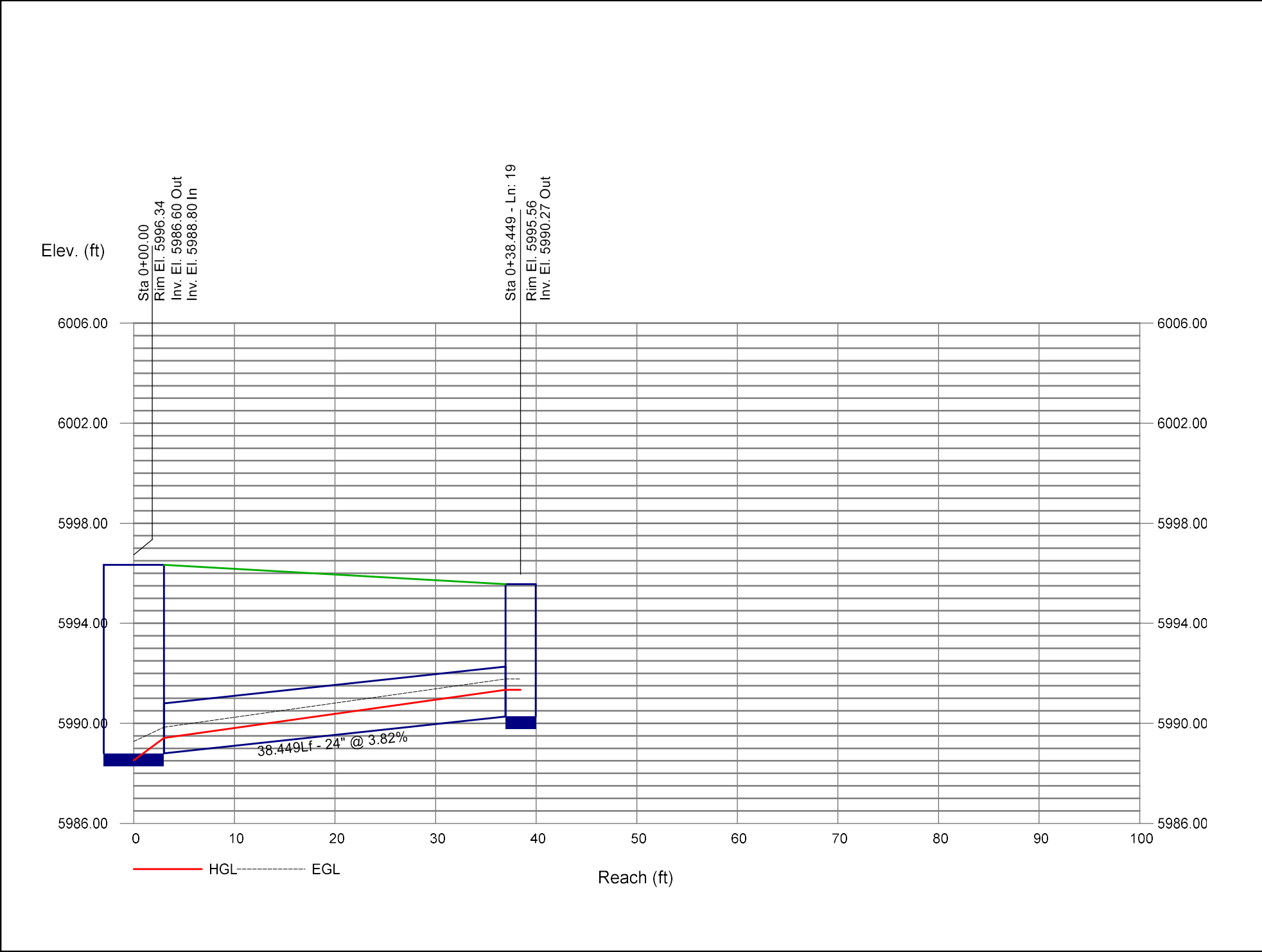




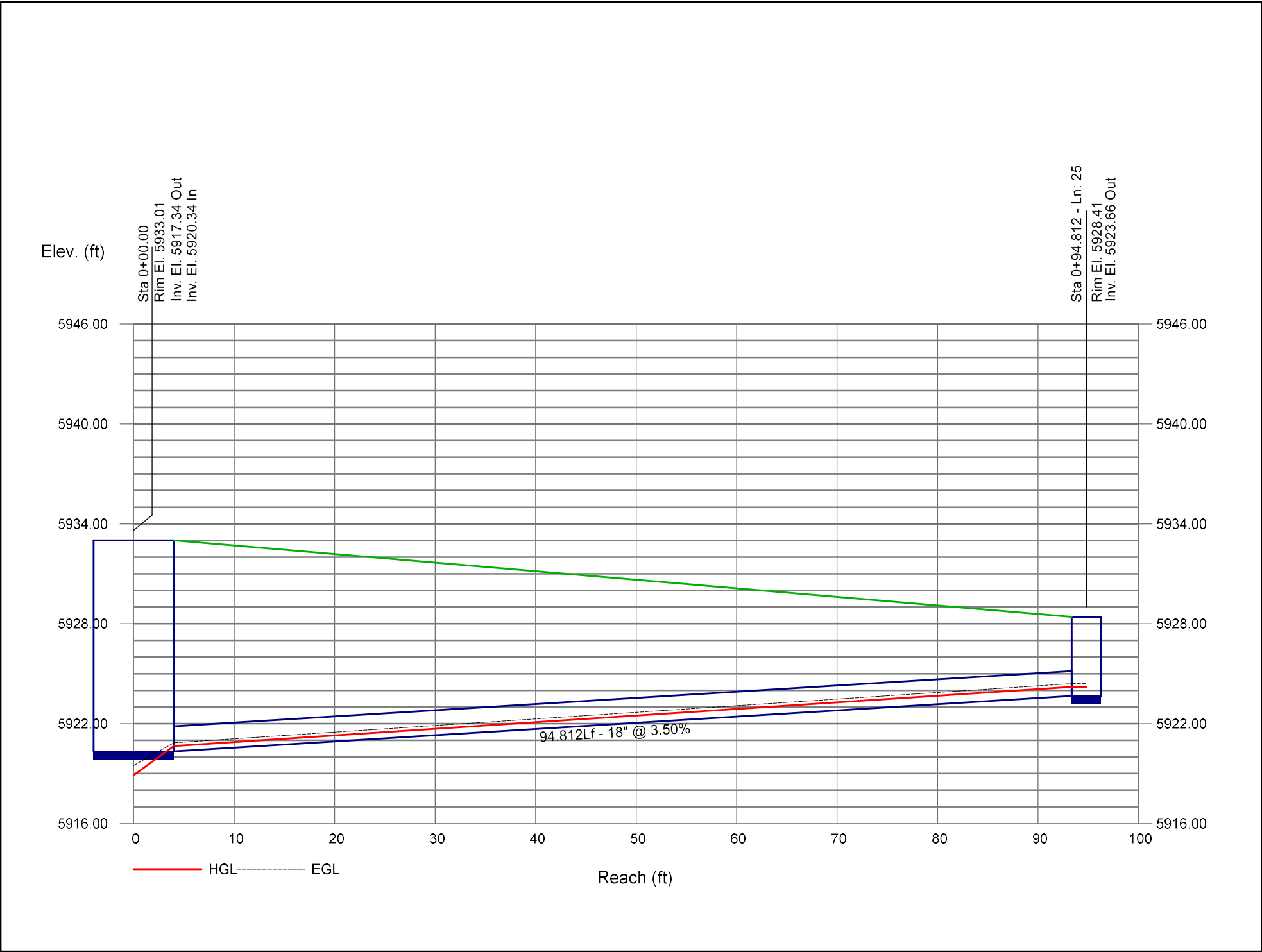
Storm Sewer Profile



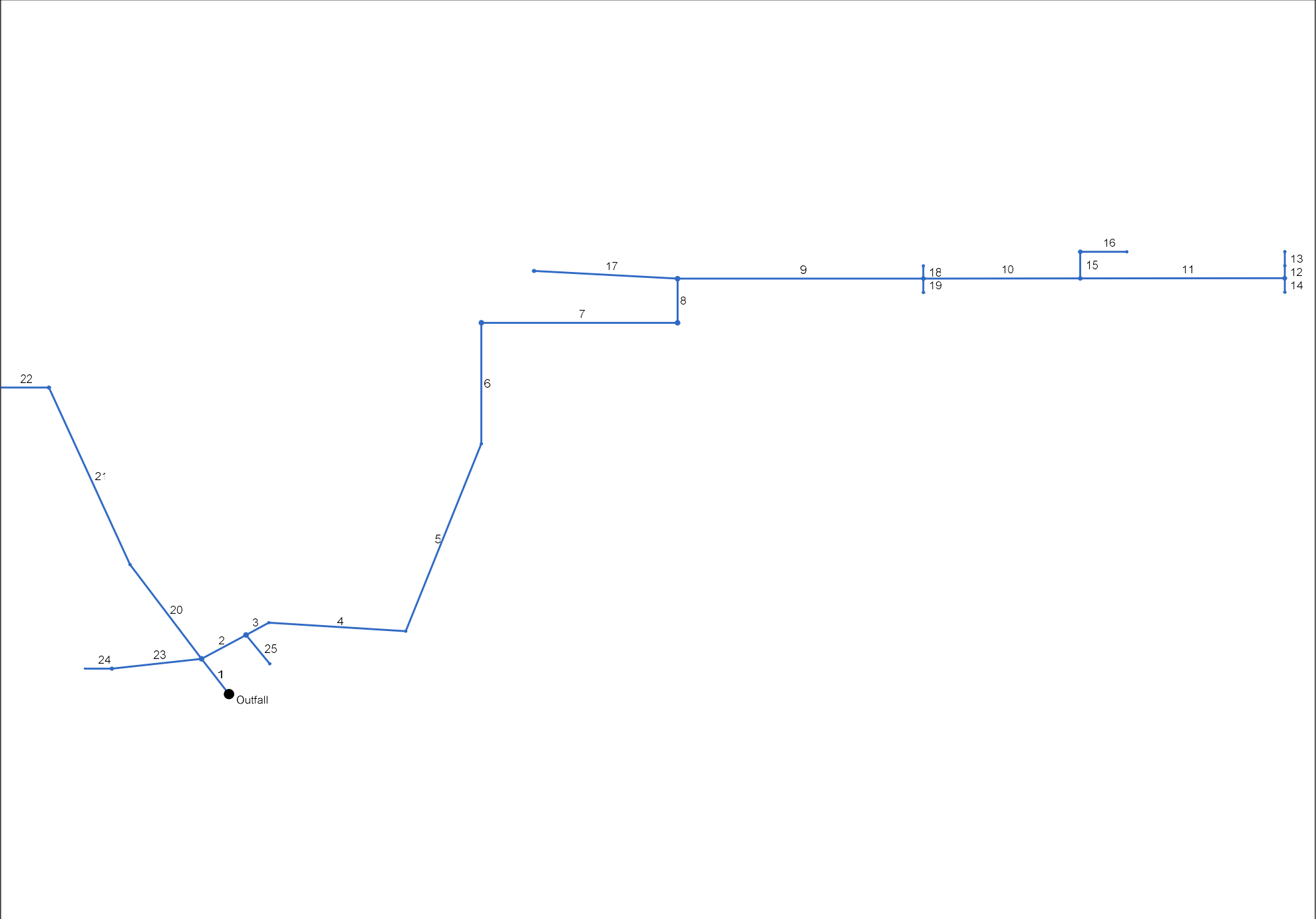
Storm Sewer Profile



Storm Sewer Profile



# Hydraflow Storm Sewers Extension for Autodesk® Civil 3D® Plan



# Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	Pipe - (17) (1)	127.2	48	Cir	114.660	5902.37	5909.25	6.000	5905.75	5912.63	1.96	5912.63	End	Manhole
2	Pipe - (35) (1)	109.0	48	Cir	118.607	5916.15	5917.34	1.003	5918.75	5920.50	n/a	5920.50	1	Manhole
3	Pipe - (35)	105.0	48	Cir	60.761	5917.64	5918.25	1.004	5920.50	5921.35	n/a	5921.35	2	Manhole
4	Pipe - (55)	93.51	48	Cir	304.454	5918.35	5942.40	7.899	5921.35	5945.33	1.37	5945.33	3	Manhole
5	Pipe - (54)	94.48	48	Cir	541.840	5942.70	5960.95	3.368	5945.33	5963.90	0.51	5963.90	4	Manhole
6	Pipe - (53)	93.70	48	Cir	332.408	5961.25	5980.18	5.695	5963.90	5983.11	n/a	5983.11	5	Manhole
7	Pipe - (52)	95.19	48	Cir	435.462	5980.48	5982.66	0.501	5983.55	5985.73	1.32	5987.05	6	Manhole
8	Pipe - (51)	95.61	48	Cir	121.238	5982.96	5983.57	0.503	5987.05	5987.46	0.91	5988.38	7	Manhole
9	Pipe - (50)	80.22	48	Cir	545.335	5983.87	5986.60	0.501	5988.38	5989.89	0.82	5990.71	8	Manhole
10	Pipe - (49)	73.03	48	Cir	348.174	5986.90	5993.49	1.893	5990.71	5996.07	n/a	5996.07	9	Manhole
11	Pipe - (48)	19.14	30	Cir	453.666	5994.99	6007.77	2.817	5996.07	6009.25	n/a	6009.25	10	Manhole
12	Pipe - (61)	15.54	24	Cir	34.551	6008.27	6008.62	1.013	6009.48	6010.04	0.10	6010.04	11	Manhole
13	Pipe - (68)	11.73	24	Cir	38.500	6008.92	6009.30	0.987	6010.04	6010.53	n/a	6010.53	12	Manhole
14	Pipe - (62)	8.31	18	Cir	38.449	6008.77	6010.46	4.395	6009.41	6011.58	n/a	6011.58	11	Manhole
15	Pipe - (60)	56.13	48	Cir	73.054	5993.79	5994.52	0.999	5996.07	5996.77	n/a	5996.77	10	Manhole
16	Pipe - (70)	32.51	24	Cir	103.148	5996.52	5999.97	3.345	5997.86	6001.87	n/a	6001.87	15	Manhole
17	Pipe - (69)	52.49	36	Cir	319.210	5992.28	5996.11	1.200	5994.16	5998.46	1.21	5998.46	8	Manhole
18	Pipe - (58)	11.51	30	Cir	34.551	5988.10	5988.80	2.025	5990.71	5990.69	0.13	5990.82	9	Manhole
19	Pipe - (59)	11.03	24	Cir	38.449	5988.80	5990.27	3.824	5990.71	5991.46	n/a	5991.46 j	9	Manhole
20	Pipe - (42)	18.51	24	Cir	303.547	5918.15	5935.25	5.633	5918.96	5936.80	0.18	5936.80	1	Manhole
21	Pipe - (41)	27.86	24	Cir	518.760	5935.45	5959.05	4.549	5936.80	5960.88	1.27	5960.88	20	Manhole
22	Pipe - (40)	28.10	24	Cir	125.000	5959.25	5971.75	10.000	5960.88	5973.58	n/a	5973.58	21	None
23	Pipe - (17)	32.69	30	Cir	200.580	5917.65	5930.10	6.205	5918.62	5932.04	n/a	5932.04	1	Manhole
24	Pipe - (23)	32.87	30	Cir	60.000	5937.70	5940.80	5.166	5938.68	5942.75	n/a	5942.75	23	None

Project File: STM2.0 & STM3.0 - 100YR.stm

Number of lines: 25

Run Date: 10/10/2022

NOTES: Return period = 100 Yrs. ; j - Line contains hyd. jump.

# Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
25	Pipe - (63)	12.41	18	Cir	94.812	5920.34	5923.66	3.502	5921.16	5924.99	n/a	5924.99	2	Manhole
Project File: STM2.0 & STM3.0 - 100YR.stm									Number of lines: 25			Run Date: 10/10/2022		
NOTES: Return period = 100 Yrs. ; j - Line contains hyd. jump.														

# Storm Sewer Tabulation

Station		Len (ft)	Drng Area		Rnoff coeff (C)	Area x C		Tc		Rain (I) (in/hr)	Total flow (cfs)	Cap full (cfs)	Vel (ft/s)	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line		Incr (ac)	Total (ac)		Incr	Total	Inlet (min)	Syst (min)					Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	114.660	0.00	105.5	0.00	0.00	51.77	0.0	59.0	2.5	127.2	351.9	11.24	48	6.00	5902.37	5909.25	5905.75	5912.63	5909.73	5934.36	Pipe - (17) (1)
2	1	118.607	0.00	94.00	0.00	0.00	44.18	0.0	58.7	2.5	109.0	143.9	11.42	48	1.00	5916.15	5917.34	5918.75	5920.50	5934.36	5933.01	Pipe - (35) (1)
3	2	60.761	13.00	90.00	0.39	5.07	42.46	24.7	58.6	2.5	105.0	143.9	10.50	48	1.00	5917.64	5918.25	5920.50	5921.35	5933.01	5930.37	Pipe - (35)
4	3	304.454	1.00	77.00	0.36	0.36	37.39	17.5	57.8	2.5	93.51	403.7	9.37	48	7.90	5918.35	5942.40	5921.35	5945.33	5930.37	5950.57	Pipe - (55)
5	4	541.840	2.10	76.00	0.36	0.76	37.03	15.2	56.5	2.6	94.48	263.6	10.16	48	3.37	5942.70	5960.95	5945.33	5963.90	5950.57	5968.75	Pipe - (54)
6	5	332.408	0.00	73.90	0.00	0.00	36.28	0.0	55.7	2.6	93.70	342.8	10.06	48	5.69	5961.25	5980.18	5963.90	5983.11	5968.75	5994.84	Pipe - (53)
7	6	435.462	0.00	73.90	0.00	0.00	36.28	0.0	54.7	2.6	95.19	101.6	9.20	48	0.50	5980.48	5982.66	5983.55	5985.73	5994.84	6001.41	Pipe - (52)
8	7	121.238	0.00	73.90	0.00	0.00	36.28	0.0	54.4	2.6	95.61	110.4	7.64	48	0.50	5982.96	5983.57	5987.05	5987.46	6001.41	6003.57	Pipe - (51)
9	8	545.335	0.00	64.00	0.00	0.00	29.74	0.0	52.9	2.7	80.22	101.6	6.82	48	0.50	5983.87	5986.60	5988.38	5989.89	6003.57	5996.34	Pipe - (50)
10	9	348.174	0.00	59.30	0.00	0.00	26.64	0.0	51.9	2.7	73.03	197.6	7.21	48	1.89	5986.90	5993.49	5990.71	5996.07	5996.34	6003.39	Pipe - (49)
11	10	453.666	0.00	14.30	0.00	0.00	6.26	0.0	45.5	3.1	19.14	68.83	7.86	30	2.82	5994.99	6007.77	5996.07	6009.25	6003.39	6016.00	Pipe - (48)
12	11	34.551	1.90	12.50	0.66	1.25	5.07	10.9	45.4	3.1	15.54	22.77	7.16	24	1.01	6008.27	6008.62	6009.48	6010.04	6016.00	6015.23	Pipe - (61)
13	12	38.500	10.60	10.60	0.36	3.82	3.82	45.2	45.2	3.1	11.73	22.47	6.14	24	0.99	6008.92	6009.30	6010.04	6010.53	6015.23	6014.63	Pipe - (68)
14	11	38.449	1.80	1.80	0.66	1.19	1.19	10.9	10.9	7.0	8.31	22.02	8.74	18	4.40	6008.77	6010.46	6009.41	6011.58	6016.00	6015.23	Pipe - (62)
15	10	73.054	12.30	45.00	0.70	8.61	20.38	7.0	51.7	2.8	56.13	143.6	7.64	48	1.00	5993.79	5994.52	5996.07	5996.77	6003.39	6002.63	Pipe - (60)
16	15	103.148	32.70	32.70	0.36	11.77	11.77	51.5	51.5	2.8	32.51	41.37	12.57	24	3.34	5996.52	5999.97	5997.86	6001.87	6002.63	6005.27	Pipe - (70)
17	8	319.210	9.90	9.90	0.66	6.53	6.53	7.0	7.0	8.0	52.49	73.06	10.03	36	1.20	5992.28	5996.11	5994.16	5998.46	6003.57	0.00	Pipe - (69)
18	9	34.551	2.40	2.40	0.66	1.58	1.58	9.8	9.8	7.3	11.51	58.36	2.62	30	2.03	5988.10	5988.80	5990.71	5990.69	5996.34	5995.56	Pipe - (58)
19	9	38.449	2.30	2.30	0.66	1.52	1.52	9.8	9.8	7.3	11.03	44.23	4.62	24	3.82	5988.80	5990.27	5990.71	5991.46	5996.34	5995.56	Pipe - (59)
20	1	303.547	0.00	5.30	0.37	0.00	3.50	20.2	20.2	5.3	18.51	53.68	11.30	24	5.63	5918.15	5935.25	5918.96	5936.80	5934.36	5940.75	Pipe - (42)
21	20	518.760	0.00	5.30	0.00	0.00	3.50	0.0	7.2	8.0	27.86	48.24	10.82	24	4.55	5935.45	5959.05	5936.80	5960.88	5940.75	5965.10	Pipe - (41)
22	21	125.000	5.30	5.30	0.66	3.50	3.50	7.0	7.0	8.0	28.10	71.52	9.81	24	10.00	5959.25	5971.75	5960.88	5973.58	5965.10	5974.17	Pipe - (40)
Project File: STM2.0 & STM3.0 - 100YR.stm																Number of lines: 25				Run Date: 10/10/2022		
NOTES:Intensity = 790.75 / (Inlet time + 27.70) ^ 1.29; Return period =Yrs. 100 ; c = cir e = ellip b = box																						

# Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID							
Line	To Line		Incr	Total		Incr	Total	Inlet	Syst					Size	Slope	Dn	Up	Dn	Up	Dn	Up								
		(ft)	(ac)	(ac)	(C)			(min)	(min)	(in/hr)	(cfs)	(cfs)	(ft/s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)								
23	1	200.580	0.00	6.20	0.00	0.00	4.09	0.0	7.1	8.0	32.69	102.2	13.24	30	6.21	5917.65	5930.10	5918.62	5932.04	5934.36	5943.62	Pipe - (17)							
24	23	60.000	6.20	6.20	0.66	4.09	4.09	7.0	7.0	8.0	32.87	101.0	13.19	30	5.17	5937.70	5940.80	5938.68	5942.75	5943.62	5946.81	Pipe - (23)							
25	2	94.812	4.00	4.00	0.43	1.72	1.72	10.0	10.0	7.2	12.41	21.29	10.00	18	3.50	5920.34	5923.66	5921.16	5924.99	5933.01	5928.41	Pipe - (63)							



# Hydraulic Grade Line Computations

Line  (1)	Size (in) (2)	Q (cfs) (3)	Downstream								Len (ft) (12)	Upstream								Check		JL coeff (K) (23)	Minor loss (ft) (24)
			Invert elev (ft) (4)	HGL elev (ft) (5)	Depth (ft) (6)	Area (sqft) (7)	Vel (ft/s) (8)	Vel head (ft) (9)	EGL elev (ft) (10)	Sf (%) (11)		Invert elev (ft) (13)	HGL elev (ft) (14)	Depth (ft) (15)	Area (sqft) (16)	Vel (ft/s) (17)	Vel head (ft) (18)	EGL elev (ft) (19)	Sf (%) (20)	Ave Sf (%) (21)	Enrgy loss (ft) (22)		
1	48	127.2	5902.37	5905.75	3.38	11.32	11.24	1.96	5907.71	0.000	114.66	5909.25	5912.63	3.38**	11.32	11.24	1.96	5914.59	0.000	0.000	n/a	1.00	1.96
2	48	109.0	5916.15	5918.75	2.60*	8.66	12.59	1.63	5920.39	0.000	118.60	5917.34	5920.50	3.15**	10.63	10.25	1.63	5922.13	0.000	0.000	n/a	1.00	n/a
3	48	105.0	5917.64	5920.50	2.85	9.59	10.94	1.57	5922.07	0.000	60.76	5918.25	5921.35	3.10**	10.45	10.05	1.57	5922.92	0.000	0.000	n/a	0.67	n/a
4	48	93.51	5918.35	5921.35	3.00	9.86	9.25	1.40	5922.75	0.000	304.45	5942.40	5945.33	2.93**	9.86	9.48	1.40	5946.73	0.000	0.000	n/a	0.98	1.37
5	48	94.48	5942.70	5945.33	2.63	8.76	10.79	1.41	5946.74	0.000	541.84	5960.95	5963.90	2.94**	9.92	9.53	1.41	5965.31	0.000	0.000	n/a	0.36	0.51
6	48	93.70	5961.25	5963.90	2.64	8.82	10.63	1.40	5965.30	0.000	332.40	5980.18	5983.11	2.93**	9.87	9.49	1.40	5984.51	0.000	0.000	n/a	1.00	n/a
7	48	95.19	5980.48	5983.55	3.07*	10.36	9.19	1.31	5984.87	0.500	435.46	5982.66	5985.73	3.07	10.34	9.21	1.32	5987.05	0.502	0.501	2.183	1.00	1.32
8	48	95.61	5982.96	5987.05	4.00	12.56	7.61	0.90	5987.95	0.378	121.23	5983.57	5987.46	3.89	12.47	7.66	0.91	5988.38	0.334	0.356	0.431	1.00	0.91
9	48	80.22	5983.87	5988.38	4.00	12.56	6.39	0.63	5989.01	0.312	545.33	5986.60	5989.89	3.29	11.05	7.26	0.82	5990.71	0.311	0.311	1.698	1.00	0.82
10	48	73.03	5986.90	5990.71	3.81	8.58	5.92	1.13	5991.83	0.000	348.17	5993.49	5996.07	2.58**	8.58	8.51	1.13	5997.20	0.000	0.000	n/a	1.00	n/a
11	30	19.14	5994.99	5996.07	1.08	2.04	9.40	0.62	5996.69	0.000	453.66	6007.77	6009.25	1.48**	3.03	6.31	0.62	6009.87	0.000	0.000	n/a	1.00	n/a
12	24	15.54	6008.27	6009.48	1.21*	1.99	7.80	0.66	6010.14	0.000	34.55	6008.62	6010.04	1.42**	2.39	6.51	0.66	6010.70	0.000	0.000	n/a	0.15	0.10
13	24	11.73	6008.92	6010.04	1.12	1.81	6.48	0.52	6010.56	0.000	38.50	6009.30	6010.53	1.23**	2.02	5.80	0.52	6011.05	0.000	0.000	n/a	1.00	n/a
14	18	8.31	6008.77	6009.41	0.64*	0.72	11.58	0.54	6009.95	0.000	38.44	6010.46	6011.58	1.12**	1.41	5.90	0.54	6012.12	0.000	0.000	n/a	1.00	n/a
15	48	56.13	5993.79	5996.07	2.28	7.29	7.57	0.92	5997.00	0.000	73.05	5994.52	5996.77	2.25**	7.29	7.70	0.92	5997.69	0.000	0.000	n/a	1.00	n/a
16	24	32.51	5996.52	5997.86	1.34*	2.23	14.58	1.73	5999.59	0.000	103.14	5999.97	6001.87	1.90**	3.08	10.56	1.73	6003.60	0.000	0.000	n/a	1.00	n/a
17	36	52.49	5992.28	5994.16	1.88*	4.67	11.24	1.21	5995.37	0.000	319.21	5996.11	5998.46	2.35**	5.95	8.82	1.21	5999.67	0.000	0.000	n/a	1.00	1.21
18	30	11.51	5988.10	5990.71	2.50	4.91	2.34	0.09	5990.79	0.079	34.55	5988.80	5990.69	1.89	3.98	2.89	0.13	5990.82	0.093	0.086	0.030	1.00	0.13
19	24	11.03	5988.80	5990.71	1.91	1.95	3.57	0.50	5991.20	0.000	38.44	5990.27	5991.46 j	1.19**	1.95	5.66	0.50	5991.96	0.000	0.000	n/a	1.00	n/a
20	24	18.51	5918.15	5918.96	0.81*	1.19	15.50	0.78	5919.74	0.000	303.54	5935.25	5936.80	1.55**	2.61	7.10	0.78	5937.58	0.000	0.000	n/a	0.23	0.18
21	24	27.86	5935.45	5936.80	1.35	2.25	12.37	1.33	5938.13	0.000	518.76	5959.05	5960.88	1.82**	3.01	9.26	1.33	5962.21	0.000	0.000	n/a	0.95	1.27

Project File: STM2.0 & STM3.0 - 100YR.stm

Number of lines: 25

Run Date: 10/10/2022

Notes: \* depth assumed; \*\* Critical depth.; j-Line contains hyd. jump ; c = cir e = ellip b = box

# Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
(1)	(in) (2)	(cfs) (3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(ft) (12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(K) (23)	(ft) (24)
22	24	28.10	5959.25	5960.88	1.62	2.73	10.28	1.35	5962.23	0.000	125.000	5971.75	5973.58	1.83**	3.01	9.33	1.35	5974.93	0.000	0.000	n/a	1.00	n/a
23	30	32.69	5917.65	5918.62	0.97*	1.77	18.50	0.99	5919.61	0.000	200.580	5930.10	5932.04	1.94**	4.10	7.98	0.99	5933.03	0.000	0.000	n/a	0.17	n/a
24	30	32.87	5937.70	5938.68	0.98*	1.79	18.37	1.00	5939.68	0.000	60.000	5940.80	5942.75	1.95**	4.11	8.00	1.00	5943.75	0.000	0.000	n/a	1.00	n/a
25	18	12.41	5920.34	5921.16	0.82*	0.99	12.50	0.87	5922.04	0.000	94.812	5923.66	5924.99	1.33**	1.66	7.50	0.87	5925.86	0.000	0.000	n/a	1.00	n/a
Project File: STM2.0 & STM3.0 - 100YR.stm														Number of lines: 25				Run Date: 10/10/2022					
Notes: * depth assumed; ** Critical depth.; j-Line contains hyd. jump ; c = cir e = ellip b = box																							

## General Procedure:

Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

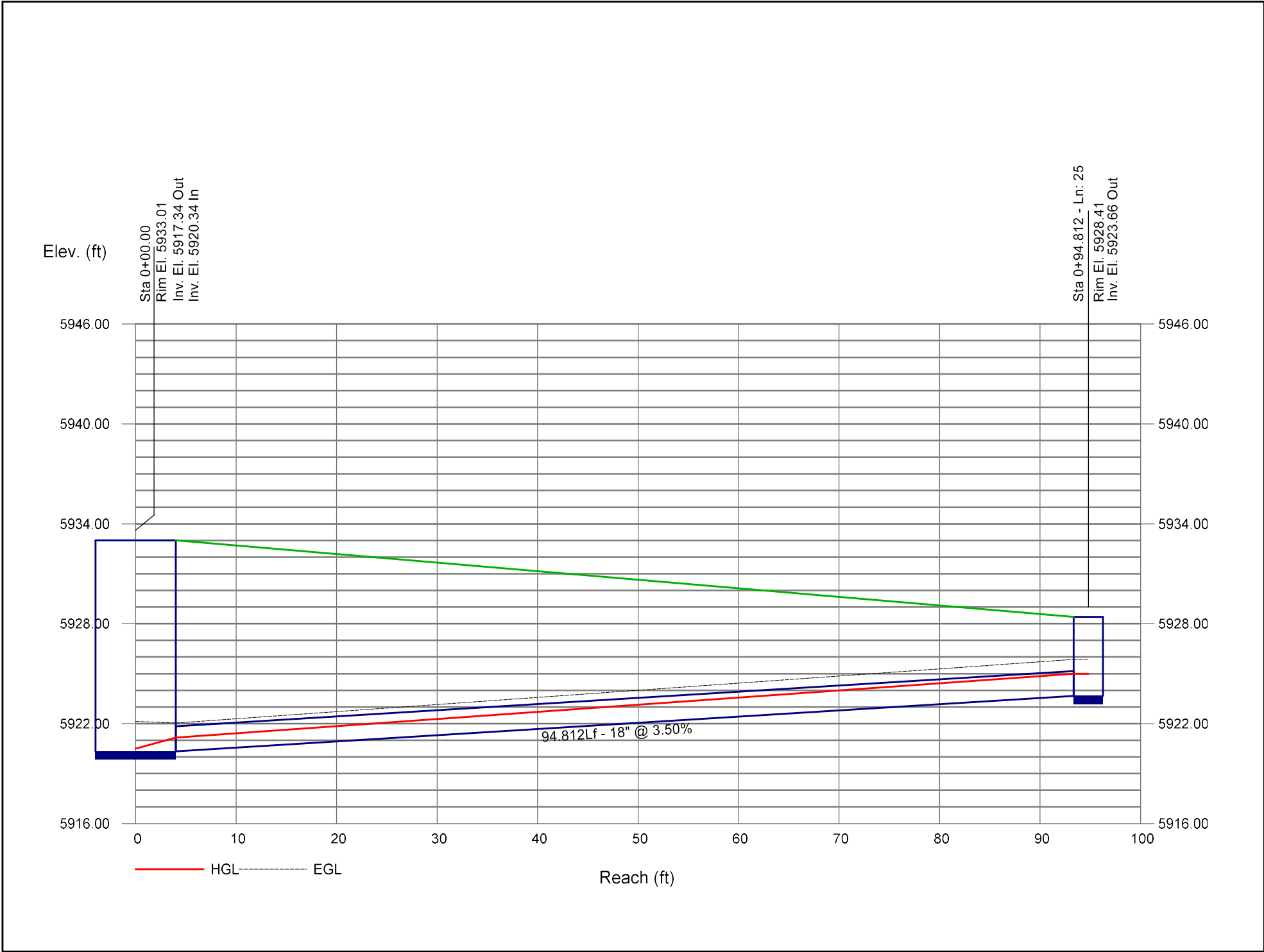
Col. 21 The average of the downstream and upstream friction slopes.

Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

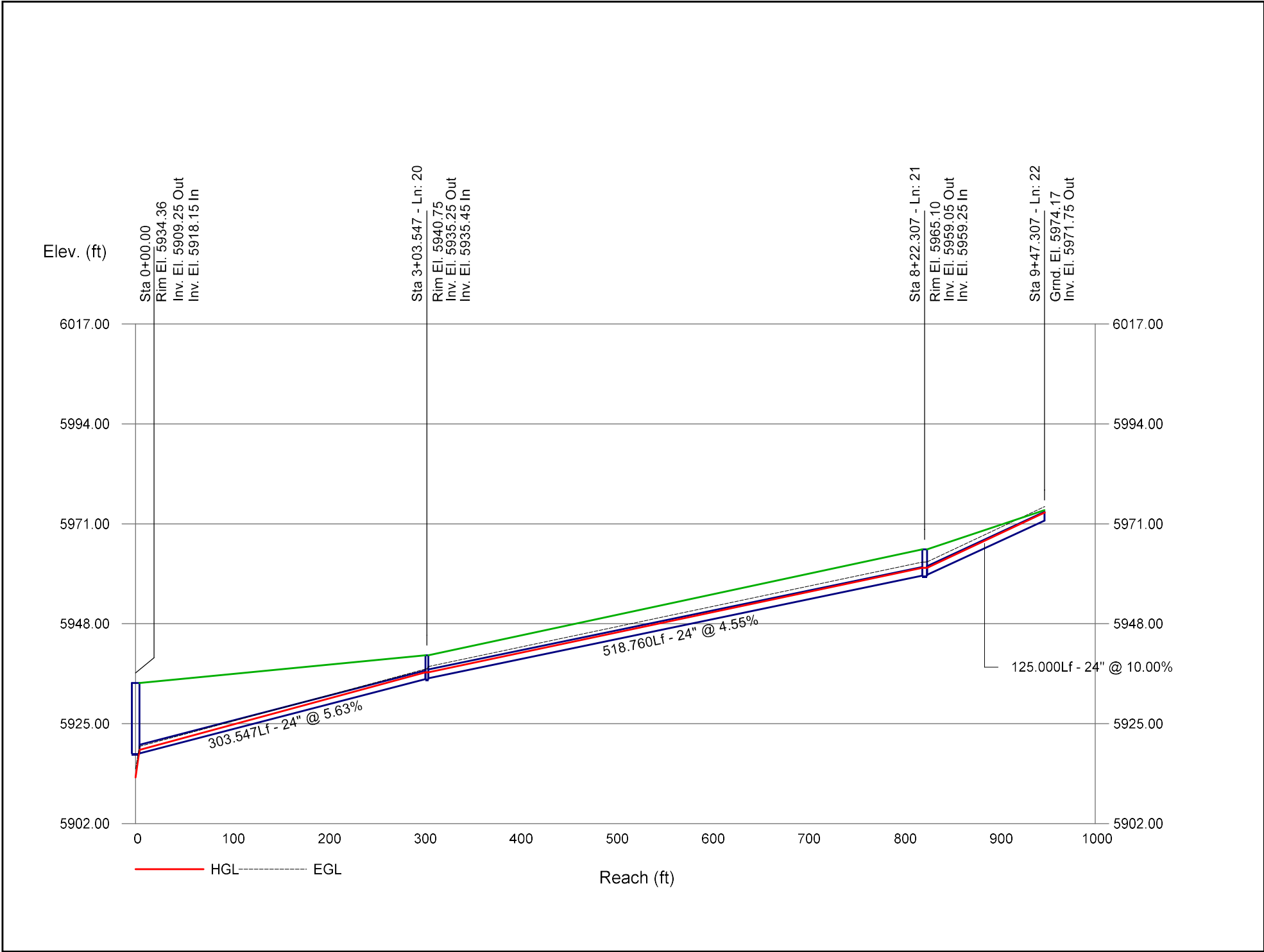
Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

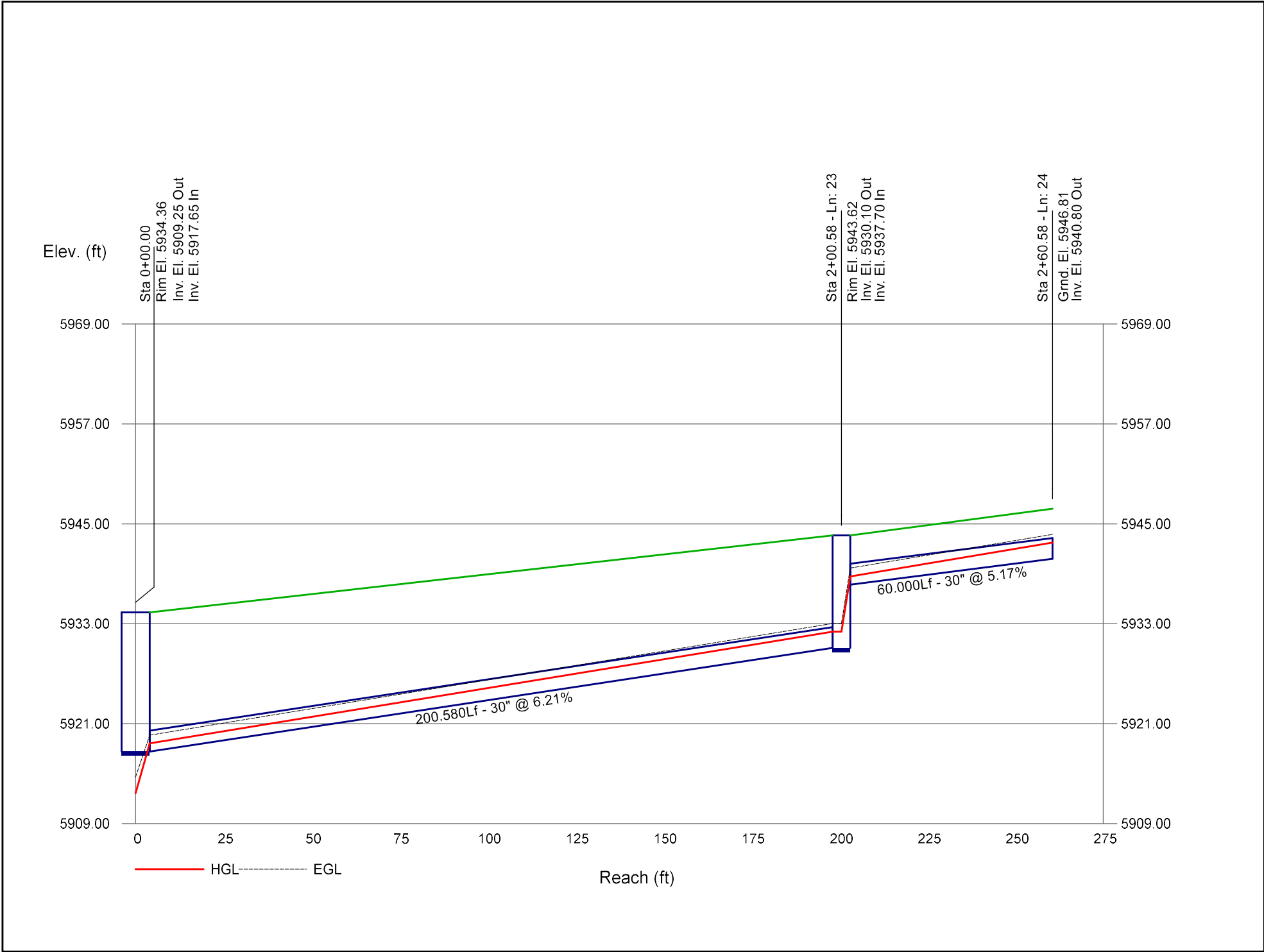
Storm Sewer Profile



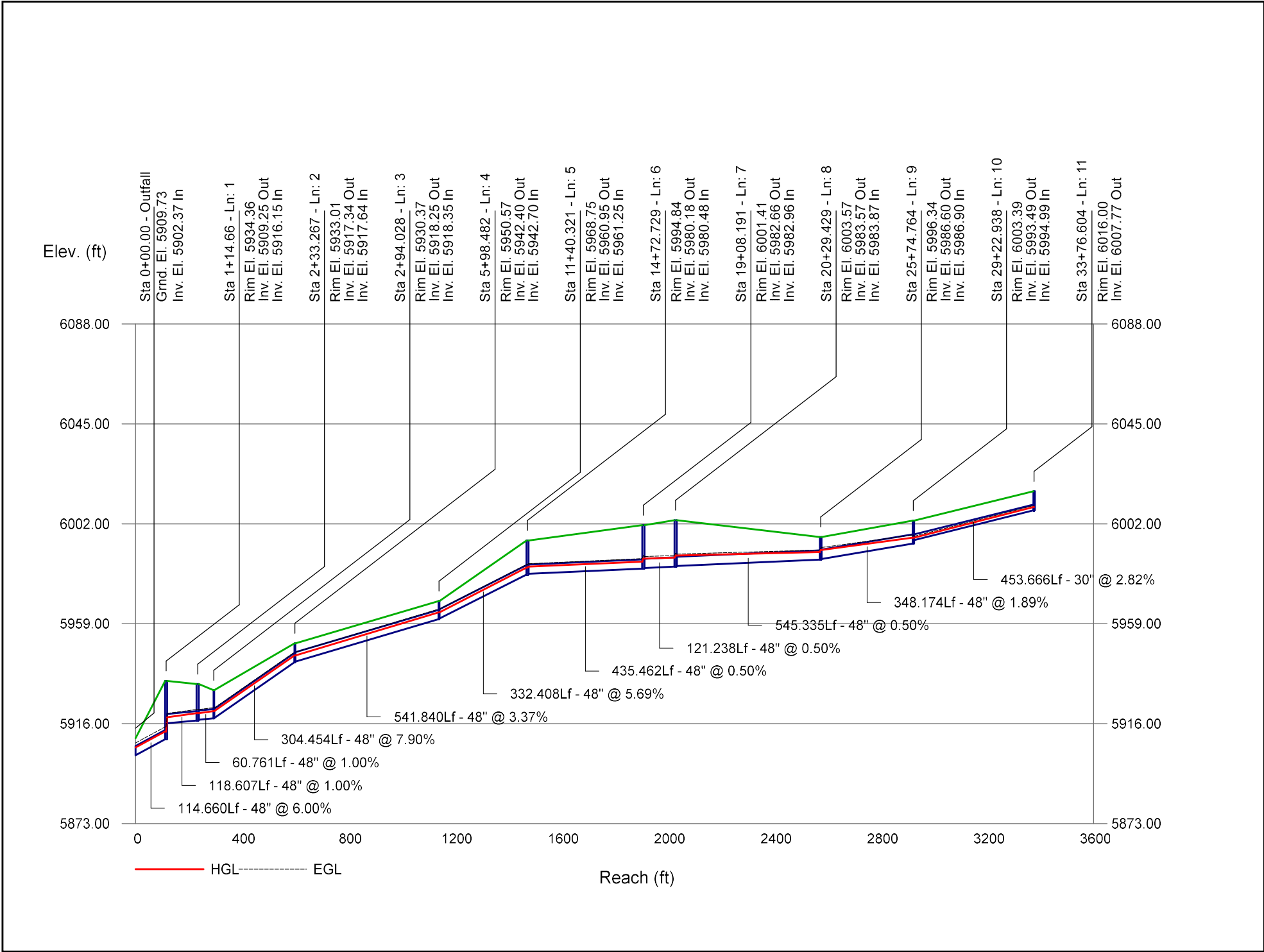
Storm Sewer Profile



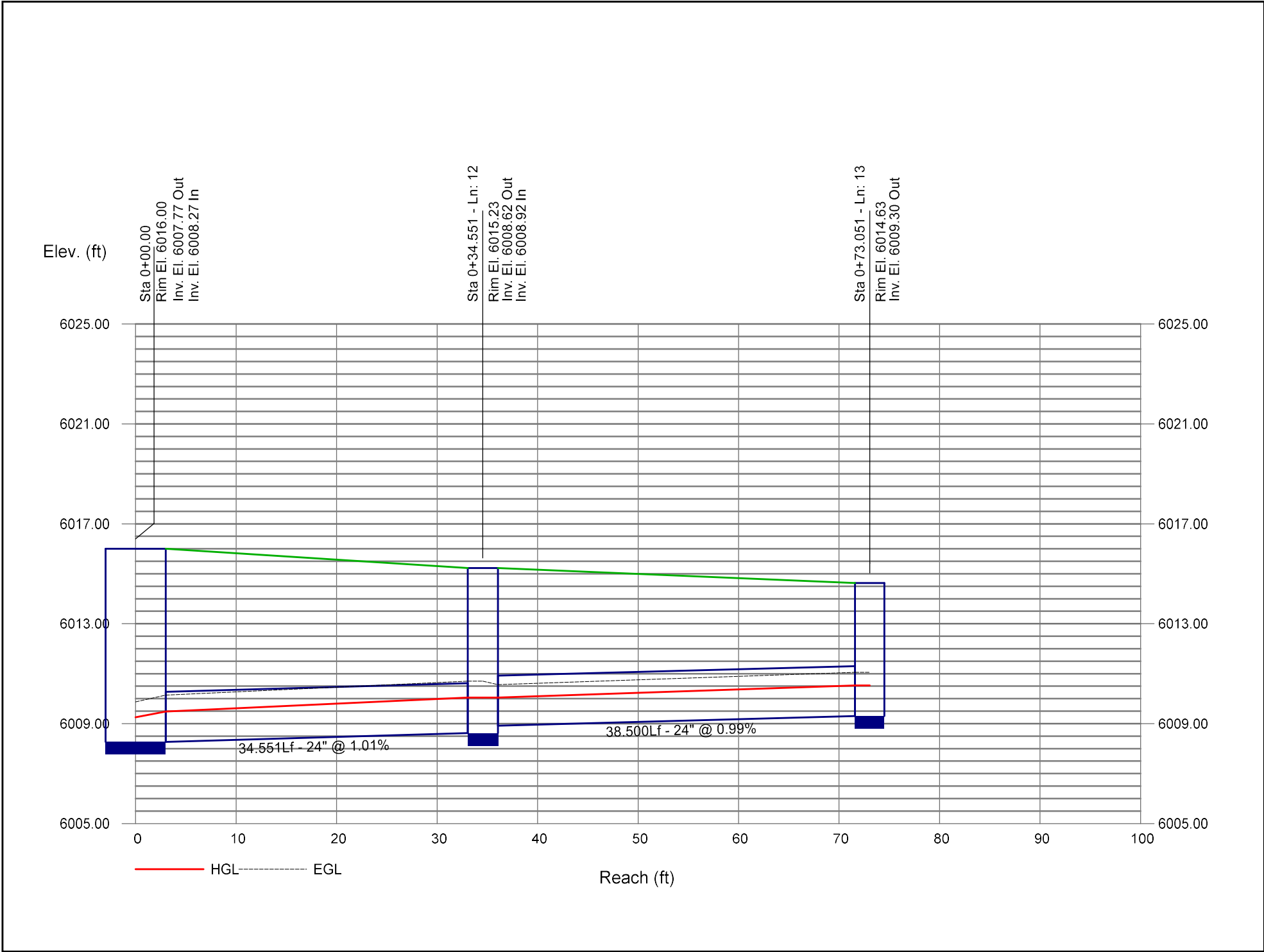
Storm Sewer Profile



Storm Sewer Profile

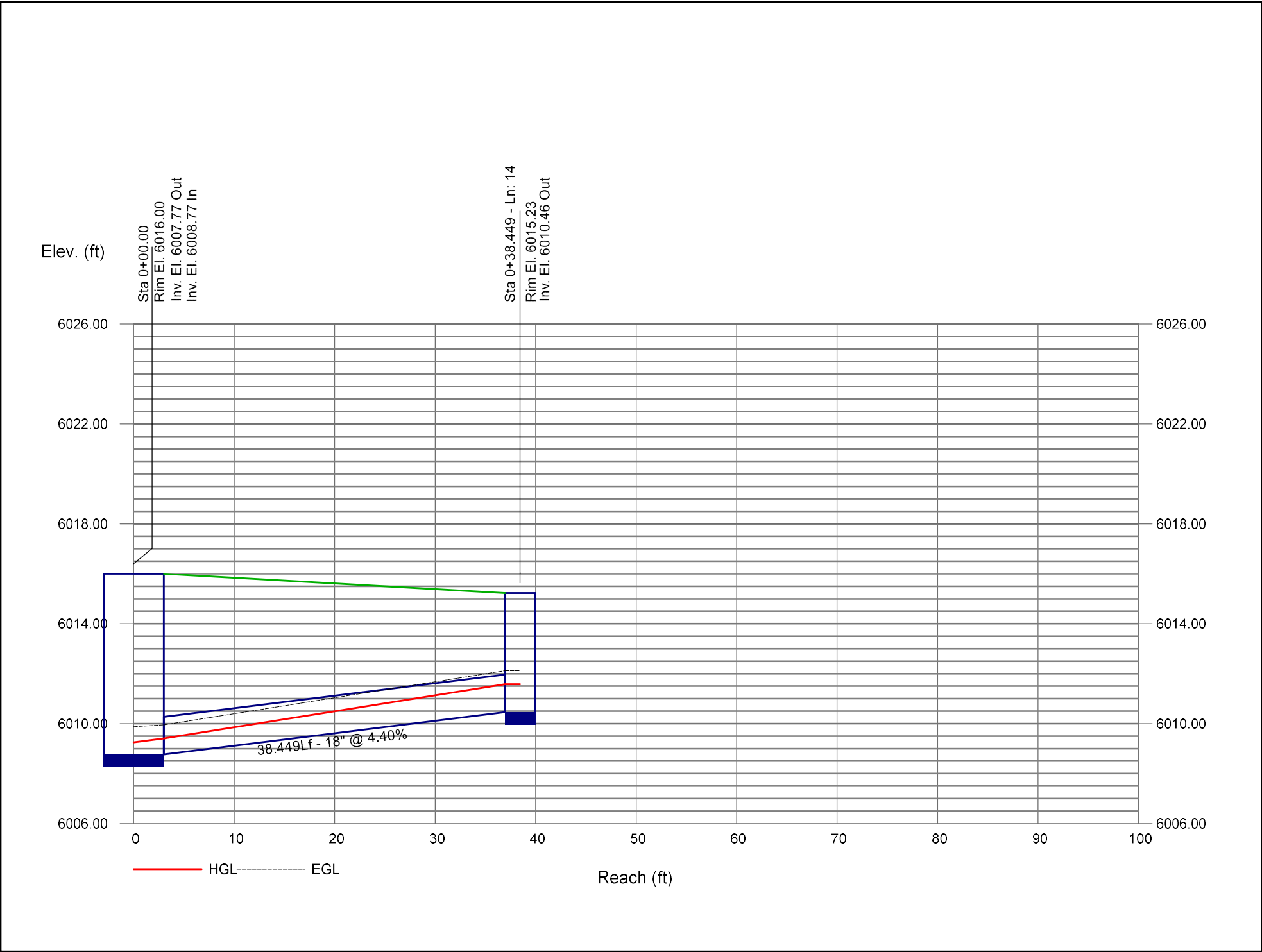


Storm Sewer Profile

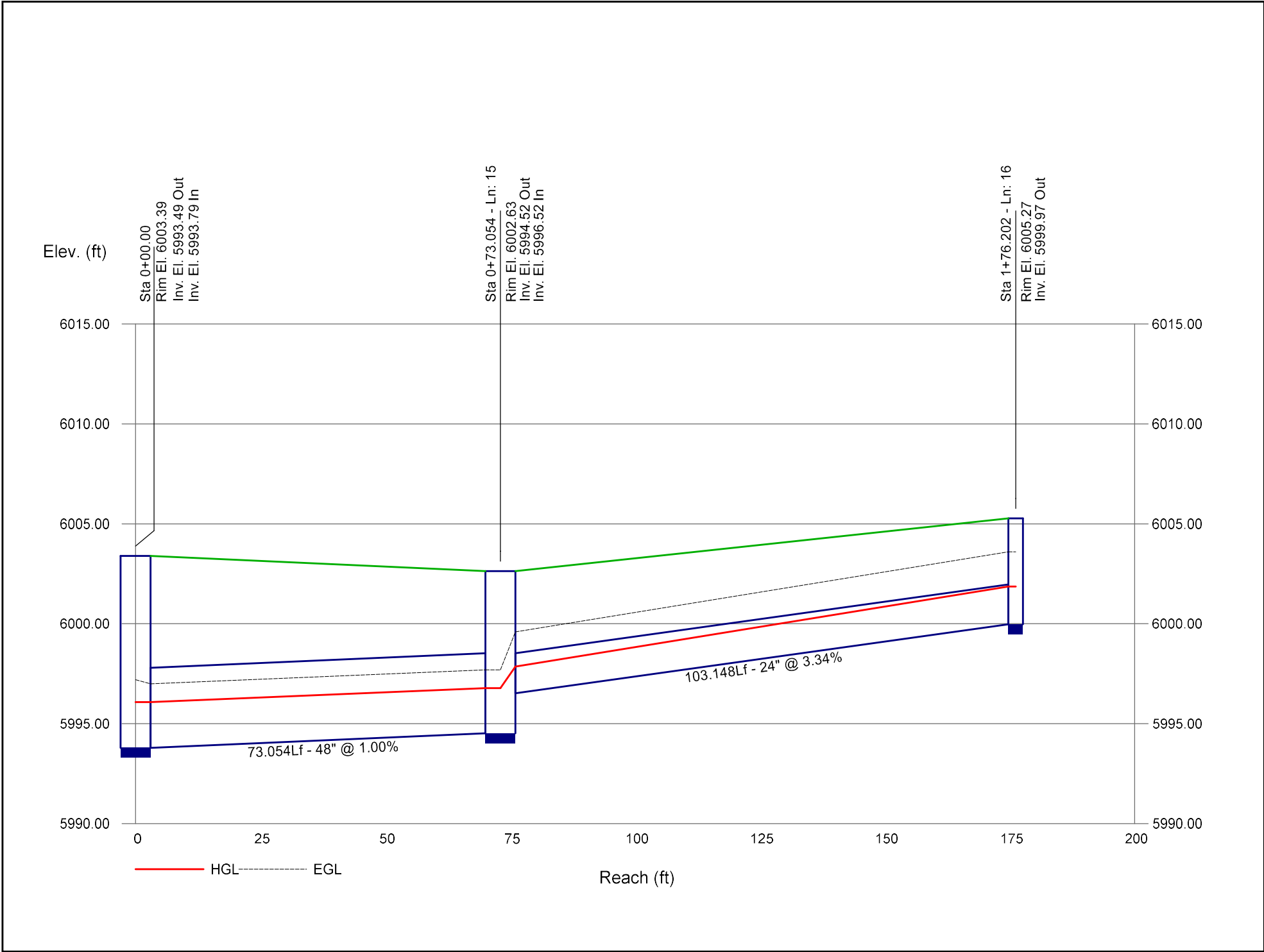




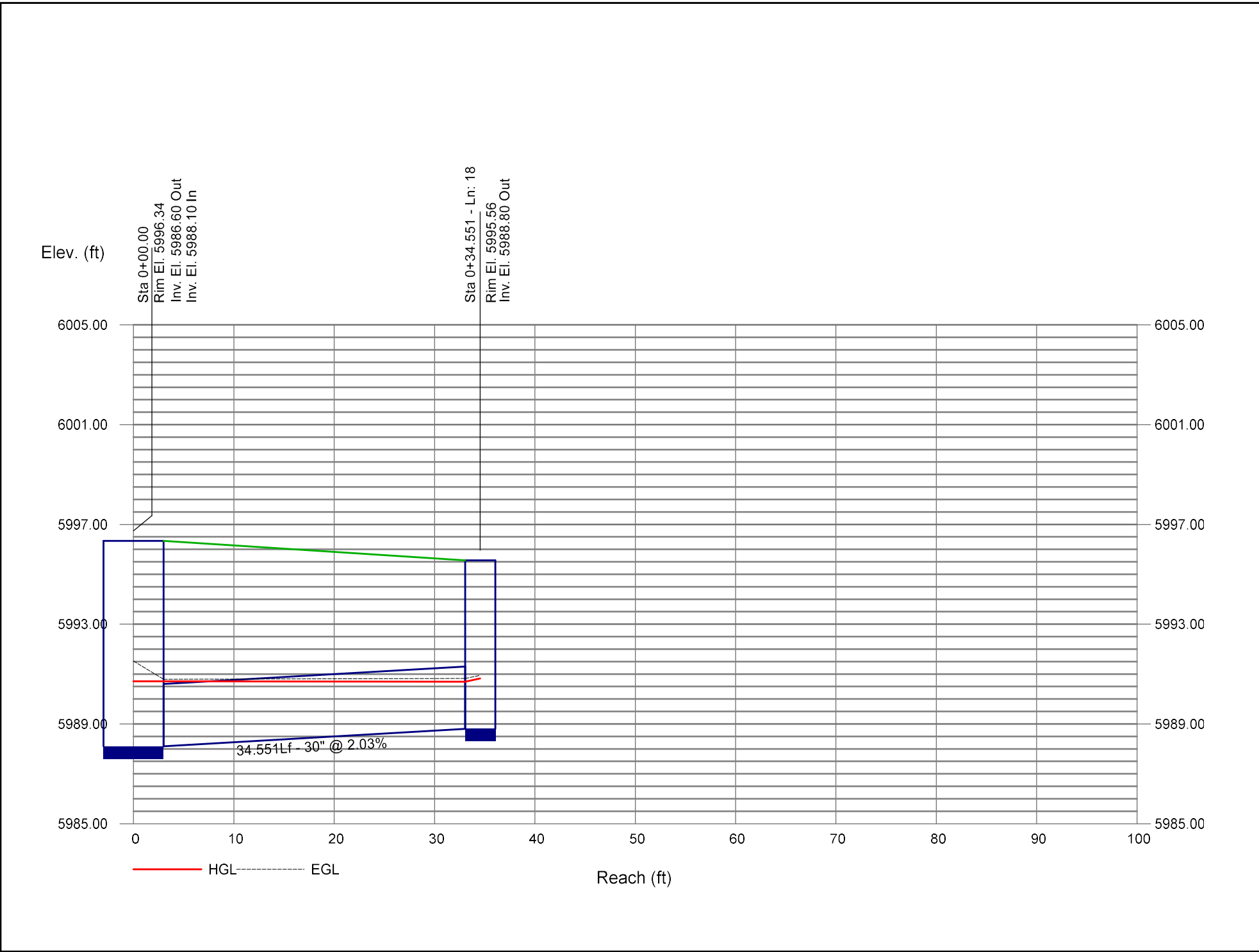
Storm Sewer Profile



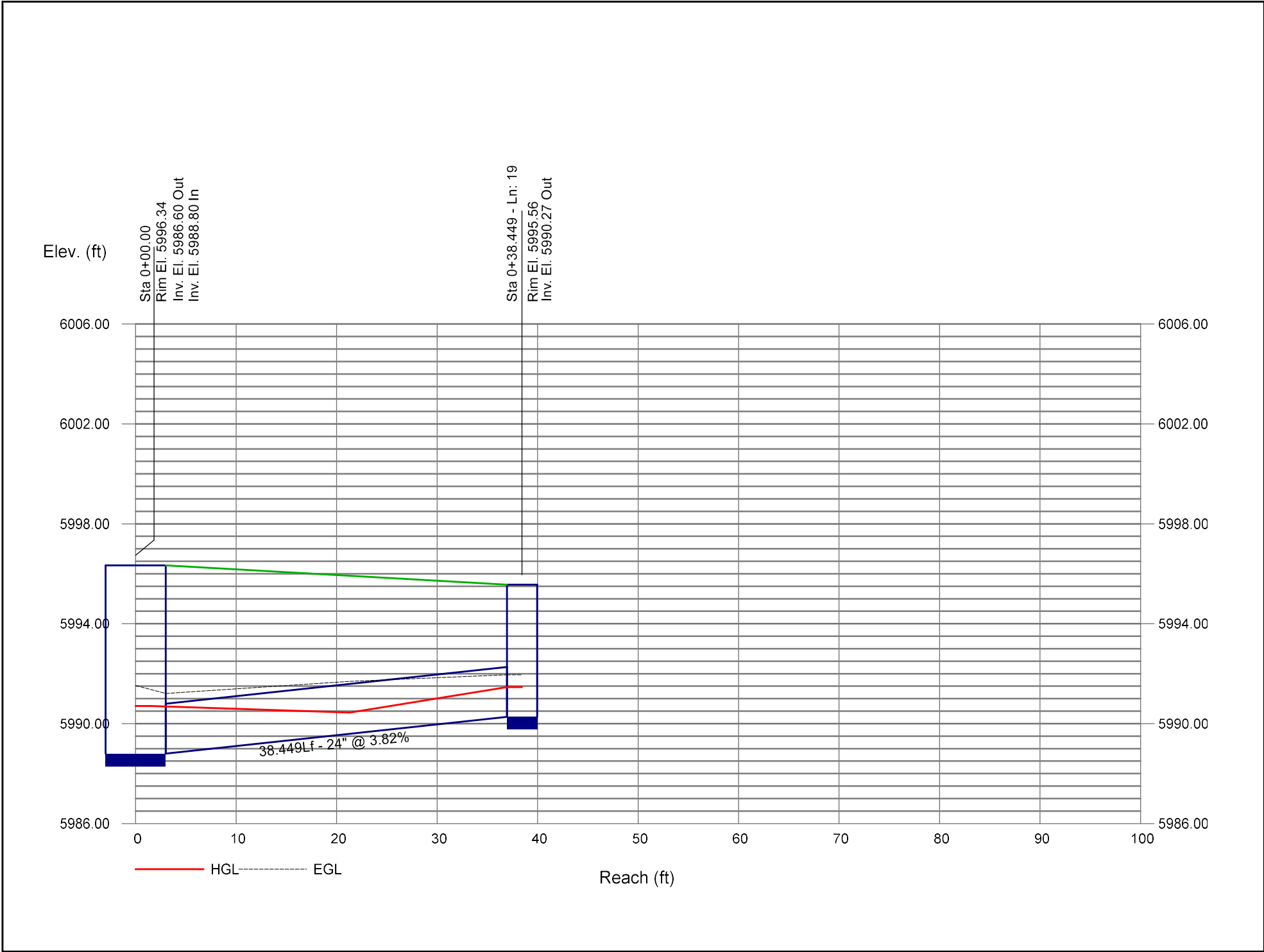
Storm Sewer Profile



# Storm Sewer Profile



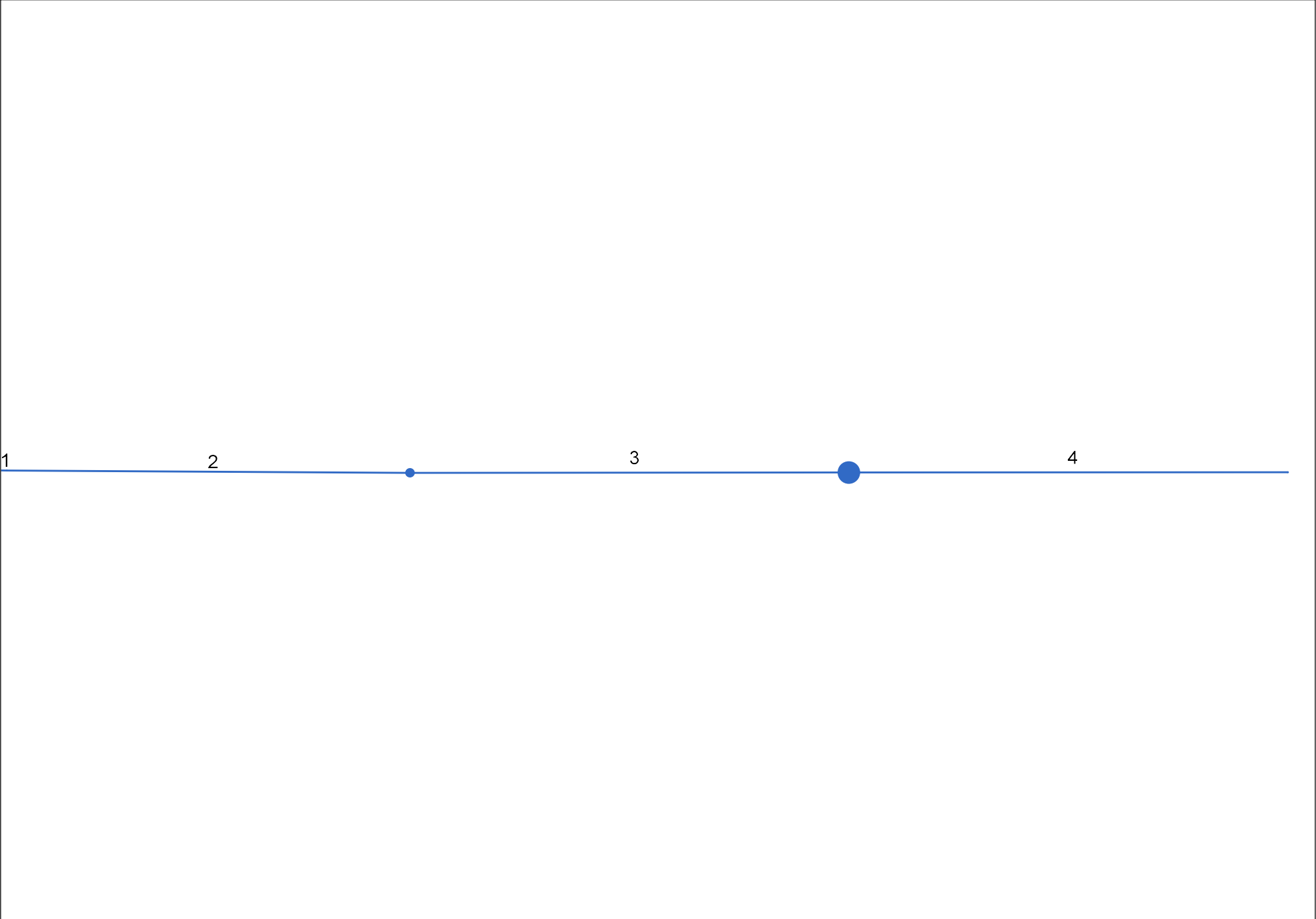
Storm Sewer Profile



## STM-4.0 Summary And Profile

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# Hydraflow Storm Sewers Extension for Autodesk® Civil 3D® Plan



Project File: STM4.0 - 5YR.stm	Number of lines: 4	Date: 10/11/2022
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# Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	Pipe - (36) (1)	117.6	60	Cir	5.000	5903.80	5903.80	0.000	5908.17	5908.18	0.10	5908.28	End	None
2	Pipe - (36)	119.1	60	Cir	155.689	5903.80	5912.75	5.749	5908.28	5915.87	n/a	5915.87	1	Manhole
3	Pipe - (47) (1)	142.3	60	Cir	169.374	5922.75	5926.14	2.002	5924.91	5929.56	0.23	5929.56	2	Manhole
4	Pipe - (47)	144.1	60	Cir	169.377	5936.14	5939.53	2.001	5938.31	5942.97	1.56	5942.97	3	None
Project File: STM4.0 - 5YR.stm									Number of lines: 4			Run Date: 10/11/2022		
NOTES: Return period = 5 Yrs.														

# Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line		Incr	Total		Incr	Total	Inlet	Syst					Size	Slope	Dn	Up	Dn	Up	Dn	Up	
		(ft)	(ac)	(ac)	(C)			(min)	(min)	(in/hr)	(cfs)	(cfs)	(ft/s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
1	End	5.000	0.00	61.20	0.00	0.00	33.91	0.0	16.8	3.5	117.6	0.00	6.46	60	0.00	5903.80	5903.80	5908.17	5908.18	5909.59	5911.17	Pipe - (36) (1)
2	1	155.689	4.40	61.20	0.09	0.40	33.91	16.4	16.4	3.5	119.1	624.5	7.84	60	5.75	5903.80	5912.75	5908.28	5915.87	5911.17	5934.95	Pipe - (36)
3	2	169.374	0.00	56.80	0.00	0.00	33.51	0.0	10.4	4.2	142.3	368.5	13.75	60	2.00	5922.75	5926.14	5924.91	5929.56	5934.95	5957.09	Pipe - (47) (1)
4	3	169.377	56.80	56.80	0.59	33.51	33.51	10.0	10.0	4.3	144.1	368.5	13.81	60	2.00	5936.14	5939.53	5938.31	5942.97	5957.09	5954.42	Pipe - (47)
Project File: STM4.0 - 5YR.stm																Number of lines: 4				Run Date: 10/11/2022		
NOTES:Intensity = 503.90 / (Inlet time + 28.20) ^ 1.31; Return period =Yrs. 5 ; c = cir e = ellip b = box																						



# Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
(1)	(in) (2)	(cfs) (3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(ft) (12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(K) (23)	(ft) (24)
1	60	117.6	5903.80	5908.17	4.37	18.20	6.46	0.65	5908.82	0.185	5.000	5903.80	5908.18	4.38	18.23	6.45	0.65	5908.83	0.185	0.185	0.009	0.15	0.10
2	60	119.1	5903.80	5908.28	4.48	12.86	6.42	1.33	5909.61	0.000	155.68	5912.75	5915.87	3.12**	12.86	9.26	1.33	5917.20	0.000	0.000	n/a	0.15	n/a
3	60	142.3	5922.75	5924.91	2.16*	8.11	17.55	1.54	5926.45	0.000	169.37	5926.14	5929.56	3.42**	14.29	9.96	1.54	5931.10	0.000	0.000	n/a	0.15	0.23
4	60	144.1	5936.14	5938.31	2.17*	8.19	17.61	1.56	5939.87	0.000	169.37	5939.53	5942.97	3.44**	14.39	10.02	1.56	5944.53	0.000	0.000	n/a	1.00	1.56
Project File: STM4.0 - 5YR.stm														Number of lines: 4					Run Date: 10/11/2022				
Notes: * depth assumed; ** Critical depth. ; c = cir e = ellip b = box																							

## General Procedure:

Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

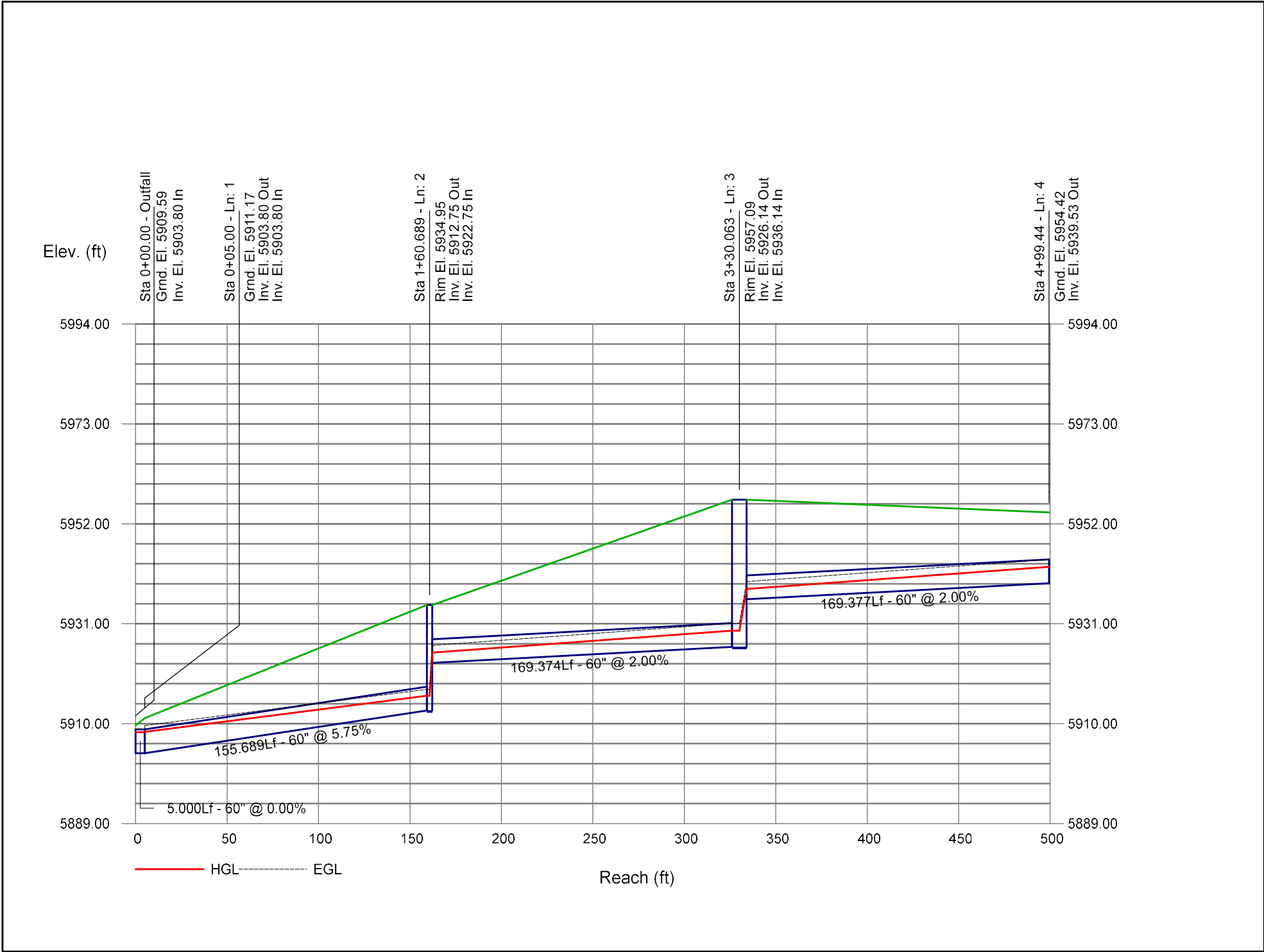
Col. 21 The average of the downstream and upstream friction slopes.

Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

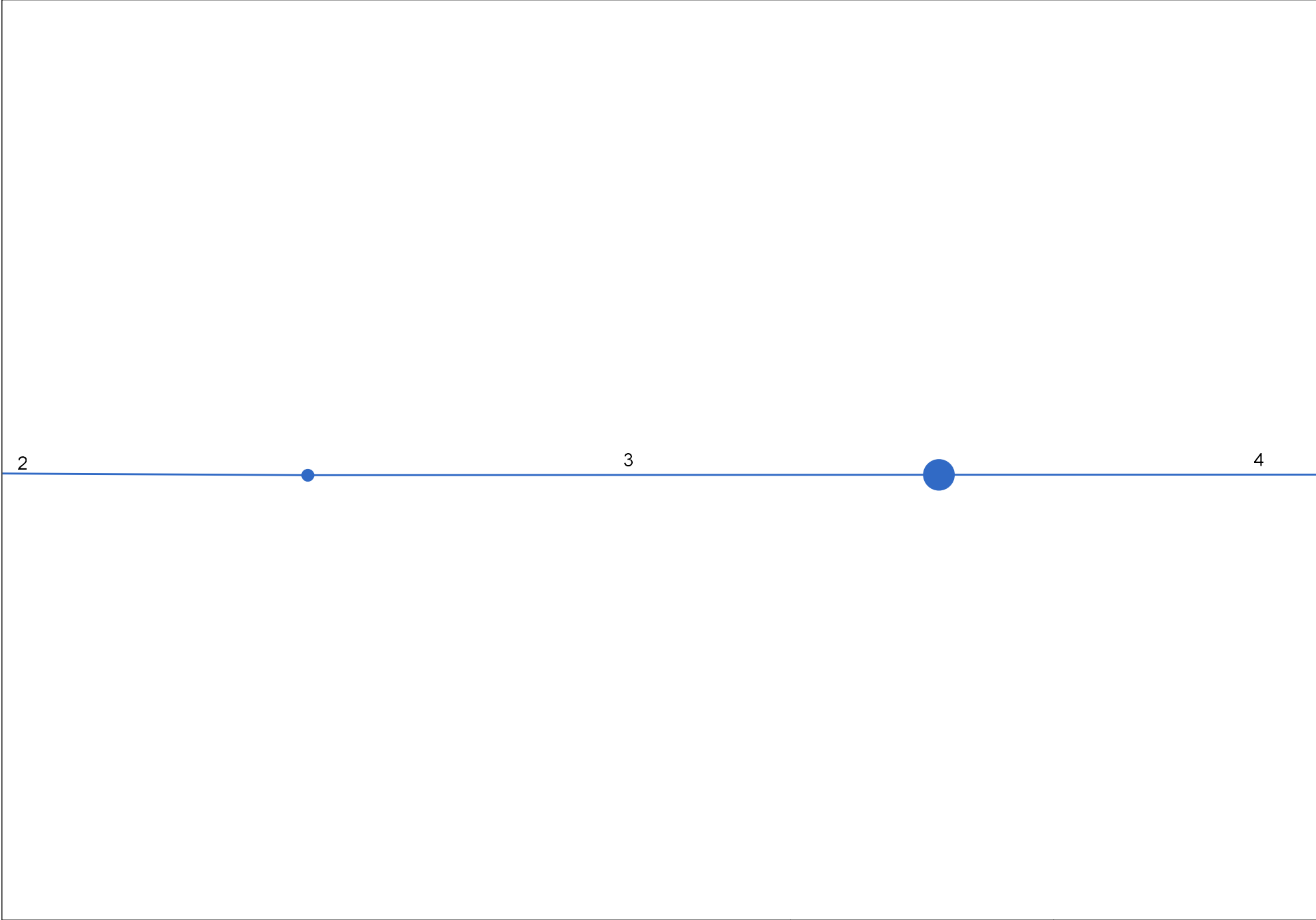
Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

Storm Sewer Profile



# Hydraflow Storm Sewers Extension for Autodesk® Civil 3D® Plan



Project File: STM4.0 - 100YR.stm	Number of lines: 4	Date: 10/11/2022
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# Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	Pipe - (36) (1)	242.0	60	Cir	5.000	5903.80	5903.80	0.000	5908.17	5908.42	0.38	5908.80	End	None
2	Pipe - (36)	243.5	60	Cir	155.689	5903.80	5912.75	5.749	5908.80	5917.13	0.42	5917.13	1	Manhole
3	Pipe - (47) (1)	285.0	60	Cir	169.374	5922.75	5926.14	2.002	5926.05	5930.75	n/a	5930.75	2	Manhole
4	Pipe - (47)	286.9	60	Cir	169.377	5936.14	5939.53	2.001	5939.46	5944.15	3.57	5944.15	3	None

# Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line		Incr	Total		Incr	Total	Inlet	Syst					Size	Slope	Dn	Up	Dn	Up	Dn	Up	
		(ft)	(ac)	(ac)	(C)			(min)	(min)	(in/hr)	(cfs)	(cfs)	(ft/s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
1	End	5.000	0.00	61.20	0.00	0.00	41.34	0.0	16.6	5.9	242.0	0.00	13.03	60	0.00	5903.80	5903.80	5908.17	5908.42	5909.59	5911.17	Pipe - (36) (1)
2	1	155.689	4.40	61.20	0.36	1.58	41.34	16.4	16.4	5.9	243.5	624.5	12.88	60	5.75	5903.80	5912.75	5908.80	5917.13	5911.17	5934.95	Pipe - (36)
3	2	169.374	0.00	56.80	0.00	0.00	39.76	0.0	10.2	7.2	285.0	368.5	17.89	60	2.00	5922.75	5926.14	5926.05	5930.75	5934.95	5957.09	Pipe - (47) (1)
4	3	169.377	56.80	56.80	0.70	39.76	39.76	10.0	10.0	7.2	286.9	368.5	17.95	60	2.00	5936.14	5939.53	5939.46	5944.15	5957.09	5954.42	Pipe - (47)
Project File: STM4.0 - 100YR.stm																Number of lines: 4				Run Date: 10/11/2022		
NOTES:Intensity = 790.75 / (Inlet time + 27.70) ^ 1.29; Return period =Yrs. 100 ; c = cir e = ellip b = box																						



# Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
(1)	(in) (2)	(cfs) (3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(ft) (12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(K) (23)	(ft) (24)
1	60	242.0	5903.80	5908.17	4.37	18.20	13.30	2.75	5910.92	0.783	5.000	5903.80	5908.42	4.62	18.96	12.77	2.53	5910.96	0.748	0.766	0.038	0.15	0.38
2	60	243.5	5903.80	5908.80	5.00	18.23	12.41	2.39	5911.20	0.875	155.689	5912.75	5917.13	4.38**	18.23	13.36	2.77	5919.90	0.791	0.833	n/a	0.15	0.42
3	60	285.0	5922.75	5926.05	3.30*	13.76	20.71	3.53	5929.58	0.000	169.374	5926.14	5930.75	4.61**	18.92	15.07	3.53	5934.28	0.000	0.000	n/a	0.15	n/a
4	60	286.9	5936.14	5939.46	3.32*	13.83	20.74	3.57	5943.03	0.000	169.377	5939.53	5944.15	4.61**	18.94	15.15	3.57	5947.71	0.000	0.000	n/a	1.00	3.57
Project File: STM4.0 - 100YR.stm															Number of lines: 4					Run Date: 10/11/2022			
Notes: * depth assumed; ** Critical depth. ; c = cir e = ellip b = box																							

## General Procedure:

Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

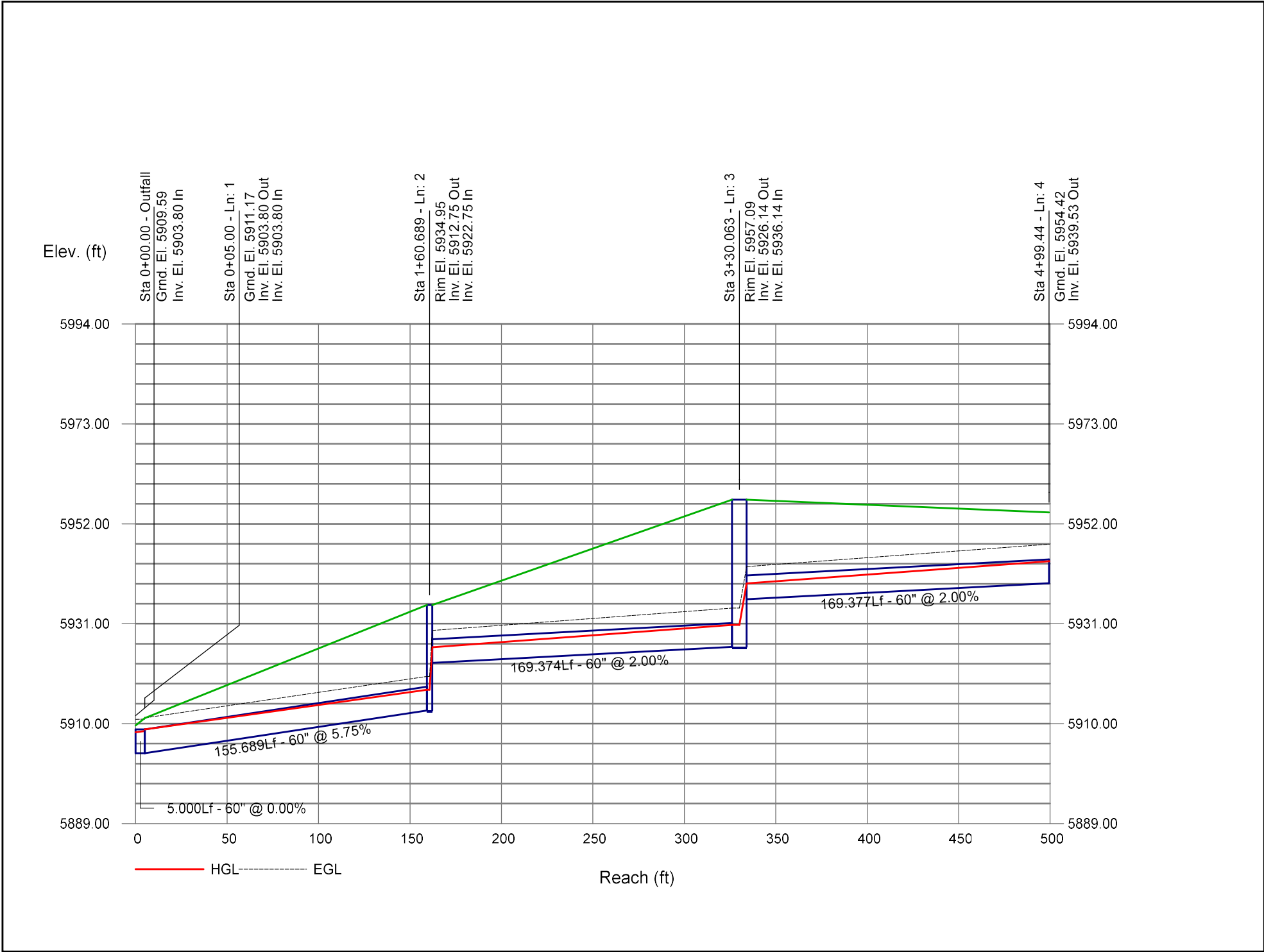
Col. 21 The average of the downstream and upstream friction slopes.

Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

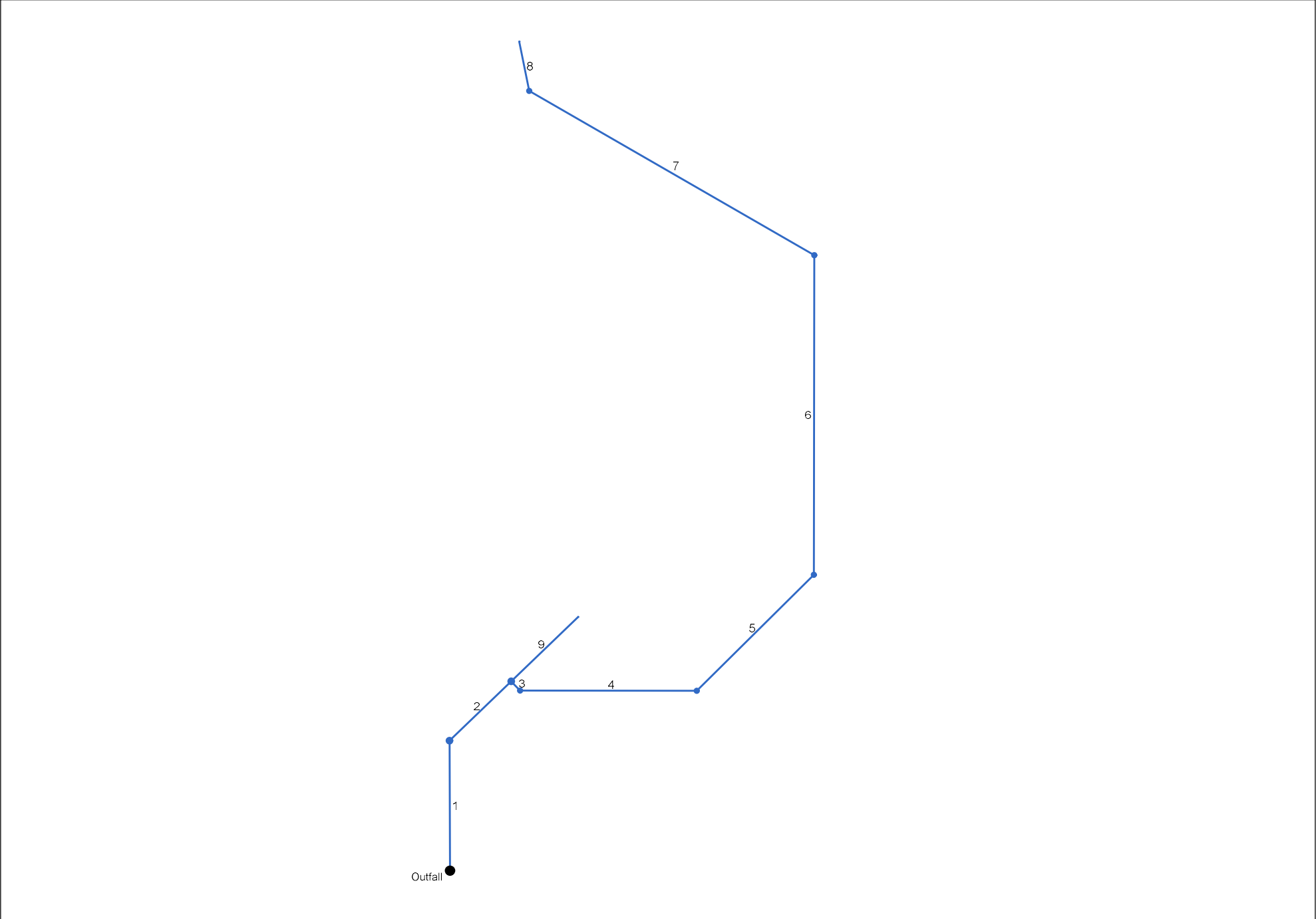
Storm Sewer Profile



# STM-5.0 & Pond 701 Outfall Summary And Profile

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# Hydraflow Storm Sewers Extension for Autodesk® Civil 3D® Plan



Project File: STM5.0 & Pond 705 Outfall- 5YR.stm	Number of lines: 9	Date: 10/28/2022
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# Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	Pipe - (71)	84.59	96	Cir	183.438	5891.00	5894.90	2.126	5894.97	5897.16	n/a	5897.16 j	End	Manhole
2	Pipe - (27)	84.62	66	Cir	120.382	5895.10	5895.60	0.415	5897.49	5898.13	0.98	5898.13	1	Manhole
3	Pipe - (22) (1) (1)	69.00	42	Cir	18.000	5897.60	5898.21	3.388	5899.08	5900.81	n/a	5900.81	2	Manhole
4	Pipe - (22) (1)	69.00	42	Cir	247.795	5898.51	5906.94	3.402	5900.81	5909.54	n/a	5909.54	3	Manhole
5	Pipe - (22)	69.00	42	Cir	231.951	5907.24	5915.12	3.397	5909.54	5917.72	n/a	5917.72	4	Manhole
6	Pipe - (20)	69.00	42	Cir	450.861	5915.42	5921.19	1.280	5917.72	5923.79	n/a	5923.79	5	Manhole
7	Pipe - (19)	69.00	42	Cir	462.515	5921.49	5927.41	1.280	5923.79	5930.01	n/a	5930.01	6	Manhole
8	Pipe - (37)	69.00	36	Cir	70.805	5927.91	5930.20	3.234	5930.01	5932.84	n/a	5932.84	7	None
9	Pipe - (26)	12.20	54	Cir	130.583	5896.60	5897.15	0.421	5898.13	5898.14	n/a	5898.14 j	2	None
Project File: STM5.0 & Pond 705 Outfall- 5YR.stm									Number of lines: 9			Run Date: 10/28/2022		
NOTES: Return period = 5 Yrs. ; j - Line contains hyd. jump.														



# Storm Sewer Inlet Time Tabulation

Line No.	Line ID	Tc Method	Sheet Flow					Shallow Concentrated Flow					Channel Flow							Total
			n-Value	flow Length (ft)	2-yr 24h P (in)	Land Slope (%)	Travel Time (min)	flow Length (ft)	Water Slope (%)	Surf Descr	Ave Vel (ft/s)	Travel Time (min)	X-sec Area (sqft)	Wetted Perim (ft)	Chan Slope (%)	n-Value	Vel	flow Length (ft)	Travel Time (min)	Travel Time (min)
1	Pipe - (71)	User																		0.00
2	Pipe - (27)	User																		42.00
3	Pipe - (22) (1) (1)	User																		0.00
4	Pipe - (22) (1)	User																		0.00
5	Pipe - (22)	User																		0.00
6	Pipe - (20)	User																		0.00
7	Pipe - (19)	User																		0.00
8	Pipe - (37)	User																		0.00
9	Pipe - (26)	User																		0.00
Project File: STM5.0 & Pond 705 Outfall- 5YR.stm					Min. Tc used for intensity calculations = 5 min						Number of lines: 9					Date: 10/28/2022				

# Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
(1)	(in) (2)	(cfs) (3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(ft) (12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(K) (23)	(ft) (24)
1	96	84.59	5891.00	5894.97	3.97	11.68	3.40	0.81	5895.79	0.000	183.438	5894.90	5897.16 j	2.26**	11.68	7.24	0.81	5897.98	0.000	0.000	n/a	0.76	n/a
2	66	84.62	5895.10	5897.49	2.39*	9.90	8.55	0.98	5898.47	0.000	120.382	5895.60	5898.13	2.53**	10.67	7.93	0.98	5899.11	0.000	0.000	n/a	1.00	0.98
3	42	69.00	5897.60	5899.08	1.48*	3.87	17.83	1.26	5900.34	0.000	18.000	5898.21	5900.81	2.60**	7.67	9.00	1.26	5902.07	0.000	0.000	n/a	0.76	n/a
4	42	69.00	5898.51	5900.81	2.30	6.71	10.29	1.26	5902.07	0.000	247.795	5906.94	5909.54	2.60**	7.67	9.00	1.26	5910.80	0.000	0.000	n/a	0.75	n/a
5	42	69.00	5907.24	5909.54	2.30	6.70	10.29	1.26	5910.80	0.000	231.951	5915.12	5917.72	2.60**	7.67	9.00	1.26	5918.98	0.000	0.000	n/a	0.75	n/a
6	42	69.00	5915.42	5917.72	2.30	6.71	10.29	1.26	5918.98	0.000	450.861	5921.19	5923.79	2.60**	7.67	9.00	1.26	5925.05	0.000	0.000	n/a	0.89	n/a
7	42	69.00	5921.49	5923.79	2.30	6.70	10.29	1.26	5925.05	0.000	462.515	5927.41	5930.01	2.60**	7.67	9.00	1.26	5931.27	0.000	0.000	n/a	0.79	n/a
8	36	69.00	5927.91	5930.01	2.10	5.29	13.05	1.70	5931.71	0.000	70.805	5930.20	5932.84	2.64**	6.59	10.47	1.70	5934.55	0.000	0.000	n/a	1.00	n/a
9	54	12.20	5896.60	5898.13	1.53	2.58	2.56	0.35	5898.48	0.000	130.583	5897.15	5898.14 j	0.99**	2.58	4.73	0.35	5898.48	0.000	0.000	n/a	1.00	n/a
Project File: STM5.0 & Pond 705 Outfall- 5YR.stm														Number of lines: 9					Run Date: 10/28/2022				
Notes: * depth assumed; ** Critical depth.; j-Line contains hyd. jump ; c = cir e = ellip b = box																							

## General Procedure:

Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

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Col. 16 Cross-sectional area of the flow at the upstream end.

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Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

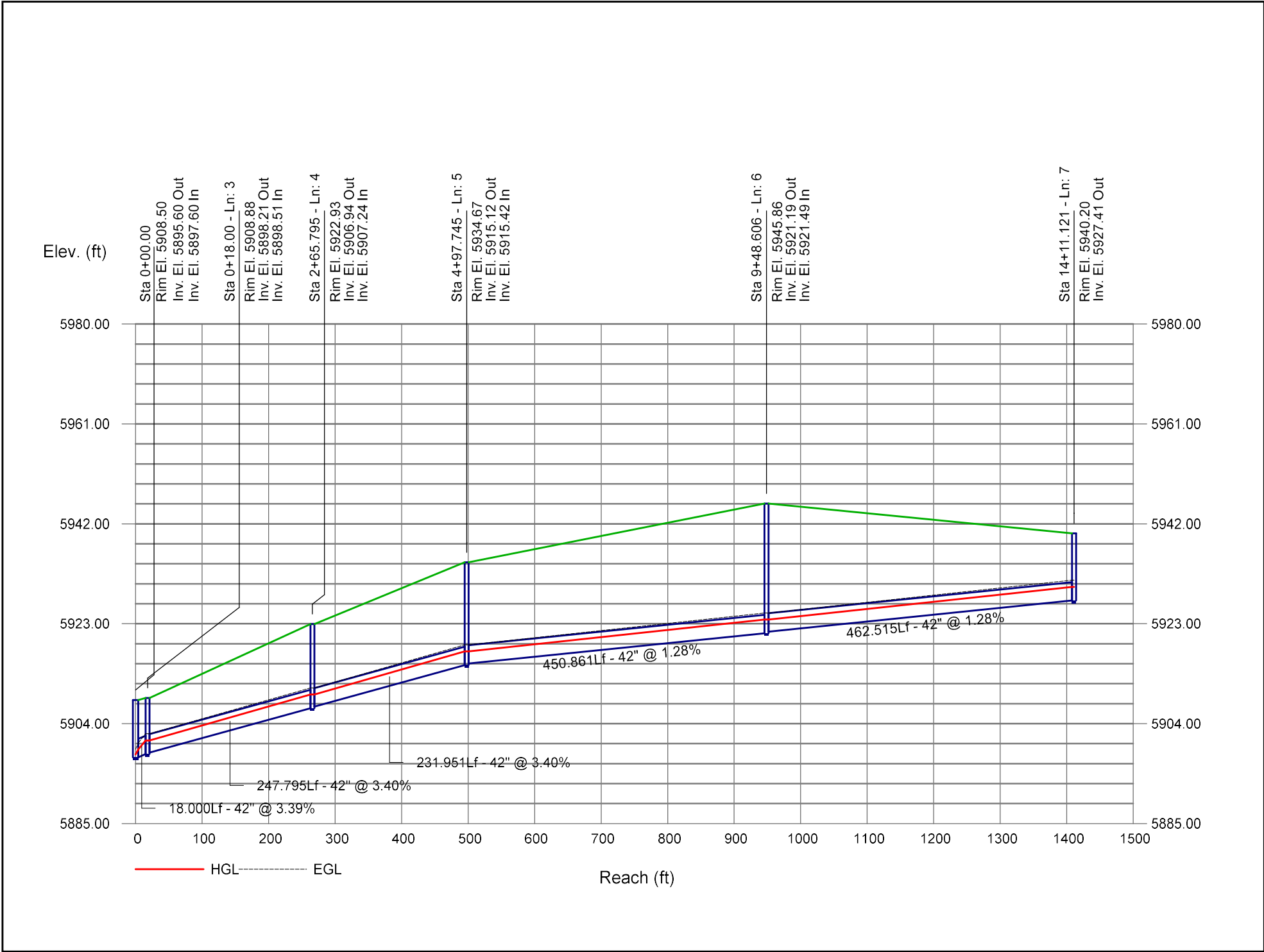
Col. 21 The average of the downstream and upstream friction slopes.

Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

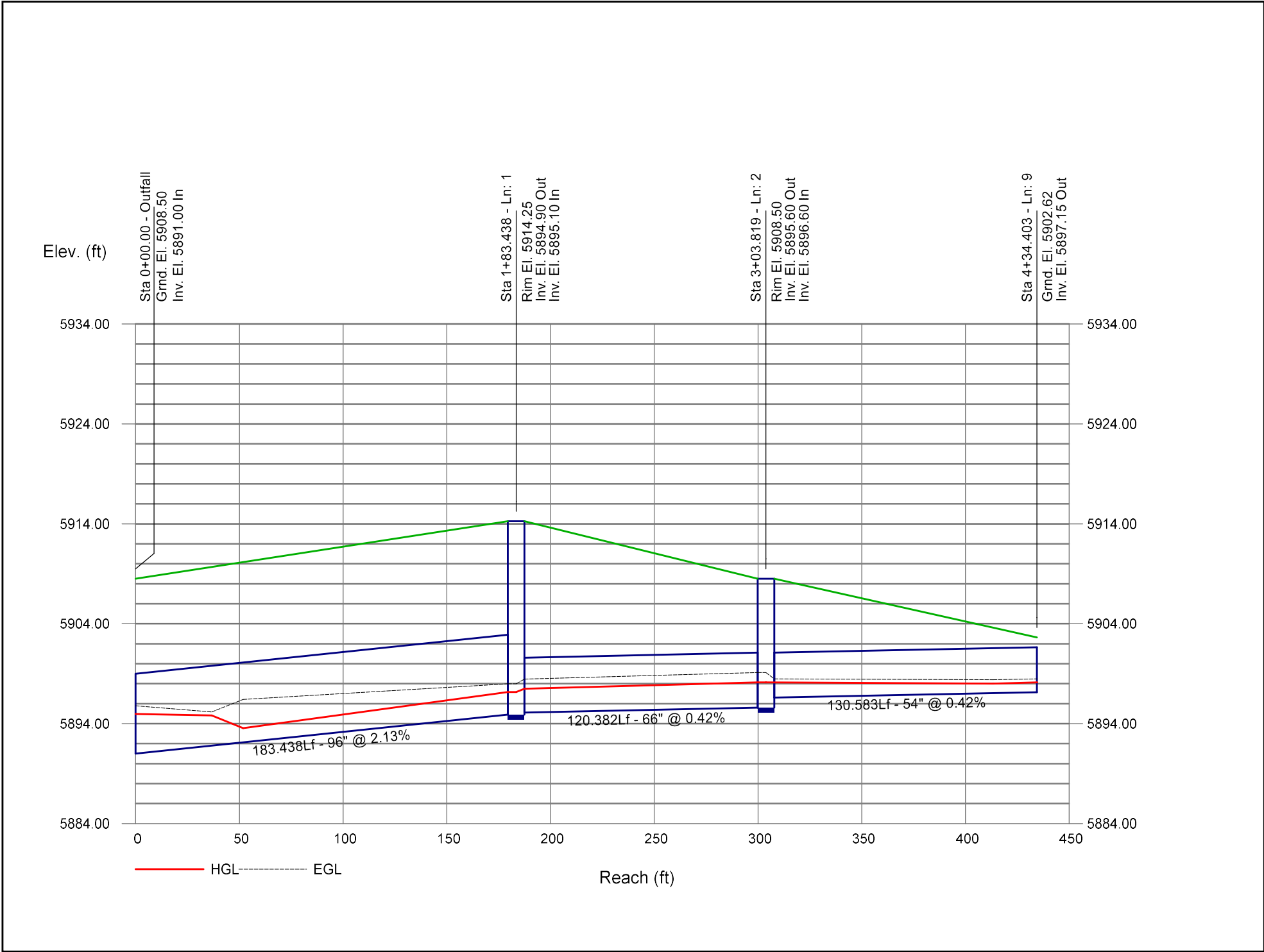
Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

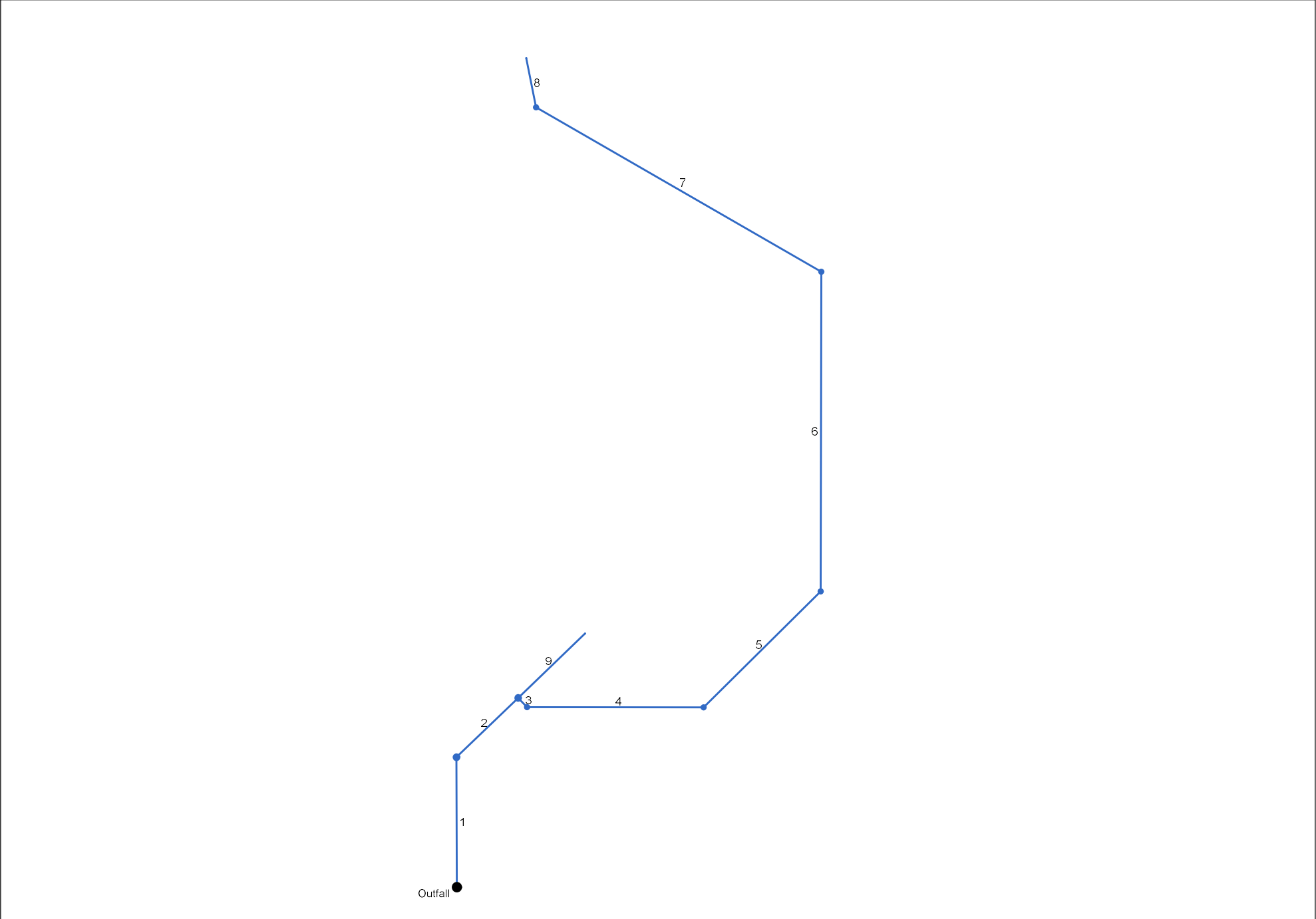
Storm Sewer Profile



Storm Sewer Profile



# Hydraflow Storm Sewers Extension for Autodesk® Civil 3D® Plan



Project File: STM5.0 & Pond 705 Outfall - 100YR.stm	Number of lines: 9	Date: 10/28/2022
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# Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	Pipe - (71)	301.3	96	Cir	183.438	5891.00	5894.90	2.126	5893.59	5899.28	1.35	5899.28	End	Manhole
2	Pipe - (27)	301.3	66	Cir	120.382	5895.10	5895.60	0.415	5900.60*	5901.57*	2.50	5904.07	1	Manhole
3	Pipe - (22) (1) (1)	136.9	42	Cir	18.000	5897.60	5898.21	3.388	5904.07*	5904.41*	2.39	5906.80	2	Manhole
4	Pipe - (22) (1)	136.9	42	Cir	247.795	5898.51	5906.94	3.402	5906.80*	5911.39*	2.36	5913.75	3	Manhole
5	Pipe - (22)	136.9	42	Cir	231.951	5907.24	5915.12	3.397	5913.75	5918.46	2.44	5918.46	4	Manhole
6	Pipe - (20)	136.9	42	Cir	450.861	5915.42	5921.19	1.280	5918.92*	5927.27*	2.80	5930.07	5	Manhole
7	Pipe - (19)	136.9	42	Cir	462.515	5921.49	5927.41	1.280	5930.07*	5938.64*	2.49	5941.13	6	Manhole
8	Pipe - (37)	136.9	36	Cir	70.805	5927.91	5930.20	3.234	5941.13*	5944.11*	5.83	5949.94	7	None
9	Pipe - (26)	150.7	54	Cir	130.583	5896.60	5897.15	0.421	5904.07*	5904.84*	1.40	5906.24	2	None
Project File: STM5.0 & Pond 705 Outfall - 100YR.stm									Number of lines: 9			Run Date: 10/28/2022		
NOTES: Return period = 100 Yrs. ; *Surcharged (HGL above crown).														

# Storm Sewer Inlet Time Tabulation

Line No.	Line ID	Tc Method	Sheet Flow					Shallow Concentrated Flow					Channel Flow								Total
			n-Value	flow Length (ft)	2-yr 24h P (in)	Land Slope (%)	Travel Time (min)	flow Length (ft)	Water Slope (%)	Surf Descr	Ave Vel (ft/s)	Travel Time (min)	X-sec Area (sqft)	Wetted Perim (ft)	Chan Slope (%)	n-Value	Vel	flow Length (ft)	Travel Time (min)	Travel Time (min)	
1	Pipe - (71)	User																		0.00	
2	Pipe - (27)	User																		42.00	
3	Pipe - (22) (1) (1)	User																		0.00	
4	Pipe - (22) (1)	User																		0.00	
5	Pipe - (22)	User																		0.00	
6	Pipe - (20)	User																		0.00	
7	Pipe - (19)	User																		0.00	
8	Pipe - (37)	User																		0.00	
9	Pipe - (26)	User																		0.00	
Project File: STM5.0 & Pond 705 Outfall - 100YR.stm					Min. Tc used for intensity calculations = 5 min						Number of lines: 9				Date: 10/28/2022						

# Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
(1)	(in) (2)	(cfs) (3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(ft) (12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(K) (23)	(ft) (24)
1	96	301.3	5891.00	5893.59	2.59	14.09	21.38	1.78	5895.37	0.000	183.438	5894.90	5899.28	4.38**	28.19	10.69	1.78	5901.06	0.000	0.000	n/a	0.76	1.35
2	66	301.3	5895.10	5900.60	5.50*	23.75	12.69	2.50	5903.10	0.805	120.382	5895.60	5901.57	5.50	23.76	12.68	2.50	5904.07	0.805	0.805	0.969	1.00	2.50
3	42	136.9	5897.60	5904.07	3.50	9.62	14.23	3.15	5907.22	1.852	18.000	5898.21	5904.41	3.50	9.62	14.23	3.15	5907.55	1.852	1.852	0.333	0.76	2.39
4	42	136.9	5898.51	5906.80	3.50	9.62	14.23	3.15	5909.95	1.852	247.795	5906.94	5911.39	3.50	9.62	14.23	3.15	5914.54	1.852	1.852	4.589	0.75	2.36
5	42	136.9	5907.24	5913.75	3.50	9.46	14.23	3.15	5916.90	1.852	231.951	5915.12	5918.46	3.34**	9.46	14.47	3.25	5921.71	1.607	1.730	n/a	0.75	2.44
6	42	136.9	5915.42	5918.92	3.50*	9.62	14.23	3.15	5922.07	1.852	450.861	5921.19	5927.27	3.50	9.62	14.23	3.15	5930.42	1.852	1.852	8.350	0.89	2.80
7	42	136.9	5921.49	5930.07	3.50	9.62	14.23	3.15	5933.22	1.852	462.515	5927.41	5938.64	3.50	9.62	14.23	3.15	5941.79	1.852	1.852	8.566	0.79	2.49
8	36	136.9	5927.91	5941.13	3.00	7.07	19.37	5.83	5946.96	4.215	70.805	5930.20	5944.11	3.00	7.07	19.37	5.83	5949.94	4.214	4.214	2.984	1.00	5.83
9	54	150.7	5896.60	5904.07	4.50	15.90	9.48	1.40	5905.47	0.587	130.583	5897.15	5904.84	4.50	15.90	9.48	1.40	5906.24	0.587	0.587	0.767	1.00	1.40
Project File: STM5.0 & Pond 705 Outfall - 100YR.stm														Number of lines: 9					Run Date: 10/28/2022				
Notes: * depth assumed; ** Critical depth. ; c = cir e = ellip b = box																							

## General Procedure:

Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

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Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

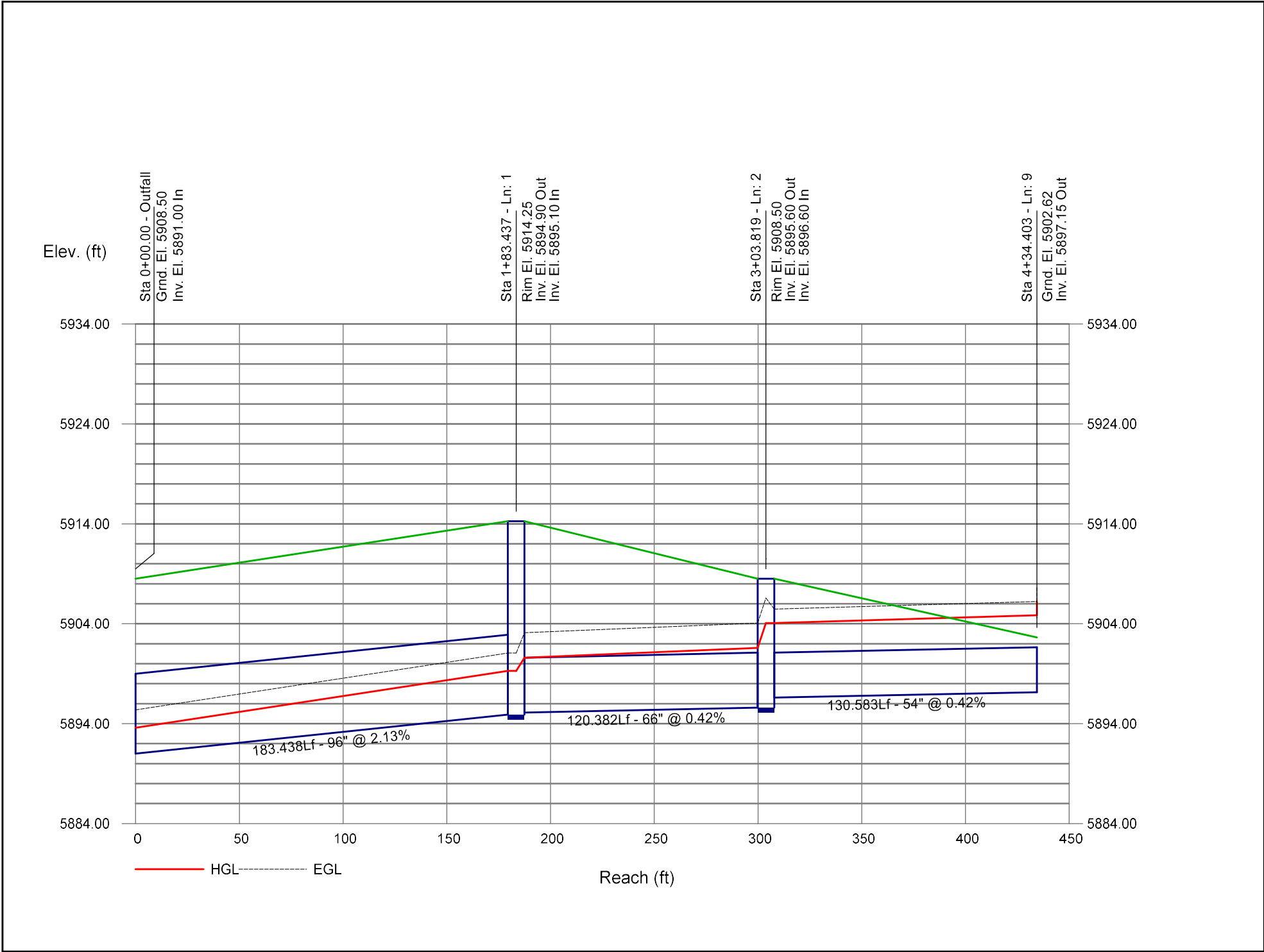
Col. 21 The average of the downstream and upstream friction slopes.

Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

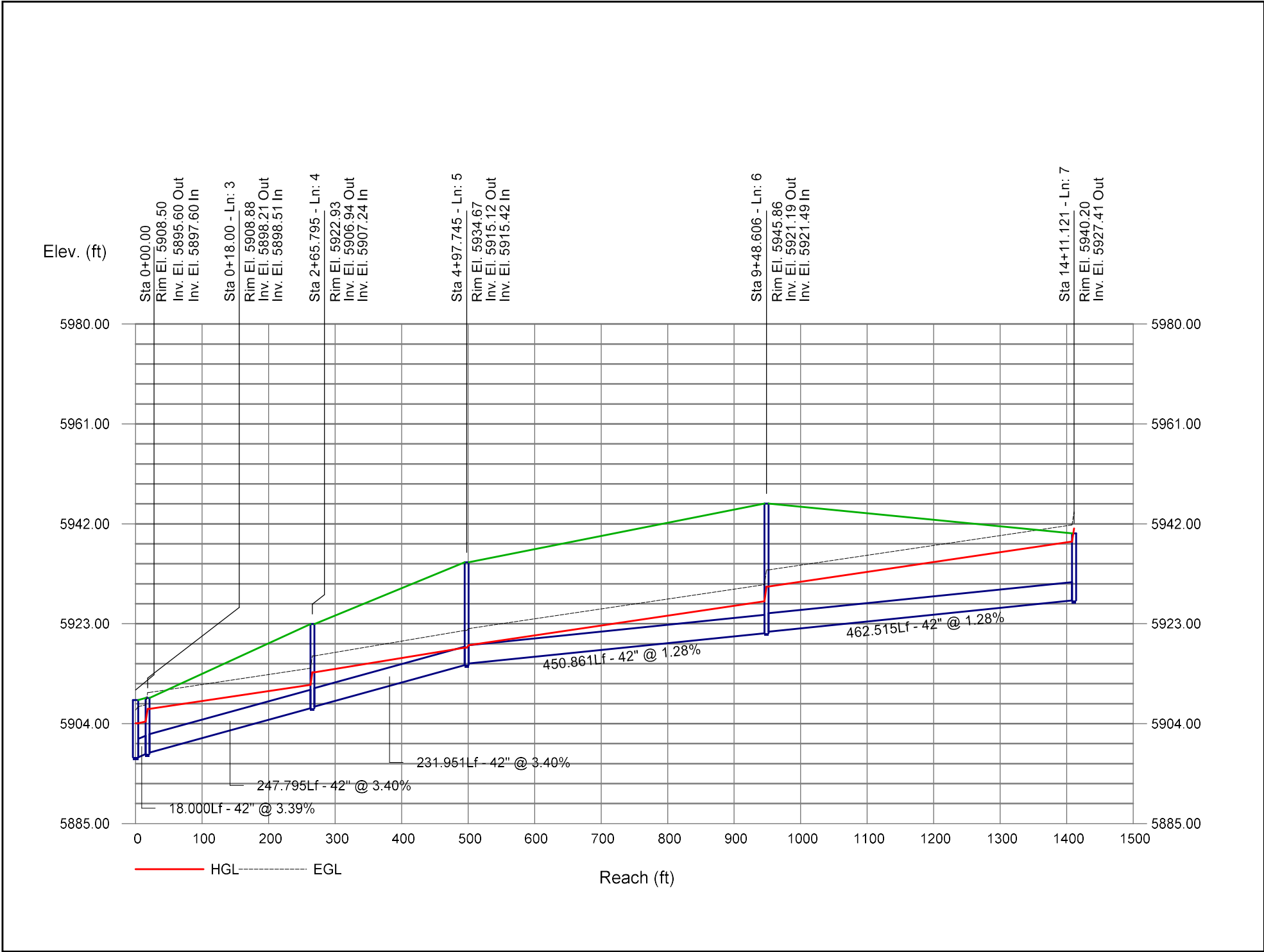
Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

Storm Sewer Profile



Storm Sewer Profile





## Swale Calculations

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# Channel Report

## SWALE 01

### Triangular

Side Slopes (z:1) = 4.00, 4.00  
Total Depth (ft) = 1.50

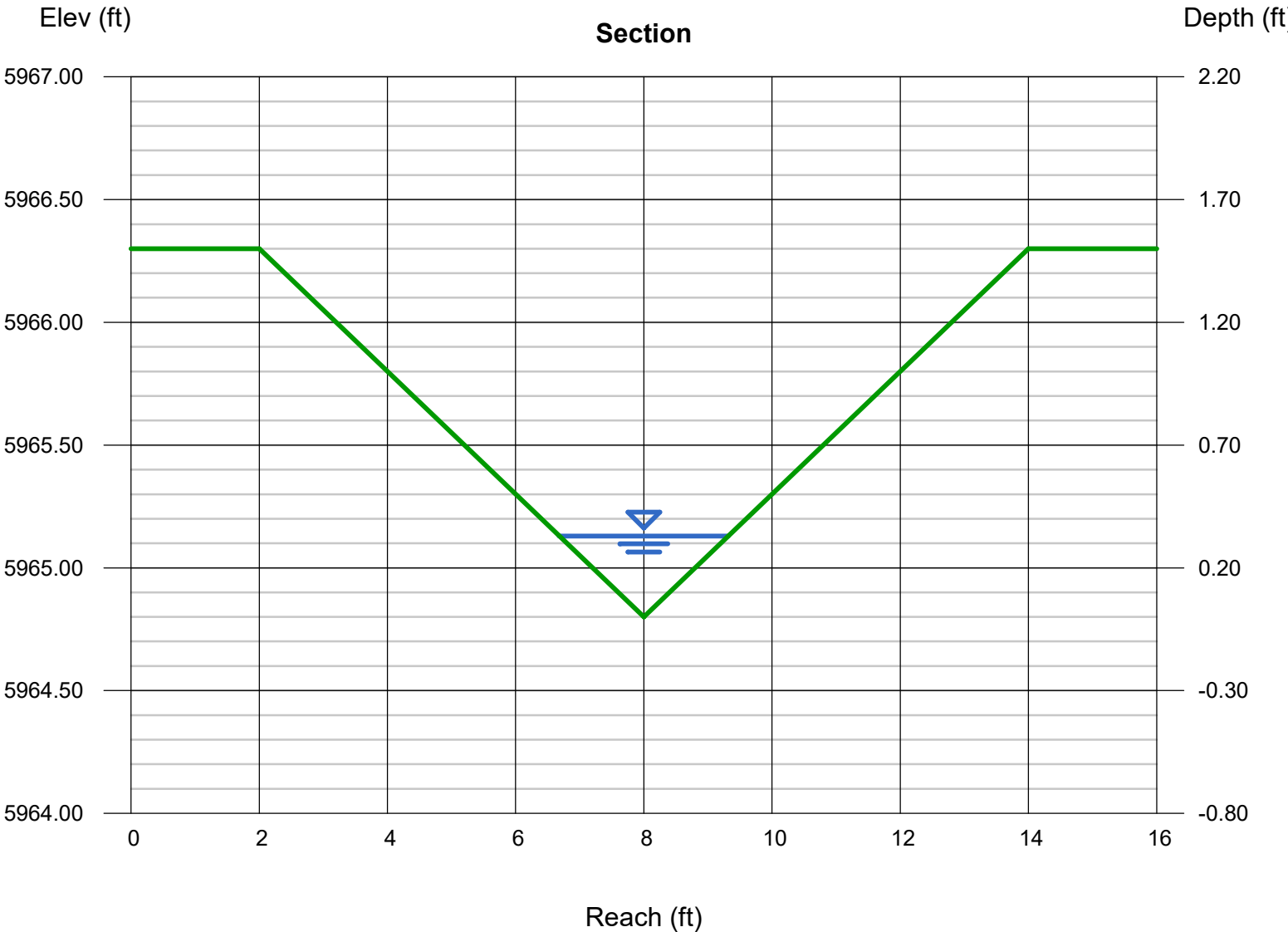
Invert Elev (ft) = 5964.80  
Slope (%) = 5.00  
N-Value = 0.030

### Calculations

Compute by: Known Q  
Known Q (cfs) = 1.40

### Highlighted

Depth (ft) = 0.33  
Q (cfs) = 1.400  
Area (sqft) = 0.44  
Velocity (ft/s) = 3.21  
Wetted Perim (ft) = 2.72  
Crit Depth, Yc (ft) = 0.38  
Top Width (ft) = 2.64  
EGL (ft) = 0.49



# Channel Report

## SWALE 02

### Triangular

Side Slopes (z:1) = 4.00, 4.00  
Total Depth (ft) = 2.25

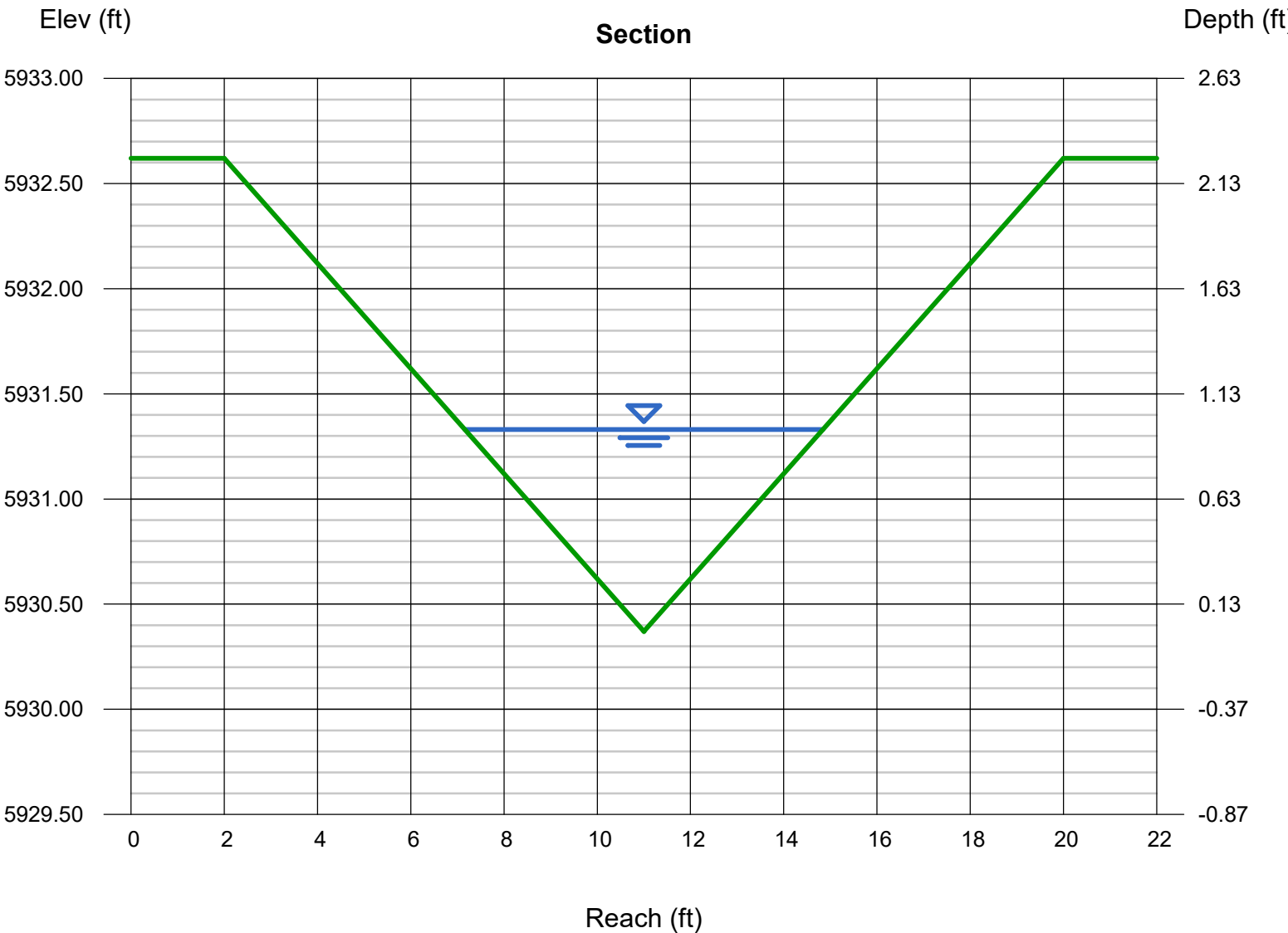
Invert Elev (ft) = 5930.37  
Slope (%) = 4.74  
N-Value = 0.030

### Calculations

Compute by: Known Q  
Known Q (cfs) = 23.50

### Highlighted

Depth (ft) = 0.96  
Q (cfs) = 23.50  
Area (sqft) = 3.69  
Velocity (ft/s) = 6.37  
Wetted Perim (ft) = 7.92  
Crit Depth, Yc (ft) = 1.17  
Top Width (ft) = 7.68  
EGL (ft) = 1.59



# Channel Report

## SWALE 03

### Triangular

Side Slopes (z:1) = 4.00, 4.00  
Total Depth (ft) = 1.50

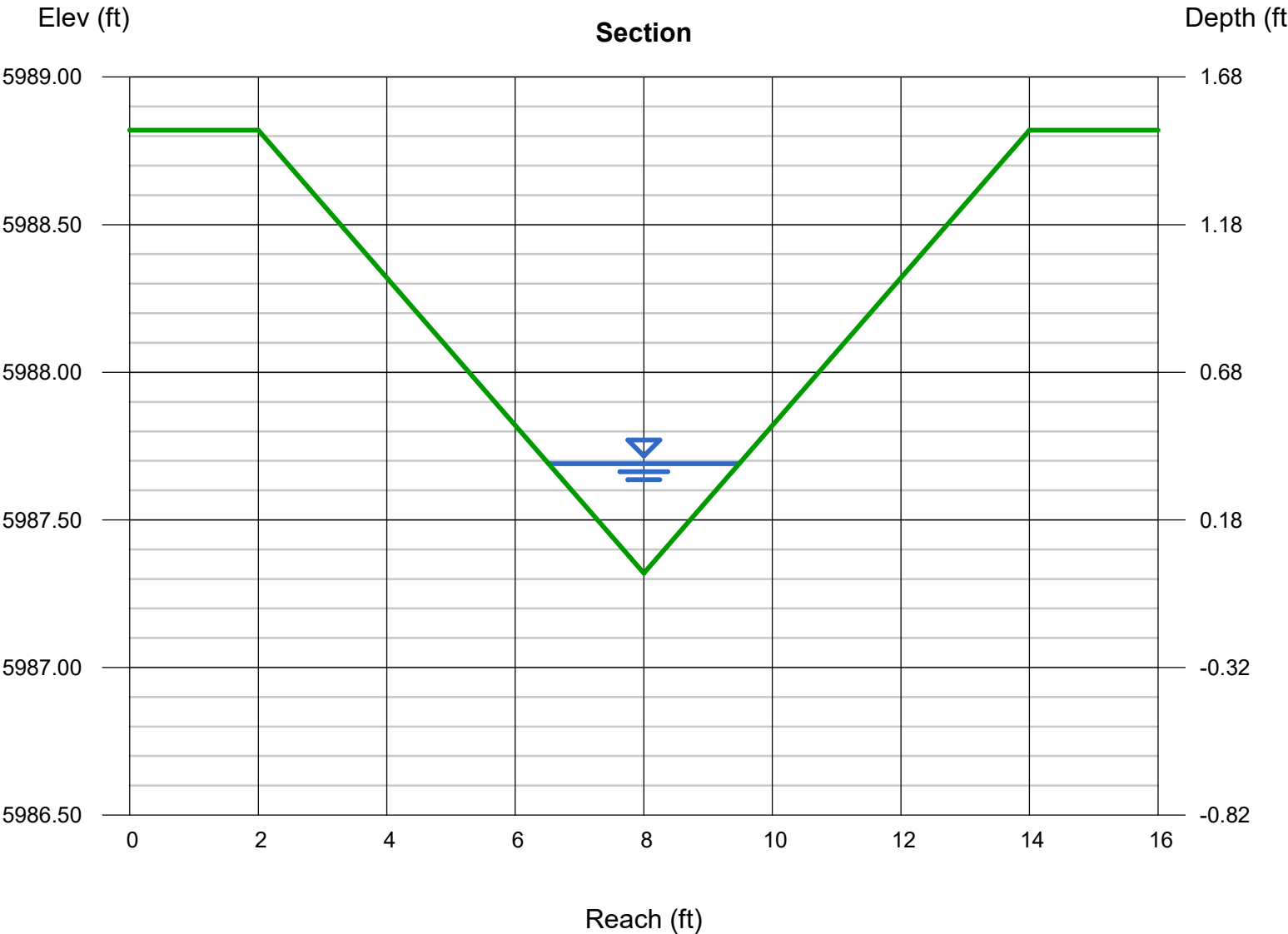
Invert Elev (ft) = 5987.32  
Slope (%) = 5.00  
N-Value = 0.030

### Calculations

Compute by: Known Q  
Known Q (cfs) = 1.80

### Highlighted

Depth (ft) = 0.37  
Q (cfs) = 1.800  
Area (sqft) = 0.55  
Velocity (ft/s) = 3.29  
Wetted Perim (ft) = 3.05  
Crit Depth, Yc (ft) = 0.42  
Top Width (ft) = 2.96  
EGL (ft) = 0.54



# Channel Report

## SWALE 04

### Triangular

Side Slopes (z:1) = 4.00, 4.00  
Total Depth (ft) = 2.25

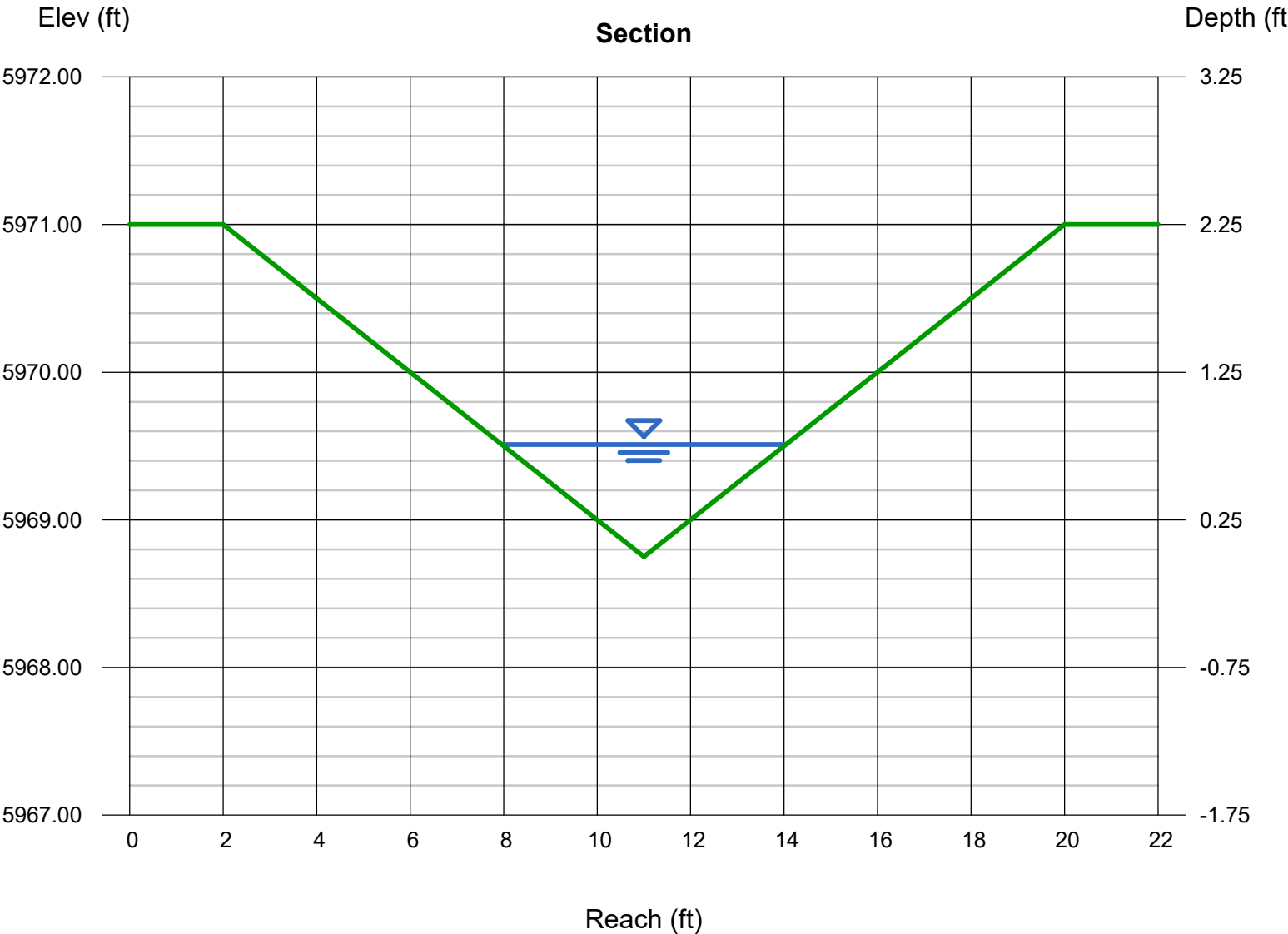
Invert Elev (ft) = 5968.75  
Slope (%) = 5.00  
N-Value = 0.030

### Calculations

Compute by: Known Q  
Known Q (cfs) = 13.00

### Highlighted

Depth (ft) = 0.76  
Q (cfs) = 13.00  
Area (sqft) = 2.31  
Velocity (ft/s) = 5.63  
Wetted Perim (ft) = 6.27  
Crit Depth, Yc (ft) = 0.92  
Top Width (ft) = 6.08  
EGL (ft) = 1.25



# Channel Report

## SWALE 05

### Triangular

Side Slopes (z:1) = 4.00, 4.00  
Total Depth (ft) = 2.25

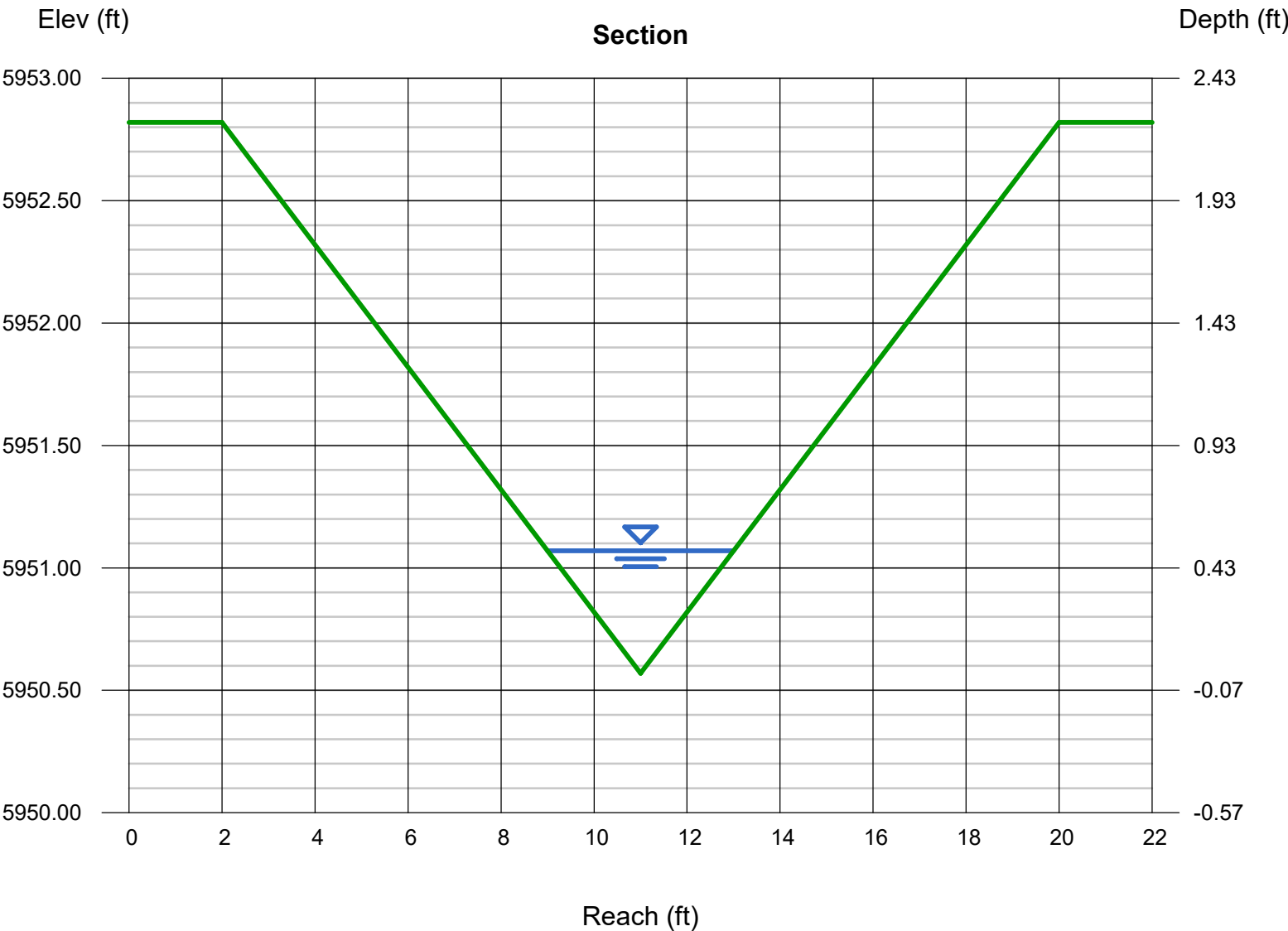
Invert Elev (ft) = 5950.57  
Slope (%) = 5.00  
N-Value = 0.030

### Calculations

Compute by: Known Q  
Known Q (cfs) = 4.10

### Highlighted

Depth (ft) = 0.50  
Q (cfs) = 4.100  
Area (sqft) = 1.00  
Velocity (ft/s) = 4.10  
Wetted Perim (ft) = 4.12  
Crit Depth, Yc (ft) = 0.58  
Top Width (ft) = 4.00  
EGL (ft) = 0.76



# Channel Report

## SWALE 06

### Triangular

Side Slopes (z:1) = 4.00, 4.00  
Total Depth (ft) = 2.25

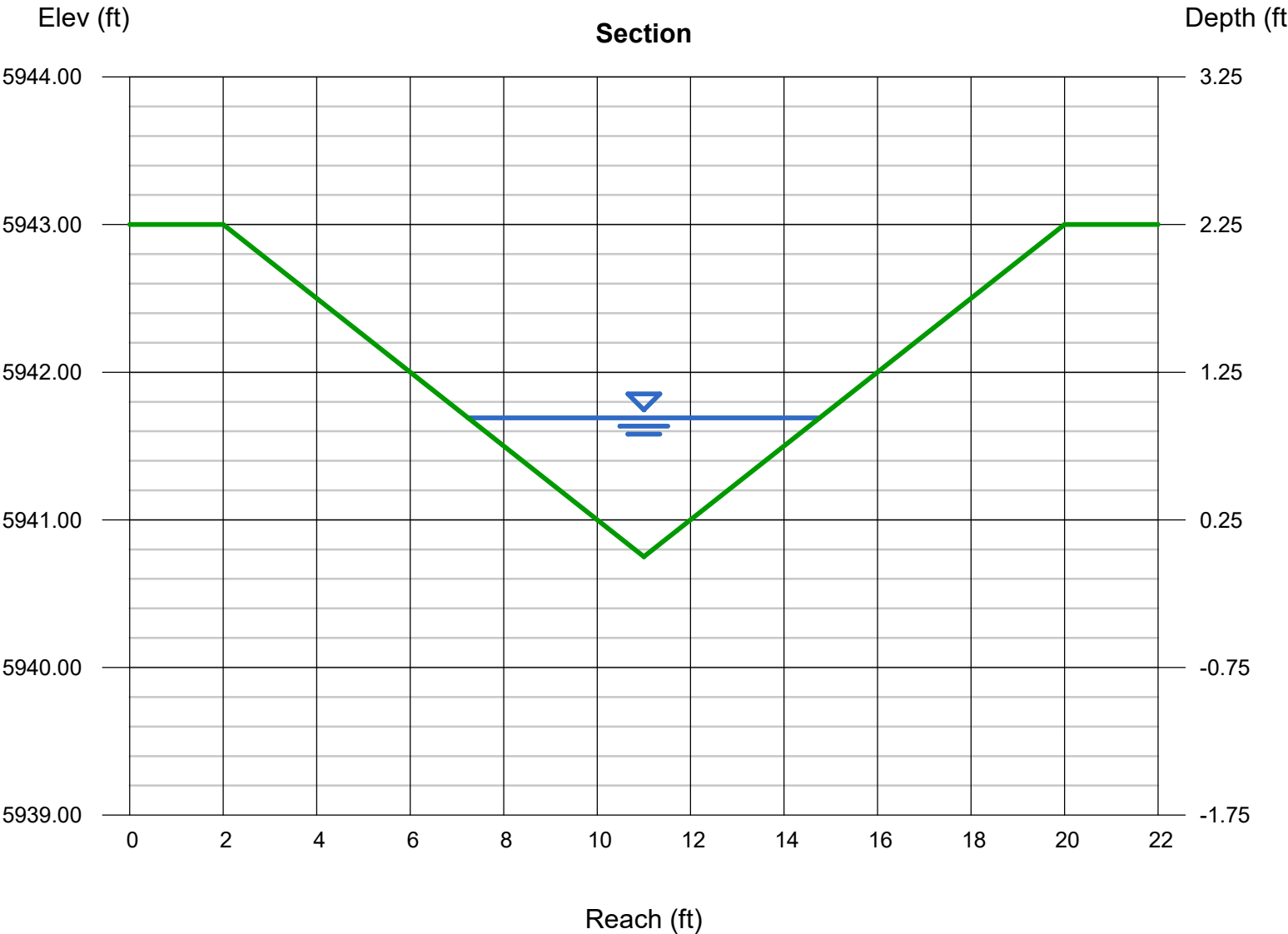
Invert Elev (ft) = 5940.75  
Slope (%) = 5.00  
N-Value = 0.030

### Calculations

Compute by: Known Q  
Known Q (cfs) = 22.60

### Highlighted

Depth (ft) = 0.94  
Q (cfs) = 22.60  
Area (sqft) = 3.53  
Velocity (ft/s) = 6.39  
Wetted Perim (ft) = 7.75  
Crit Depth, Yc (ft) = 1.15  
Top Width (ft) = 7.52  
EGL (ft) = 1.58





# Channel Report

## SWALE 07

### Triangular

Side Slopes (z:1) = 4.00, 4.00  
Total Depth (ft) = 2.00

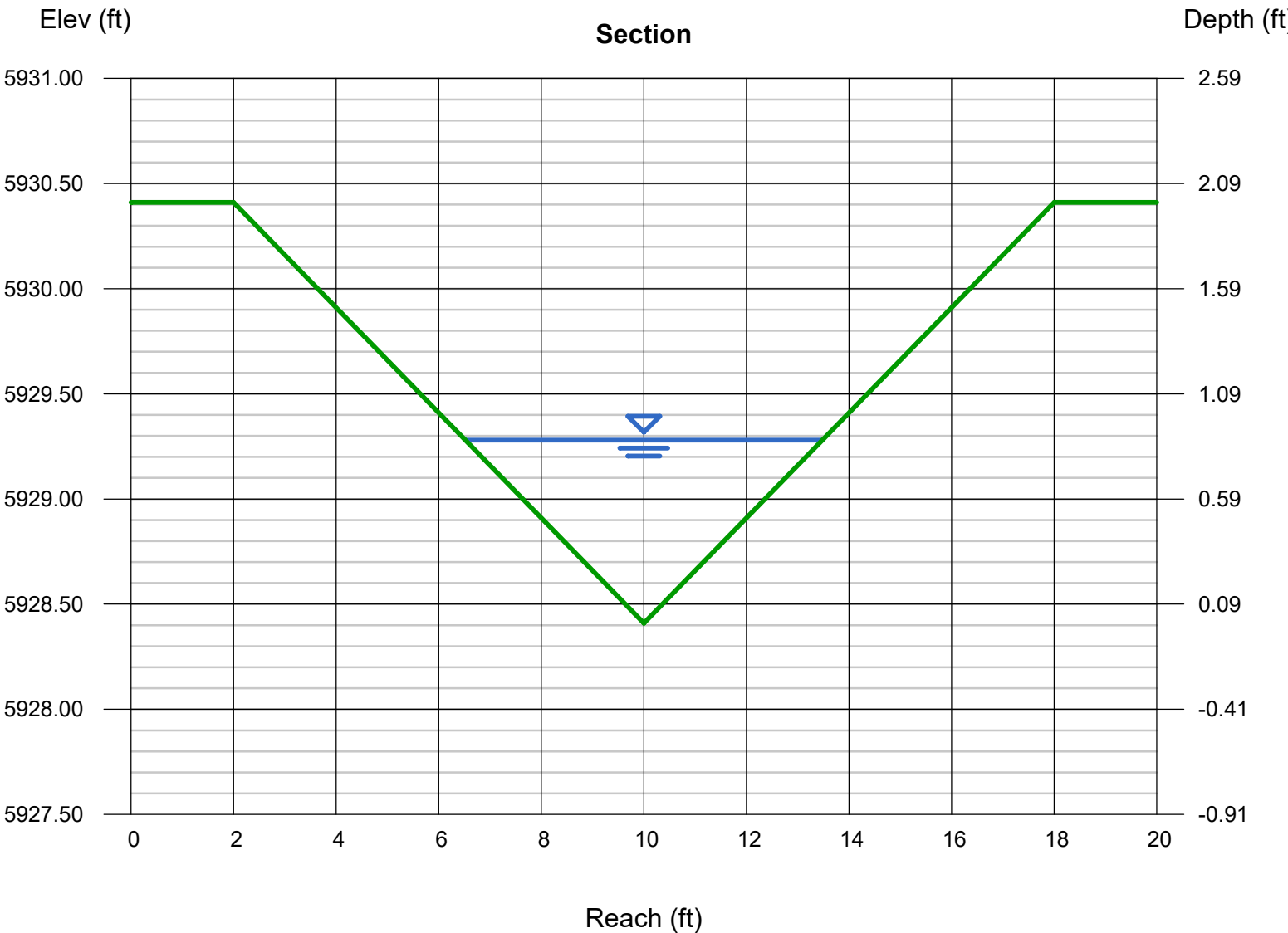
Invert Elev (ft) = 5928.41  
Slope (%) = 1.00  
N-Value = 0.030

