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Woodmen Heights Commercial Center Filing No. 2
Master Development Drainage Plan / Final Drainage Report

July 2020

HR Green Project No: 191850

Prepared For:

All Pro Capital, Inc.

Mr. Tony Bettis

13521 Northgate Estates Drive #200

Colorado Springs, CO 80921

719-358-8580

Prepared By:

HR Green Development, LLC

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Engineer's Statement

This report and plan for the drainage design of the development, Woodmen Heights Commercial Center Filing No. 2, 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.

Chris McFarland, PE Date 07/14/2020

State of Colorado No. 44947

For and on behalf of HR Green Development, LLC

COLORADO LICENSED PROFESSIONAL ENGINEER CHRISTIAN M. MCFARLAND 44947 06-17-20

Developer's Statement

All Pro Capital hereby certifies that the drainage facilities for Woodmen Heights Commercial Center Filing No. 2 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 , Woodmen Heights Commercial Center Filing No. 2, 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.

All Pro Marksheffel LLLP by All Pro Real Estate, LLC, General Partner of All Pro Marksheffel LLLP, by All Pro Capital, LLC, All Pro Real Estate, LLC's manager, by Tony Bettis, All Pro Capital, LLC's CEO and President 7/17/2020

Name of Developer | Authorized Signature | Date

BY: Tony Bettis, All Pro Capital, LLC's CEO and President 13521 Northgate Estates Dr., Suite 200, Colorado Springs, CO 80921

Printed Name | Title | 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.

07/17/2020

For City Engineer Date

Conditions:

Master Development Drainage Plan / FDR – Woodmen Heights Commercial Center Filing No. 2

I. General Purpose, Location and Description

a. Purpose and Scope of study

The Purpose of this Master Development Drainage Plan (MDDP) / FDR is to describe the onsite and offsite drainage patterns, existing and proposed storm infrastructure, areas tributary to the site and the planned storm water management for Woodmen Heights Commercial Center Filing No. 2 development. This report is to support the current plat and construction documents that are currently in review for Woodmen Heights Commercial Center Filing No. 2. All future developments within the platted boundary of Woodmen Heights Commercial Center Filing No 2 will be required to submit a site specific Final Drainage Report in conjunction with the individual. The site contains 8 platted lots.

b. DBPS Investigations

The Sand Creek Drainage Basin Planning Study (DBPS) Preliminary Design Report prepared by Kiowa Engineering was reviewed to determine existing plans and constraints that would influence the success of Woodmen Heights Commercial Center. The proposed plans for Woodmen Heights are in general conformance with the DBPS. Hydrology contained in the report was not intended to be applied when sizing storm drainage facilities draining areas less than 100 acres in size and therefore was calculated as described later in this report.

c. Agency Jurisdictions

Listed below are the jurisdictions that this project will conform to:

Woodmen Heights Metro District No.3

City of Colorado Springs

Colorado Springs Utilities

El Paso County

d. General Project Description

Woodmen Heights Commercial Center Filing No. 2 is located in Colorado Springs, Colorado within El Paso County and contains approximately 22.88 acres. Located northwest of the intersection of East Woodmen Drive and North Marksheffel Road. More specifically, Woodmen Heights Commercial Center Filing No. 2 is located within Section 4, Township 13 South, Range 65 West of the 6th Principal Meridian. The site is within the Sand Creek Drainage Basin and is located south of the proposed development The Nook at Shiloh Mesa.

Figure 1 - Site Map

e. Data Sources

Listed Below are the technical resources reviewed in the preparation of this MDDP:

City of Colorado Springs Drainage Criteria Manual (DCM), Volumes 1 and 2

Mile High Flood District Street Capacity Spreadsheet

NOAA Atlas 2

NRCS Soil Survey for El Paso County Area, Colorado

FEMA FIRM 08041C0533G (eff. 12/06/2018)

Kiowa Engineering's 1996 Sand Creek Drainage Basin Planning Study

El Paso County Assessor Property Records

Colorado Springs Streamside Design Guidelines

f. Applicable Criteria and Standards

Per the DBPS, flows from the proposed site will be limited to historic flows in an effort to maintain the stability and current health of the nearby stretch of Sand Creek. The project will also abide by criteria and standards set forth in the City of Colorado Springs DCM, Colorado Springs Streamside requirements, and by other applicable jurisdiction requirements.

II. Project Characteristics

a. Location In Drainage Basin, offsite flows, size

The Woodmen Heights Commercial Center is located within the Sand Creek basin just north of Woodmen Road and just west of Sand Creek. The site is approximately 14 miles above the confluence of Sand Creek and Fountain Creek, or 3 miles below Sand Creek headwaters.

b. Compliance with DBPS

This MDDP is in general conformance with the guidelines outline in the 1996 DBPS by Kiowa Engineering for the Sand Creek Basin. The Woodmen Heights Commercial Center development will include the construction of a sub-regional extended detention facility that is to provide water quality treatment as well as release flows comparable to predevelopment flows as outlined in this document prior to the construction of the regional detention facilities outlined in the DBPS. Said sub-regional pond will provide water quality treatment and detention storage for future commercial development within Filing 2, the proposed Townes at Woodmen Heights along with the western portion of the expansion of Marksheffel Road.

c. Site Characteristic

Per the USDA soil survey, approximately 97% of the soils located within Woodmen Heights Commercial Center Filing No. 2 site are Pring coarse sandy loam loams; they are of hydrologic soil group B. Group B soils tend to maintain a moderate infiltration rate when thoroughly wet. The remaining 3% of the site soils are Blakeland-Fluvaquentic Haplaquolls soils; they are of hydrologic soil group A. Group A soils have a high infiltration rate when thoroughly wet and consist of deep well drained to excessively drained sand or gravely clays.

Current ground cover is predominantly short- to mid-grass prairie grasslands. Per the DBPS, the site also falls in the region of Sand creek that has a high water table, and is more prone to springs and seeps. According to the DBPS, wildlife that is common to the upper stretches of Sand Creek include deer, antelope, small mammals, birds and predators that tolerate people and roads.

The stretch of Sand Creek upstream of the Woodmen Heights Commercial Center was classified as having both good quality riparian/wetlands and dry channel in the DBPS. In the DBPS “good quality wetlands/riparian” is classified as having desirable vegetation with a high percentage of ground cover. The DBPS classified “Dry Channel” as either a natural stream or floodplain that is dry and/or not perennial and subsequently riparian vegetation is either nonexistent or nearly gone.

d. Major drainage ways and structures

Sand Creek is the nearest major drainage way and it is located approximately 650 feet to the west of the Woodmen Heights Commercial Center. There is a steel bridge that crosses Sand Creek at Woodmen Road that was classified as adequate in the DBPS for proposed future flows within Sand Creek. On the western edge of Sand Creek there are two large unknown diameter RCP discharging to Sand Creek most likely from the Forest Meadows Development to the Northwest. From the east, there is a single flared end section of unknown diameter discharging into Sand Creek, most likely from the temporary water quality pond currently in place to the east. There are currently no major irrigation facilities affecting the site.

e. Existing and proposed land uses

The proposed site is currently undeveloped land and proposed land uses include commercial and residential portions. Plans for the northwest region include multifamily housing that would generally follow existing topography with drainage concentrating near the south of the site where the sub-regional detention facility has been proposed. The eastern and southern portions of the site are planned as commercial sites.

III. Drainage Basins and Subbasins

a. Existing Drainage

Existing runoff from the western portion of the site generally sheet flows from the east to the west. The remainder of the site generally flows from the north to the south as sheet flow to existing storm infrastructure that ultimately drains to Sand Creek. This Master Development Drainage Plan also accounts for flows from the current 7-11 to the southwest of the site. Five separate basins contribute to the cumulative site flows. Basins analyzed to quantify existing flows are as follows:

- Basin 1 includes a major portion of the north center of the site as well as the majority of the overall site flow; composed of 14.52 acres of undeveloped land basin 1 contributes 3.7 and 25.4 cfs for the 5 and 100-year events respectively.
- Basin 2 is located along the entire east side of basin 1, wrapping around its southern end. At 9.70 acres, basin 2 is the second largest basin, consists of undeveloped land with groundcover and contributes 2.4 and 16.8 cfs for the 5 and 100-year events respectively.
- Basin 3 borders basin 2 to the southeast and makes up the southeast corner of the site. North Marksheffel Road borders basin 3 to the east and East Woodmen Road border it to the south. This basin consists of 4.45 acres of undeveloped land and contributes 1.3 and 9.1 cfs for the 5 and 100-year events respectively.
- Basin 4 borders basin 1 to the west and follows the western boundary of the site. This basin drains to the southwest towards the existing Kenosha Drive. Basin 4 is composed of 3.44 acres of undeveloped land and contributes 1.1 and 7.5 cfs for the 5 and 100-year events respectively.
- Basin 5 includes the current 7-11 site located along the southwest portion of the site. It is bordered by basins 2, 3, 4 and 5 along its north and east boundaries; composed of 1.25 acres of undeveloped land, basin 5 contributes 1.7 and 3.6 cfs for the 5 and 100-year events respectively. Basin 5 is conveyed to an existing detention and water quality pond to the west of the site near Sand Creek.
- Basin 6 includes the western portion of Woodmen Heights Commercial Center Filing No 2. This portion of the platted area currently drains directly to Sand Creek and is to remain untouched. As this basin does not contribute to onsite flows, it will not be touched and as it will therefore not be detained, it has been left out of the onsite flow analysis and detention pond sizing.

The majority of flows concentrate at the approximate center of the south boundary of the proposed development in a depression and is currently drained by a flared end section affixed to a 42” storm line. An existing drainage map can be found in Appendix A.

b. Major Basin Description

- Previous basin study: Sand Creek Drainage Basin Planning Study
- The project is within the Sand Creek Drainage Basin.
- Per FEMA FIRM 08041C0533G (eff. 12/06/2018), Woodmen Heights Commercial Center Filing No. 2, in its entirety, is classified as an area of minimal flood hazard; the site is just east of the regulatory floodway surrounding Sand Creek. See appendix for FIRMETTE.
- Per aerial imaging, no major irrigation is in the vicinity that would affect Woodmen Heights Commercial Center Filing No. 2 site.
- The western portion of the site does extend into the City streamside zone and is to remain untouched.

c. Subbasin Description

Drainage Patterns through Property: The entire site will drain towards the south. The site is classified as a single major basin and has been subdivided into sixteen onsite subbasins and six offsite subbasins for analysis.

- Subbasin 1 is located in the northeast corner of the property, is comprised of 1.08 acres of commercial development and for the 5 and 100-year event contributes 2.1 and 4.5 cfs respectively.
- Subbasin 1A is located along the south boundary of subbasin 1 and along the north boundary of subbasin 2. It is entirely roadway, comprised of 0.12 acres, and for the 5 and 100-year event contributes 0.5 and 1.0 cfs respectively.
- Subbasin 2 is located just south of subbasin 1 along the east boundary of the property, is comprised of 0.89 acres of commercial development and for the 5 and 100-year event contributes 1.7 and 3.8 cfs respectively.
- Subbasin 2A is located along the east boundary of subbasin 9 and along the west boundary of subbasin 2. It is entirely roadway, comprised of 0.18 acres, and for the 5 and 100-year event contributes 0.8 and 1.5 cfs respectively.
- Subbasin 3 is located just south of subbasin 2 along the east boundary of the property, is comprised of 0.67 acres of commercial development and for the 5 and 100-year event contributes 1.3 and 2.9 cfs respectively.
- Subbasin 3A is located along the east boundary of subbasin 6 and along the west boundary of subbasin 3. It is entirely roadway, comprised of 0.08 acres, and for the 5 and 100-year event contributes 0.4 and 0.7 cfs respectively.
- Subbasin 4 is located just south of subbasin 3 along the east boundary of the property, is comprised of 1.16 acres of commercial development and for the 5 and 100-year event contributes 2.1 and 4.6 cfs respectively.
- Subbasin 4A is comprised of a portion of roadway that begins south of subbasin 3 and north of subbasin 4 and ends along the east boundary of subbasin 6 and along the west boundary of

subbasin 4. With an area of 0.26 acres, subbasin 4A contributes 1.2 and 2.2 cfs for the 5 and 100-year events respectively.