### Calculations

Compute by: Known Q  
Known Q (cfs) = 8.20

### Highlighted

Depth (ft) = 0.87  
Q (cfs) = 8.200  
Area (sqft) = 3.03  
Velocity (ft/s) = 2.71  
Wetted Perim (ft) = 7.17  
Crit Depth, Yc (ft) = 0.77  
Top Width (ft) = 6.96  
EGL (ft) = 0.98



# Channel Report

## SWALE 08

### Triangular

Side Slopes (z:1) = 4.00, 4.00  
Total Depth (ft) = 2.25

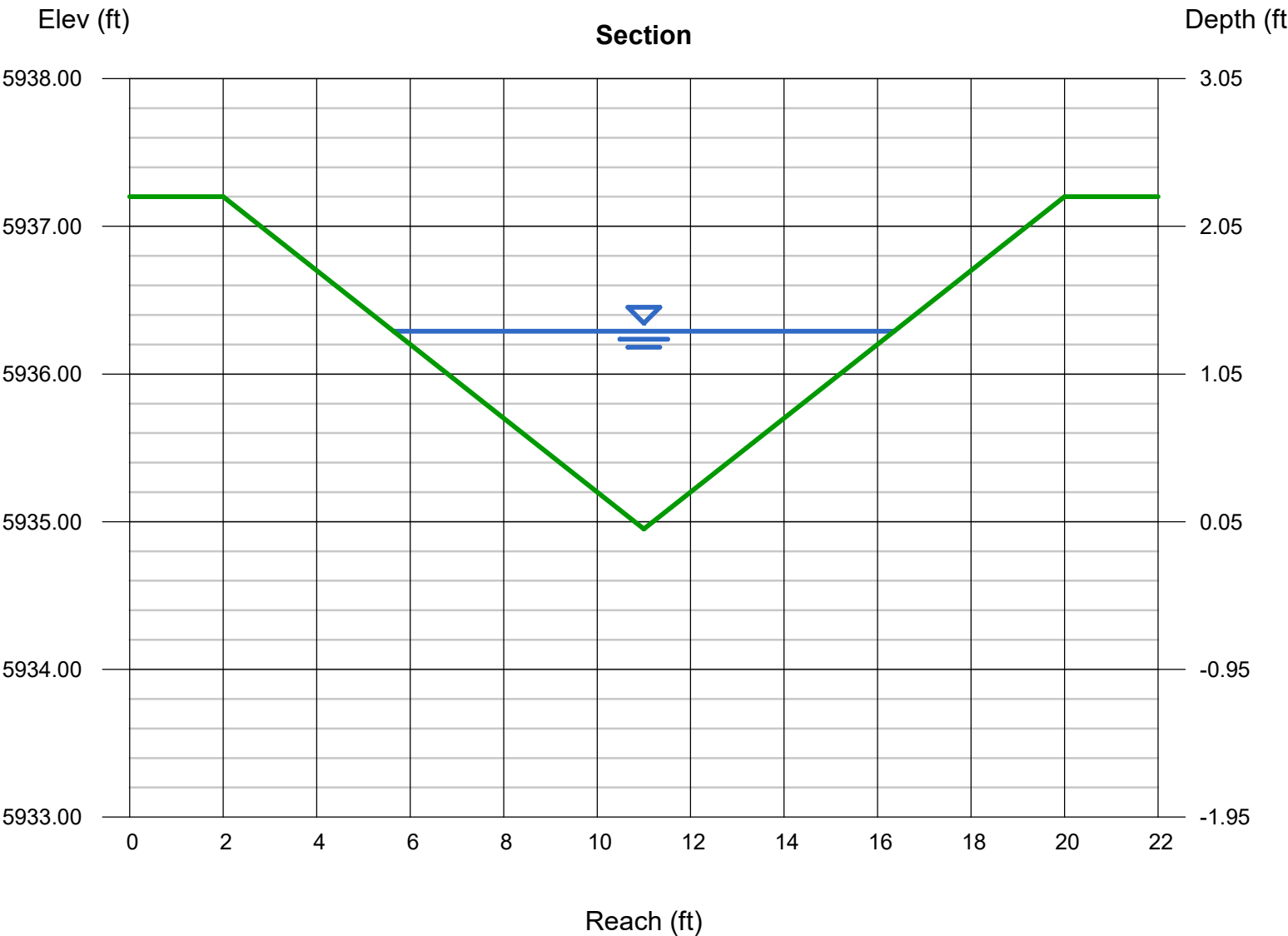
Invert Elev (ft) = 5934.95  
Slope (%) = 2.82  
N-Value = 0.030

### Calculations

Compute by: Known Q  
Known Q (cfs) = 44.00

### Highlighted

Depth (ft) = 1.34  
Q (cfs) = 44.00  
Area (sqft) = 7.18  
Velocity (ft/s) = 6.13  
Wetted Perim (ft) = 11.05  
Crit Depth, Yc (ft) = 1.50  
Top Width (ft) = 10.72  
EGL (ft) = 1.92



# Channel Report

## SWALE 09

### Triangular

Side Slopes (z:1) = 4.00, 4.00  
Total Depth (ft) = 2.25

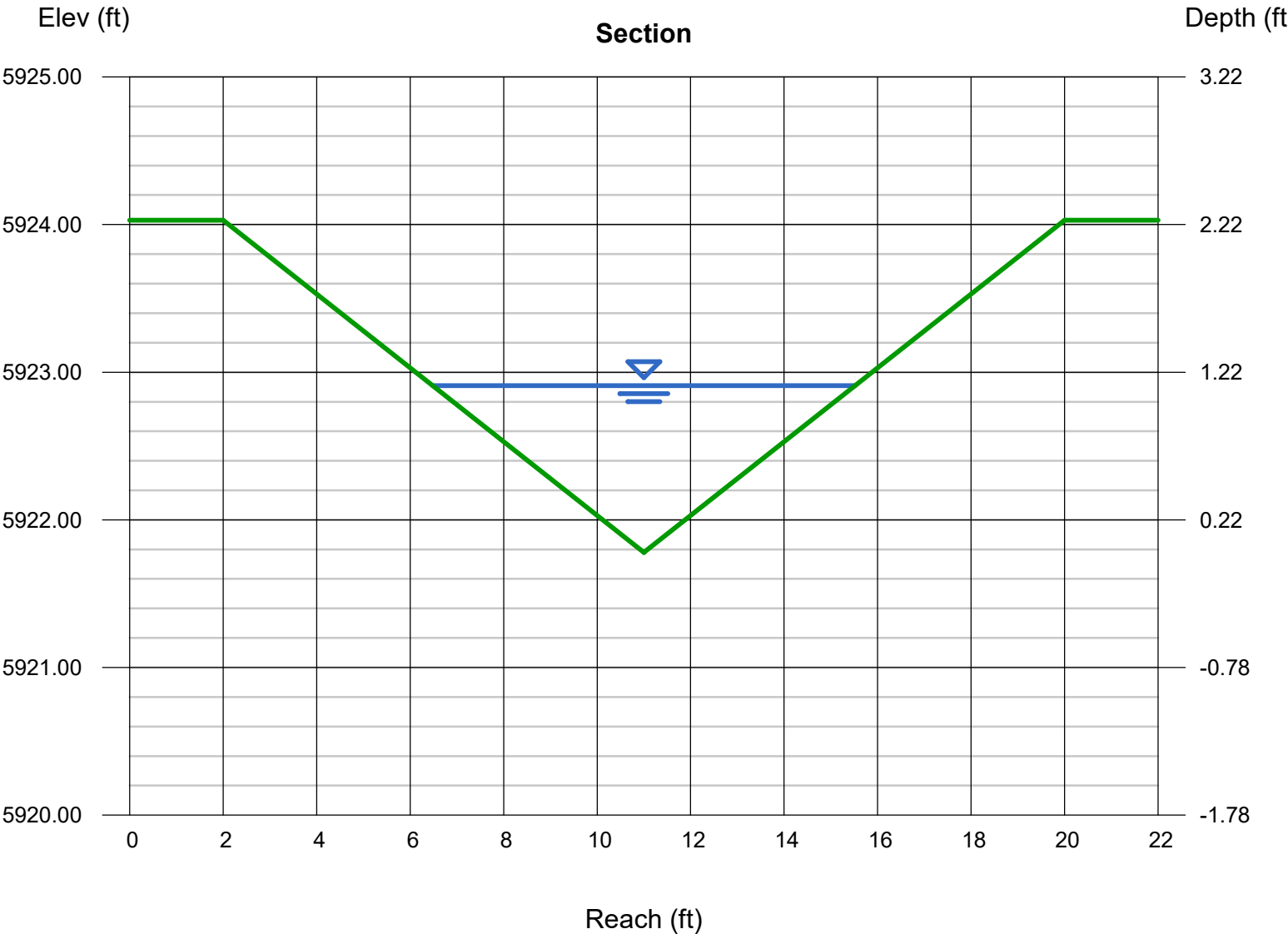
Invert Elev (ft) = 5921.78  
Slope (%) = 1.00  
N-Value = 0.030

### Calculations

Compute by: Known Q  
Known Q (cfs) = 16.80

### Highlighted

Depth (ft) = 1.13  
Q (cfs) = 16.80  
Area (sqft) = 5.11  
Velocity (ft/s) = 3.29  
Wetted Perim (ft) = 9.32  
Crit Depth, Yc (ft) = 1.02  
Top Width (ft) = 9.04  
EGL (ft) = 1.30



# Channel Report

## SWALE 10

### Triangular

Side Slopes (z:1) = 4.00, 4.00  
Total Depth (ft) = 1.75

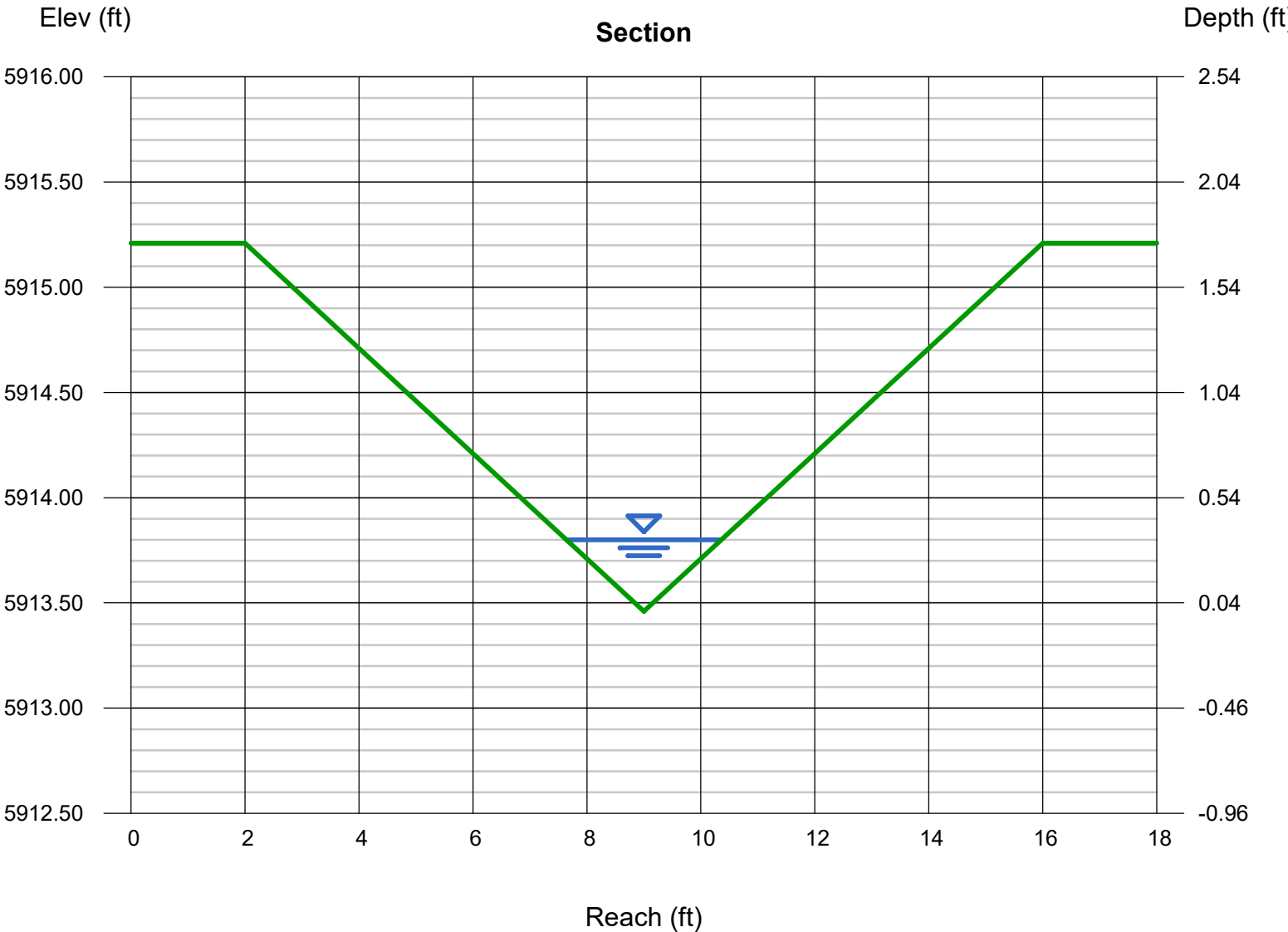
Invert Elev (ft) = 5913.46  
Slope (%) = 4.12  
N-Value = 0.030

### Calculations

Compute by: Known Q  
Known Q (cfs) = 1.30

### Highlighted

Depth (ft) = 0.34  
Q (cfs) = 1.300  
Area (sqft) = 0.46  
Velocity (ft/s) = 2.81  
Wetted Perim (ft) = 2.80  
Crit Depth, Yc (ft) = 0.37  
Top Width (ft) = 2.72  
EGL (ft) = 0.46



# Channel Report

## SWALE 11

### Triangular

Side Slopes (z:1) = 4.00, 4.00  
Total Depth (ft) = 2.25

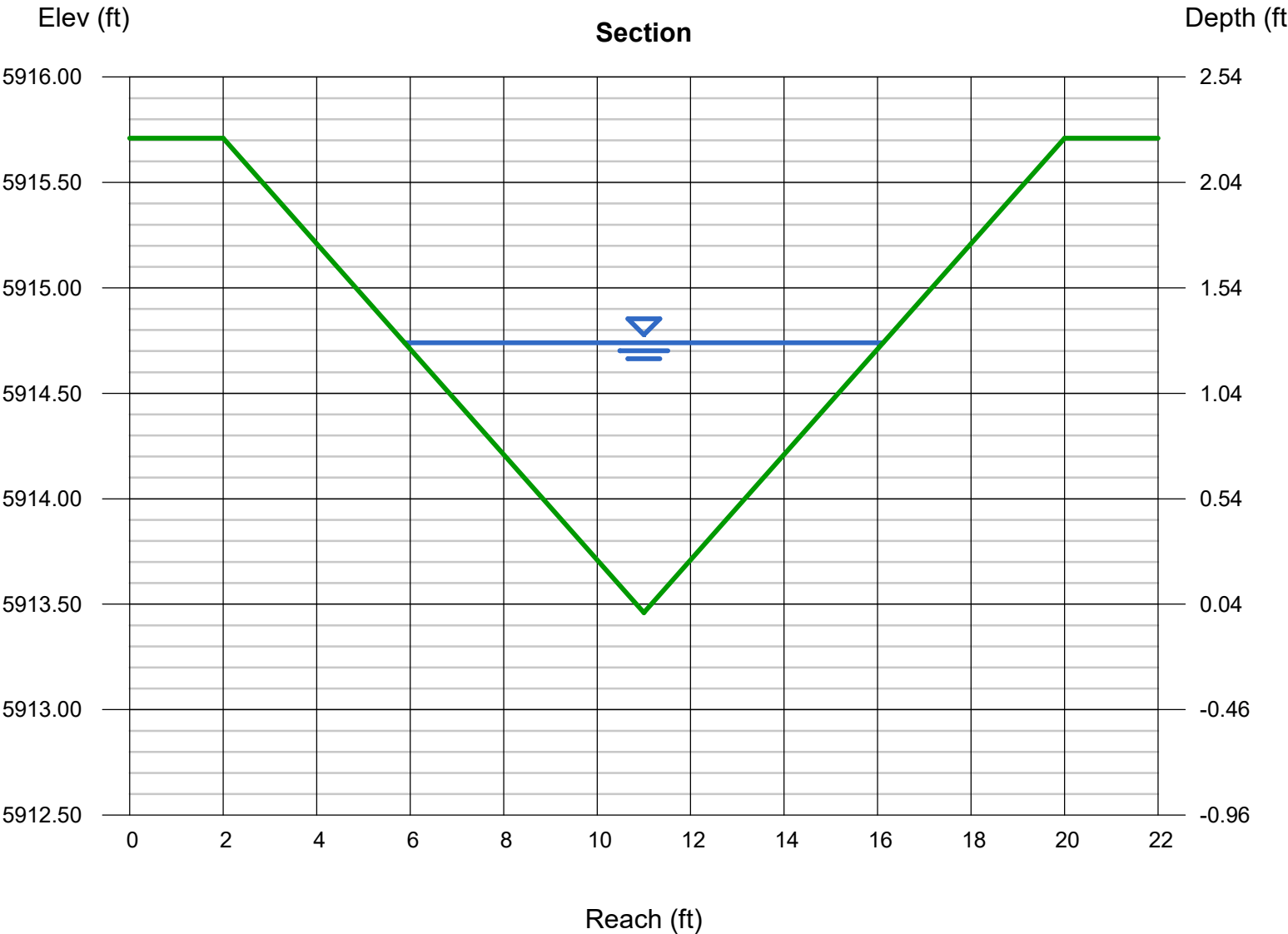
Invert Elev (ft) = 5913.46  
Slope (%) = 1.23  
N-Value = 0.030

### Calculations

Compute by: Known Q  
Known Q (cfs) = 25.70

### Highlighted

Depth (ft) = 1.28  
Q (cfs) = 25.70  
Area (sqft) = 6.55  
Velocity (ft/s) = 3.92  
Wetted Perim (ft) = 10.56  
Crit Depth, Yc (ft) = 1.21  
Top Width (ft) = 10.24  
EGL (ft) = 1.52



# Channel Report

## SWALE 12

### Triangular

Side Slopes (z:1) = 4.00, 4.00  
Total Depth (ft) = 1.50

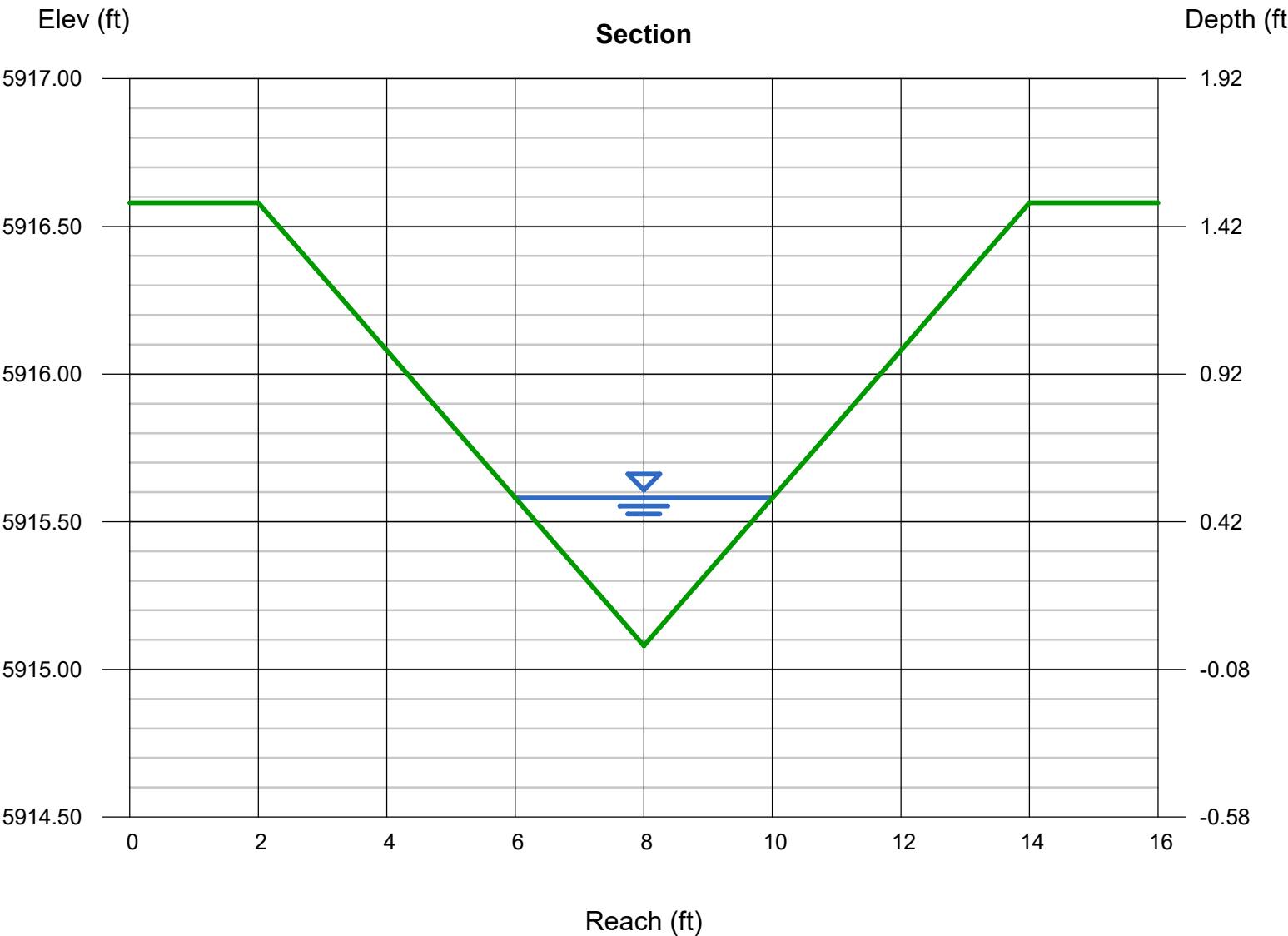
Invert Elev (ft) = 5915.08  
Slope (%) = 1.00  
N-Value = 0.030

### Calculations

Compute by: Known Q  
Known Q (cfs) = 1.90

### Highlighted

Depth (ft) = 0.50  
Q (cfs) = 1.900  
Area (sqft) = 1.00  
Velocity (ft/s) = 1.90  
Wetted Perim (ft) = 4.12  
Crit Depth, Yc (ft) = 0.43  
Top Width (ft) = 4.00  
EGL (ft) = 0.56



# Channel Report

## SWALE 13

### Triangular

Side Slopes (z:1) = 4.00, 4.00  
Total Depth (ft) = 1.50

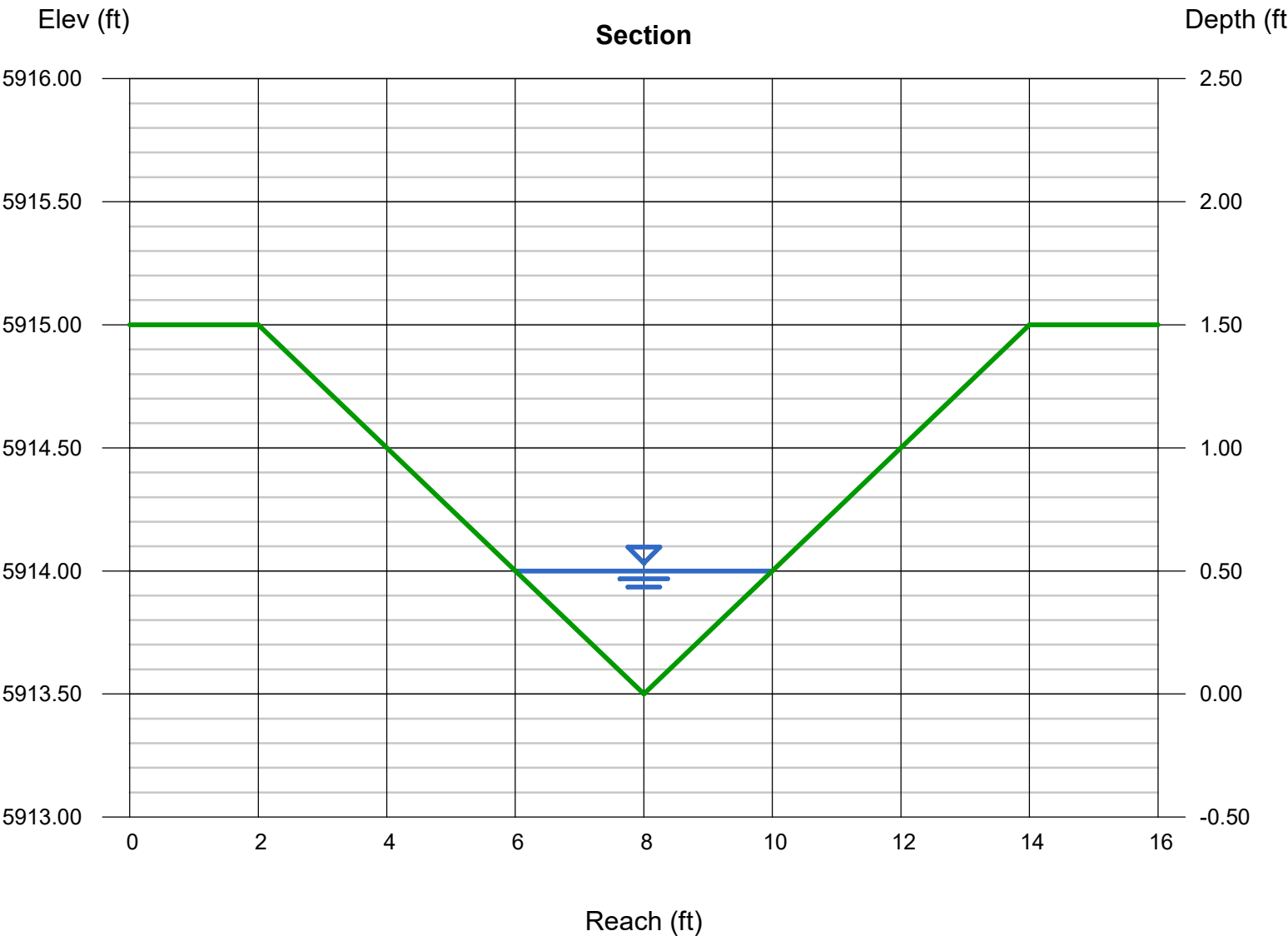
Invert Elev (ft) = 5913.50  
Slope (%) = 2.99  
N-Value = 0.030

### Calculations

Compute by: Known Q  
Known Q (cfs) = 3.20

### Highlighted

Depth (ft) = 0.50  
Q (cfs) = 3.200  
Area (sqft) = 1.00  
Velocity (ft/s) = 3.20  
Wetted Perim (ft) = 4.12  
Crit Depth, Yc (ft) = 0.53  
Top Width (ft) = 4.00  
EGL (ft) = 0.66





# Channel Report

## SWALE 14

### Triangular

Side Slopes (z:1) = 4.00, 4.00  
Total Depth (ft) = 2.25

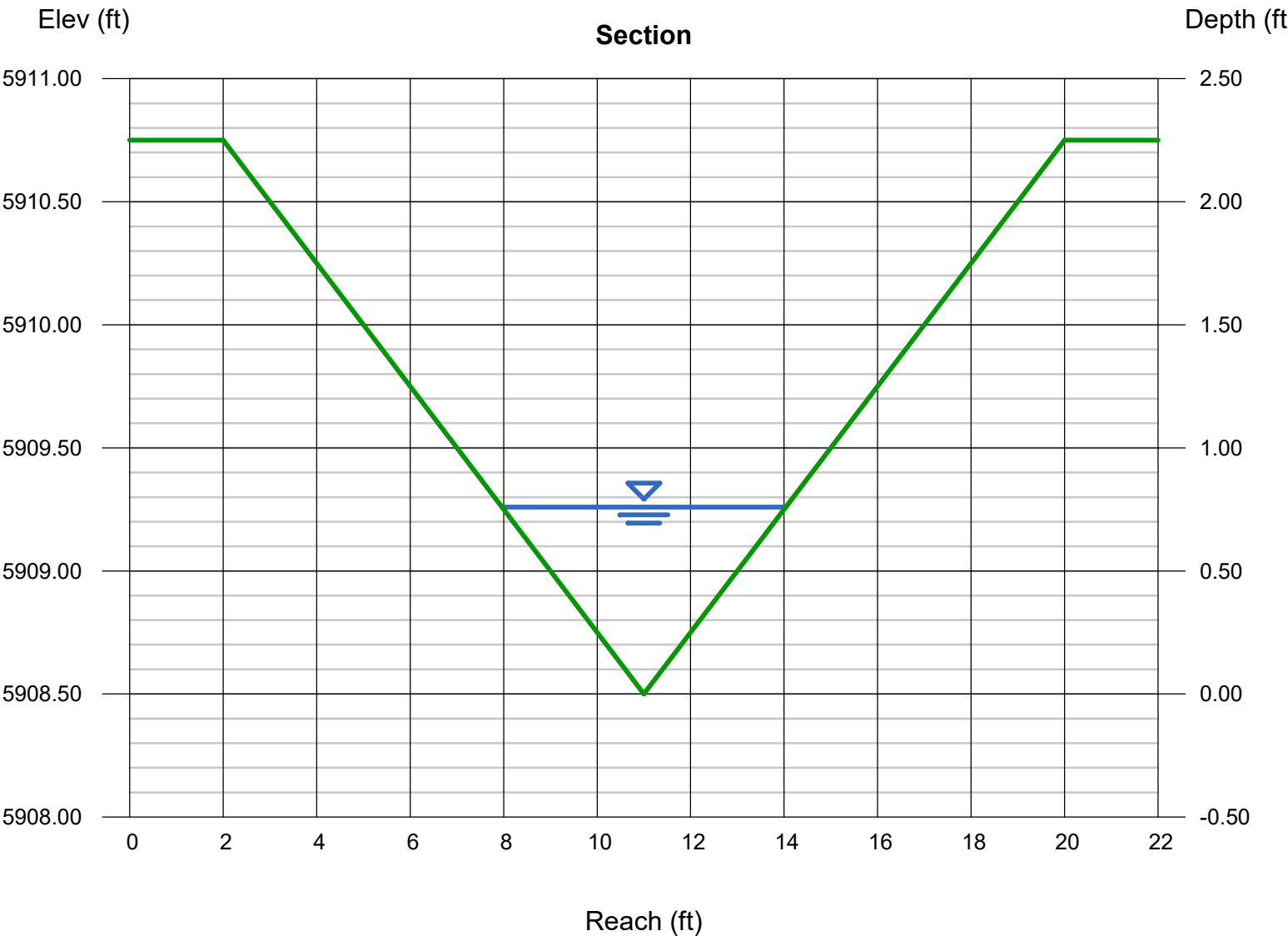
Invert Elev (ft) = 5908.50  
Slope (%) = 5.95  
N-Value = 0.030

### Calculations

Compute by: Known Q  
Known Q (cfs) = 14.00

### Highlighted

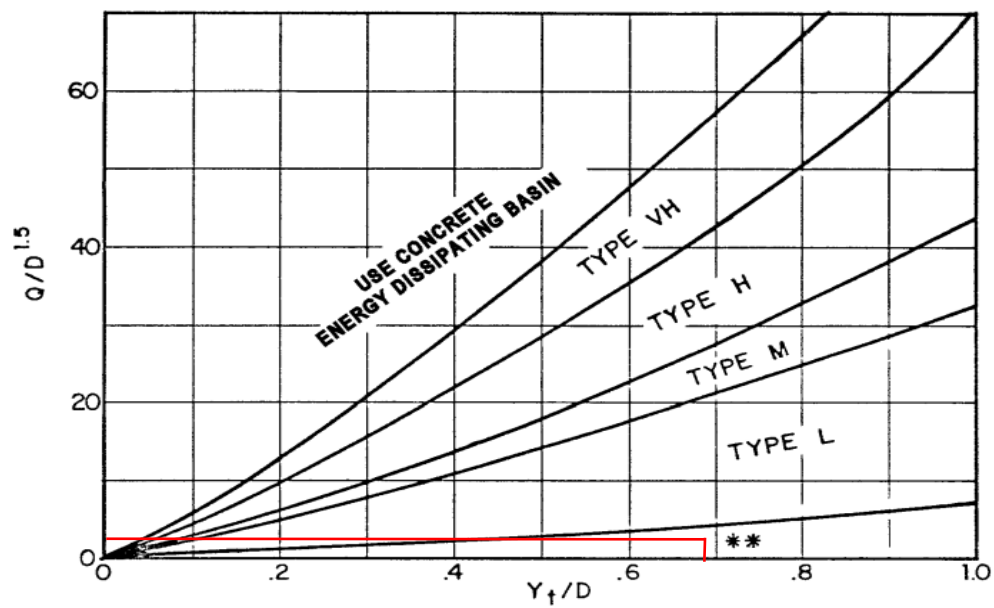
Depth (ft) = 0.76  
Q (cfs) = 14.00  
Area (sqft) = 2.31  
Velocity (ft/s) = 6.06  
Wetted Perim (ft) = 6.27  
Crit Depth, Yc (ft) = 0.95  
Top Width (ft) = 6.08  
EGL (ft) = 1.33



## Riprap Calculations

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Low Tailwater Basin - Riprap Sizing	
$y_t$	1.02 ft
$D$	1.5 ft
$y_t/D$	0.68
$Q$	7 CFS
$D$	1.5 ft
$Q/D^{1.5}$	10.08



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

USE TYPE L RIPRAP

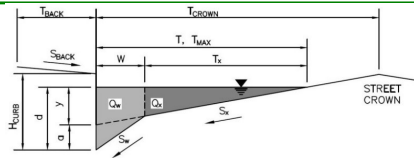
# Appendix D

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## Gutter & Inlet Calculations

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

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

Project: **Integration - Phase 4**Inlet ID: **CB-3.10****Gutter Geometry:**

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)

$T_{BACK} =$	13.0	ft
$S_{BACK} =$	0.020	ft/ft
$n_{BACK} =$	0.013	

$H_{CURB} =$	6.00	inches
$T_{CROWN} =$	36.5	ft
$W =$	2.00	ft
$S_x =$	0.020	ft/ft
$S_w =$	0.083	ft/ft
$S_o =$	0.035	ft/ft
$n_{STREET} =$	0.013	

Max. Allowable Spread for Minor &amp; Major Storm

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

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX} =$	20.0	27.8	ft
$d_{MAX} =$	5.8	7.7	inches
	<input type="checkbox"/>	<input type="checkbox"/>	

MINOR STORM Allowable Capacity is based on Depth Criterion

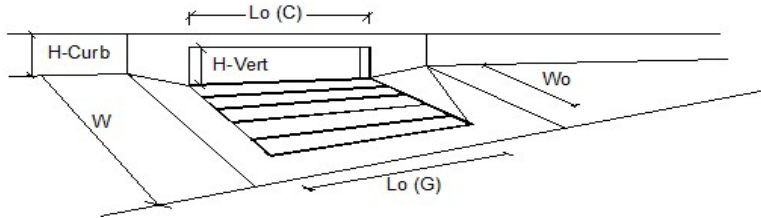
MAJOR STORM Allowable Capacity is based on Depth Criterion

	Minor Storm	Major Storm	
$Q_{allow} =$	20.9	39.2	cfs

**Minor storm max. allowable capacity GOOD - greater than the design peak flow of 3.80 cfs on sheet 'Inlet Management'****Major storm max. allowable capacity GOOD - greater than the design peak flow of 7.90 cfs on sheet 'Inlet Management'**

# INLET ON A CONTINUOUS GRADE

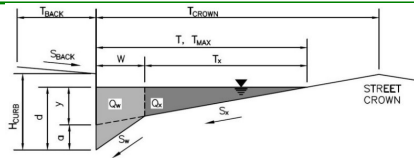
MHFD-Inlet, Version 5.02 (August 2022)



Design Information (Input)		MINOR		MAJOR	
Type of Inlet	CDOT Type R Curb Opening	CDOT Type R Curb Opening			
Local Depression (additional to continuous gutter depression 'a')		$a_{LOCAL}$	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		$N_o$	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)		$L_o$	10.00	10.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		$W_o$	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		$C_f (G)$	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		$C_f (C)$	0.10	0.10	
Street Hydraulics: OK - $Q < \text{Allowable Street Capacity}$					
Total Inlet Interception Capacity		$Q$	3.7	6.0	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)		$Q_b$	0.1	1.9	cfs
Capture Percentage = $Q_o/Q_a$		$C\%$	98	76	%

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

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

Project: **Integration - Phase 4**Inlet ID: **CB-3.9****Gutter Geometry:**

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)

$T_{BACK} =$	17.0	ft
$S_{BACK} =$	0.020	ft/ft
$n_{BACK} =$	0.013	

$H_{CURB} =$	6.00	inches
$T_{CROWN} =$	36.5	ft
$W =$	2.00	ft
$S_x =$	0.020	ft/ft
$S_W =$	0.083	ft/ft
$S_o =$	0.035	ft/ft
$n_{STREET} =$	0.013	

Max. Allowable Spread for Minor &amp; Major Storm

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

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX} =$	20.0	27.8	ft
$d_{MAX} =$	5.8	7.7	inches
	<input type="checkbox"/>	<input type="checkbox"/>	

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

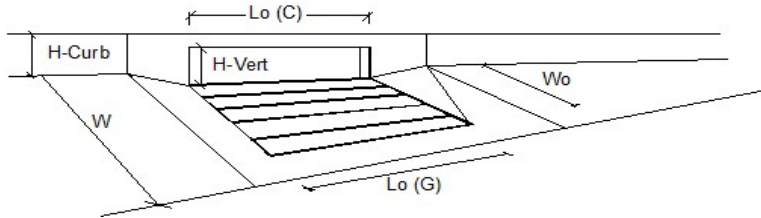
	Minor Storm	Major Storm	
$Q_{allow} =$	20.9	39.2	cfs

**Minor storm max. allowable capacity GOOD - greater than the design peak flow of 4.00 cfs on sheet 'Inlet Management'****Major storm max. allowable capacity GOOD - greater than the design peak flow of 8.30 cfs on sheet 'Inlet Management'**



# INLET ON A CONTINUOUS GRADE

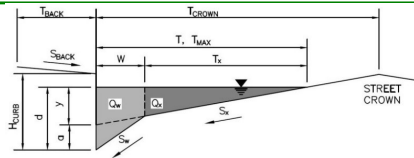
MHFD-Inlet, Version 5.02 (August 2022)



Design Information (Input)		MINOR		MAJOR	
Type of Inlet	CDOT Type R Curb Opening	CDOT Type R Curb Opening			
Local Depression (additional to continuous gutter depression 'a')		$a_{LOCAL}$	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		$N_o$	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)		$L_o$	10.00	10.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		$W_o$	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		$C_f (G)$	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		$C_f (C)$	0.10	0.10	
Street Hydraulics: OK - $Q < \text{Allowable Street Capacity}$					
Total Inlet Interception Capacity		$Q$	3.9	6.1	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)		$Q_o$	0.1	2.2	cfs
Capture Percentage = $Q_o/Q_o$		$C\%$	97	74	%

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

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

Project: **Integration - Phase 4**Inlet ID: **CB-3.6****Gutter Geometry:**

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)

$T_{BACK} =$	13.0	ft
$S_{BACK} =$	0.020	ft/ft
$n_{BACK} =$	0.013	

$H_{CURB} =$	6.00	inches
$T_{CROWN} =$	36.5	ft
$W =$	2.00	ft
$S_x =$	0.020	ft/ft
$S_w =$	0.083	ft/ft
$S_o =$	0.000	ft/ft
$n_{STREET} =$	0.013	

Max. Allowable Spread for Minor &amp; Major Storm

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

Check boxes are not applicable in SUMP conditions

	Minor Storm	Major Storm	
$T_{MAX} =$	20.0	27.8	ft
$d_{MAX} =$	5.8	7.7	inches
	<input type="checkbox"/>	<input type="checkbox"/>	

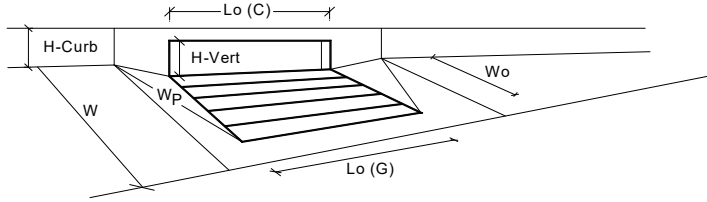
MINOR STORM Allowable Capacity is not applicable to Sump Condition

MAJOR STORM Allowable Capacity is not applicable to Sump Condition

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

# INLET IN A SUMP OR SAG LOCATION

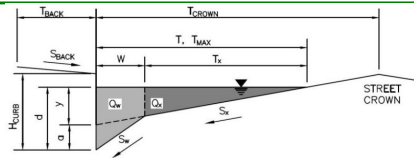
MHFD-Inlet, Version 5.02 (August 2022)



Design Information (Input)		MINOR		MAJOR	
Type of Inlet	CDOT Type R Curb Opening	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)		$a_{local}$ =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)		$N_o$ =	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	5.8	7.7	inches
<b>Grate Information</b>		MINOR		MAJOR	
Length of a Unit Grate		$L_o(G)$ =	N/A	N/A	feet
Width of a Unit Grate		$W_o$ =	N/A	N/A	feet
Open Area Ratio for a Grate (typical values 0.15-0.90)		$A_{ratio}$ =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		$C_f(G)$ =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)		$C_w(G)$ =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		$C_o(G)$ =	N/A	N/A	
<b>Curb Opening Information</b>		MINOR		MAJOR	
Length of a Unit Curb Opening		$L_o(C)$ =	10.00	10.00	feet
Height of Vertical Curb Opening in Inches		$H_{vert}$ =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches		$H_{throat}$ =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		$W_o$ =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)		$C_f(C)$ =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)		$C_w(C)$ =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		$C_o(C)$ =	0.67	0.67	
<b>Low Head Performance Reduction (Calculated)</b>		MINOR		MAJOR	
Depth for Grate Midwidth		$d_{Grate}$ =	N/A	N/A	ft
Depth for Curb Opening Weir Equation		$d_{Curb}$ =	0.32	0.47	ft
Grated Inlet Performance Reduction Factor for Long Inlets		$RF_{Grate}$ =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets		$RF_{Curb}$ =	0.92	1.00	
Combination Inlet Performance Reduction Factor for Long Inlets		$RF_{Combination}$ =	N/A	N/A	
Total Inlet Interception Capacity (assumes clogged condition)		MINOR		MAJOR	
		$Q_a$ =	7.6	15.0	cfs
<b>Inlet Capacity IS GOOD for Minor and Major Storms (&gt;Q Peak)</b>		$Q_{PEAK REQUIRED}$ =	5.2	12.4	cfs

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

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

Project: **Integration - Phase 4**Inlet ID: **CB-3.4****Gutter Geometry:**

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)

Max. Allowable Spread for Minor &amp; Major Storm

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

Check boxes are not applicable in SUMP conditions

MINOR STORM Allowable Capacity is not applicable to Sump Condition

MAJOR STORM Allowable Capacity is not applicable to Sump Condition

$T_{BACK} =$	17.0	ft
$S_{BACK} =$	0.020	ft/ft
$n_{BACK} =$	0.013	

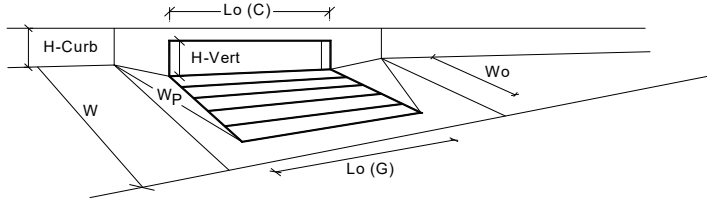
$H_{CURB} =$	6.00	inches
$T_{CROWN} =$	36.5	ft
$W =$	2.00	ft
$S_X =$	0.020	ft/ft
$S_W =$	0.083	ft/ft
$S_O =$	0.000	ft/ft
$n_{STREET} =$	0.013	

	Minor Storm	Major Storm	
$T_{MAX} =$	20.0	27.8	ft
$d_{MAX} =$	5.8	7.7	inches
	<input type="checkbox"/>	<input type="checkbox"/>	

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

# INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.02 (August 2022)

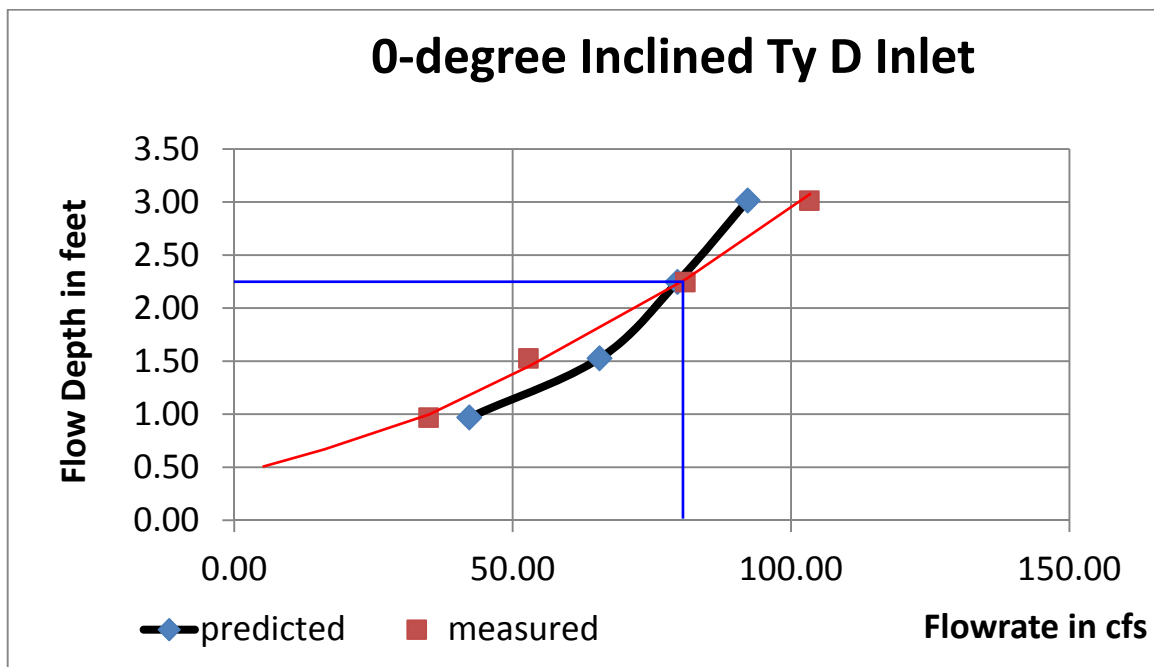


Design Information (Input)		MINOR		MAJOR	
Type of Inlet	CDOT Type R Curb Opening	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)		$a_{local}$ =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)		$N_o$ =	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	5.8	7.7	inches
<u>Grate Information</u>		MINOR		MAJOR	
Length of a Unit Grate		$L_o (G)$ =	N/A	N/A	feet
Width of a Unit Grate		$W_o$ =	N/A	N/A	feet
Open Area Ratio for a Grate (typical values 0.15-0.90)		$A_{ratio}$ =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		$C_f (G)$ =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)		$C_w (G)$ =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		$C_o (G)$ =	N/A	N/A	
<u>Curb Opening Information</u>		MINOR		MAJOR	
Length of a Unit Curb Opening		$L_o (C)$ =	10.00	10.00	feet
Height of Vertical Curb Opening in Inches		$H_{vert}$ =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches		$H_{throat}$ =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		$W_o$ =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)		$C_f (C)$ =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)		$C_w (C)$ =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		$C_o (C)$ =	0.67	0.67	
<u>Low Head Performance Reduction (Calculated)</u>		MINOR		MAJOR	
Depth for Grate Midwidth		$d_{Grate}$ =	N/A	N/A	ft
Depth for Curb Opening Weir Equation		$d_{Curb}$ =	0.32	0.47	ft
Grated Inlet Performance Reduction Factor for Long Inlets		$RF_{Grate}$ =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets		$RF_{Curb}$ =	0.92	1.00	
Combination Inlet Performance Reduction Factor for Long Inlets		$RF_{Combination}$ =	N/A	N/A	
Total Inlet Interception Capacity (assumes clogged condition)		MINOR		MAJOR	
		$Q_a$ =	7.6	15.0	cfs
<b>Inlet Capacity IS GOOD for Minor and Major Storms (&gt;Q Peak)</b>		$Q_{PEAK REQUIRED}$ =	5.5	13.3	cfs

Width of Grate	B	3.00		(input)						
Inclined Length of Grate	L	6.00	ft							
Opening Ratio of Grate	n	0.70		(input)						
Grate Discharge Coeff	Cd	0.79		(input)						
Height of Box	Hb=	0.00	ft							
Inclined Angle	@	0.00	degree	(input)						
Orifice/ Weir Coeff	Co=	0.53	Cw=	1.69						
Orientation	Ko=	0								

Water Depth H ft	Submerged Si Weir Length ft (X)	Inclined Left S Weir cfs	Inclined Right S Weir cfs	Base Weir cfs	Total Weir cfs	Total Orifice cfs	Predicted Flow cfs	Observed Flow cfs	Error %	Sq error cfs^2
0.97	6.00	16.89	16.89	8.44	42.22	52.28	42.22	34.9	-20.97%	53.58
1.53	6.00	33.41	33.41	16.70	83.52	65.63	65.63	52.8	-24.27%	164.26
2.25	6.00	59.63	59.63	29.82	149.08	79.62	79.62	81.0	1.73%	1.96
3.02	6.00	92.69	92.69	46.34	231.71	92.22	92.22	103.3	10.72%	122.57
										342.37



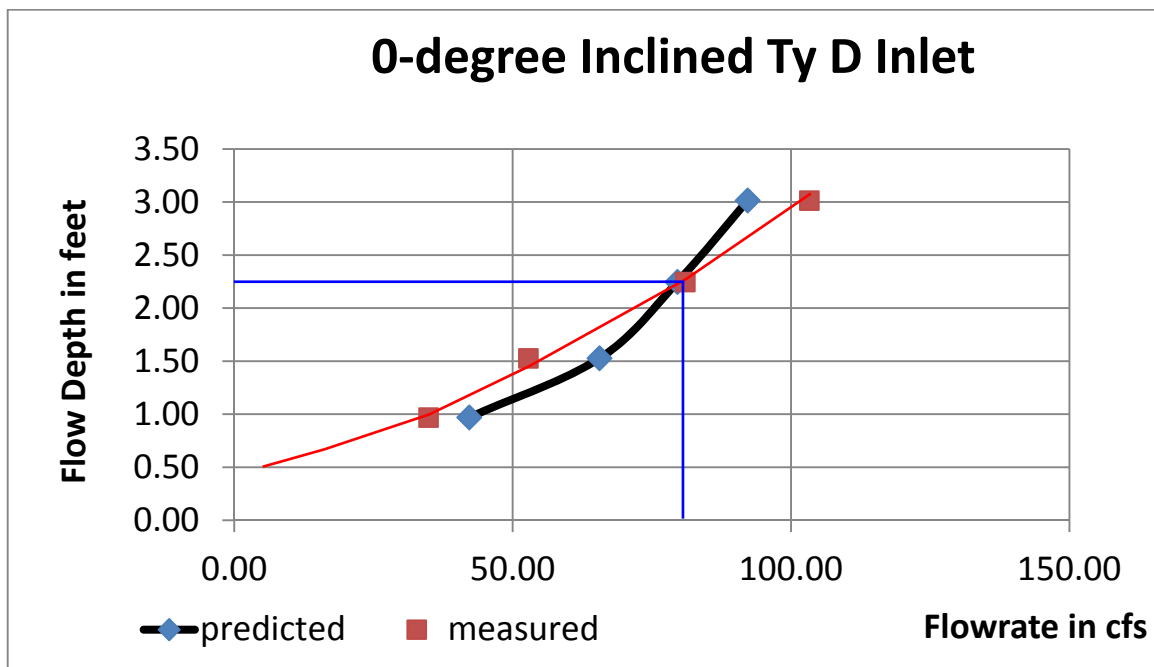
Urban Drainage & Flood Control District  
HYDRAULIC CAPACITY of CDOT  
TYPE C and D AREA INLETS  
Dr. Jame C.Y. Guo, PhD and PE  
Revised March 5, 2012

Q100 @ CB-1.0 = 39.3 CFS  
2\*Q100 = 78.6 CFS  
**CAPACITY OK W/ 2.25FT  
FLOW DEPTH**  
Q100 @ CB-1.2 = 6.0 CFS  
2\*Q100 = 12.0 CFS  
**CAPACITY OK W/ 2FT FLOW  
DEPTH**

Width of Grate	B	3.00		(input)						
Inclined Length of Grate	L	6.00	ft							
Opening Ratio of Grate	n	0.70		(input)						
Grate Discharge Coeff	Cd	0.79		(input)						
Height of Box	Hb=	0.00	ft							
Inclined Angle	@	0.00	degree	(input)						
Orifice/ Weir Coeff	Co=	0.53	Cw=	1.69						
Orientation	Ko=	0								

Water Depth H ft	Submerged Si Weir Length ft (X)	Inclined Left S Weir cfs	Inclined Right S Weir cfs	Base Weir cfs	Total Weir cfs	Total Orifice cfs	Predicted Flow cfs	Observed Flow cfs	Error %	Sq error cfs^2
0.97	6.00	16.89	16.89	8.44	42.22	52.28	42.22	34.9	-20.97%	53.58
1.53	6.00	33.41	33.41	16.70	83.52	65.63	65.63	52.8	-24.27%	164.26
2.25	6.00	59.63	59.63	29.82	149.08	79.62	79.62	81.0	1.73%	1.96
3.02	6.00	92.69	92.69	46.34	231.71	92.22	92.22	103.3	10.72%	122.57
										342.37



Urban Drainage & Flood Control District  
HYDRAULIC CAPACITY of CDOT  
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Revised March 5, 2012

Q100 @ CB-2.0 = 22.6 CFS  
2\*Q100 = 45.2 CFS  
**CAPACITY OK W/ 2.25FT  
FLOW DEPTH**

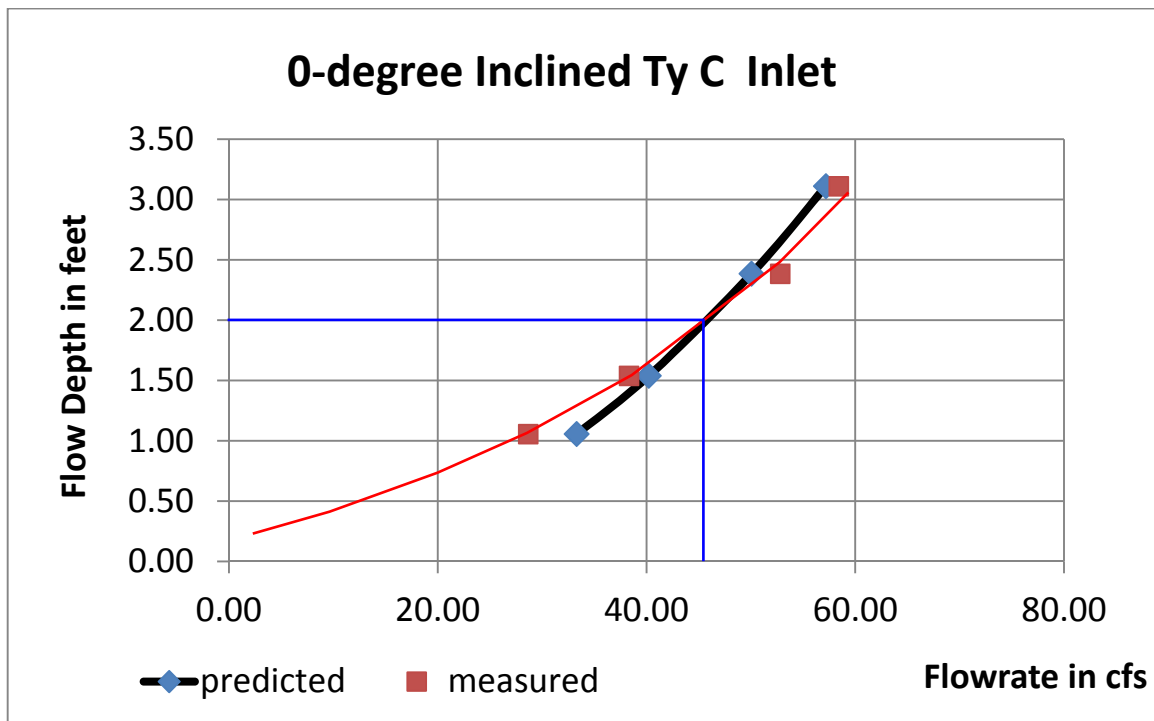


## Appendix IV Sample Analyses for Flow Coefficients

Width of Grate	B	3.00	(input)							
Inclined Length of Grate	L	3.00	ft							
Opening Ratio of Grate	n	0.70	(input)							
Grate Discharge Coeff	Cd	0.96	(input)							
Height of Box	Hb=	0.00	ft							
Inclined Angle	@	0.00	degree	(input)						
Orifice/ Weir Coeff	Co=	0.64	Cw=	2.06						
Orientation	Ko=	0								

Water Depth H ft	Submerged Side Weir Length ft (X)	Inclined Left S Weir cfs	Inclined Right S Weir cfs	Base Weir cfs	Total Weir cfs	Total Orifice cfs	Predicted Flow cfs	Observed Flow cfs	Error %	Sq error cfs^2
1.06	3.00	11.73	11.73	16.76	40.21	33.32	33.32	28.7	-16.23%	21.66
1.54	3.00	20.64	20.64	29.48	70.75	40.23	40.23	38.3	-4.96%	3.61
2.39	3.00	39.81	39.81	56.87	136.49	50.08	50.08	52.8	5.19%	7.51
3.11	3.00	59.31	59.31	84.73	203.34	57.19	57.19	58.4	2.11%	1.52
										34.29



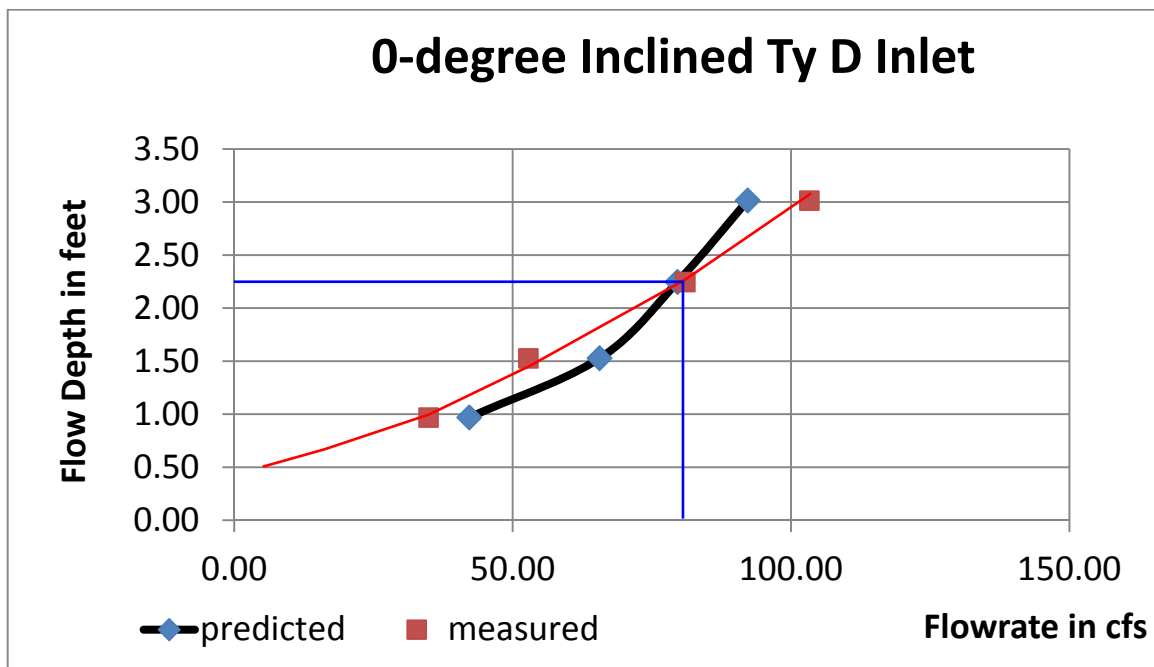
Urban Drainage & Flood Control District  
HYDRAULIC CAPACITY of CDOT  
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Dr. Jame C.Y. Guo, PhD and PE  
Revised March 5, 2012

Q100 @ CB-3.0 = 13.7 CFS  
2\*Q100 = 27.4 CFS  
**CAPACITY OK W/ 2FT FLOW  
DEPTH**

Width of Grate	B	3.00		(input)						
Inclined Length of Grate	L	6.00	ft							
Opening Ratio of Grate	n	0.70		(input)						
Grate Discharge Coeff	Cd	0.79		(input)						
Height of Box	Hb=	0.00	ft							
Inclined Angle	@	0.00	degree	(input)						
Orifice/ Weir Coeff	Co=	0.53	Cw=	1.69						
Orientation	Ko=	0								

Water Depth H	Submerged Sill Weir Length	Inclined Left S Weir	Inclined Right S Weir	Base Weir	Total Weir	Total Orifice	Predicted Flow	Observed Flow	Error	Sq error
ft	ft (X)	cfs	cfs	cfs	cfs	cfs	cfs	cfs	%	cfs^2
0.97	6.00	16.89	16.89	8.44	42.22	52.28	42.22	34.9	-20.97%	53.58
1.53	6.00	33.41	33.41	16.70	83.52	65.63	65.63	52.8	-24.27%	164.26
2.25	6.00	59.63	59.63	29.82	149.08	79.62	79.62	81.0	1.73%	1.96
3.02	6.00	92.69	92.69	46.34	231.71	92.22	92.22	103.3	10.72%	122.57
										342.37



Q100 @ CB-3.1 = 28.2 CFS  
 2\*Q100 = 56.4 CFS  
**CAPACITY OK W/ 2.25FT FLOW DEPTH**  
 Q100 @ CB-3.2 = 4.1 CFS  
 2\*Q100 = 8.2 CFS  
**CAPACITY OK W/ 2.25FT FLOW DEPTH**  
 Q100 @ CB-3.3 = 13.0 CFS  
 2\*Q100 = 26.0 CFS  
**CAPACITY OK W/ 2.25FT FLOW DEPTH**

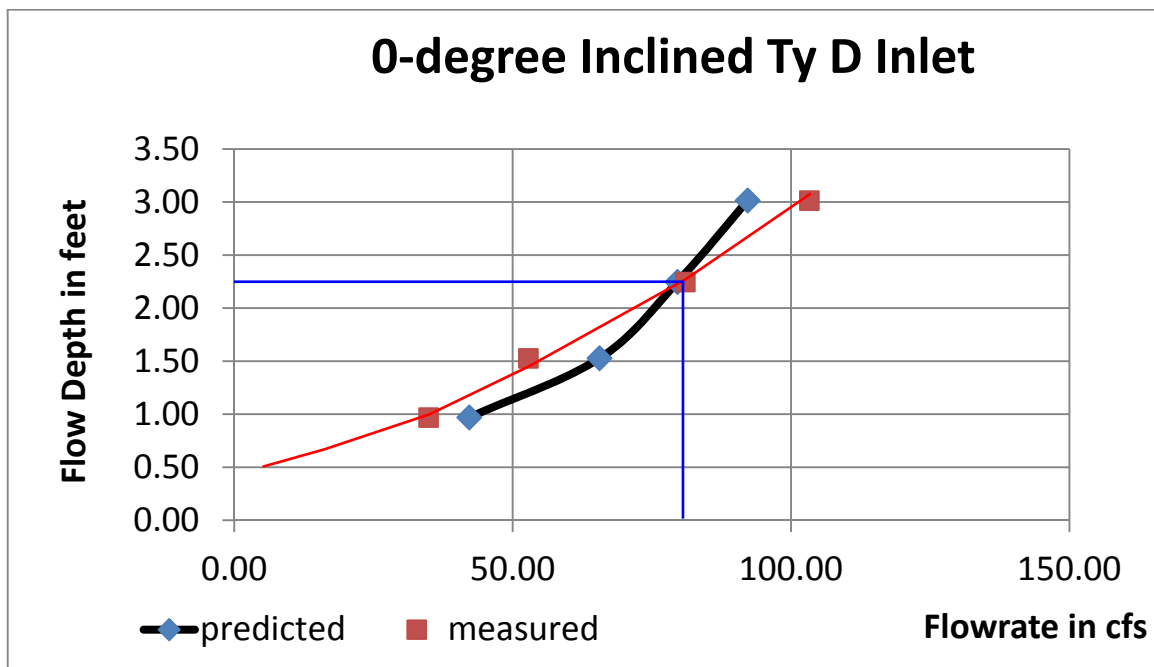
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 TYPE C and D AREA INLETS  
 Dr. Jame C.Y. Guo, PhD and PE  
 Revised March 5, 2012

Q100 @ CB-3.5 = 34.7 CFS  
 2\*Q100 = 69.4 CFS  
**CAPACITY OK W/ 2.25FT FLOW DEPTH**  
 Q100 @ CB-3.7 = 33.1 CFS  
 2\*Q100 = 66.2 CFS  
**CAPACITY OK W/ 2.25FT FLOW DEPTH**  
 Q100 @ CB-3.9 = 12.0 CFS  
 2\*Q100 = 24.0 CFS  
**CAPACITY OK W/ 2.25FT FLOW DEPTH**

Width of Grate	B	3.00		(input)						
Inclined Length of Grate	L	6.00	ft							
Opening Ratio of Grate	n	0.70		(input)						
Grate Discharge Coeff	Cd	0.79		(input)						
Height of Box	Hb=	0.00	ft							
Inclined Angle	@	0.00	degree	(input)						
Orifice/ Weir Coeff	Co=	0.53	Cw=	1.69						
Orientation	Ko=	0								

Water Depth H ft	Submerged Si Weir Length ft (X)	Inclined Left S Weir cfs	Inclined Right S Weir cfs	Base Weir cfs	Total Weir cfs	Total Orifice cfs	Predicted Flow cfs	Observed Flow cfs	Error %	Sq error cfs^2
0.97	6.00	16.89	16.89	8.44	42.22	52.28	42.22	34.9	-20.97%	53.58
1.53	6.00	33.41	33.41	16.70	83.52	65.63	65.63	52.8	-24.27%	164.26
2.25	6.00	59.63	59.63	29.82	149.08	79.62	79.62	81.0	1.73%	1.96
3.02	6.00	92.69	92.69	46.34	231.71	92.22	92.22	103.3	10.72%	122.57
										342.37



Q100 @ CB-4.0 = 9.1 CFS  
2\*Q100 = 18.2 CFS  
**CAPACITY NOT OK W/ 2.25FT FLOW DEPTH**

Urban Drainage & Flood Control District  
HYDRAULIC CAPACITY of CDOT  
TYPE C and D AREA INLETS  
Dr. Jame C.Y. Guo, PhD and PE  
Revised March 5, 2012

Q100 @ CB-4.0 = 44.0 CFS  
2\*Q100 = 88.0 CFS  
**CAPACITY NOT OK W/ 2.25FT FLOW DEPTH**

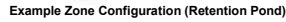
# Appendix E

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Water Quality & Detention Pond Calculations

*MHFD-Detention, Version 4.05 (January 2022)*

**Basin ID: Pond 705 (actual volume = 24.54 ac-ft)**



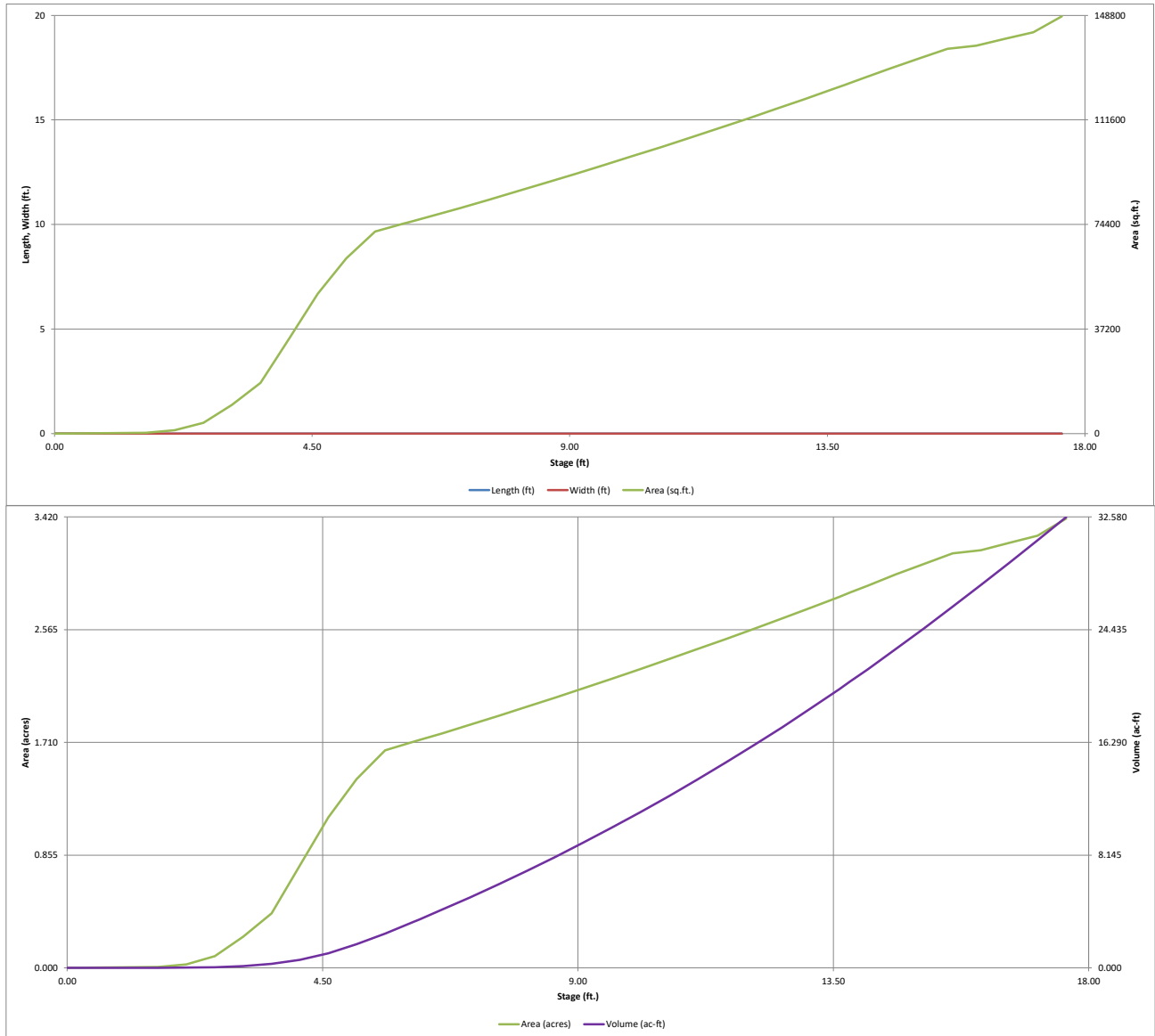
	acre-feet
	acre-feet
1.03	inches
1.31	inches
1.58	inches
2.01	inches
2.37	inches
2.77	inches
3.85	inches

Initial Surcharge Area ( $A_{ISV}$ ) =	<input type="text" value="user"/>	ft <sup>2</sup>
Surcharge Volume Length ( $L_{ISV}$ ) =	<input type="text" value="user"/>	ft
Surcharge Volume Width ( $W_{ISV}$ ) =	<input type="text" value="user"/>	ft
Depth of Basin Floor ( $H_{FLOOR}$ ) =	<input type="text" value="user"/>	ft
Length of Basin Floor ( $L_{FLOOR}$ ) =	<input type="text" value="user"/>	ft
Width of Basin Floor ( $W_{FLOOR}$ ) =	<input type="text" value="user"/>	ft
Area of Basin Floor ( $A_{FLOOR}$ ) =	<input type="text" value="user"/>	ft <sup>2</sup>
Volume of Basin Floor ( $V_{FLOOR}$ ) =	<input type="text" value="user"/>	ft <sup>3</sup>
Depth of Main Basin ( $H_{MAIN}$ ) =	<input type="text" value="user"/>	ft
Length of Main Basin ( $L_{MAIN}$ ) =	<input type="text" value="user"/>	ft
Width of Main Basin ( $W_{MAIN}$ ) =	<input type="text" value="user"/>	ft
Area of Main Basin ( $A_{MAIN}$ ) =	<input type="text" value="user"/>	ft <sup>2</sup>
Volume of Main Basin ( $V_{MAIN}$ ) =	<input type="text" value="user"/>	ft <sup>3</sup>
Calculated Total Basin Volume ( $V_{TOTAL}$ ) =	<input type="text" value="user"/>	acre-feet

10/28/2022, 12:44 PM

# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)

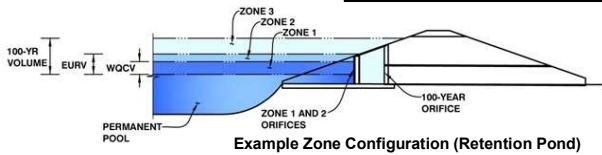


# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)

Project: **INTEGRATION LOOP PHASE 4**

Basin ID: **Pond 705 (actual volume = 24.54 ac-ft)**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	6.21	3.494	Orifice Plate
Zone 2 (EURV)	9.63	6.691	Orifice Plate
Zone 3 (100-year)	13.34	9.198	Weir&Pipe (Restrict)
Total (all zones)		19.384	

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

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

Calculated Parameters for Underdrain  
Underdrain Orifice Area =  ft<sup>2</sup>  
Underdrain Orifice Centroid =  feet

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

Centroid of Lowest Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Orifice Plate =  ft (relative to basin bottom at Stage = 0 ft)  
Orifice Plate: Orifice Vertical Spacing =  inches  
Orifice Plate: Orifice Area per Row =  sq. inches

Calculated Parameters for Plate  
WQ Orifice Area per Row =  ft<sup>2</sup>  
Elliptical Half-Width =  feet  
Elliptical Slot Centroid =  feet  
Elliptical Slot Area =  ft<sup>2</sup>

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	3.90	5.00	5.85	6.80			
Orifice Area (sq. inches)	7.56	7.56	52.56	81.00	81.00			

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

User Input: Vertical Orifice (Circular or Rectangular)

Invert of Vertical Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Vertical Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Vertical Orifice Diameter =  inches

Calculated Parameters for Vertical Orifice  
Vertical Orifice Area =  ft<sup>2</sup>  
Vertical Orifice Centroid =  feet

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

Overflow Weir Front Edge Height, H<sub>o</sub> =  ft (relative to basin bottom at Stage = 0 ft)  
Overflow Weir Front Edge Length =  feet  
Overflow Weir Grate Slope =  H:V  
Horiz. Length of Weir Sides =  feet  
Overflow Grate Type =   
Debris Clogging % =  %

Calculated Parameters for Overflow Weir  
Height of Grate Upper Edge, H<sub>u</sub> =  feet  
Overflow Weir Slope Length =  feet  
Grate Open Area / 100-yr Orifice Area =   
Overflow Grate Open Area w/o Debris =  ft<sup>2</sup>  
Overflow Grate Open Area w/ Debris =  ft<sup>2</sup>