- Subbasin 5 is located just south of subbasin 4 at the southeast corner of the property, is comprised of 1.44 acres of commercial development and for the 5 and 100-year event contributes 3.0 and 6.2 cfs respectively.
- Subbasin 5A is comprised of a portion of roadway southeast of subbasin 6 and northwest of subbasin 5. With an area of 0.04 acres, subbasin 5A contributes 0.2 and 0.3 cfs for the 5 and 100-year events respectively.
- Subbasin 6 is located just east of the properties center, bordered by basin 9 to the south and east and bordered by subbasin 10 to the west and north. It is comprised of 1.20 acres of commercial development and for the 5 and 100-year event contributes 2.2 and 4.8 cfs respectively.
- Subbasin 7 is located just south of subbasin 9 and west of subbasin 5. It falls along the south central boundary of the property. It is comprised of 0.70 acres of commercial development and for the 5 and 100-year event contributes 1.3 and 2.8 cfs respectively.
- Subbasin 7A is comprised of a portion of roadway south of subbasin 6 and north of subbasin 7. With an area of 0.06 acres, subbasin 7A contributes 0.3 and 0.5 cfs for the 5 and 100-year events respectively.
- Subbasin 8 is located just west of subbasin 7 along the east boundary of the property, is comprised of 1.30 acres, is the proposed location for a sub-regional detention facility and for the 5 and 100-year event contributes 0.4 and 3.0 cfs respectively.
- Subbasin 8A is comprised of a portion of roadway south of subbasin 9 and north of subbasin 8. With an area of 0.15 acres, subbasin 8A contributes 0.9 and 1.7 cfs for the 5 and 100-year events respectively.
- Subbasin 9 is located in the northwest corner of the property, is comprised of 6.28 acres of multifamily development, known as the Townes at Woodmen Heights, and for the 5 and 100-year event contributes 9.2 and 20.9 cfs respectively.
- Offsite basin 1 is located north of subbasin 1, is comprised of 1.76 acres of undeveloped land and for the 5 and 100 year event contributes 0.5 and 3.6 cfs respectively.
- Offsite basin 2 is located north of subbasin 10, is comprised of 10.45 acres of undeveloped land and for the 5 and 100 year event contributes 2.9 and 20.2 cfs respectively. Offsite basin 2 includes the future Nook at Shiloh Mesa Development. Flows derived from the predevelopment analysis were used in the sizing of storm infrastructure and the sub-regional detention facility as a conservative measure as they are significantly higher than the future flows per the proposed Nook drainage plan. This is to also account for the interim condition, after the development of the Woodmen Heights Commercial Center and prior to the Nooks Development, should Woodmen Heights be developed prior to the Nooks Development.
- Offsite basin 3 begins from the same point that offsite basins 1 and 2 begin from and runs along the entire east border of the site wrapping around the southern boundary, is comprised of 2.1 acres of roadway, 2.32 acres of undeveloped land and approximately 0.97 acres of proposed

multifamily developed land and for the 5 and 100 year event contributes 7.1 and 16.4 cfs respectively.

- Offsite basin 4 is located southwest of the property and is the location of an existing 7-11 and portion of the existing road to the north of 7-11. It is comprised of 1.45 acres of undeveloped land and for the 5 and 100 year event contributes 2.6 and 5.7 cfs respectively.
- Offsite basin 5 is located northwest of the property and north of offsite basin 6, is comprised of 0.92 acres of undeveloped land and for the 5 and 100 year event contributes 0.3 and 2.1 cfs respectively.
- Offsite basin 6 is located west of subbasin 10, is comprised of 2.38 acres of undeveloped land and for the 5 and 100 year event contributes 0.8 and 5.2 cfs respectively.
- The western portion of Filing Number 2 that currently drains directly to Sand Creek is to remain untouched and historic flows are to remain unaltered. This portion of Filing Number 2 will therefore not be rerouted or detained.

All flows from the 5-year and 100 year events for subbasins 1-8 and offsite basin 1 are to be conveyed via storm sewer once development occurs. The storm sewer has been designed to convey the entire 5-year event at a maximum of 80% capacity and stubs have been provided for each subbasin/ lot to tie into once developed. The storm sewer has also been sized to convey the 100 year event without the HGL passing higher than 1 foot below finished grade.

Flows from subbasin 9 and offsite basin 2 are to be conveyed according to the drainage plan for the Townes at Woodmen Heights to the sub-regional detention facility in subbasin 8.

Storm piping was sized utilizing Hydraflow to analyze flow characteristics and to derive the HGL. A comparison of HGL results from Hydraflow and UD Sewer, per DCM Volume 1 Chapter 9 requirements can be found in Appendix E. The HGL was used to verify pipe sizing was large enough and that there was a minimum of 1 foot of cover above the HGL, per COS DCM V1. Hydraflow computes the HGL using the Bernoulli equation and Manning's equation to determine energy losses due to pipe friction. Should the inlet clog, flows will continue along the curb to a second existing inlet to the west.

Proposed conditions are summarized in the Proposed Drainage Plan exhibit in Appendix A

IV. Environmental Evaluations

a. Significant existing or potential wetland and riparian areas impacts

As discussed in the DBPS, the current state of Sand Creek in proximity to the proposed site is "good wetland /riparian". Woodmen Heights Commercial Center will follow the guidance set forth by Stream Side Overlay criteria and standards to negate any impact to any nearby wetland or riparian areas.

b. Stormwater quality considerations and proposed practices

Within the DBPS, the largest concerns for future development on the overall health and stability of Sand Creek are increased flows and increased pollutant loads. These issues will be addressed by the implementation of a sub-regional extended detention basin and a storm system that will ensure that release rates do not exceed historic flows and that water quality requirements are met.

c. Permitting requirements

A Colorado Department of Health Stormwater Quality permit as well as a permit for the construction of the detention facility will be required through the State of Colorado. Permitting for stormwater will also be required through the City of Colorado Springs.

V. Drainage Design Criteria

a. General Concept

In the analysis and design of site drainage the four step process to minimize adverse impacts of urbanization was applied as described in the succeeding sections.

b. Step One – Employ Runoff Reduction Practices

The development of the project site is proposed commercial and single family residential lots with open spaces and lawn areas interspersed within the development to help disconnect imperious areas and reduce runoff volumes. There is onsite detention and grass buffers to promote infiltration, increase time of concentration, decrease overland flow velocities, and to improve the general quality of storm water prior to its arrival at the onsite EDB.

c. Step Two – Implement BMPs that Provide a WQCV with Slow Releases

The onsite sub-regional detention pond is located along the southern edge of the site in Tract “A. It is to be an extended detention basin that will provide detention in excess of the WQCV and a drain time of 40 hours for the WQCV.

d. Step Three– Stabilize Drainageways

Drainage fees will be paid at time of platting in order to help fund major drainage basin improvements in the Sand Creek drainage basin. These improvements will help stabilize drainage ways within the Sand Creek Drainage basin. The channel adjacent to the site has been previously improved by the City.

e. Step Four – Implement Site Specific and Other Source Control BMPs

Site specific storm water quality and erosion control plan and narrative are prepared in conjunction with this report. Site specific temporary source control BMPs as well as permanent BMPs are detailed in this plan and narrative.

f. Four Step Summary

The four step process to minimize adverse impacts of urbanization has been followed to reduce offsite flows and ensure the capture and treatment of the water quality capture volume. Portions of land that are to remain undeveloped and grassed are of hydrologic soil group B to promote increased infiltration. There is to be no barren soil, disturbed areas are to follow the erosion control plan to ensure stabilization while vegetation reestablishes in turn reducing sediment transport and protecting receiving water bodies and downstream detention facilities. Overland flows are also to be detained in the sub-regional detention facility to ensure full treatment. Urban Drainages UD BMP spreadsheet was also used to analyze flow reductions from decreasing directly connected impervious areas with grass buffers, the results can be found in Appendix B.

g. Development Criteria Reference

Procedures found in the *Colorado Springs Drainage Criteria Manual Volume 1* were followed in the design of the proposed drainage system. The analysis also looked at the Sand Creek Drainage Basin Planning Study from 1996.

h. Hydrologic Criteria

Design rainfall was determined utilizing figures from the NOAA atlas 2 (figures 6-6, 6-11, 6-12 and 6-17) to determine the 2-year and 100-year rainfall values for 6 and 24-hour events. The rainfall values were then used as inputs for equations 6-1 and 6-2 from the Colorado Springs DCM V1 (COS DCM V1) to determine the 2-year and 100-year rainfall values for a 1-hour rainfall event. These two values, 1.14 and 2.50 inches respectively, were then plotted on the nomograph provided in COS DMC V1 (table 6-18b) to determine the 1-hour rainfall depth for a 5-year event, approximately 1.45 inches.

As Woodmen Heights Commercial Center Filing No. 2 encompasses approximately 22.88 acres, the rational method were used to calculate peak flow. Flows will be determined for storms with 5 and 100-year recurrence intervals. Initial predevelopment calculations will assume 2% imperviousness across the site and will utilize runoff coefficients consistent with Colorado Springs Drainage Criteria Manual Volume 1 Chapter 6.

VI. Drainage Facility Design

a. General Concept

An onsite sub-regional extended detention facility (EDB) will attenuate increased runoff attributed to increasing imperviousness. The increased site flows will be directed towards the south central area of Woodmen Heights Commercial Center Filing No. 2 were the EDB has been proposed. Future discharges from the EDB are to remain consistent with historic flows and are to be directed to Sand Creek.

The EDB was designed to attenuate flows from Woodmen Heights Commercial Center Filing No. 2 development for the 100 year event. The stage at the top of freeboard is 8.70 feet and volume at the top of freeboard is 2.71 acre-ft. Calculated peak flows are predicted to produce 19.1 cfs for the 100-year event, 1.3 cfs for the 5-year event and 0.2 cfs for the WQCV. Peak outflow rates are to never exceed predevelopment peak flows. The outlet works are designed to release 99% of the WQCV in 40 hours and the EURV in 72 hours. The emergency overflow spillway crest is to be set at the 100 year water surface elevation with a width of 16 feet and was sized to maintain a minimum of 1 foot of freeboard when conveying the 100-year developed condition flow for the 19.9 acres tributary to the detention facility. The spillway is to be protected from erosion by a layer of buried rip-rap that is to cover the spillway crest and the entire downstream face of the embankment. Flows that pass through the spillway are to be conveyed along East Woodmen Road to Sand Creek located just west of the site. See appendix C for documents pertaining to the detention facility.

Upon completion of construction, landscaping will provide site stabilization acting as a source control in addition to BMPs to be implemented per the erosion control plan.

b. Drainage and Bridge Fees

Woodmen Heights Commercial Center Filing No. 2 site lies entirely within the Sand Creek Drainage basin; therefore the following fees are due prior to plat recordation. The following fee table was derived using the 2020 fees and the platted acreage of 22.88 acres. These fees are non-refundable and the system is to be private.

	Drainage Fee	Bridge Fee	Pond Land Fee	Pond Facility Fee
	$13,309 / Acre	$791 / Acre	$1,070 / Acre	$3,823 / Acre
Sub-total[1]	$304,509.92	$18,098.08	$24,481.60	$87,470.24
			Total Fees	**$434,559.84**

c. Proposed Drainage Facility Cost Summary

The engineers opinion of probable cost to construct onsite drainage facilities is a total of $503,030. These costs are for the private drainage facilities and are non-refundable. The full breakdown of costs can be found in Appendix A.

VII. Drawings

Please refer to the appendices for vicinity maps and drainage basin maps.

VIII. Summary

Woodmen Heights Commercial Center Filing No. 2, as described in this Master Development Drainage Plan and the Final erosion control plan, will not produce site runoff that will adversely affect the downstream and surrounding developments. This report is in general conformance with previous reports.

Two variances have been requested for this design which are included as a separate submittal and summarized below.

Variance #1: Using private inlets #4, #10, #11, and #12 as junction structures

Variance #2: For Inlet #3 HGL to be less than 1’ below the FG. The HGL will be approximately 0.7’ below FG as shown in the variance request.

IX. References

City of Colorado Springs – Drainage Criteria Manual, May 2014

Urban Storm Drainage Criteria Manual, Urban Drainage Flood Control District, January 2018

Master Development Drainage Plan for Woodmen Heights Commercial Center Filing No. 2, Kiowa Engineering Corporation, 2019.

Sand Creek Drainage Basin Planning Study, Kiowa Engineering Corporation, 1996.

Streamside Design Guidelines, Colorado Springs, 2009

[1] Total fee calculated based off platted acreage, 22.88 acres, per City of Colorado Springs Drainage Report Checklist Section I.3. The site is not located within Ridgeview or Indigo Ranch.

APPENDIX A
MAPS

LEGEND:

- PROPOSED MAJOR CONTOUR — 5250
- PROPOSED MINOR CONTOUR
- EXISTING MAJOR CONTOUR — 5250
- EXISTING MINOR CONTOUR
- PROPOSED STORM DRAIN PIPE
- EXISTING STORM DRAIN PIPE
- EXISTING STORM DRAIN PIPE
- PROPOSED DRAINAGE CHANNEL
- PROPERTY LINE
- DIRECTIONAL FLOW ARROW
- MAJOR BASIN LINE
- PROPOSED PEAK FLOW RATE (CFS) (71)
- DESIGN POINT (X)
- PROPOSED BASIN LABEL: XX = BASIN DESIGNATION; AREA (AC.) XX | XX % IMPERVIOUSNESS

BASIN	AREA (ACRES)	% IMPERVIOUS	Q5 (CFS)	Q100 (CFS)
1	14.52	2	3.7	25.4
2	9.70	2	2.4	16.8
3	4.45	2	1.3	9.1
4	3.44	2	1.1	7.5
5	1.25	70	2.0	4.4

DESIGN POINT	ΣAREA (ACRES)	ΣQ5 (CFS)	ΣQ100 (CFS)
D1	25.47	8.1	46.6
D2	29.92	9.4	55.7
D3	3.44	1.1	7.5

NORTH

0 60 120

DRAWN BY: TBI
JOB DATE: 4/3/2020
APPROVED: CMM
JOB NUMBER: ####
CAD DATE: 6/16/2020
CAD FILE: J:\2019\191850\CAD\Dwgs\Exhibits\Existing Drainage Basins

BAR IS ONE INCH ON OFFICIAL DRAWINGS. 0 1" IF NOT ONE INCH, ADJUST SCALE ACCORDINGLY.

NO.	DATE	BY	REVISION DESCRIPTION

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WOODMEN HEIGHTS COMMERCIAL CENTER FILING NO. 2
ALL PRO CAPITAL, INC.
COLORADO SPRINGS, COLORADO

WOODMEN HEIGHTS COMMERCIAL CENTER FILING NO. 2
EXISTING DRAINAGE BASINS

SHEET DR1

HR GREEN Xrefs: 01-XV-DSGN; 01-XG-KEYMAP-DR; xgt-1-DH01; 01-xv-util; DV-STORM

HR GREEN Xrefs: xgt-1-DH01

DRAWN BY:	TBI	JOB DATE:	5/12/2020
APPROVED:	CMM	JOB NUMBER:	191850
CAD DATE:	5/12/2020		
CAD FILE:	J:\2019\191850\CAD\Dwgs\C\01-VICINITY MAP		

BAR IS ONE INCH ON OFFICIAL DRAWINGS.
0 1"
IF NOT ONE INCH, ADJUST SCALE ACCORDINGLY.

NO.	DATE	BY	REVISION DESCRIPTION

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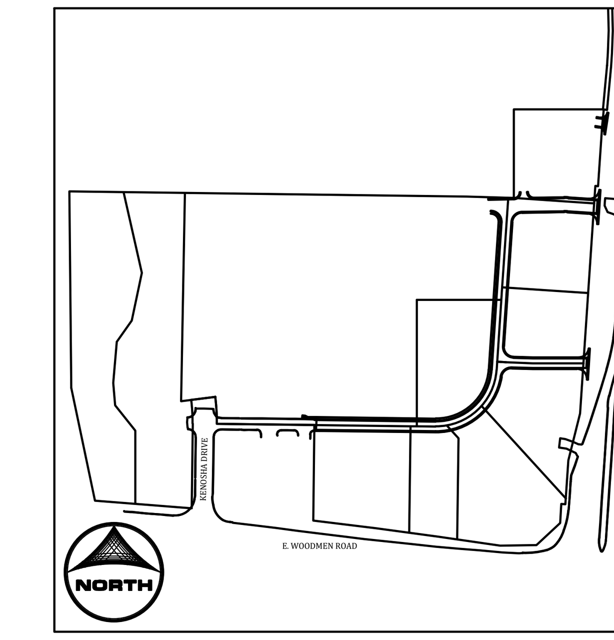
WOODMEN HEIGHTS COMMERCIAL CENTER FILING NO. 2
ALL PRO CAPITAL, INC.
COLORADO SPRINGS, COLORADO

VICINITY MAP

SHEET
VM1
1

BASIN	AREA (ACRES)	% IMPERVIOUS	Q5 (CFS)	Q100 (CFS)
1	1.08	70	2.1	4.5
1A	0.12	100	0.5	1.0
2	0.89	70	1.7	3.8
2A	0.18	100	0.8	1.5
3	0.67	70	1.3	2.9
3A	0.08	100	0.4	0.7
4	1.16	70	2.1	4.6
4A	0.27	100	1.2	2.2
5	1.44	76	3.0	6.2
5A	0.04	100	0.2	0.3
6	1.20	70	2.2	4.8
7	0.70	70	1.3	2.8
7A	0.06	100	0.3	0.5
8	1.30	2	0.4	3.0
8A	0.15	100	0.9	1.7
9	6.28	65	9.2	20.9
OS1	1.76	2	0.5	3.6
OS2	10.45	2	2.9	20.2
OS3	5.39	26	7.06	16.44
OS4	1.45	70	2.6	5.7
OS5	0.92	2	0.3	2.1
OS6	2.38	2	0.8	5.2

DESIGN POINT	ΣAREA (ACRES)	ΣQ5 (CFS)	ΣQ100 (CFS)
D1	1.76	0.52	3.58
D2	1.2	3.03	8.91
D3	2.27	5.27	13.55
D4	3.02	6.86	16.96
D5	4.45	16.57	38.89
D6	5.93	19.65	45.31
D7	6.65	21.09	48.40
D8	7.83	23.14	52.93
D9	8.04	23.88	54.31
D10	10.45	2.93	20.22
D11	6.28	12.29	40.13
D12	5.39	7.06	16.44
D13	1.45	2.60	5.68
D14	15.62	35.81	97.66
D15	0.92	0.30	2.08
D16	3.3	1.04	7.18
D17		92.20	157.90



KEYMAP

PROJECT LEGEND:

- PROPERTY LINE
- ROAD CENTERLINE
- RIGHT-OF-WAY LINE
- PROPOSED DETENTION BASIN
- 5250 PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 5250 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- FLOW ARROW
- EFFECTIVE 100-YR FLOODPLAIN
- EFFECTIVE 100-YR FLOODWAY
- STORM LINE
- STORM MANHOLE
- PROPOSED BASIN LINE
- MASTER BASIN LINE (PER MDR)
- MASTER BASIN LINE (UPDATED)
- DESIGN POINT

AREA (AC.) 1.00 — C-6 BASIN DESIGNATION; .40 MINOR 2-YR RUNOFF COEF.; .60 MAJOR 100-YR RUNOFF COEF.

NOTE: ALL PROPOSED STORM INFRASTRUCTURE PRIVATE UNLESS NOTED OTHERWISE

NORTH

0 50 100

811 UNCC CALL BEFORE YOU DIG 811 OR 1-800-922-1987 Utility Notification Center of Colorado

DRAWN BY: TBI JOB DATE: 6/26/2020
APPROVED: CMM JOB NUMBER: 191850
CAD DATE: 7/17/2020
CAD FILE: J:\2019\191850\CAD\Dwgs\Exhibits\Proposed Drainage Basins

BAR IS ONE INCH ON OFFICIAL DRAWINGS. 0 1" IF NOT ONE INCH, ADJUST SCALE ACCORDINGLY.

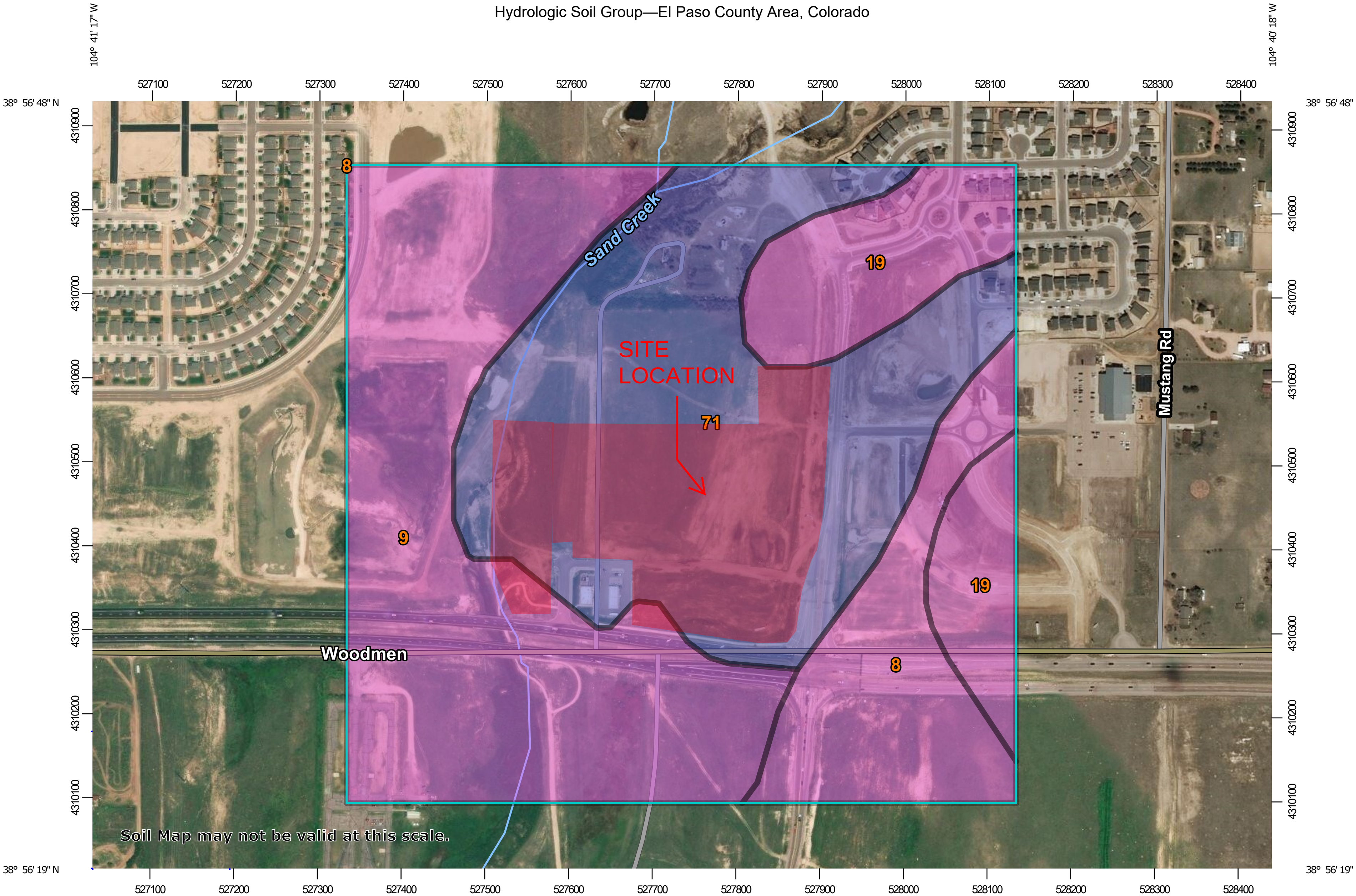
NO.	DATE	BY	REVISION DESCRIPTION

HRGreen HRGreen.com

WOODMEN HEIGHTS COMMERCIAL CENTER FILING NO. 2
ALL PRO CAPITAL, INC.
COLORADO SPRINGS, COLORADO

WOODMEN HEIGHTS COMMERCIAL CENTER
PROPOSED DRAINAGE BASINS

SHEET DB1 1



Map Scale: 1:6,440 if printed on A landscape (11" x 8.5") sheet.