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

Depth to Invert of Outlet Pipe =  ft (distance below basin bottom at Stage = 0 ft)  
Outlet Pipe Diameter =  inches  
Restrictor Plate Height Above Pipe Invert =  inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate  
Outlet Orifice Area =  ft<sup>2</sup>  
Outlet Orifice Centroid =  feet  
Half-Central Angle of Restrictor Plate on Pipe =  radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

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

## Routed Hydrograph Results

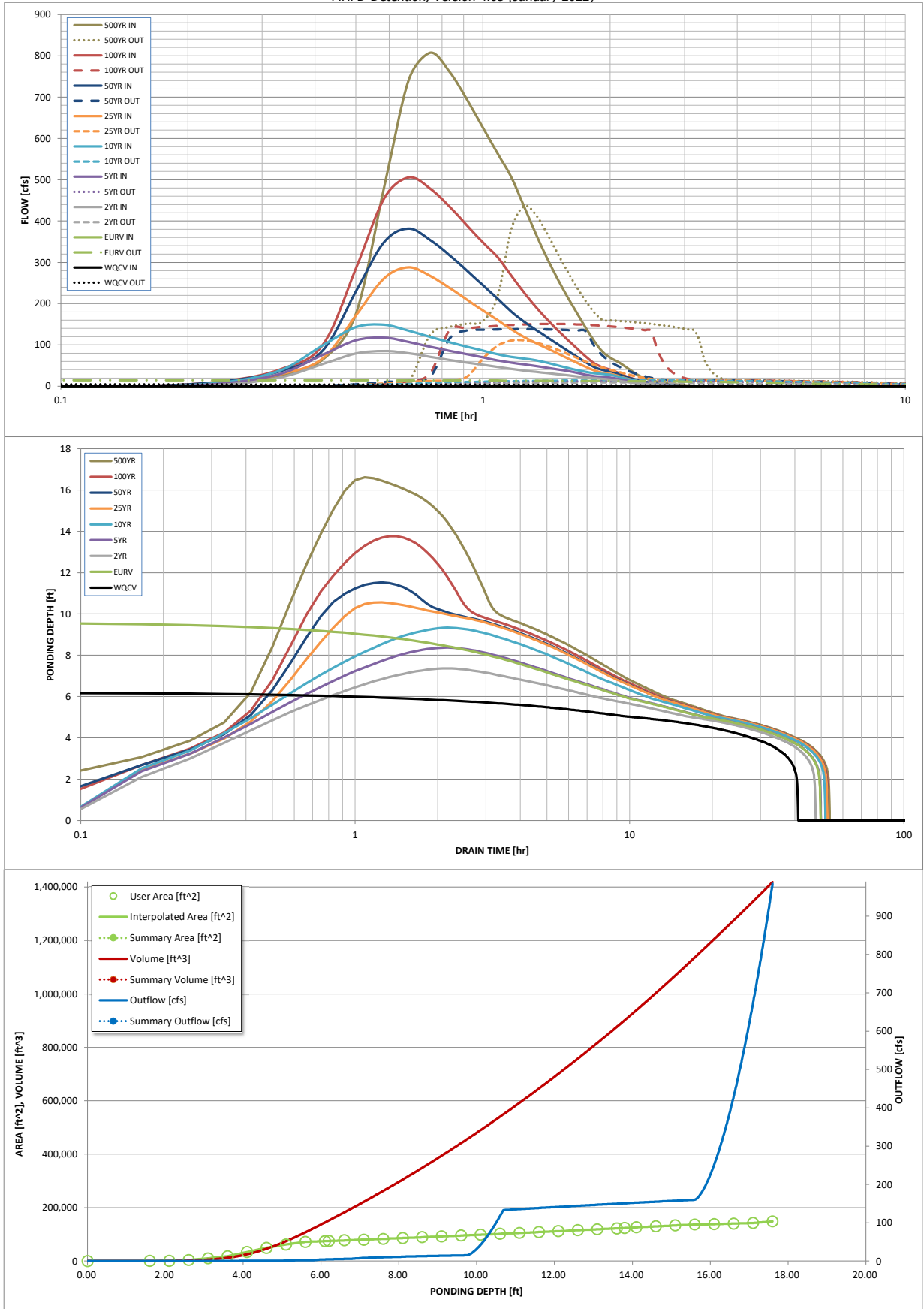
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	N/A	N/A	1.03	1.31	1.58	2.01	2.37	2.77	3.85
One-Hour Rainfall Depth (in) =	3.494	10.186	6.731	9.173	11.570	19.270	25.255	33.762	54.250
CUHP Runoff Volume (acre-ft) =	N/A	N/A	6.731	9.173	11.570	19.270	25.255	33.762	54.250
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	1.4	2.9	4.4	88.8	148.4	237.8	442.9
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A							
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.01	0.02	0.39	0.65	1.03	1.93
Peak Inflow Q (cfs) =	N/A	N/A	85.2	117.4	148.8	287.8	381.7	505.4	807.3
Peak Outflow Q (cfs) =	4.5	14.9	9.2	12.2	14.4	111.0	138.2	150.7	435.9
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	4.1	3.3	1.3	0.9	0.6	1.0
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	1.3	1.7	1.9	2.0
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	41	42	42	42	38	35	31	22
Time to Drain 99% of Inflow Volume (hours) =	40	47	46	47	48	47	46	44	40
Maximum Ponding Depth (ft) =	6.21	9.63	7.37	8.38	9.34	10.56	11.52	13.76	16.62
Area at Maximum Ponding Depth (acres) =	1.73	2.20	1.88	2.02	2.15	2.34	2.48	2.84	3.22
Maximum Volume Stored (acre-ft) =	3.510	10.207	5.584	7.552	9.554	12.315	14.626	20.582	29.300



DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)



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

# DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

## Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	1.30	1.03	5.19
	0:15:00	0.00	0.00	4.38	8.07	11.06	9.10	13.25	13.73	25.18
	0:20:00	0.00	0.00	21.91	31.05	39.43	29.45	37.43	41.62	64.09
	0:25:00	0.00	0.00	53.45	75.75	98.51	66.70	85.71	98.73	174.55
	0:30:00	0.00	0.00	79.28	111.36	142.98	170.84	229.11	284.21	482.03
	0:35:00	0.00	0.00	85.21	117.44	148.79	261.23	349.30	455.18	741.44
	0:40:00	0.00	0.00	79.47	106.95	134.23	287.83	381.75	505.40	807.28
	0:45:00	0.00	0.00	71.04	95.18	119.15	266.89	353.76	478.51	761.31
	0:50:00	0.00	0.00	63.44	85.77	106.50	238.04	317.31	434.96	694.11
	0:55:00	0.00	0.00	57.09	77.48	95.68	209.39	279.70	389.27	625.71
	1:00:00	0.00	0.00	51.55	69.55	85.84	183.41	244.07	348.05	562.99
	1:05:00	0.00	0.00	46.61	62.36	77.17	160.18	211.75	312.19	506.79
	1:10:00	0.00	0.00	41.95	56.99	71.02	137.72	180.97	268.33	436.26
	1:15:00	0.00	0.00	37.98	52.89	67.12	119.39	156.77	227.31	370.02
	1:20:00	0.00	0.00	34.71	48.81	62.78	104.67	136.88	192.53	311.97
	1:25:00	0.00	0.00	31.84	44.68	56.92	91.98	119.29	162.76	261.49
	1:30:00	0.00	0.00	29.15	40.75	50.59	79.73	102.40	136.76	217.40
	1:35:00	0.00	0.00	26.50	36.98	44.59	67.93	86.46	113.44	178.12
	1:40:00	0.00	0.00	23.90	32.55	39.18	56.92	71.64	91.94	142.07
	1:45:00	0.00	0.00	21.59	28.07	34.63	46.88	58.07	72.39	109.67
	1:50:00	0.00	0.00	19.97	24.63	31.62	38.21	46.42	55.78	84.10
	1:55:00	0.00	0.00	18.20	22.61	29.70	32.82	39.68	46.07	69.08
	2:00:00	0.00	0.00	16.31	21.10	27.67	29.80	35.81	40.25	59.60
	2:05:00	0.00	0.00	13.77	18.19	23.74	25.41	30.35	33.09	48.40
	2:10:00	0.00	0.00	11.07	14.60	19.03	20.05	23.79	25.32	36.56
	2:15:00	0.00	0.00	8.73	11.46	14.95	15.50	18.33	18.90	26.87
	2:20:00	0.00	0.00	6.90	9.05	11.75	12.04	14.18	14.10	19.71
	2:25:00	0.00	0.00	5.42	7.12	9.17	9.33	10.93	10.56	14.61
	2:30:00	0.00	0.00	4.23	5.54	7.07	7.19	8.39	8.11	11.15
	2:35:00	0.00	0.00	3.29	4.24	5.38	5.46	6.34	6.16	8.41
	2:40:00	0.00	0.00	2.54	3.21	4.09	4.13	4.79	4.69	6.39
	2:45:00	0.00	0.00	1.93	2.42	3.13	3.15	3.65	3.61	4.91
	2:50:00	0.00	0.00	1.44	1.81	2.35	2.38	2.75	2.71	3.67
	2:55:00	0.00	0.00	1.03	1.30	1.69	1.73	1.98	1.94	2.60
	3:00:00	0.00	0.00	0.68	0.89	1.14	1.17	1.33	1.29	1.72
	3:05:00	0.00	0.00	0.41	0.57	0.70	0.73	0.81	0.78	1.02
	3:10:00	0.00	0.00	0.21	0.32	0.37	0.39	0.42	0.39	0.50
	3:15:00	0.00	0.00	0.09	0.15	0.15	0.15	0.15	0.13	0.16
	3:20:00	0.00	0.00	0.03	0.04	0.03	0.02	0.01	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

## DETENTION BASIN OUTLET STRUCTURE DESIGN

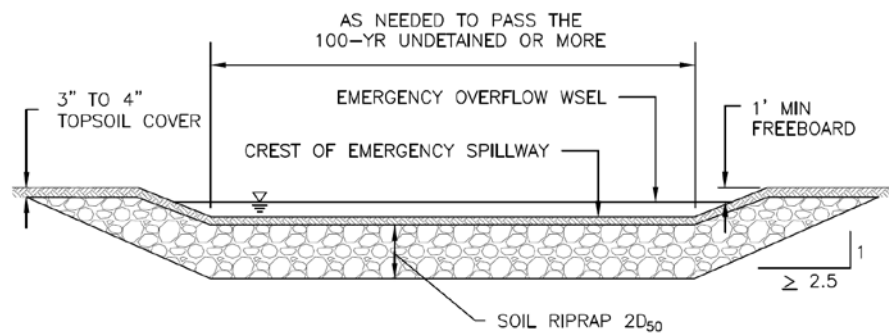
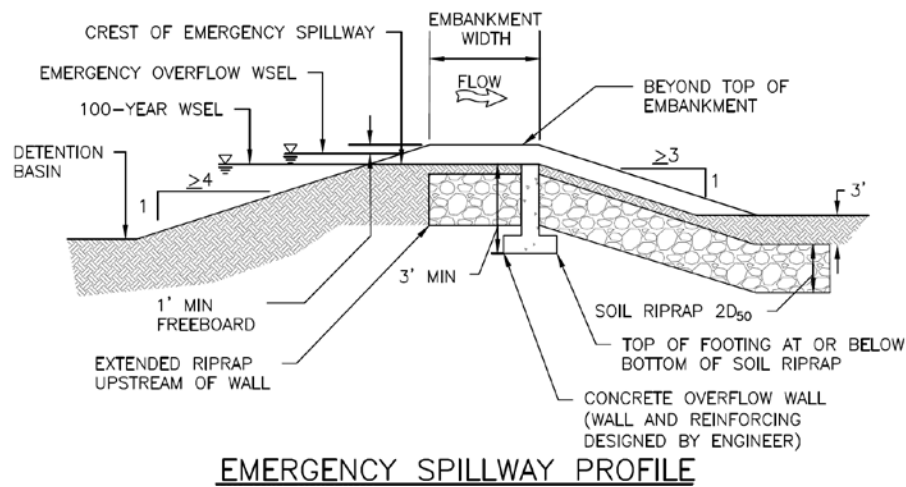
*MHFD-Detention, Version 4.05 (January 2022)*

### Summary Stage-Area-Volume-Discharge Relationships

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

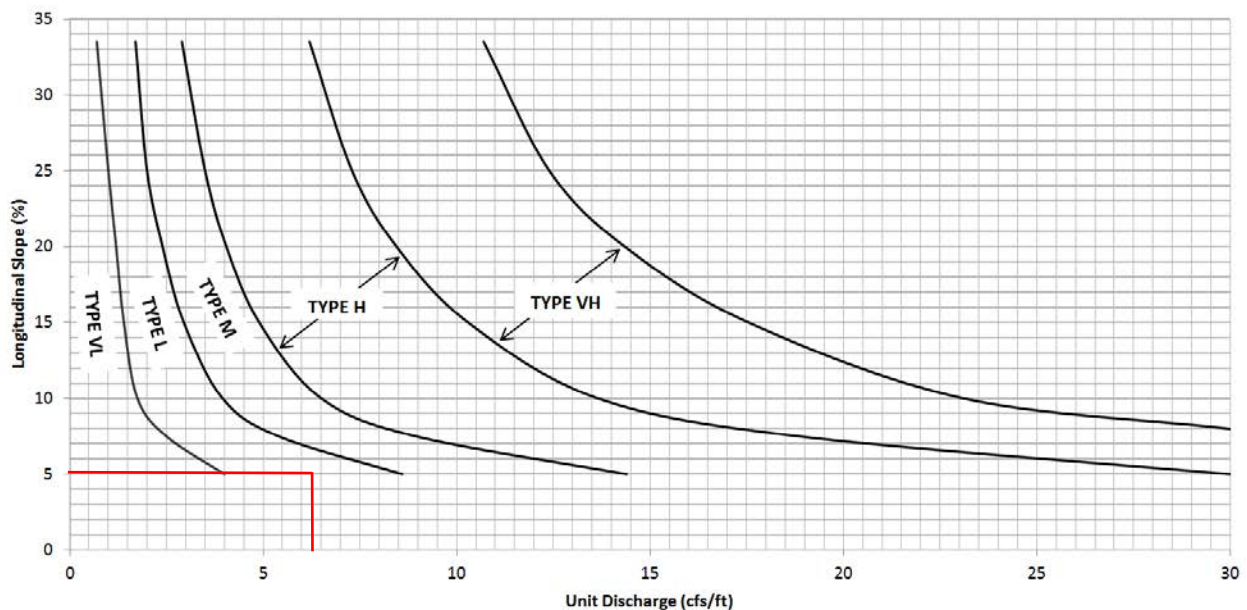
The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

[illegible]



Q100 = 506 CFS (UD-DETENTION)  
L = 80 FT  
UNIT DISCHARGE = 6.3 CFS/FT

**EMERGENCY SPILLWAY SECTION AND SPILLWAY CHANNEL**



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

# Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Sheet 1 of 3

Designer: **SWK**  
 Company: **ENERTIA CONSULTING GROUP**  
 Date: **October 26, 2022**  
 Project: **COSA - INTEGRATION LOOP PHASE 4**  
 Location: **POND 705 - FOREBAY 1.0**

## 1. Basin Storage Volume

- A) Effective Imperviousness of Tributary Area,  $I_a$
- B) Tributary Area's Imperviousness Ratio ( $i = I_a / 100$ )
- C) Contributing Watershed Area
- D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm
- E) Design Concept  
(Select EURV when also designing for flood control)
- F) Design Volume (WQCV) Based on 40-hour Drain Time  
( $V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area)$ )
- G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume  
( $V_{WQCV\ OTHER} = (d_s * (V_{DESIGN} / 0.43))$ )
- H) User Input of Water Quality Capture Volume (WQCV) Design Volume  
(Only if a different WQCV Design Volume is desired)
- I) NRCS Hydrologic Soil Groups of Tributary Watershed  
 i) Percentage of Watershed consisting of Type A Soils  
 ii) Percentage of Watershed consisting of Type B Soils  
 iii) Percentage of Watershed consisting of Type C/D Soils
- J) Excess Urban Runoff Volume (EURV) Design Volume  
 For HSG A:  $EURV_A = 1.68 * i^{1.28}$   
 For HSG B:  $EURV_B = 1.36 * i^{1.08}$   
 For HSG C/D:  $EURV_{C/D} = 1.20 * i^{1.08}$
- K) User Input of Excess Urban Runoff Volume (EURV) Design Volume  
(Only if a different EURV Design Volume is desired)

$I_a = 29.0$  %

$i = 0.290$

Area = 37.980 ac

$d_s =$  in

Choose One

☒ Water Quality Capture Volume (WQCV)

☐ Excess Urban Runoff Volume (EURV)

$V_{DESIGN} = 0.469$  ac-ft

$V_{DESIGN\ OTHER} =$  ac-ft

$V_{DESIGN\ USER} =$  ac-ft

HSG A = %

HSG B = %

HSG C/D = %

$EURV_{DESIGN} =$  ac-ft

$EURV_{DESIGN\ USER} =$  ac-ft

## 2. Basin Shape: Length to Width Ratio

(A basin length to width ratio of at least 2:1 will improve TSS reduction.)

L : W = : 1

## 3. Basin Side Slopes

- A) Basin Maximum Side Slopes  
(Horizontal distance per unit vertical, 4:1 or flatter preferred)

Z = ft / ft

## 4. Inlet

- A) Describe means of providing energy dissipation at concentrated inflow locations:

INTEGRATED FOREBAY PER COCS DCM FIGURE 13-9 W/ BAFFLES

## 5. Forebay

- A) Minimum Forebay Volume  
( $V_{FMIN} = 3\%$  of the WQCV)

- B) Actual Forebay Volume

- C) Forebay Depth  
( $D_F = 18$  inch maximum)

- D) Forebay Discharge

- i) Undetained 100-year Peak Discharge

- ii) Forebay Discharge Design Flow  
( $Q_F = 0.02 * Q_{100}$ )

- E) Forebay Discharge Design

- F) Discharge Pipe Size (minimum 8-inches)

- G) Rectangular Notch Width

$V_{FMIN} = 0.014$  ac-ft

$V_F = 0.015$  ac-ft

$D_F = 30.0$  in

DF > DF MAXIMUM

$Q_{100} = 75.73$  cfs

$Q_F = 1.51$  cfs

Choose One

☐ Berm With Pipe

☒ Wall with Rect. Notch

☐ Wall with V-Notch Weir

Flow too small for berm w/ pipe

Calculated  $D_P =$  in

Calculated  $W_N = 7.4$  in

# Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Sheet 1 of 3

Designer: **SWK**  
 Company: **ENERTIA CONSULTING GROUP**  
 Date: **October 26, 2022**  
 Project: **COSA - INTEGRATION LOOP PHASE 4**  
 Location: **POND 705 - FOREBAY 3.0**

## 1. Basin Storage Volume

- A) Effective Imperviousness of Tributary Area,  $I_a$
- B) Tributary Area's Imperviousness Ratio ( $i = I_a / 100$ )
- C) Contributing Watershed Area
- D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm
- E) Design Concept  
(Select EURV when also designing for flood control)
- F) Design Volume (WQCV) Based on 40-hour Drain Time  
( $V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area)$ )
- G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume  
( $V_{WQCV\ OTHER} = (d_s * (V_{DESIGN} / 0.43))$ )
- H) User Input of Water Quality Capture Volume (WQCV) Design Volume  
(Only if a different WQCV Design Volume is desired)
- I) NRCS Hydrologic Soil Groups of Tributary Watershed  
 i) Percentage of Watershed consisting of Type A Soils  
 ii) Percentage of Watershed consisting of Type B Soils  
 iii) Percentage of Watershed consisting of Type C/D Soils
- J) Excess Urban Runoff Volume (EURV) Design Volume  
 For HSG A:  $EURV_A = 1.68 * i^{1.28}$   
 For HSG B:  $EURV_B = 1.36 * i^{1.08}$   
 For HSG C/D:  $EURV_{C/D} = 1.20 * i^{1.08}$
- K) User Input of Excess Urban Runoff Volume (EURV) Design Volume  
(Only if a different EURV Design Volume is desired)

$I_a = 30.0$  %

$i = 0.300$

Area = 115.300 ac

$d_s =$  in

Choose One

☒ Water Quality Capture Volume (WQCV)

☐ Excess Urban Runoff Volume (EURV)

$V_{DESIGN} = 1.455$  ac-ft

$V_{DESIGN\ OTHER} =$  ac-ft

$V_{DESIGN\ USER} =$  ac-ft

HSG A = %

HSG B = %

HSG C/D = %

$EURV_{DESIGN} =$  ac-ft

$EURV_{DESIGN\ USER} =$  ac-ft

## 2. Basin Shape: Length to Width Ratio

(A basin length to width ratio of at least 2:1 will improve TSS reduction.)

L : W = : 1

## 3. Basin Side Slopes

- A) Basin Maximum Side Slopes  
(Horizontal distance per unit vertical, 4:1 or flatter preferred)

Z = ft / ft

## 4. Inlet

- A) Describe means of providing energy dissipation at concentrated inflow locations:

INTEGRATED FOREBAY PER COCS DCM FIGURE 13-9 W/ BAFFLES

## 5. Forebay

- A) Minimum Forebay Volume  
( $V_{MIN} = 3\%$  of the WQCV)

- B) Actual Forebay Volume

- C) Forebay Depth  
( $D_F = 30$  inch maximum)

- D) Forebay Discharge

- i) Undetained 100-year Peak Discharge

- ii) Forebay Discharge Design Flow  
( $Q_F = 0.02 * Q_{100}$ )

- E) Forebay Discharge Design

- F) Discharge Pipe Size (minimum 8-inches)

- G) Rectangular Notch Width

$V_{MIN} = 0.044$  ac-ft

$V_F = 0.046$  ac-ft

$D_F = 30.0$  in

$Q_{100} = 127.20$  cfs

$Q_F = 2.54$  cfs

Choose One

☐ Berm With Pipe

☒ Wall with Rect. Notch

☐ Wall with V-Notch Weir

Calculated  $D_P =$  in

Calculated  $W_N = 8.3$  in

# Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Sheet 1 of 3

**Designer:** SWK  
**Company:** ENERTIA CONSULTING GROUP  
**Date:** October 27, 2022  
**Project:** COSA - INTEGRATION LOOP PHASE 4  
**Location:** POND 705 - FOREBAY 4.0

## 1. Basin Storage Volume

- A) Effective Imperviousness of Tributary Area,  $I_a$
- B) Tributary Area's Imperviousness Ratio ( $i = I_a / 100$ )
- C) Contributing Watershed Area
- D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm
- E) Design Concept  
(Select EURV when also designing for flood control)
- F) Design Volume (WQCV) Based on 40-hour Drain Time  
( $V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * \text{Area})$ )
- G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume  
( $V_{WQCV \text{ OTHER}} = (d_s * (V_{DESIGN} / 0.43))$ )
- H) User Input of Water Quality Capture Volume (WQCV) Design Volume  
(Only if a different WQCV Design Volume is desired)
- I) NRCS Hydrologic Soil Groups of Tributary Watershed  
 i) Percentage of Watershed consisting of Type A Soils  
 ii) Percentage of Watershed consisting of Type B Soils  
 iii) Percentage of Watershed consisting of Type C/D Soils
- J) Excess Urban Runoff Volume (EURV) Design Volume  
 For HSG A:  $EURV_A = 1.68 * i^{1.28}$   
 For HSG B:  $EURV_B = 1.36 * i^{1.08}$   
 For HSG C/D:  $EURV_{C/D} = 1.20 * i^{1.08}$
- K) User Input of Excess Urban Runoff Volume (EURV) Design Volume  
(Only if a different EURV Design Volume is desired)

$I_a = 75.0$  %

$i = 0.750$

Area = 61.260 ac

$d_s =$  in

Choose One

☒ Water Quality Capture Volume (WQCV)

☐ Excess Urban Runoff Volume (EURV)

$V_{DESIGN} = 1.529$  ac-ft

$V_{DESIGN \text{ OTHER}} =$  ac-ft

$V_{DESIGN \text{ USER}} =$  ac-ft

HSG A = %

HSG B = %

HSG C/D = %

$EURV_{DESIGN} =$  ac-ft

$EURV_{DESIGN \text{ USER}} =$  ac-ft

## 2. Basin Shape: Length to Width Ratio

(A basin length to width ratio of at least 2:1 will improve TSS reduction.)

L : W = : 1

## 3. Basin Side Slopes

- A) Basin Maximum Side Slopes  
(Horizontal distance per unit vertical, 4:1 or flatter preferred)

Z = ft / ft

## 4. Inlet

- A) Describe means of providing energy dissipation at concentrated inflow locations:

INTEGRATED FOREBAY PER COCS DCM FIGURE 13-9 W/ BAFFLES

## 5. Forebay

- A) Minimum Forebay Volume  
( $V_{FMIN} = 3\%$  of the WQCV)

- B) Actual Forebay Volume

- C) Forebay Depth  
( $D_F = 30$  inch maximum)

- D) Forebay Discharge

- i) Undetained 100-year Peak Discharge

- ii) Forebay Discharge Design Flow  
( $Q_F = 0.02 * Q_{100}$ )

- E) Forebay Discharge Design

- F) Discharge Pipe Size (minimum 8-inches)

- G) Rectangular Notch Width

$V_{FMIN} = 0.046$  ac-ft

$V_F = 0.048$  ac-ft

$D_F = 16.0$  in

$Q_{100} = 242.00$  cfs

$Q_F = 4.84$  cfs

Choose One

☐ Berm With Pipe

☒ Wall with Rect. Notch

☐ Wall with V-Notch Weir

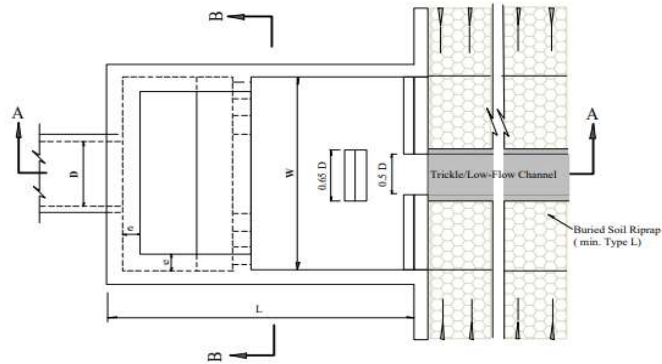
Calculated  $D_P =$  in

Calculated  $W_N = 14.5$  in

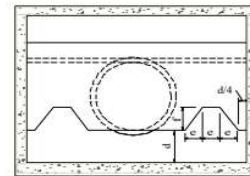


**POND 705 IMPACT STILLING BASIN DESIGN - FOREBAY-4.1**  
(MHFD Manual Volume 2, Chapter 9, Section 3.2.4)

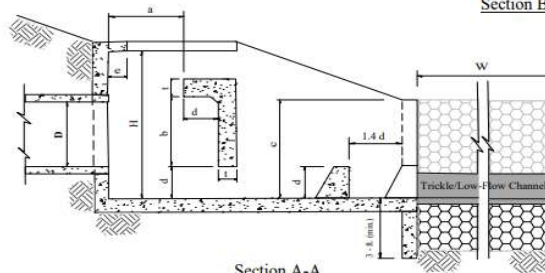
V =	13.3 ft/s	from analysis
A =	18.2 sf	from analysis
D =	4.27 ft	use 4'-3.5"
W =	13.46 ft	use 13'-6"
H =	10.09 ft	use 10'-1.5"
L =	17.94 ft	use 18'-0"
a =	6.73 ft	use 6'-9"
b =	5.05 ft	use 5'-1"
c =	6.73 ft	use 6'-9"
d =	2.24 ft	use 2'-3"
e =	1.12 ft	use 1'-2"
f =	1.68 ft	use 1'-8.5"
t =	1.12 ft	use 1'-2"



$W = 2.94 D [V/gD]^{0.556}$	$H = 3/4 W$	$c = 1/2 W$
$V = \text{Velocity, ft/s}$	$L = 4/3 W$	$d = 1/6 W$
$D = \sqrt{A}$	$a = 1/2 W$	$e = 1/12 W$
$A = \text{Area of flow, sq. ft.}$	$b = 3/8 W$	$f = 1/8 W$
	$t = 1/12 W$ (suggested min.)	



**Section B-B**



**Section A-A**

USGS Impact Stilling Basin Modified by UDFCD February 2004

**Figure HS-14—General Design Dimensions for a USBR Type VI Impact Stilling Basin**

# Design Procedure Form: Extended Detention Basin (EDB)

Sheet 2 of 3

Designer: **SWK**  
 Company: **ENERTIA CONSULTING GROUP**  
 Date: **October 26, 2022**  
 Project: **COSA - INTEGRATION LOOP PHASE 4**  
 Location: **POND 705 - FOREBAY 1.0**

## 6. Trickle Channel

A) Type of Trickle Channel

F) Slope of Trickle Channel

Choose One  
☒ Concrete  
☐ Soft Bottom

S =  ft / ft

## 7. Micropool and Outlet Structure

A) Depth of Micropool (2.5-foot minimum)

B) Surface Area of Micropool (10 ft<sup>2</sup> minimum)

C) Outlet Type

D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention)

E) Total Outlet Area

D<sub>M</sub> =  ft

A<sub>M</sub> =  sq ft

Choose One  
☒ Orifice Plate  
☐ Other (Describe):

D<sub>orifice</sub> =  inches

A<sub>orifice</sub> =  square inches

## 8. Initial Surge Volume

A) Depth of Initial Surge Volume (Minimum recommended depth is 4 inches)

B) Minimum Initial Surge Volume (Minimum volume of 0.3% of the WQCV)

C) Initial Surge Provided Above Micropool

D<sub>IS</sub> =  in

V<sub>IS</sub> =  cu ft

V<sub>s</sub> =  cu ft

## 9. Trash Rack

A) Water Quality Screen Open Area:  $A_t = A_{ot} * 38.5 * (e^{-0.095D})$

B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open area to the total screen area for the material specified.)

Other (Y/N):

C) Ratio of Total Open Area to Total Area (only for type 'Other')

D) Total Water Quality Screen Area (based on screen type)

E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E)

F) Height of Water Quality Screen (H<sub>TR</sub>)

G) Width of Water Quality Screen Opening (W<sub>opening</sub>) (Minimum of 12 inches is recommended)

A<sub>t</sub> =  square inches

User Ratio =

A<sub>total</sub> =  sq. in.

H =  feet

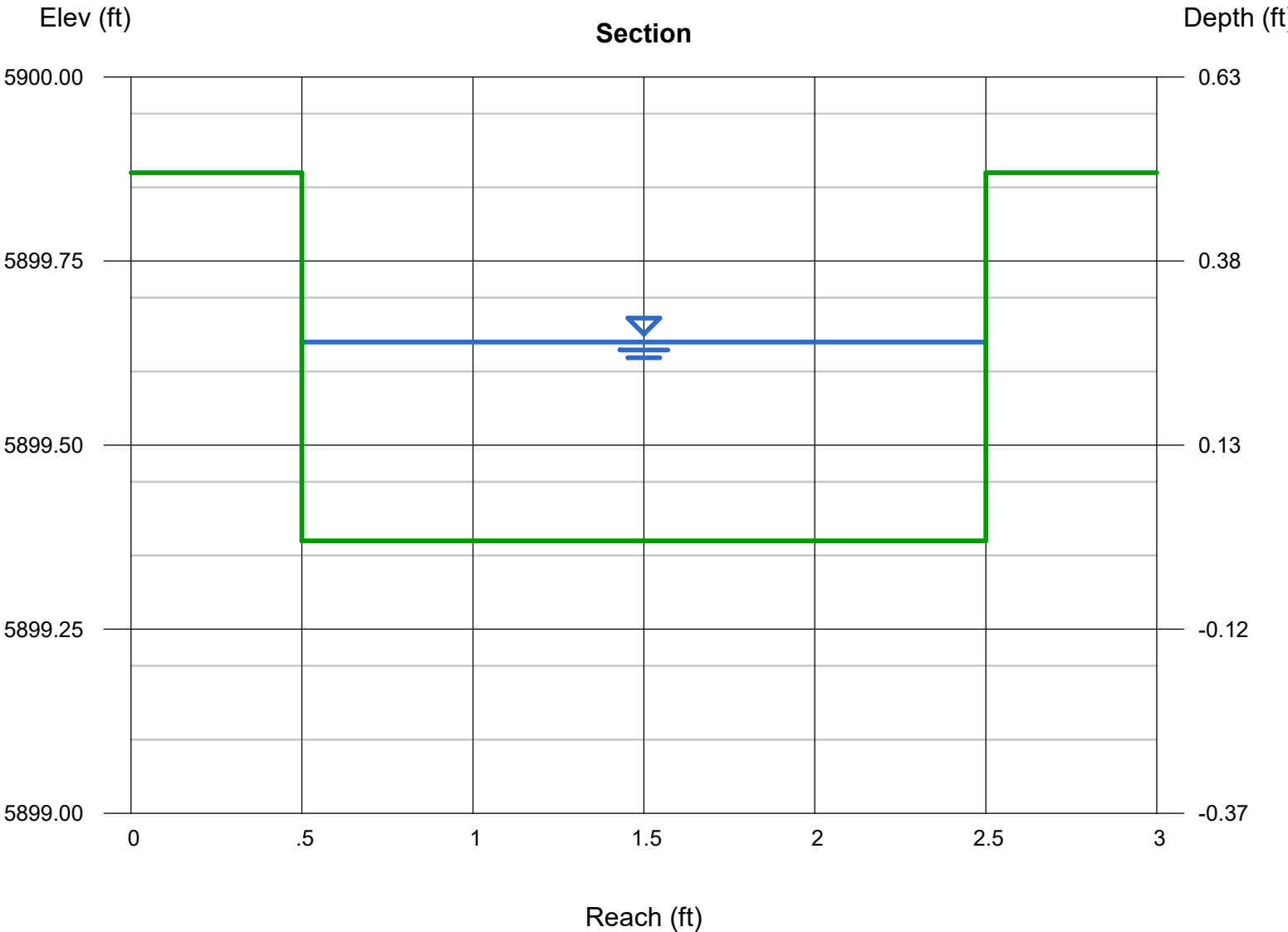
H<sub>TR</sub> =  inches

W<sub>opening</sub> =  inches

# Channel Report

## POND 705 TRICKLE CHANNEL - 1.0

<b>Rectangular</b>		<b>Highlighted</b>	
Bottom Width (ft)	= 2.00	Depth (ft)	= 0.27
Total Depth (ft)	= 0.50	Q (cfs)	= 1.520
		Area (sqft)	= 0.54
Invert Elev (ft)	= 5899.37	Velocity (ft/s)	= 2.81
Slope (%)	= 0.50	Wetted Perim (ft)	= 2.54
N-Value	= 0.013	Crit Depth, Yc (ft)	= 0.27
		Top Width (ft)	= 2.00
		EGL (ft)	= 0.39
<b>Calculations</b>			
Compute by:	Known Q		
Known Q (cfs)	= 1.52		



# Channel Report

## POND 705 TRICKLE CHANNEL - 3.0

### Rectangular

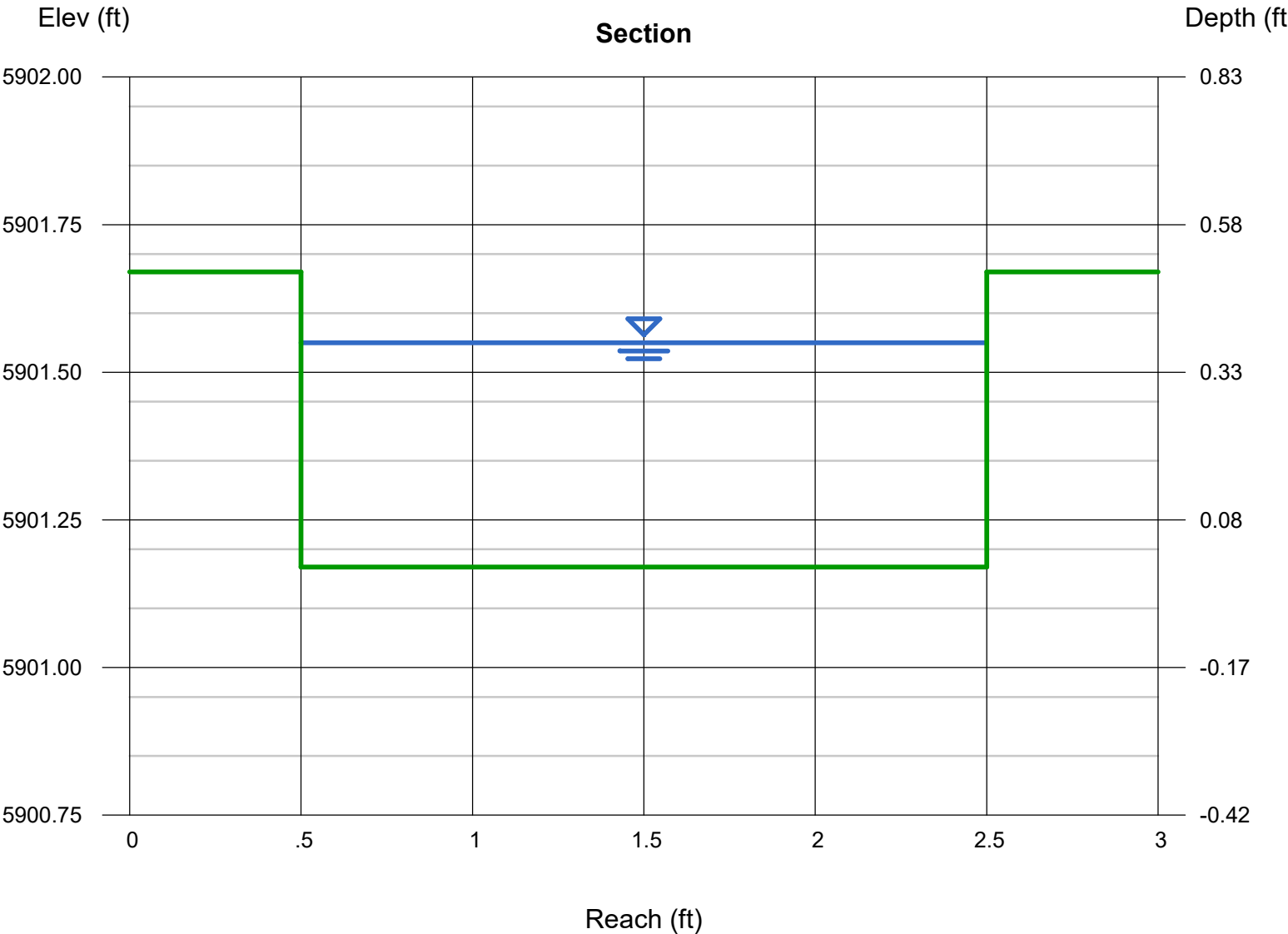
Bottom Width (ft) = 2.00  
Total Depth (ft) = 0.50  
  