N

0 50 100 200 300 Meters

0 300 600 1200 1800 Feet

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

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

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

Soil Rating Lines

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

Soil Rating Points

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

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 17, Sep 13, 2019

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

Date(s) aerial images were photographed: Jun 7, 2016—May 26, 2019

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
8	Blakeland loamy sand, 1 to 9 percent slopes	A	18.0	12.0%
9	Blakeland-Fluvaquentic Haplaquolls	A	55.0	36.5%
19	Columbine gravelly sandy loam, 0 to 3 percent slopes	A	19.0	12.6%
71	Pring coarse sandy loam, 3 to 8 percent slopes	B	58.7	38.9%
Totals for Area of Interest			**150.8**	**100.0%**

Description

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

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

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

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

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

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

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

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

National Flood Hazard Layer FIRMette

FEMA

38°56'47.68"N

104°41'8.28"W

104°40'30.82"W

38°56'19.69"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 12/16/2019 at 2:16:52 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

WOODMEN COMMERCIAL FILING NO. 2 - OPINION OF COST				6/17/2020
June 17, 2020				
PRIVATE STORM SEWER IMPROVEMENTS	**UNIT PRICE**	**UNITS**	**QTY**	**COST**
5' Type R Inlet	$ 5,500.00	**EA**	7	38,500.00
4' COS Type D-10-R	$ 5,500.00	**EA**	1	5,500.00
15" RCP	$ 77.00	**LF**	263	20,251.00
18" RCP	$ 85.00	**LF**	177	15,045.00
24" RCP	$ 155.00	**LF**	394	61,070.00
30" RCP	$ 196.00	**LF**	187	36,711.00
36" RCP	$ 210.00	**LF**	132	27,720.00
48" RCP	$ 275.00	**LF**	16	4,400.00
38"x60" Elliptical RCP	$ 350.00	**LF**	273	95,550.00
15" FES	$ 1,400.00	**EA**	1	1,400.00
38" x 60" FES	$ 4,000.00	**EA**	1	4,000.00
4' Storm Sewer MH	$ 4,000.00	**EA**	5	20,000.00
5' Storm Sewer MH	$ 5,400.00	**EA**	1	5,400.00
6' Storm Sewer MH	$ 7,500.00	**EA**	1	7,500.00
Concrete Forebay	$ 18.00	**SF**	277	4,986.00
Forebay Splash Block	$ 900.00	**EA**	1	900.00
Trickle Channel	$ 12.00	**SF**	210	2,520.00
Type C Outlet Structure	$ 16,000.00	**EA**	1	16,000.00
Earthwork (Pond Excavation, Complete In Place)	$ 3.00	**SY**	13388	40,164.00
Junction Structure	$ 27,500.00	**EA**	1	27,500.00
Spillway	$ 2,300.00	**EA**	1	2,300.00
			SUBTOTAL	437,417.00
			CONTINGENCY (15%)	65,612.55
			TOTAL	**503,029.55**

APPENDIX B
RATIONAL CALCULATIONS

HRGreen

TIME OF CONCENTRATION - PREDEVELOPMENT													REMARKS
LOCATION: Woodman Heights Commercial Center Filing No								BY: TBI			6/16/2020		
BASIN DATA			INIT./OVERLAND TIME (Ti)			TRAVEL TIME (Tt)					TOTAL	FINAL Tc	
DESIGNATION	C5	AREA (AC)	LENGTH (FT)	SLOPE %	Ti (Min.)*	GRASS/ PAVED	LENGTH (FT)	SLOPE %	VEL. (FPS)**	Tt(Min.)	Ti+Tt(Min.)	(minutes)	
1	0.09	14.52	300	2.3	24.3	GRASS	1580	2.4	2.3	11.3	35.6	20.4	
2	0.09	9.70	300	2.2	24.7	GRASS	1654	2.3	2.3	12.1	36.8	20.9	
3	0.09	4.45	300	2.1	25.0	GRASS	581	2.4	2.3	4.2	29.2	14.9	
4	0.09	3.44	300	2.9	22.5	GRASS	253	2.5	2.4	1.8	24.3	13.1	
5	0.49	1.25	100	0.8	12.3	GRASS	230	0.8	1.3	3.0	15.3	15.3	Existing 7-11

FORMULAS: * Ti = 0.395 (1.1-C5)L^0.5/S^1/3
** V=Cv(Sw^1/2)

HRGreen

COMPOSITE 'C' FACTORS - PREDEVELOPMENT

Location: Woodm Woodman Heights Commercial Center Filing No. 2 | City of Colorado Springs | DATE : 6/16/2020

BASIN	AREAS (ACRES)				SOIL	UNDEV					DEV					COMP. C FACTOR			
DESIGNATION	UNDEV	DEV	TOTAL	TOTAL (SQ MI)	TYPE	%I	2YR	5 YR	10 yr	100 YR	%I	2YR	5 YR	10 YR	100 YR	%I	2YR	5 YR	100 YR
1	14.52	0.00	14.52	0.0227	B	2	0.03	0.09	0.17	0.36	70	0.45	0.49	0.53	0.62	2.0	0.03	0.09	0.36
2	9.70	0.00	9.70	0.0152	B	2	0.03	0.09	0.17	0.36	70	0.45	0.49	0.53	0.62	2.0	0.03	0.09	0.36
3	4.45	0.00	4.45	0.0070	B	2	0.03	0.09	0.17	0.36	70	0.45	0.49	0.53	0.62	2.0	0.03	0.09	0.36
4	3.44	0.00	3.44	0.0054	B	2	0.03	0.09	0.17	0.36	70	0.45	0.49	0.53	0.62	2.0	0.03	0.09	0.36
5	0.00	1.25	1.25	0.0020	B	2	0.03	0.09	0.17	0.36	70	0.45	0.49	0.53	0.62	70.0	0.45	0.49	0.62

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

DESIGN STORM: 5-YEAR PREDEVELOPMENT

Calc. by: TBI
Chk'd by:

LOCATION: Woodman Heights Commercial Center Filing No. 2   City of Colorado Springs   **Date:** 6/16/2020

		DIRECT RUNOFF						TOTAL RUNOFF						REMARKS
DESIGN POINT	BASIN	AREA (AC)	COEFF. (C)	Tc (Min.)	C*A	I (in./ hr.)	Q (cfs)	Sum AREA	Sum Tc (min.)	I (in./hr.)	Sum CA	Total Q (cfs)	TRAVEL TIME Tt	
	1	14.52	0.09	20.4	1.31	2.82	3.7							
D1	2	9.70	0.09	20.9	0.87	2.79	2.4	25.47	20.85	2.79	2.79	7.79		BASINS 1,2,5
D2	3	4.45	0.09	14.9	0.40	3.30	1.3	29.92	20.85	2.79	3.19	8.91		BASINS 1,2,3,5
D3	4	3.44	0.09	13.1	0.31	3.51	1.1							
	5	1.25	0.49	15.3	0.61	3.27	2.0							Existing 7-11

HRGreen

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

DESIGN STORM: 100-YEAR PREDEVELOPMENT

Calc. by: TBI
Chk'd by: 0
Date: 6/16/2020

LOCATION: Woodman Heights Commercial Center Filing No. 2 City of Colorado Springs

		DIRECT RUNOFF						TOTAL RUNOFF						REMARKS
DESIGN POINT	BASIN	AREA (AC)	COEFF. (C)	Tc (Min.)	C*A	I (in./ hr.)	Q (cfs)	Sum AREA	Sum Tc (min.)	I (in./hr.)	Sum CA	Total Q (cfs)	TRAVEL TIME Tt	
	1	14.52	0.36	20.4	5.23	4.86	25.4							
D1	2	9.70	0.36	20.9	3.49	4.81	16.8	25.47	20.85	4.81	9.49	45.67		BASINS 1,2,5
D2	3	4.45	0.36	14.9	1.60	5.69	9.1	29.92	20.85	4.81	11.10	53.38		BASINS 1,2,3,5
D3	4	3.44	0.36	13.1	1.24	6.04	7.5							
	5	1.25	0.62	15.3	0.78	5.63	4.4							Existing 7-11

HRGreen

TIME OF CONCENTRATION - POST DEVELOPMENT														REMARKS
LOCATION: Woodman Heights Commercial Center Filing 2								BY: TBI		DATE: 6/16/2020				
BASIN DATA			INIT./OVERLAND TIME (Ti)			TRAVEL TIME (Tt)					Tc Check (Urbanized Basins)		FINAL Tc	
DESIGNATION	C5	AREA (AC)	LENGTH (FT)	SLOPE %	Ti (Min.)*	GRASS/ PAVED	LENGTH (FT)	SLOPE %	VEL. (FPS)**	Tt(Min.)	LGTH. (FT)	Tc = (L/180) + 10	(minutes)	
1	0.49	1.08	100	2.5	8.2	PAVED	285	2.0	2.8	1.7	385	12.1	9.9	
	0.90	0.12	100	2.6	2.7	PAVED	41	2.6	3.2	0.2	141	10.8	5.0	ROAD
2	0.49	0.89	100	2.6	8.1	PAVED	256	2.1	2.9	1.5	356	12.0	9.6	
	0.90	0.18	100	3.0	2.5	PAVED	130	3.0	3.5	0.6	230	11.3	5.0	ROAD
3	0.49	0.67	100	3.2	7.6	PAVED	218	2.0	2.8	1.3	318	11.8	8.9	
	0.90	0.08	100	3.3	2.5	PAVED	38	3.3	3.6	0.2	138	10.8	5.0	ROAD
4	0.49	1.16	100	1.5	9.8	PAVED	185	0.9	1.9	1.6	285	11.6	11.4	
	0.90	0.27	100	2.1	2.9	PAVED	140	2.1	2.9	0.8	240	11.3	5.0	ROAD
5	0.55	1.44	100	1.4	9.0	PAVED	204	0.6	1.5	2.2	304	11.7	11.2	
	0.90	0.04	60	2.1	2.2	PAVED	0	0.0	0.0	#DIV/0!	60	10.3	5.0	ROAD
6	0.49	1.20	100	2.4	8.4	PAVED	290	0.6	1.5	3.1	390	12.2	11.5	
7	0.49	0.70	100	1.3	10.2	PAVED	159	0.5	1.4	1.9	259	11.4	11.4	
	0.90	0.06	89	2.1	2.7	PAVED	0	0.0	0.0	#DIV/0!	89	10.5	5.0	ROAD
8	0.09	1.30	100	1.2	17.4	PAVED	223	0.7	1.7	2.2	323	11.8	11.8	
8A	0.90	0.15	100	2.0	2.9	PAVED	47	2.0	2.8	0.3	147	10.8		
9	0.45	6.28	100	1.7	10.0	PAVED	849	1.5	2.4	5.8	949	15.3	15.3	
OS1	0.09	1.76	300	2.2	24.7	GRASS	624	2.3	2.3	4.6	924	15.1	15.1	
OS2	0.09	10.45	300	2.3	24.3	GRASS	924	2.4	2.3	6.6	1224	16.8	16.8	
OS3	0.47	5.39	300	3.7	12.9	GRASS	1666	3.8	2.9	9.5	1966	20.9	20.9	
OS4	0.49	1.45	300	0.8	21.3	GRASS	30	0.8	1.3	0.4	330	11.8	11.8	Existing 7-11
OS5	0.09	0.92	300	2.1	25.0	GRASS	57	2.6	2.4	0.4	357	12.0	12.0	
OS6	0.09	2.38	300	2.0	25.5	GRASS	254	3.0	2.6	1.6	554	13.1	13.1	

FORMULAS: * Ti = 0.395 (1.1-C5)L^0.5/S^1/3
** V=Cv(Sw^1/2)

HRGreen

COMPOSITE 'C' FACTORS - POST DEVELOPMENT

Location: Woodman Heights Commercial Center Filing 2 **City of Colorado Springs** **TBI** **DATE : 6/16/2020**

BASIN							SOIL	COMMERCIAL					ROAD					UNDEV					MF-DEV					COMP. C FACTOR				
DESIGNATION	COMMERCIAL	ROAD	UNDEV	MF-DEV	TOTAL	TOTAL (SQ MI)	TYPE	%I	2YR	5 YR	10 YR	100 YR	%I	2YR	5 YR	10 YR	100 YR	%I	2YR	5 YR	10 YR	100 YR	%I	2YR	5 YR	10 YR	100 YR	%I	2YR	5 YR	10 YR	100 YR
1	1.08	0.00	0.00	0.00	1.08	0.0017	A/B	70	0.45	0.49	0.53	0.62	100	0.89	0.90	0.92	0.96	2	0.03	0.09	0.17	0.36	65	0.41	0.45	0.49	0.59	70.0	0.45	0.49	0.53	0.62
1A	0.00	0.12	0.00	0.00	0.12	0.0002	A/B	70	0.45	0.49	0.53	0.62	100	0.89	0.90	0.92	0.96	2	0.03	0.09	0.17	0.36	65	0.41	0.45	0.49	0.59	100.0	0.89	0.90	0.92	0.96
2	0.89	0.00	0.00	0.00	0.89	0.0014	A/B	70	0.45	0.49	0.53	0.62	100	0.89	0.90	0.92	0.96	2	0.03	0.09	0.17	0.36	65	0.41	0.45	0.49	0.59	70.0	0.45	0.49	0.53	0.62
2A	0.00	0.18	0.00	0.00	0.18	0.0003	A/B	70	0.45	0.49	0.53	0.62	100	0.89	0.90	0.92	0.96	2	0.03	0.09	0.17	0.36	65	0.41	0.45	0.49	0.59	100.0	0.89	0.90	0.92	0.96
3	0.67	0.00	0.00	0.00	0.67	0.0010	A/B	70	0.45	0.49	0.53	0.62	100	0.89	0.90	0.92	0.96	2	0.03	0.09	0.17	0.36	65	0.41	0.45	0.49	0.59	70.0	0.45	0.49	0.53	0.62
3A	0.00	0.08	0.00	0.00	0.08	0.0001	A/B	70	0.45	0.49	0.53	0.62	100	0.89	0.90	0.92	0.96	2	0.03	0.09	0.17	0.36	65	0.41	0.45	0.49	0.59	100.0	0.89	0.90	0.92	0.96
4	1.16	0.00	0.00	0.00	1.16	0.0018	A/B	70	0.45	0.49	0.53	0.62	100	0.89	0.90	0.92	0.96	2	0.03	0.09	0.17	0.36	65	0.41	0.45	0.49	0.59	70.0	0.45	0.49	0.53	0.62
4A	0.00	0.27	0.00	0.00	0.27	0.0004	A/B	70	0.45	0.49	0.53	0.62	100	0.89	0.90	0.92	0.96	2	0.03	0.09	0.17	0.36	65	0.41	0.45	0.49	0.59	100.0	0.89	0.90	0.92	0.96
5	1.44	0.00	0.00	0.00	1.44	0.0023	A/B	76	0.52	0.55	0.59	0.67	100	0.89	0.90	0.92	0.96	2	0.03	0.09	0.17	0.36	65	0.41	0.45	0.49	0.59	76.1	0.52	0.55	0.59	0.67
5A	0.00	0.04	0.00	0.00	0.04	0.0001	A/B	70	0.45	0.49	0.53	0.62	100	0.89	0.90	0.92	0.96	2	0.03	0.09	0.17	0.36	65	0.41	0.45	0.49	0.59	100.0	0.89	0.90	0.92	0.96
6	1.20	0.00	0.00	0.00	1.20	0.0019	A/B	70	0.45	0.49	0.53	0.62	100	0.89	0.90	0.92	0.96	2	0.03	0.09	0.17	0.36	65	0.41	0.45	0.49	0.59	70.0	0.45	0.49	0.53	0.62
7	0.70	0.00	0.00	0.00	0.70	0.0011	A/B	70	0.45	0.49	0.53	0.62	100	0.89	0.90	0.92	0.96	2	0.03	0.09	0.17	0.36	65	0.41	0.45	0.49	0.59	70.0	0.45	0.49	0.53	0.62
7A	0.00	0.06	0.00	0.00	0.06	0.0001	A/B	70	0.45	0.49	0.53	0.62	100	0.89	0.90	0.92	0.96	2	0.03	0.09	0.17	0.36	65	0.41	0.45	0.49	0.59	100.0	0.89	0.90	0.92	0.96
8	0.00	0.00	1.30	0.00	1.30	0.0020	A/B	70	0.45	0.49	0.53	0.62	100	0.89	0.90	0.92	0.96	2	0.03	0.09	0.17	0.36	65	0.41	0.45	0.49	0.59	2.0	0.03	0.09	0.17	0.36
8A	0.00	0.15	0.00	0.00	0.15	0.0002	A/B	70	0.45	0.49	0.53	0.62	100	0.89	0.90	0.92	0.96	2	0.03	0.09	0.17	0.36	65	0.41	0.45	0.49	0.59	100.0	0.89	0.90	0.92	0.96
9	0.00	0.00	0.00	6.28	6.28	0.0098	A/B	70	0.45	0.49	0.53	0.62	100	0.89	0.90	0.92	0.96	2	0.03	0.09	0.17	0.36	65	0.41	0.45	0.49	0.59	65.0	0.41	0.45	0.49	0.59
OS1	0.00	0.00	1.76	0.00	1.76	0.0028	A/B	70	0.45	0.49	0.53	0.62	100	0.89	0.90	0.92	0.96	2	0.03	0.09	0.17	0.36	65	0.41	0.45	0.49	0.59	2.0	0.03	0.09	0.17	0.36
OS2	0.00	0.00	10.45	0.00	10.45	0.0163	A/B	70	0.45	0.49	0.53	0.62	100	0.89	0.90	0.92	0.96	2	0.03	0.09	0.17	0.36	65	0.41	0.45	0.49	0.59	2.0	0.03	0.09	0.17	0.36
OS3	0.00	2.10	2.32	0.97	5.39	0.0084	A/B	70	0.45	0.49	0.53	0.62	100	0.89	0.90	0.92	0.96	2	0.03	0.09	0.17	0.36	65	0.41	0.45	0.49	0.59	51.5	0.43	0.47	0.52	0.64
OS4	1.45	0.00	0.00	0.00	1.45	0.0023	A/B	70	0.45	0.49	0.53	0.62	100	0.89	0.90	0.92	0.96	2	0.03	0.09	0.17	0.36	65	0.41	0.45	0.49	0.59	70.0	0.45	0.49	0.53	0.62
OS5	0.00	0.00	0.92	0.00	0.92	0.0014	A/B	70	0.45	0.49	0.53	0.62	100	0.89	0.90	0.92	0.96	2	0.03	0.09	0.17	0.36	65	0.41	0.45	0.49	0.59	2.0	0.03	0.09	0.17	0.36
OS6	0.00	0.00	2.38	0.00	2.38	0.0037	A/B	70	0.45	0.49	0.53	0.62	100	0.89	0.90	0.92	0.96	2	0.03	0.09	0.17	0.36	65	0.41	0.45	0.49	0.59	2.0	0.03	0.09	0.17	0.36

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

DESIGN STORM: 5-YEAR DEVELOPED

Calc. by: TBI

Chk'd by:

Date: 6/16/2020

LOCATION: Woodman Heights Commercial Center Filing 2 City of Colorado Springs

		DIRECT RUNOFF						TOTAL RUNOFF					PIPE		TRAVEL TIME				REMARKS
DESIGN POINT	BASIN	AREA (AC)	COEFF. (C)	Tc (Min.)	C*A	I (in./ hr.)	Q (cfs)	Sum AREA	Sum Tc (min.)	I (in./hr.)	Sum CA	Total Q (cfs)	FLOW (CFS)	SLOPE %	PIPE SIZE	LENGTH (FT)	VEL. (FPS)	TRAVEL TIME Tt	
D2	1	1.08	0.49	9.9	0.53	3.94	2.1	1.20	9.92	3.94	0.64	3.03	3.0	2.1%	10	240	6.7	0.6	D1 - D2 &1A
	1A	0.12	0.90	5.0	0.11	4.92	0.5	0.12	5.00	4.92	0.11	0.53							ROAD
D3	2	0.89	0.49	9.6	0.44	3.98	1.7	2.27	10.52	3.84	1.24	5.27	5.3	2.2%	10	135	6.0	0.4	D1 - D3, 1A &2A
	2A	0.18	0.90	5.0	0.16	4.92	0.8	0.30	5.00	4.92	0.27	1.33							ROAD
D4	3	0.67	0.49	8.9	0.33	4.11	1.3	3.02	10.29	3.88	1.64	6.86	6.9	2.4%	12	150	7.0	0.4	D1 - D4, 1A-3A
	3A	0.08	0.90	5.0	0.07	4.92	0.4	0.38	5.00	4.92	0.34	1.68							ROAD
D5	4	1.16	0.49	11.4	0.57	3.72	2.1	4.45	11.75	3.67	2.45	16.57	16.6	1.1%	15	90	5.5	0.3	D1 - D5 & D12, 1A-4A
	4A	0.27	0.90	5.0	0.24	4.92	1.2	0.65	5.00	4.92	0.59	2.88							ROAD
D6	5	1.44	0.55	11.2	0.79	3.75	3.0	5.93	11.67	3.68	3.28	19.65	19.6	0.9%	18	85	5.5	0.3	D1 - D6 & D12, 1A-5A
	5A	0.04	0.90	5.0	0.04	4.92	0.2	0.69	5.00	4.92	0.62	3.05							ROAD
D8	6	1.20	0.49	11.5	0.59	3.71	2.2	7.83	11.55	3.70	4.21	23.14	23.1	1.1%	18	25	6.1	0.1	D1 - D8 & D12, 1A-5A &7A
D7	7	0.70	0.49	11.4	0.34	3.71	1.3	6.65	11.70	3.68	3.67	21.09	21.1	0.8%	18	25	5.3	0.1	D1 - D7 & D12, 1A-5A &7A
	7A	0.06	0.90	5.0	0.05	4.92	0.3	0.75	5.00	4.92	0.68	3.32							ROAD
D14	8	1.30	0.09	11.8	0.12	3.67	0.4	33.22	15.27	3.26	10.97	35.81							D1 - D14
D9	8A	0.15	0.90	0.0	0.14	6.76	0.9	8.04	11.47	3.71	4.40	23.88							
D11	9	6.28	0.45	15.3	2.83	3.26	9.2	16.73	15.27	3.26	3.77	12.29							D10 - D11
D1	OS1	1.76	0.09	15.1	0.16	3.28	0.5												
D10	OS2	10.45	0.09	16.8	0.94	3.12	2.9												
D12	OS3	5.39	0.47	20.9	2.54	2.79	7.1												
D13	OS4	1.45	0.49	11.8	0.71	3.66	2.6												Existing 7-11
D15	OS5	0.92	0.09	12.0	0.08	3.64	0.3												
D16	OS6	2.38	0.09	13.1	0.21	3.51	0.8	3.30	13.08	3.51	0.30	1.04							D15 & D16
D17							92.2												From Shiloh Mesa at Woodmen Heights