Invert Elev (ft) = 5901.17  
Slope (%) = 0.50  
N-Value = 0.013

### Calculations

Compute by: Known Q  
Known Q (cfs) = 2.54

### Highlighted

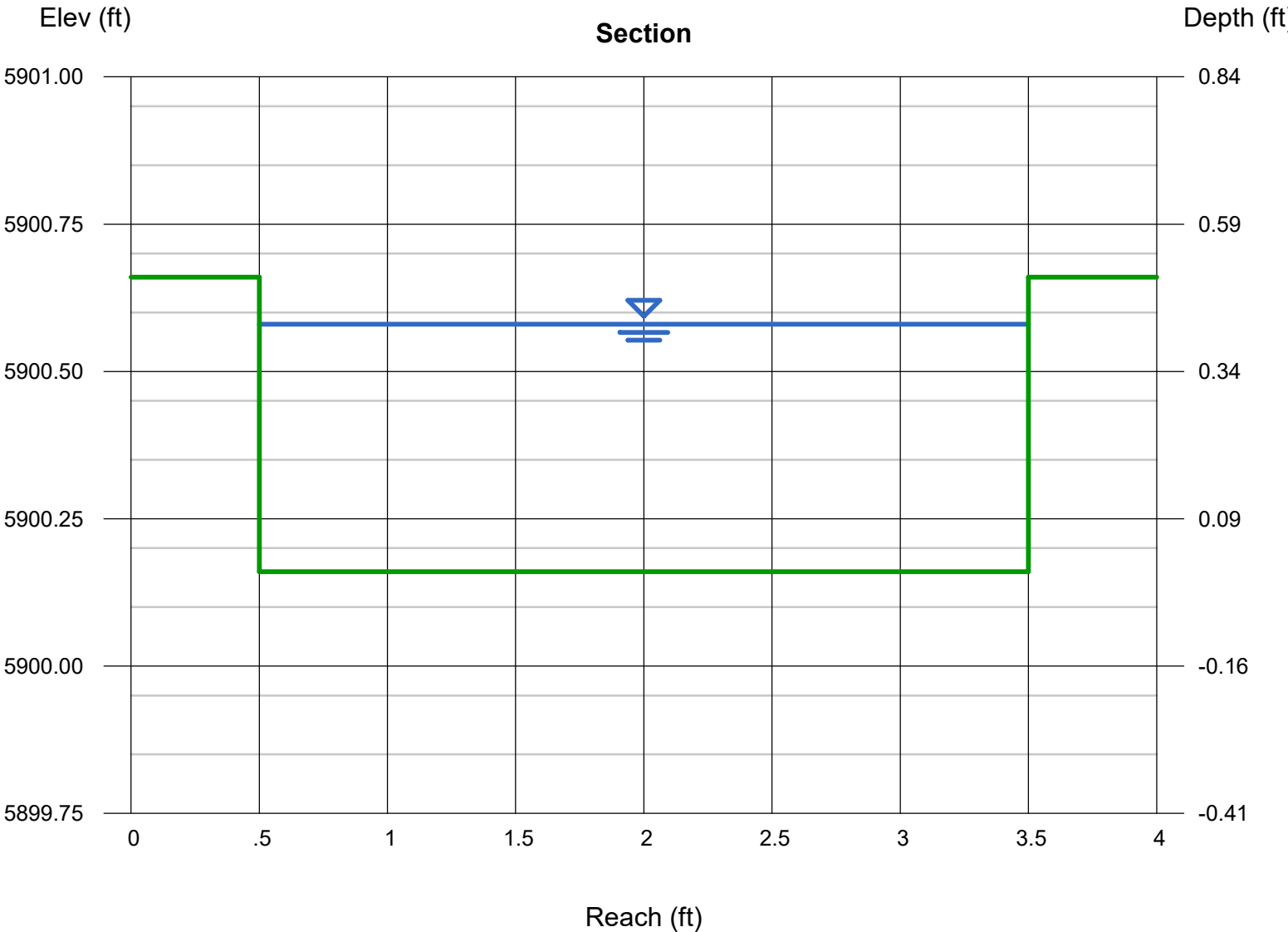
Depth (ft) = 0.38  
Q (cfs) = 2.540  
Area (sqft) = 0.76  
Velocity (ft/s) = 3.34  
Wetted Perim (ft) = 2.76  
Crit Depth, Yc (ft) = 0.37  
Top Width (ft) = 2.00  
EGL (ft) = 0.55



# Channel Report

## POND 705 TRICKLE CHANNEL - 4.0

<b>Rectangular</b>		<b>Highlighted</b>	
Bottom Width (ft)	= 3.00	Depth (ft)	= 0.42
Total Depth (ft)	= 0.50	Q (cfs)	= 4.840
		Area (sqft)	= 1.26
Invert Elev (ft)	= 5900.16	Velocity (ft/s)	= 3.84
Slope (%)	= 0.50	Wetted Perim (ft)	= 3.84
N-Value	= 0.013	Crit Depth, Yc (ft)	= 0.44
		Top Width (ft)	= 3.00
		EGL (ft)	= 0.65
<b>Calculations</b>			
Compute by:	Known Q		
Known Q (cfs)	= 4.84		



# Channel Report

## POND 705 TRICKLE CHANNEL - COMBINED

### Rectangular

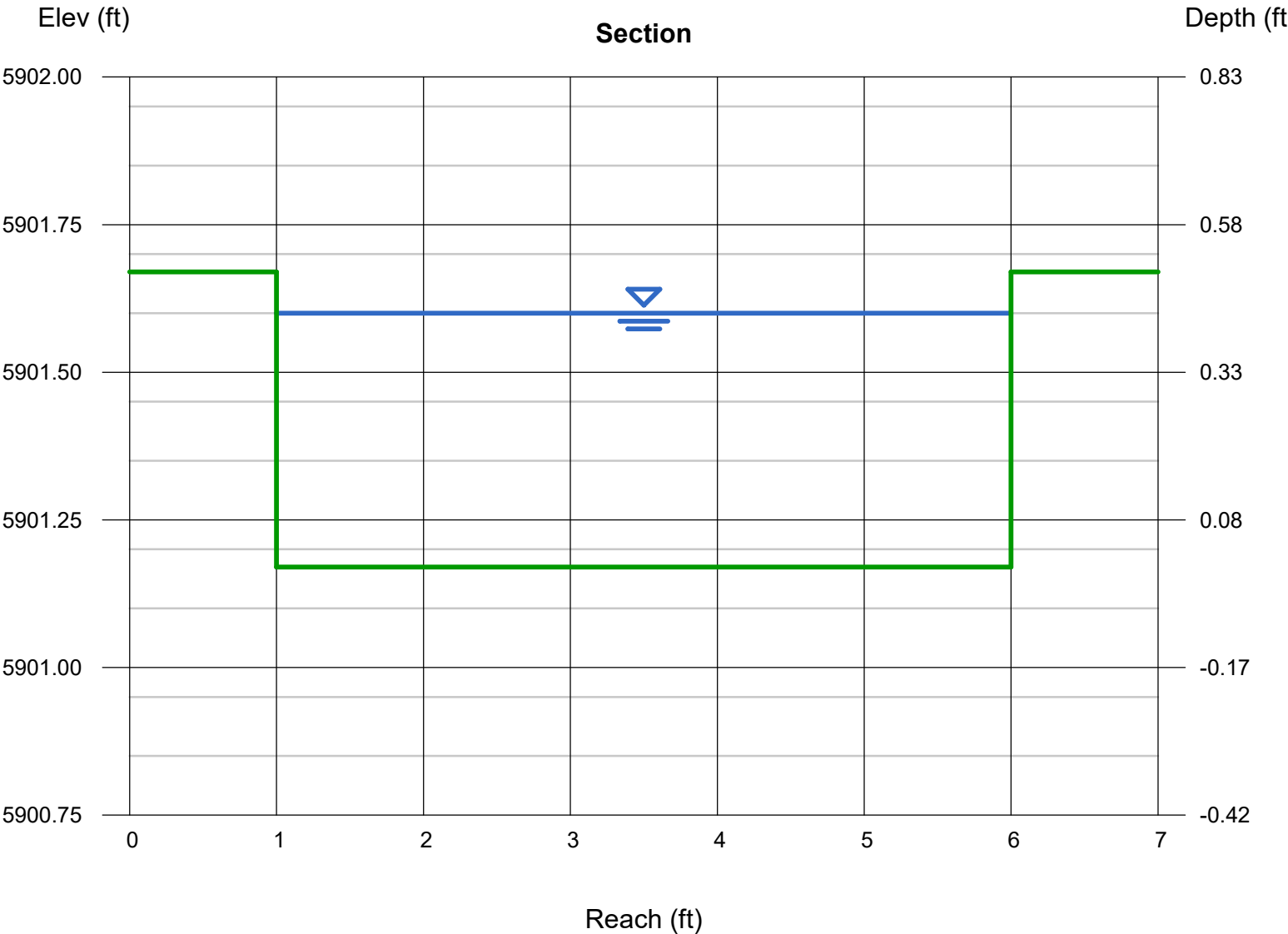
Bottom Width (ft) = 5.00  
Total Depth (ft) = 0.50  
  
Invert Elev (ft) = 5901.17  
Slope (%) = 0.50  
N-Value = 0.013

### Calculations

Compute by: Known Q  
Known Q (cfs) = 8.90

### Highlighted

Depth (ft) = 0.43  
Q (cfs) = 8.900  
Area (sqft) = 2.15  
Velocity (ft/s) = 4.14  
Wetted Perim (ft) = 5.86  
Crit Depth, Yc (ft) = 0.47  
Top Width (ft) = 5.00  
EGL (ft) = 0.70



Pond 705

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# Appendix F

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Reference Documents



## NRCS Web Soil Survey

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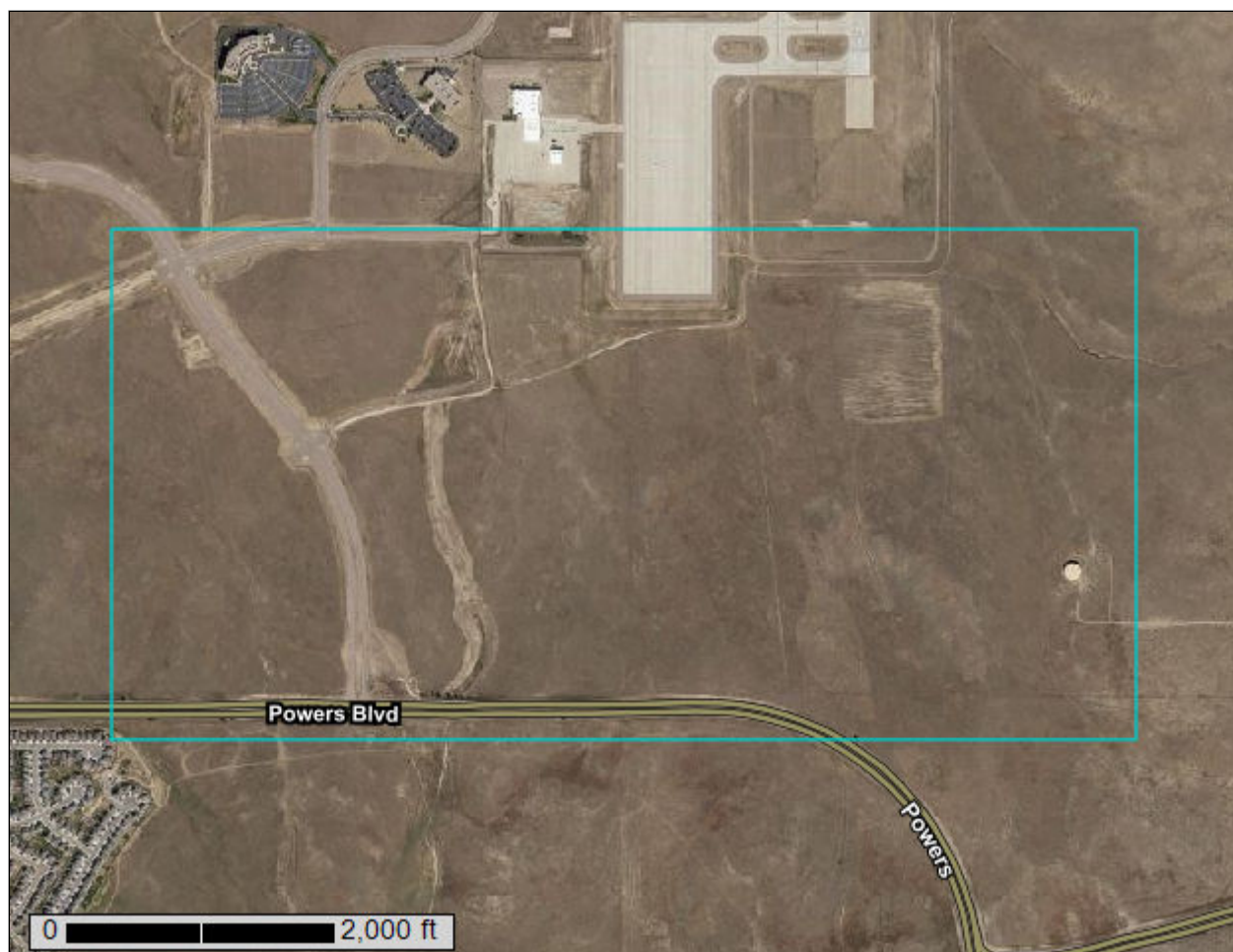
United States  
Department of  
Agriculture

**NRCS**

Natural  
Resources  
Conservation  
Service

A product of the National  
Cooperative Soil Survey,  
a joint effort of the United  
States Department of  
Agriculture and other  
Federal agencies, State  
agencies including the  
Agricultural Experiment  
Stations, and local  
participants

# Custom Soil Resource Report for **El Paso County Area, Colorado**



# Preface

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Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (<http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/>) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (<https://offices.sc.egov.usda.gov/locator/app?agency=nrcs>) or your NRCS State Soil Scientist ([http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2\\_053951](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951)).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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# How Soil Surveys Are Made

---

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

## Custom Soil Resource Report

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.



# Soil Map

---

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

# Custom Soil Resource Report Soil Map



## MAP LEGEND

### Area of Interest (AOI)

 Area of Interest (AOI)

### Soils

 Soil Map Unit Polygons

 Soil Map Unit Lines

 Soil Map Unit Points

### Special Point Features

 Blowout

 Borrow Pit

 Clay Spot

 Closed Depression

 Gravel Pit

 Gravelly Spot

 Landfill

 Lava Flow

 Marsh or swamp

 Mine or Quarry

 Miscellaneous Water

 Perennial Water

 Rock Outcrop

 Saline Spot

 Sandy Spot

 Severely Eroded Spot


 Sinkhole

 Slide or Slip

 Sodic Spot

 Spoil Area

 Stony Spot

 Very Stony Spot

 Wet Spot

 Other

 Special Line Features

### Water Features

 Streams and Canals

### Transportation

 Rails

 Interstate Highways

 US Routes

 Major Roads

 Local Roads

### Background

 Aerial Photography

## MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado  
Survey Area Data: Version 20, Sep 2, 2022

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

Date(s) aerial images were photographed: Aug 19, 2018—Sep 23, 2018

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.

## Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
3	Ascalon sandy loam, 3 to 9 percent slopes	6.4	1.0%
8	Blakeland loamy sand, 1 to 9 percent slopes	436.9	65.8%
11	Bresser sandy loam, cool, 0 to 3 percent slopes	19.1	2.9%
31	Fort Collins loam, 3 to 8 percent slopes	0.4	0.1%
86	Stoneham sandy loam, 3 to 8 percent slopes	49.6	7.5%
95	Truckton loamy sand, 1 to 9 percent slopes	6.6	1.0%
97	Truckton sandy loam, 3 to 9 percent slopes	127.7	19.2%
108	Wiley silt loam, 3 to 9 percent slopes	17.1	2.6%
<b>Totals for Area of Interest</b>		<b>663.9</b>	<b>100.0%</b>

## Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas

are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

## El Paso County Area, Colorado

### 3—Ascalon sandy loam, 3 to 9 percent slopes

#### Map Unit Setting

*National map unit symbol:* 2tlny  
*Elevation:* 3,870 to 5,960 feet  
*Mean annual precipitation:* 13 to 18 inches  
*Mean annual air temperature:* 46 to 54 degrees F  
*Frost-free period:* 95 to 155 days  
*Farmland classification:* Not prime farmland

#### Map Unit Composition

*Ascalon and similar soils:* 85 percent  
*Minor components:* 15 percent  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

#### Description of Ascalon

##### Setting

*Landform:* Interfluves  
*Landform position (two-dimensional):* Backslope  
*Landform position (three-dimensional):* Side slope  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Parent material:* Wind-reworked alluvium and/or calcareous sandy eolian deposits

##### Typical profile

*Ap - 0 to 6 inches:* sandy loam  
*Bt1 - 6 to 12 inches:* sandy clay loam  
*Bt2 - 12 to 19 inches:* sandy clay loam  
*Bk1 - 19 to 35 inches:* fine sandy loam  
*Bk2 - 35 to 80 inches:* fine sandy loam

##### Properties and qualities

*Slope:* 3 to 9 percent  
*Depth to restrictive feature:* More than 80 inches  
*Drainage class:* Well drained  
*Runoff class:* Medium  
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high  
(0.60 to 5.98 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Calcium carbonate, maximum content:* 10 percent  
*Maximum salinity:* Nonsaline (0.1 to 1.9 mmhos/cm)  
*Sodium adsorption ratio, maximum:* 1.0  
*Available water supply, 0 to 60 inches:* Moderate (about 7.1 inches)

##### Interpretive groups

*Land capability classification (irrigated):* 6e  
*Land capability classification (nonirrigated):* 6e  
*Hydrologic Soil Group:* B  
*Ecological site:* R067BY024CO - Sandy Plains  
*Hydric soil rating:* No

## Minor Components

### Olnest

*Percent of map unit:* 10 percent  
*Landform:* Interfluves  
*Landform position (two-dimensional):* Backslope  
*Landform position (three-dimensional):* Side slope  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Ecological site:* R067BY024CO - Sandy Plains  
*Hydric soil rating:* No

### Vona

*Percent of map unit:* 5 percent  
*Landform:* Interfluves  
*Landform position (two-dimensional):* Backslope  
*Landform position (three-dimensional):* Side slope  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Ecological site:* R067BY024CO - Sandy Plains  
*Hydric soil rating:* No

## 8—Blakeland loamy sand, 1 to 9 percent slopes

### Map Unit Setting

*National map unit symbol:* 369v  
*Elevation:* 4,600 to 5,800 feet  
*Mean annual precipitation:* 14 to 16 inches  
*Mean annual air temperature:* 46 to 48 degrees F  
*Frost-free period:* 125 to 145 days  
*Farmland classification:* Not prime farmland

### Map Unit Composition

*Blakeland and similar soils:* 98 percent  
*Minor components:* 2 percent  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Blakeland

#### Setting

*Landform:* Flats, hills  
*Landform position (three-dimensional):* Side slope, talf  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Parent material:* Alluvium derived from sedimentary rock and/or eolian deposits  
derived from sedimentary rock

#### Typical profile

*A - 0 to 11 inches:* loamy sand  
*AC - 11 to 27 inches:* loamy sand

## Custom Soil Resource Report

*C - 27 to 60 inches: sand*

### Properties and qualities

*Slope: 1 to 9 percent*

*Depth to restrictive feature: More than 80 inches*

*Drainage class: Somewhat excessively drained*

*Runoff class: Low*

*Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)*

*Depth to water table: More than 80 inches*

*Frequency of flooding: None*

*Frequency of ponding: None*

*Calcium carbonate, maximum content: 5 percent*

*Available water supply, 0 to 60 inches: Low (about 4.5 inches)*

### Interpretive groups

*Land capability classification (irrigated): 3e*

*Land capability classification (nonirrigated): 6e*

*Hydrologic Soil Group: A*

*Ecological site: R049XB210CO - Sandy Foothill*

*Hydric soil rating: No*

### Minor Components

#### Other soils

*Percent of map unit: 1 percent*

*Hydric soil rating: No*

#### Pleasant

*Percent of map unit: 1 percent*

*Landform: Depressions*

*Hydric soil rating: Yes*

## 11—Bresser sandy loam, cool, 0 to 3 percent slopes

### Map Unit Setting

*National map unit symbol: 2tlph*

*Elevation: 5,850 to 6,880 feet*

*Mean annual precipitation: 15 to 19 inches*

*Mean annual air temperature: 48 to 52 degrees F*

*Frost-free period: 100 to 130 days*

*Farmland classification: Prime farmland if irrigated and the product of I (soil erodibility) x C (climate factor) does not exceed 60*

### Map Unit Composition

*Bresser, cool, and similar soils: 85 percent*

*Minor components: 15 percent*

*Estimates are based on observations, descriptions, and transects of the mapunit.*



## **Description of Bresser, Cool**

### **Setting**

*Landform:* Interfluves  
*Landform position (two-dimensional):* Summit  
*Landform position (three-dimensional):* Interfluve  
*Down-slope shape:* Linear  
*Across-slope shape:* Convex  
*Parent material:* Tertiary aged alluvium derived from arkose

### **Typical profile**

*Ap - 0 to 5 inches:* sandy loam  
*Bt1 - 5 to 8 inches:* sandy loam  
*Bt2 - 8 to 27 inches:* sandy clay loam  
*Bt3 - 27 to 36 inches:* sandy loam  
*C - 36 to 80 inches:* loamy coarse sand

### **Properties and qualities**

*Slope:* 0 to 3 percent  
*Depth to restrictive feature:* More than 80 inches  
*Drainage class:* Well drained  
*Runoff class:* Low  
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high  
(0.60 to 6.00 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Calcium carbonate, maximum content:* 5 percent  
*Maximum salinity:* Nonsaline to very slightly saline (0.1 to 2.0 mmhos/cm)  
*Available water supply, 0 to 60 inches:* Low (about 5.4 inches)

### **Interpretive groups**

*Land capability classification (irrigated):* 3e  
*Land capability classification (nonirrigated):* 4c  
*Hydrologic Soil Group:* B  
*Ecological site:* R049XB210CO - Sandy Foothill  
*Hydric soil rating:* No

## **Minor Components**

### **Truckton**

*Percent of map unit:* 10 percent  
*Landform:* Interfluves  
*Landform position (two-dimensional):* Summit  
*Landform position (three-dimensional):* Interfluve  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Ecological site:* R049XB210CO - Sandy Foothill  
*Hydric soil rating:* No

### **Yoder**

*Percent of map unit:* 5 percent  
*Landform:* Alluvial fans  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Ecological site:* R049XY214CO - Gravelly Foothill

*Hydric soil rating:* No

### **31—Fort Collins loam, 3 to 8 percent slopes**

#### **Map Unit Setting**

*National map unit symbol:* 3684

*Elevation:* 5,200 to 6,500 feet

*Mean annual precipitation:* 14 to 16 inches

*Mean annual air temperature:* 48 to 52 degrees F

*Farmland classification:* Not prime farmland

#### **Map Unit Composition**

*Fort collins and similar soils:* 98 percent

*Minor components:* 2 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

#### **Description of Fort Collins**

##### **Setting**

*Landform:* Hills

*Landform position (three-dimensional):* Side slope

*Down-slope shape:* Linear

*Across-slope shape:* Linear

*Parent material:* Loamy alluvium

##### **Typical profile**

*A - 0 to 9 inches:* loam

*Bt - 9 to 16 inches:* clay loam

*Bk - 16 to 21 inches:* clay loam

*Ck - 21 to 60 inches:* loam

##### **Properties and qualities**

*Slope:* 3 to 8 percent

*Depth to restrictive feature:* More than 80 inches

*Drainage class:* Well drained

*Runoff class:* Medium

*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high  
(0.57 to 2.00 in/hr)

*Depth to water table:* More than 80 inches

*Frequency of flooding:* None

*Frequency of ponding:* None

*Calcium carbonate, maximum content:* 15 percent

*Maximum salinity:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)

*Available water supply, 0 to 60 inches:* High (about 10.1 inches)

##### **Interpretive groups**

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 6e

*Hydrologic Soil Group:* B

*Ecological site:* R067BY002CO - Loamy Plains

*Other vegetative classification:* LOAMY PLAINS (069AY006CO)

*Hydric soil rating:* No

**Minor Components**

**Other soils**

*Percent of map unit:* 1 percent

*Hydric soil rating:* No

**Pleasant**

*Percent of map unit:* 1 percent

*Landform:* Depressions

*Hydric soil rating:* Yes

**86—Stoneham sandy loam, 3 to 8 percent slopes**

**Map Unit Setting**

*National map unit symbol:* 36b2

*Elevation:* 5,100 to 6,500 feet

*Mean annual precipitation:* 13 to 15 inches

*Mean annual air temperature:* 48 to 52 degrees F

*Frost-free period:* 135 to 155 days

*Farmland classification:* Not prime farmland

**Map Unit Composition**

*Stoneham and similar soils:* 95 percent

*Minor components:* 5 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Stoneham**

**Setting**

*Landform:* Hills

*Landform position (three-dimensional):* Side slope

*Down-slope shape:* Linear

*Across-slope shape:* Linear

*Parent material:* Calcareous loamy alluvium

**Typical profile**

*A - 0 to 4 inches:* sandy loam

*Bt - 4 to 8 inches:* sandy clay loam

*Btk - 8 to 11 inches:* sandy clay loam

*Ck - 11 to 60 inches:* loam

**Properties and qualities**

*Slope:* 3 to 8 percent

*Depth to restrictive feature:* More than 80 inches

*Drainage class:* Well drained

*Runoff class:* Medium

*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high  
(0.60 to 2.00 in/hr)

*Depth to water table:* More than 80 inches

## Custom Soil Resource Report

*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Calcium carbonate, maximum content:* 15 percent  
*Maximum salinity:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)  
*Available water supply, 0 to 60 inches:* High (about 9.5 inches)

### Interpretive groups

*Land capability classification (irrigated):* 3e  
*Land capability classification (nonirrigated):* 4e  
*Hydrologic Soil Group:* B  
*Ecological site:* R067BY024CO - Sandy Plains  
*Other vegetative classification:* SANDY PLAINS (069AY026CO)  
*Hydric soil rating:* No

### Minor Components

#### Other soils

*Percent of map unit:* 4 percent  
*Hydric soil rating:* No

#### Pleasant

*Percent of map unit:* 1 percent  
*Landform:* Depressions  
*Hydric soil rating:* Yes

## 95—Truckton loamy sand, 1 to 9 percent slopes

### Map Unit Setting

*National map unit symbol:* 2yvrn  
*Elevation:* 5,800 to 7,100 feet  
*Mean annual precipitation:* 12 to 19 inches  
*Mean annual air temperature:* 46 to 50 degrees F  
*Frost-free period:* 90 to 155 days  
*Farmland classification:* Not prime farmland

### Map Unit Composition

*Truckton and similar soils:* 87 percent  
*Minor components:* 13 percent  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Truckton

#### Setting

*Landform:* Interfluves, fan remnants  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Parent material:* Wind re-worked alluvium derived from arkose

#### Typical profile

*A - 0 to 4 inches:* loamy sand  
*Bt1 - 4 to 12 inches:* sandy loam

## Custom Soil Resource Report

*Bt2 - 12 to 19 inches: sandy loam*

*C - 19 to 80 inches: sandy loam*

### Properties and qualities

*Slope: 1 to 9 percent*

*Depth to restrictive feature: More than 80 inches*

*Drainage class: Well drained*

*Runoff class: Low*

*Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)*

*Depth to water table: More than 80 inches*

*Frequency of flooding: None*

*Frequency of ponding: None*

*Calcium carbonate, maximum content: 1 percent*

*Maximum salinity: Nonsaline to very slightly saline (0.1 to 2.0 mmhos/cm)*

*Available water supply, 0 to 60 inches: Moderate (about 6.5 inches)*

### Interpretive groups

*Land capability classification (irrigated): 6e*

*Land capability classification (nonirrigated): 6e*

*Hydrologic Soil Group: A*

*Ecological site: R049XB210CO - Sandy Foothill*

*Hydric soil rating: No*

### Minor Components

#### Blakeland

*Percent of map unit: 5 percent*

*Landform: Interfluves, hills*

*Landform position (two-dimensional): Summit, shoulder, backslope*

*Landform position (three-dimensional): Crest, side slope*

*Down-slope shape: Linear, convex*

*Across-slope shape: Linear, convex*

*Ecological site: R049XB210CO - Sandy Foothill*

*Hydric soil rating: No*

#### Bresser

*Percent of map unit: 5 percent*

*Landform: Interfluves, terraces*

*Landform position (three-dimensional): Tread*

*Down-slope shape: Linear*

*Across-slope shape: Linear*

*Ecological site: R049XB210CO - Sandy Foothill*

*Hydric soil rating: No*

#### Urban land

*Percent of map unit: 2 percent*

*Hydric soil rating: No*

#### Ellicott, occasionally flooded

*Percent of map unit: 1 percent*

*Landform: Flood plains, drainageways*

*Down-slope shape: Linear*

*Across-slope shape: Linear, concave*

*Ecological site: R067BY031CO - Sandy Bottomland*

*Hydric soil rating: No*

## 97—Truckton sandy loam, 3 to 9 percent slopes

### Map Unit Setting

*National map unit symbol:* 2x0j2

*Elevation:* 5,300 to 6,850 feet

*Mean annual precipitation:* 14 to 19 inches

*Mean annual air temperature:* 48 to 52 degrees F

*Frost-free period:* 85 to 155 days

*Farmland classification:* Not prime farmland

### Map Unit Composition

*Truckton and similar soils:* 85 percent

*Minor components:* 15 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Truckton

#### Setting

*Landform:* Hillslopes, interfluves

*Landform position (two-dimensional):* Backslope

*Landform position (three-dimensional):* Side slope

*Down-slope shape:* Linear

*Across-slope shape:* Linear

*Parent material:* Re-worked alluvium derived from arkose

#### Typical profile

*A - 0 to 4 inches:* sandy loam

*Bt1 - 4 to 12 inches:* sandy loam

*Bt2 - 12 to 19 inches:* sandy loam

*C - 19 to 80 inches:* sandy loam

#### Properties and qualities

*Slope:* 3 to 9 percent

*Depth to restrictive feature:* More than 80 inches

*Drainage class:* Well drained

*Runoff class:* Low

*Capacity of the most limiting layer to transmit water (Ksat):* High (2.00 to 6.00 in/hr)

*Depth to water table:* More than 80 inches

*Frequency of flooding:* None

*Frequency of ponding:* None

*Calcium carbonate, maximum content:* 1 percent

*Maximum salinity:* Nonsaline (0.1 to 1.9 mmhos/cm)

*Available water supply, 0 to 60 inches:* Moderate (about 6.6 inches)

#### Interpretive groups

*Land capability classification (irrigated):* 6e

*Land capability classification (nonirrigated):* 6e

*Hydrologic Soil Group:* A

*Ecological site:* R049XB210CO - Sandy Foothill

*Hydric soil rating:* No

**Minor Components**

**Blakeland**

*Percent of map unit:* 8 percent  
*Landform:* Hillslopes, interfluves  
*Landform position (two-dimensional):* Shoulder, backslope, summit  
*Landform position (three-dimensional):* Crest, side slope  
*Down-slope shape:* Linear, convex  
*Across-slope shape:* Linear, convex  
*Ecological site:* R049XB210CO - Sandy Foothill  
*Hydric soil rating:* No

**Bresser**

*Percent of map unit:* 7 percent  
*Landform:* Low hills, interfluves  
*Landform position (two-dimensional):* Footslope, toeslope  
*Landform position (three-dimensional):* Base slope  
*Down-slope shape:* Linear, concave  
*Across-slope shape:* Linear, concave  
*Ecological site:* R049XB210CO - Sandy Foothill  
*Hydric soil rating:* No

**108—Wiley silt loam, 3 to 9 percent slopes**

**Map Unit Setting**

*National map unit symbol:* 367b  
*Elevation:* 5,200 to 6,200 feet  
*Mean annual precipitation:* 12 to 14 inches  
*Mean annual air temperature:* 48 to 52 degrees F  
*Frost-free period:* 135 to 155 days  
*Farmland classification:* Not prime farmland

**Map Unit Composition**

*Wiley and similar soils:* 95 percent  
*Minor components:* 5 percent  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Wiley**

**Setting**

*Landform:* Hills  
*Landform position (three-dimensional):* Side slope  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Parent material:* Calcareous silty eolian deposits

**Typical profile**

*A - 0 to 4 inches:* silt loam  
*Bt - 4 to 16 inches:* silt loam

## Custom Soil Resource Report

*Bk - 16 to 60 inches: silt loam*

### Properties and qualities

*Slope: 3 to 9 percent*

*Depth to restrictive feature: More than 80 inches*

*Drainage class: Well drained*

*Runoff class: Medium*

*Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high  
(0.60 to 2.00 in/hr)*

*Depth to water table: More than 80 inches*

*Frequency of flooding: None*

*Frequency of ponding: None*

*Calcium carbonate, maximum content: 15 percent*

*Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)*

*Available water supply, 0 to 60 inches: High (about 11.5 inches)*

### Interpretive groups

*Land capability classification (irrigated): 4e*

*Land capability classification (nonirrigated): 6e*

*Hydrologic Soil Group: B*

*Ecological site: R067BY002CO - Loamy Plains*

*Other vegetative classification: LOAMY PLAINS (069AY006CO)*

*Hydric soil rating: No*

### Minor Components

#### Other soils

*Percent of map unit: 4 percent*

*Hydric soil rating: No*

#### Pleasant

*Percent of map unit: 1 percent*

*Landform: Depressions*

*Hydric soil rating: Yes*



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## Custom Soil Resource Report

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FEMA Panel

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NOTES TO USERS

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

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

**Coastal Base Flood Elevations** shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

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

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

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the **North American Vertical Datum of 1988 (NAVD88)**. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at <http://www.ngs.noaa.gov/> or contact the National Geodetic Survey at the following address:

NGS Information Services  
NOAA, NIMS12  
National Geodetic Survey  
SSMC-3, #9202  
1315 East-West Highway  
Silver Spring, MD 20910-3282

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

**Base Map** information shown on this FIRM was provided in digital format by El Paso County, Colorado Springs Utilities, and Anderson Consulting Engineers, Inc. These data are current as of 2008.

This map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map. The profile baselines depicted on this map represent the hydraulic modeling baselines that match the flood profiles and Floodway Data Tables if applicable, in the FIS report. As a result, the profile baselines may deviate significantly from the new base map channel representation and may appear outside of the floodplain.

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

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

Contact **FEMA Map Service Center (MSC)** via the FEMA Map Information eXchange (FIMX) 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. The MSC may also be reached by Fax at 1-800-358-9620 and its website at <http://www.msc.fema.gov/>.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at <http://www.fema.gov/business/nfip>.

El Paso County Vertical Datum Offset Table	
Flooding Source	Vertical Datum Offset (ft)
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION	

Panel Location Map

Additional Flood Hazard information and resources are available from local communities and the Colorado Water Conservation Board.

This Digital Flood Insurance Rate Map (DFIRM) was produced through a Cooperating Technical Partner (CTP) agreement between the State of Colorado Water Conservation Board (CWCB) and the Federal Emergency Management Agency (FEMA).

NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 14 SOUTH, RANGE 65 WEST, AND TOWNSHIP 15 SOUTH, RANGE 65 WEST.

LEGEND

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

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

ZONE A

No Base Flood Elevations determined.

ZONE AE

Base Flood Elevations determined.

ZONE AH

Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

ZONE AO

Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE AR

Special Flood Hazard Area Formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

ZONE A99

Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.

ZONE V

Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

ZONE VE

Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

ZONE X

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

OTHER AREAS

ZONE X

Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D

Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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

Floodplain boundary

Floodway boundary

Zone D Boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

513

(EL 987)

Base Flood Elevation line and value; elevation in feet\*

Base Flood Elevation value where uniform within zone; elevation in feet\*

\* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A

A

Cross section line

23

23

Transect line

97° 07' 30.00"

32° 22' 30.00"

Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)

42°56'00"N

1000-meter Universal Transverse Mercator grid ticks, zone 13

6000000 FT

5000-foot grid ticks: Colorado State Plane coordinate system, central zone (FIPSZONE 0902), Lambert Conformal Conic Projection

DX5510

Bench mark (see explanation in Notes to Users section of this FIRM panel)

M1.5

River Mile

MAP REPOSITORIES

Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP

MARCH 17, 1997

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

DECEMBER 7, 2018 - to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to update map format, to add roads and road names, and to incorporate previously issued Letters of Map Revision

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

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

MAP SCALE 1" = 500'

250

0

500

1000

FEET

150

0

150

300

METERS

NFIP

FIRM

PANEL 0764G

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 764 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	080060	0764	G
EL PASO COUNTY	080059	0764	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 08041C0764G

MAP REVISED

DECEMBER 7, 2018

Federal Emergency Management Agency