HRGreen

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

DESIGN STORM: 100-YEAR DEVELOPED

Calc. by: TBI
Chk'd by: 0
Date: 6/16/2020

LOCATION: Woodman Heights Commercial Center Filing 2 City of Colorado Springs

		DIRECT RUNOFF						TOTAL RUNOFF					PIPE			TRAVEL TIME			REMARKS
DESIGN POINT	BASIN	AREA (AC)	COEFF. (C)	Tc (Min.)	C*A	I (in./ hr.)	Q (cfs)	Sum AREA	Sum Tc (min.)	I (in./hr.)	Sum CA	Total Q (cfs)	FLOW (CFS)	SLOPE %	PIPE SIZE	LENGTH (FT)	VEL. (FPS)	TRAVEL TIME T	
D2	1	1.08	0.62	9.9	0.67	6.78	4.5	1.20	9.92	6.78	0.78	8.91	8.9	2.1%	10	240	5.9	0.7	D1 - D2 &1A
	1A	0.12	0.96	5.0	0.12	8.48	1.0	0.12	5.00	8.48	0.12	0.98							
D3	2	0.89	0.62	9.6	0.55	6.87	3.8	2.27	10.60	6.61	1.51	13.55	13.6	2.2%	10	135	6.0	0.4	D1 - D3, 1A &2A
	2A	0.18	0.96	5.0	0.17	8.48	1.5	0.30	5.00	8.48	0.29	2.44							
D4	3	0.67	0.62	8.9	0.42	7.08	2.9	3.02	10.29	6.69	2.00	16.96	17.0	2.4%	12	150	7.0	0.4	D1 - D4, 1A-3A
	3A	0.08	0.96	5.0	0.08	8.48	0.7	0.38	5.00	8.48	0.36	3.09							
D5	4	1.16	0.62	11.4	0.72	6.41	4.6	4.45	11.75	6.33	2.98	38.89	38.9	1.1%	15	90	5.5	0.3	D1 - D5 & D12, 1A-4A
	4A	0.27	0.96	5.0	0.26	8.48	2.2	0.65	5.00	8.48	0.62	5.29							
D6	5	1.44	0.67	11.2	0.96	6.46	6.2	5.93	11.67	6.35	3.98	45.31	45.3	0.9%	18	85	5.5	0.3	D1 - D6 & D12, 1A-5A
	5A	0.04	0.96	5.0	0.04	8.48	0.3	0.69	5.00	8.48	0.66	5.62							
D8	6	1.20	0.62	11.5	0.74	6.40	4.8	7.83	11.55	6.38	5.16	52.93	52.9	1.1%	18	25	6.1	0.1	D1 - D8 & D12, 1A-5A &7A
D7	7	0.70	0.62	11.4	0.43	6.40	2.8	6.65	11.70	6.34	4.47	48.40	48.4	0.8%	18	25	5.3	0.1	D1 - D7 & D12, 1A-5A &7A
	7A	0.06	0.96	5.0	0.06	8.48	0.5	0.75	5.00	8.48	0.72	6.11							
D14	8	1.30	0.36	11.8	0.47	6.32	3.0	33.22	15.27	5.63	17.35	97.66							D1 - D14
D9	8A	0.15	0.96	0.0	0.14	11.66	1.7	8.04	11.47	6.40	5.36	54.31							
D11	9	6.28	0.59	15.3	3.71	5.63	20.9	16.73	16.80	5.37	7.47	40.13							D10 - D11
D1	OS1	1.76	0.36	15.1	0.63	5.65	3.6												
D10	OS2	10.45	0.36	16.8	3.76	5.37	20.2												
D12	OS3	5.39	0.64	20.9	3.42	4.80	16.4												
D13	OS4	1.45	0.62	11.8	0.90	6.31	5.7												Existing 7-11
D15	OS5	0.92	0.36	12.0	0.33	6.28	2.1												
D16	OS6	2.38	0.36	13.1	0.86	6.04	5.2	3.30	13.08	6.04	1.19	7.18							D15 & D16
D17							157.9												From Shiloh Mesa at Woodmen Heights

APPENDIX C

HYDRAULIC CALCULATIONS

Worksheet for DP2

Project Description

Friction Method	Manning Formula		
Solve For	Normal Depth		

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.02100	ft/ft
Diameter	1.25	ft
Discharge	3.03	ft³/s

Results

Normal Depth	0.49	ft
Flow Area	0.45	ft²
Wetted Perimeter	1.69	ft
Hydraulic Radius	0.26	ft
Top Width	1.22	ft
Critical Depth	0.70	ft
Percent Full	39.1	%
Critical Slope	0.00604	ft/ft
Velocity	6.81	ft/s
Velocity Head	0.72	ft
Specific Energy	1.21	ft
Froude Number	1.99	
Maximum Discharge	10.07	ft³/s
Discharge Full	9.36	ft³/s
Slope Full	0.00220	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	39.14	%
Downstream Velocity	Infinity	ft/s

Worksheet for DP2

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.49	ft
Critical Depth	0.70	ft
Channel Slope	0.02100	ft/ft
Critical Slope	0.00604	ft/ft

Worksheet for DP3

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.02200	ft/ft
Diameter	1.25	ft
Discharge	5.27	ft^3/s

Results

Normal Depth	0.66	ft
Flow Area	0.66	ft^2
Wetted Perimeter	2.04	ft
Hydraulic Radius	0.32	ft
Top Width	1.25	ft
Critical Depth	0.93	ft
Percent Full	52.9	%
Critical Slope	0.00814	ft/ft
Velocity	7.99	ft/s
Velocity Head	0.99	ft
Specific Energy	1.65	ft
Froude Number	1.94	
Maximum Discharge	10.31	ft^3/s
Discharge Full	9.58	ft^3/s
Slope Full	0.00666	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	52.92	%
Downstream Velocity	Infinity	ft/s

Worksheet for DP3

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.66	ft
Critical Depth	0.93	ft
Channel Slope	0.02200	ft/ft
Critical Slope	0.00814	ft/ft

Worksheet for DP4

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.02400	ft/ft
Diameter	1.50	ft
Discharge	6.86	ft³/s

Results

Normal Depth	0.68	ft
Flow Area	0.78	ft²
Wetted Perimeter	2.22	ft
Hydraulic Radius	0.35	ft
Top Width	1.49	ft
Critical Depth	1.01	ft
Percent Full	45.3	%
Critical Slope	0.00668	ft/ft
Velocity	8.81	ft/s
Velocity Head	1.21	ft
Specific Energy	1.89	ft
Froude Number	2.15	
Maximum Discharge	17.50	ft³/s
Discharge Full	16.27	ft³/s
Slope Full	0.00427	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	45.32	%
Downstream Velocity	Infinity	ft/s

Worksheet for DP4

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.68	ft
Critical Depth	1.01	ft
Channel Slope	0.02400	ft/ft
Critical Slope	0.00668	ft/ft

Worksheet for DP5

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.01400	ft/ft
Diameter	2.50	ft
Discharge	16.57	ft³/s

Results

Normal Depth	1.01	ft
Flow Area	1.85	ft²
Wetted Perimeter	3.44	ft
Hydraulic Radius	0.54	ft
Top Width	2.45	ft
Critical Depth	1.38	ft
Percent Full	40.3	%
Critical Slope	0.00474	ft/ft
Velocity	8.95	ft/s
Velocity Head	1.25	ft
Specific Energy	2.25	ft
Froude Number	1.82	
Maximum Discharge	52.20	ft³/s
Discharge Full	48.53	ft³/s
Slope Full	0.00163	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	40.29	%
Downstream Velocity	Infinity	ft/s

Worksheet for DP5

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	1.01	ft
Critical Depth	1.38	ft
Channel Slope	0.01400	ft/ft
Critical Slope	0.00474	ft/ft

Worksheet for DP6

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.01050	ft/ft
Diameter	3.00	ft
Discharge	19.65	ft³/s

Results

Normal Depth	1.10	ft
Flow Area	2.35	ft²
Wetted Perimeter	3.91	ft
Hydraulic Radius	0.60	ft
Top Width	2.89	ft
Critical Depth	1.42	ft
Percent Full	36.7	%
Critical Slope	0.00417	ft/ft
Velocity	8.35	ft/s
Velocity Head	1.08	ft
Specific Energy	2.19	ft
Froude Number	1.63	
Maximum Discharge	73.52	ft³/s
Discharge Full	68.34	ft³/s
Slope Full	0.00087	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	36.71	%
Downstream Velocity	Infinity	ft/s

Worksheet for DP6

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	1.10	ft
Critical Depth	1.42	ft
Channel Slope	0.01050	ft/ft
Critical Slope	0.00417	ft/ft

Worksheet for DP7

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.01050	ft/ft
Diameter	3.00	ft
Discharge	21.09	ft³/s

Results

Normal Depth	1.14	ft
Flow Area	2.48	ft²
Wetted Perimeter	3.99	ft
Hydraulic Radius	0.62	ft
Top Width	2.91	ft
Critical Depth	1.48	ft
Percent Full	38.1	%
Critical Slope	0.00423	ft/ft
Velocity	8.52	ft/s
Velocity Head	1.13	ft
Specific Energy	2.27	ft
Froude Number	1.63	
Maximum Discharge	73.52	ft³/s
Discharge Full	68.34	ft³/s
Slope Full	0.00100	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	38.13	%
Downstream Velocity	Infinity	ft/s

Worksheet for DP7

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	1.14	ft
Critical Depth	1.48	ft
Channel Slope	0.01050	ft/ft
Critical Slope	0.00423	ft/ft

Worksheet for DP8

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.01100	ft/ft
Rise	38.00	ft
Span	60.00	ft
Discharge	23.14	ft³/s

Results

Normal Depth		0.50	ft
Flow Area		4.56	ft²
Wetted Perimeter		16.53	ft
Hydraulic Radius		0.28	ft
Top Width		13.66	ft
Critical Depth		0.62	ft
Percent Full		1.3	%
Critical Slope		0.00392	ft/ft
Velocity		5.08	ft/s
Velocity Head		0.40	ft
Specific Energy		0.90	ft
Froude Number		1.55	
Maximum Discharge		119242.18	ft³/s
Discharge Full		109292.44	ft³/s
Slope Full		245380.09564	ft/ft
Flow Type	Supercritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	1.31	%

Worksheet for DP8

GVF Output Data

Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.50	ft
Critical Depth	0.62	ft
Channel Slope	0.01100	ft/ft
Critical Slope	0.00392	ft/ft

Worksheet for DP9

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.01100	ft/ft
Rise	38.00	ft
Span	60.00	ft
Discharge	63.15	ft³/s

Results

Normal Depth	0.77	ft
Flow Area	8.66	ft²
Wetted Perimeter	18.24	ft
Hydraulic Radius	0.47	ft
Top Width	16.87	ft
Critical Depth	1.03	ft
Percent Full	2.0	%
Critical Slope	0.00287	ft/ft
Velocity	7.29	ft/s
Velocity Head	0.83	ft
Specific Energy	1.59	ft
Froude Number	1.80	
Maximum Discharge	119242.18	ft³/s
Discharge Full	109292.44	ft³/s
Slope Full	32949.25741	ft/ft
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	2.02	%

Worksheet for DP9

GVF Output Data

Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.77	ft
Critical Depth	1.03	ft
Channel Slope	0.01100	ft/ft
Critical Slope	0.00287	ft/ft

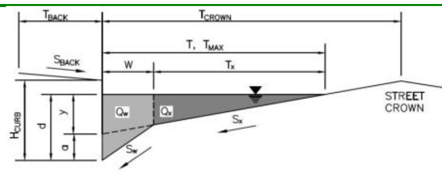
Version 4.05 Released March 2017

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

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

Project: Woodmen Heights Commercial Center Filing No. 2

Inlet ID: DP2



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	10.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.015	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	12.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.023	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	12.0	12.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	9.3	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☑	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	2.88	2.88	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline	d =	4.39	4.39	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	10.0	10.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.491	0.491	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	4.5	4.5	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	4.3	4.3	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**8.8**	**8.8**	**cfs**
Flow Velocity within the Gutter Section	V =	7.6	7.6	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	2.8	2.8	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	32.2	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	30.2	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.318	0.180	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	17.5	85.5	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	16.0	56.2	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	8.2	18.7	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	8.4	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	24.2	83.3	cfs
Average Flow Velocity Within the Gutter Section	V =	9.8	13.6	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	4.9	10.5	
Slope-Based Depth Safety Reduction Factor for Major & Minor ($d \geq$ 6") Storm	R =	0.92	0.75	
Max Flow Based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**22.3**	**62.2**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.84	8.35	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	1.44	3.96	inches

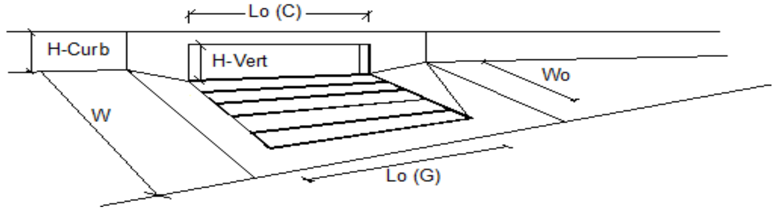
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**8.8**	**62.2**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

Version 4.05 Released March 2017



Design Information (Input)	CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet		Type =	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)		No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)		L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, 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 < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.7**	**2.6**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.4**	**1.9**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**82**	**57**	**%**

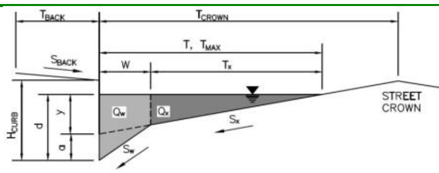
Version 4.05 Released March 2017

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

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

Project: Woodmen Heights Commercial Center Filing No. 2

Inlet ID: DP3



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	10.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.015	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	12.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.033	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	12.0	12.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	10.3	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☑	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	2.88	2.88	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline	d =	4.39	4.39	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	10.0	10.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.491	0.491	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	5.3	5.3	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	5.1	5.1	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**10.4**	**10.4**	**cfs**
Flow Velocity within the Gutter Section	V =	9.1	9.1	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	3.3	3.3	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	36.4	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\ TH}$ =	16.7	34.4	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.318	0.158	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\ TH}$	$Q_{X\ TH}$ =	20.9	143.3	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	19.0	86.0	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	9.7	26.9	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	18.8	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	28.7	131.7	cfs
Average Flow Velocity Within the Gutter Section	V =	11.6	17.5	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	5.8	14.9	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	0.70	0.57	
Max Flow Based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**20.1**	**74.5**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.34	8.38	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.94	3.98	inches

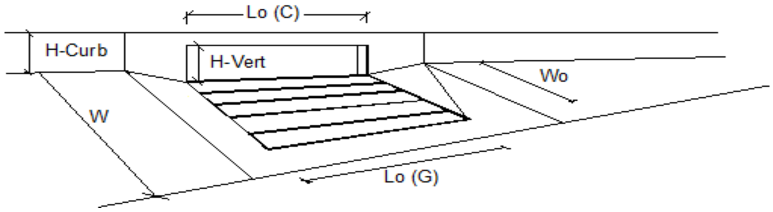
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**10.4**	**74.5**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

Version 4.05 Released March 2017



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')		a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)		L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, 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 < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.6**	**3.0**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.2**	**3.4**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**87**	**47**	**%**

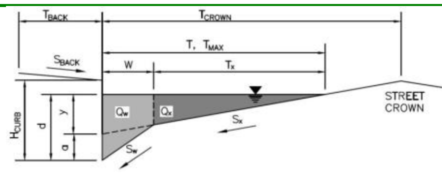
Version 4.05 Released March 2017

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

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

Project: Woodmen Heights Commercial Center Filing No. 2

Inlet ID: DP4



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	10.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.015		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	12.0		ft
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.020		ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083		ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.020		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013		
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	12.0	12.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	8.9	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☑	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	2.88	2.88	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline	d =	4.39	4.39	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	10.0	10.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.491	0.491	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	4.2	4.2	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	4.0	4.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**8.2**	**8.2**	**cfs**
Flow Velocity within the Gutter Section	V =	7.1	7.1	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	2.6	2.6	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	30.8	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	28.8	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.318	0.189	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	16.4	69.9	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	14.9	47.5	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	7.6	16.2	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	5.9	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	22.5	69.6	cfs
Average Flow Velocity Within the Gutter Section	V =	9.1	12.3	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	4.6	9.1	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	1.00	0.83	
Max Flow Based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**22.5**	**58.1**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	8.36	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	1.61	3.96	inches

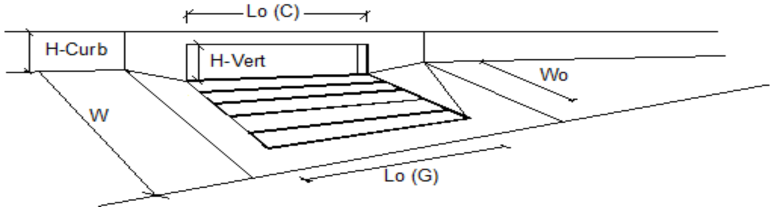
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**8.2**	**58.1**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

Version 4.05 Released March 2017



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')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, 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 < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.3**	**3.3**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.1**	**4.5**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**94**	**42**	**%**

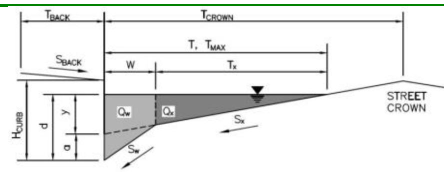
Version 4.05 Released March 2017

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

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

Project: Woodmen Heights Commercial Center Filing No. 2

Inlet ID: DP5



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	10.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.015	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	12.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.008	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	12.0	12.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	8.4	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☑	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	2.88	2.88	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline	d =	4.39	4.39	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	10.0	10.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.491	0.491	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	2.6	2.6	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	2.5	2.5	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**5.0**	**5.0**	**cfs**
Flow Velocity within the Gutter Section	V =	4.4	4.4	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	1.6	1.6	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	28.5	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\ TH}$ =	16.7	26.5	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.318	0.205	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\ TH}$	$Q_{X\ TH}$ =	10.0	34.3	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	9.1	24.6	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	4.7	8.8	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	2.1	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	13.8	35.5	cfs
Average Flow Velocity Within the Gutter Section	V =	5.6	7.2	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.8	5.0	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	1.00	1.00	
Max Flow Based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**13.8**	**35.5**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	8.35	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	1.61	3.96	inches

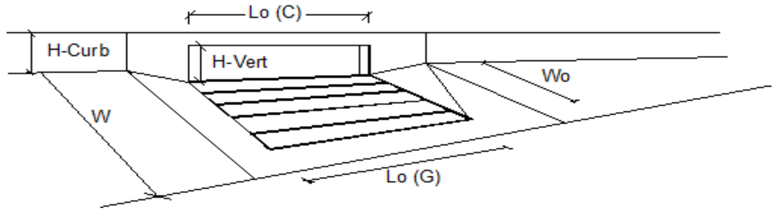
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**5.0**	**35.5**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

Version 4.05 Released March 2017



Design Information (Input)	CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet		Type =	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)		No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)		L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, 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 < Allowable Street Capacity'			MINOR	MAJOR	
Total Inlet Interception Capacity		**Q =**	**1.7**	**3.7**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)		**Q_b =**	**0.3**	**7.1**	**cfs**
Capture Percentage = Q_a/Q_o =		**C% =**	**83**	**34**	**%**

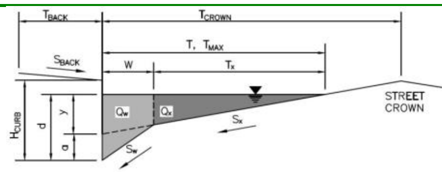
Version 4.05 Released March 2017

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

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

Project: Woodmen Heights Commercial Center Filing No. 2

Inlet ID: DP6



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	10.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.015	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	12.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.008	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	12.0	12.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	8.4	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☑	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	2.88	2.88	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline	d =	4.39	4.39	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	10.0	10.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.491	0.491	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	2.6	2.6	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	2.5	2.5	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**5.0**	**5.0**	**cfs**
Flow Velocity within the Gutter Section	V =	4.4	4.4	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	1.6	1.6	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	28.5	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	26.5	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.318	0.205	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	10.0	34.3	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	9.1	24.6	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	4.7	8.8	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	2.1	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	13.8	35.5	cfs
Average Flow Velocity Within the Gutter Section	V =	5.6	7.2	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.8	5.0	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	1.00	1.00	
Max Flow Based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**13.8**	**35.5**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	8.35	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	1.61	3.96	inches

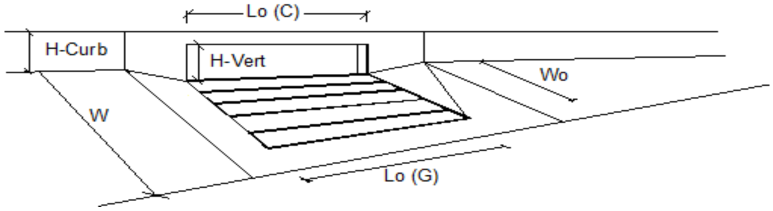
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**5.0**	**35.5**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

Version 4.05 Released March 2017



Design Information (Input) CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet	Type =	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)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, 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 < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.9**	**4.2**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.7**	**10.3**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**74**	**29**	**%**

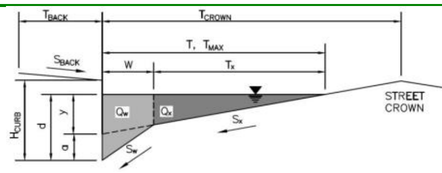
Version 4.05 Released March 2017

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

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

Project: Woodmen Heights Commercial Center Filing No. 2

Inlet ID: DP7



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	10.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.015	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	12.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.008	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	12.0	12.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	8.4	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☑	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	2.88	2.88	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline	d =	4.39	4.39	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	10.0	10.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.491	0.491	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	2.6	2.6	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	2.5	2.5	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	Q_T =	**5.0**	**5.0**	**cfs**
Flow Velocity within the Gutter Section	V =	4.4	4.4	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	1.6	1.6	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	28.5	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	26.5	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.318	0.205	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	10.0	34.3	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	9.1	24.6	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	4.7	8.8	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	2.1	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	13.8	35.5	cfs
Average Flow Velocity Within the Gutter Section	V =	5.6	7.2	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.8	5.0	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	1.00	1.00	
Max Flow Based on Allowable Depth (Safety Factor Applied)	Q_d =	**13.8**	**35.5**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	8.35	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	1.61	3.96	inches

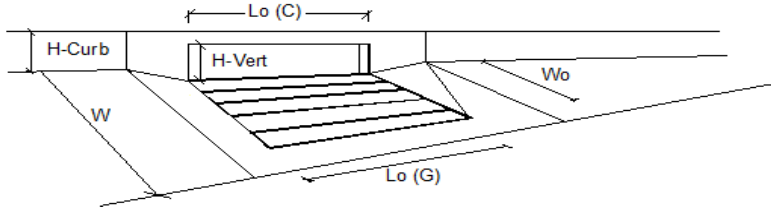
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**5.0**	**35.5**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

Version 4.05 Released March 2017



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

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

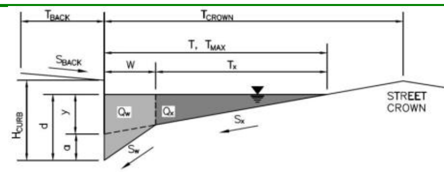
Version 4.05 Released March 2017

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

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

Project: Woodmen Heights Commercial Center Filing No. 2

Inlet ID: DP8



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	10.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.015	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	12.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.008	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	12.0	12.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	8.4	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☑	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	2.88	2.88	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.51	1.51	inches
Water Depth at Gutter Flowline	d =	4.39	4.39	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	10.0	10.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.491	0.491	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	2.6	2.6	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	2.5	2.5	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**5.0**	**5.0**	**cfs**
Flow Velocity within the Gutter Section	V =	4.4	4.4	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	1.6	1.6	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	28.5	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\ TH}$ =	16.7	26.5	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.318	0.205	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\ TH}$	$Q_{X\ TH}$ =	10.0	34.3	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	9.1	24.6	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	4.7	8.8	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	2.1	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	13.8	35.5	cfs
Average Flow Velocity Within the Gutter Section	V =	5.6	7.2	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.8	5.0	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d ≥ 6") Storm	R =	1.00	1.00	
Max Flow Based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**13.8**	**35.5**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	8.35	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	1.61	3.96	inches

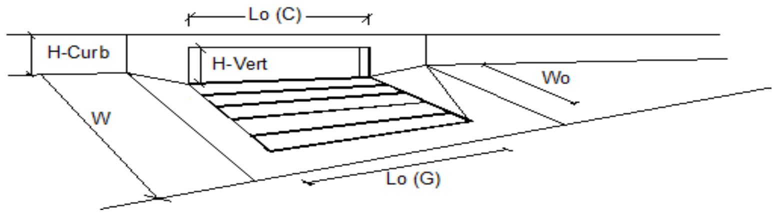
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**5.0**	**35.5**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

Version 4.05 Released March 2017



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')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, 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 < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.8**	**4.6**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.4**	**13.5**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**80**	**25**	**%**

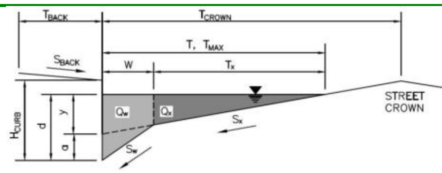
Version 4.05 Released March 2017

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

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

Project: **Woodmen Heights Commercial Center Filing No. 2**

Inlet ID: **DP12**



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.015	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	82.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.027	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	72.0	82.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.2	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☐	check = yes

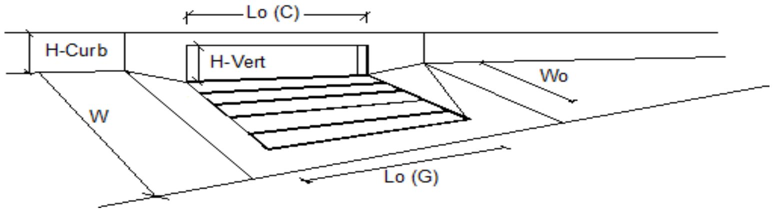
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**22.6**	**22.6**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

Version 4.05 Released March 2017



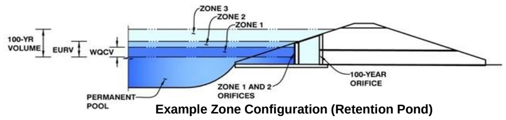
Design Information (Input)		MINOR	MAJOR	
Type of Inlet — Colorado Springs D-10-R	Type =	Colorado Springs D-10-R		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	4.0	4.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	4.00	4.00	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 < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**2.7**	**3.8**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**4.4**	**12.6**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**38**	**23**	**%**

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.00 (December 2019)

Project: **Woodmen Heights Commercial Center Filing No. 2**

Basin ID: **Sub-Regional Detention Basin**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	19.90	acres
Watershed Length =	2,000	ft
Watershed Length to Centroid =	780	ft
Watershed Slope =	0.022	ft/ft
Watershed Imperviousness =	55.38%	percent
Percentage Hydrologic Soil Group A =	4.0%	percent
Percentage Hydrologic Soil Group B =	96.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	Highlands Ranch - Highlands Ranch Mansion	

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.367	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	1.193	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.94 in.) =	0.796	acre-feet	0.94	inches
5-yr Runoff Volume (P1 = 1.22 in.) =	1.126	acre-feet	1.22	inches
10-yr Runoff Volume (P1 = 1.48 in.) =	1.500	acre-feet	1.48	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	2.220	acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.2 in.) =	2.768	acre-feet	2.20	inches
100-yr Runoff Volume (P1 = 2.5 in.) =	3.343	acre-feet	2.50	inches
500-yr Runoff Volume (P1 = 3.52 in.) =	5.111	acre-feet	3.52	inches
Approximate 2-yr Detention Volume =	0.714	acre-feet		
Approximate 5-yr Detention Volume =	0.997	acre-feet		
Approximate 10-yr Detention Volume =	1.349	acre-feet		
Approximate 25-yr Detention Volume =	1.627	acre-feet		
Approximate 50-yr Detention Volume =	1.780	acre-feet		
Approximate 100-yr Detention Volume =	1.992	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.367	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.825	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.799	acre-feet
Total Detention Basin Volume =	1.992	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Depth Increment = 0.50 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	987	0.023		
	--	1.00	--	--	--	6,668	0.153	3,827	0.088
	--	2.00	--	--	--	8,754	0.201	11,538	0.265
	--	3.00	--	--	--	10,703	0.246	21,267	0.488
	--	4.00	--	--	--	12,693	0.291	32,965	0.757
	--	5.00	--	--	--	14,784	0.339	46,703	1.072
	--	6.00	--	--	--	17,020	0.391	62,605	1.437
	--	7.00	--	--	--	19,539	0.449	80,885	1.857
	--	8.00	--	--	--	22,558	0.518	101,933	2.340
	--	8.80	--	--	--	23,902	0.549	120,517	2.767
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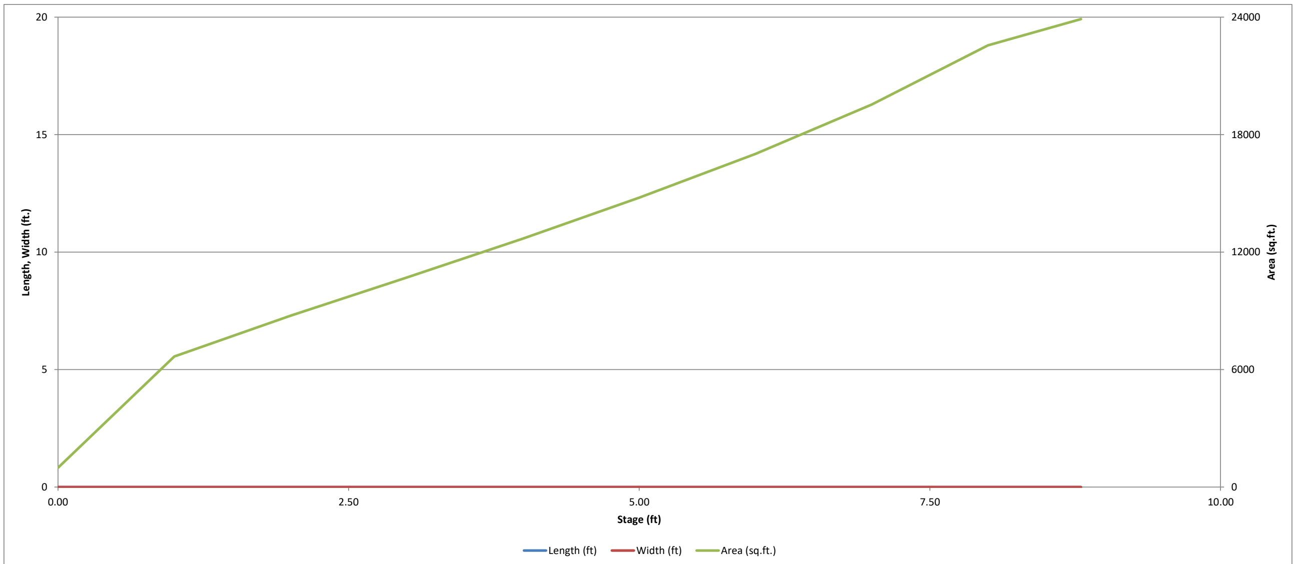
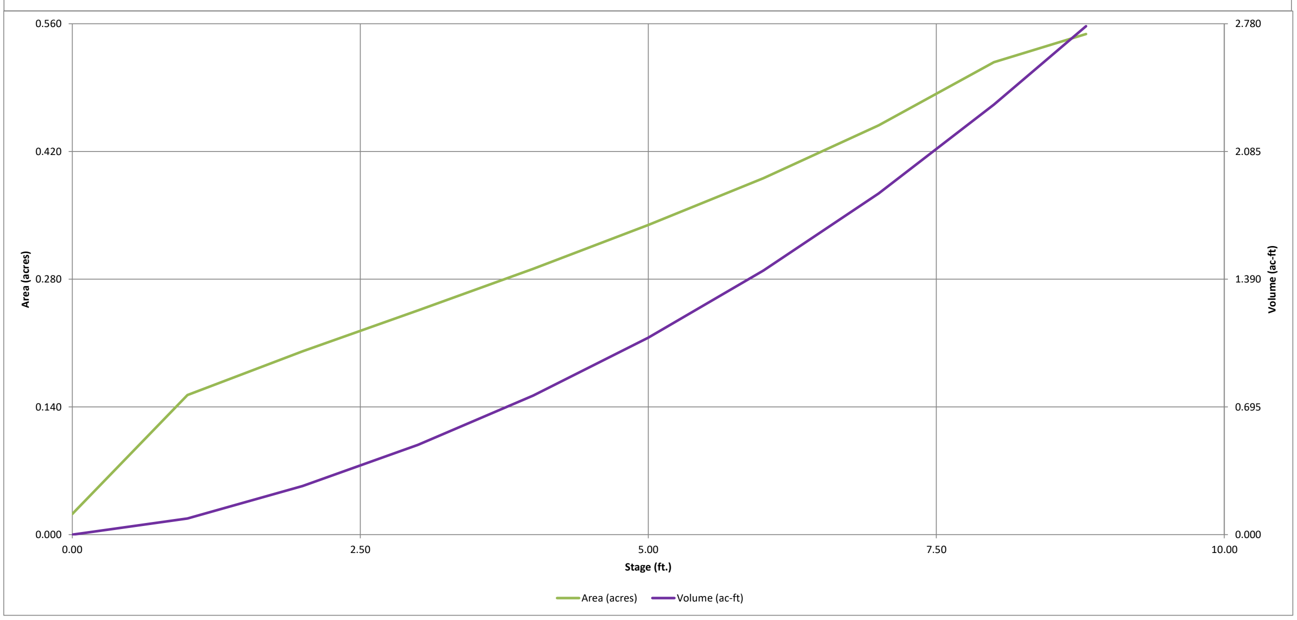
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.00 (December 2019)



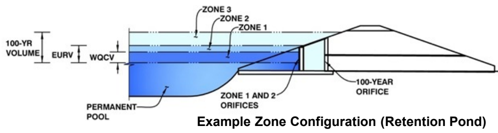


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)

Project: Woodmen Heights Commercial Center Filing No. 2

Basin ID: Sub-Regional Detention Basin



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.65	0.367	Orifice Plate
Zone 2 (EURV)	5.45	0.825	Circular Orifice
Zone 3 (100-year)	7.38	0.799	Weir&Pipe (Restrict)
Total (all zones)		1.992	

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

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

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

				Calculated Parameters for Plate	
Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	1.028E-02	ft^2
Depth at top of Zone using Orifice Plate =	1.84	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	N/A	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	1.48	sq. inches (diameter = 1-3/8 inches)	Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.42						
Orifice Area (sq. inches)	1.48	1.48						

	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)

	Zone 2 Circular	Not Selected		Calculated Parameters for Vertical Orifice	Zone 2 Circular	Not Selected	
Invert of Vertical Orifice =	3.50	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	0.08	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	5.45	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	0.16	N/A	feet
Vertical Orifice Diameter =	3.75	N/A	inches				

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

	Zone 3 Weir	Not Selected		Calculated Parameters for Overflow Weir	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	4.85	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	4.85	N/A	feet
Overflow Weir Front Edge Length =	3.42	N/A	feet	Overflow Weir Slope Length =	2.92	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	4.44	N/A	
Horiz. Length of Weir Sides =	2.92	N/A	feet	Overflow Grate Open Area w/o Debris =	6.98	N/A	ft^2
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area	Overflow Grate Open Area w/ Debris =	3.49	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

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

	Zone 3 Restrictor	Not Selected		Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.00	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	1.57	N/A	ft^2
Outlet Pipe Diameter =	24.00	N/A	inches	Outlet Orifice Centroid =	0.58	N/A	feet
Restrictor Plate Height Above Pipe Invert =	12.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.57	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

			Calculated Parameters for Spillway		
Spillway Invert Stage=	6.97	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.88	feet
Spillway Crest Length =	16.00	feet	Stage at Top of Freeboard =	8.85	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.55	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	2.73	acre-ft

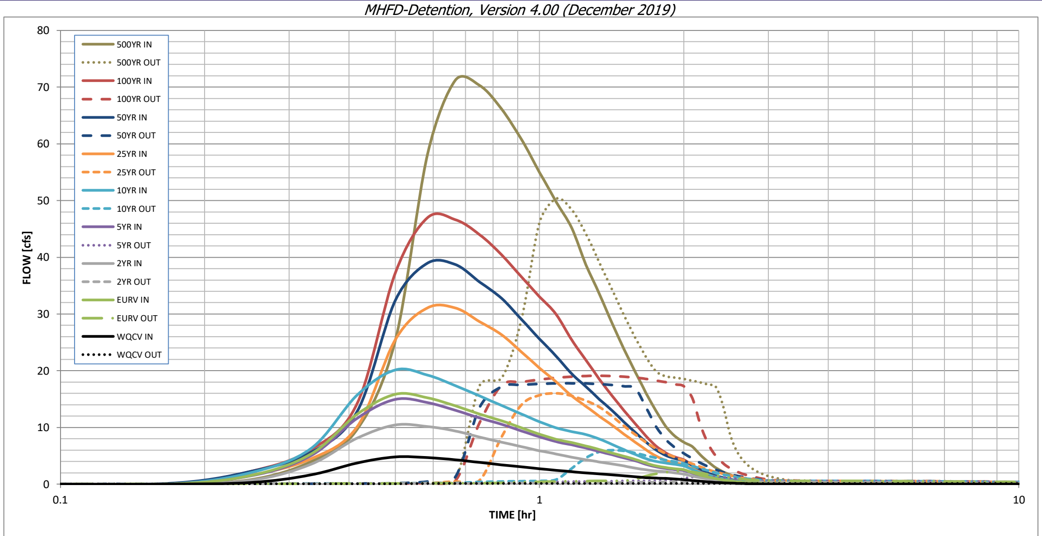
Routed Hydrograph Results

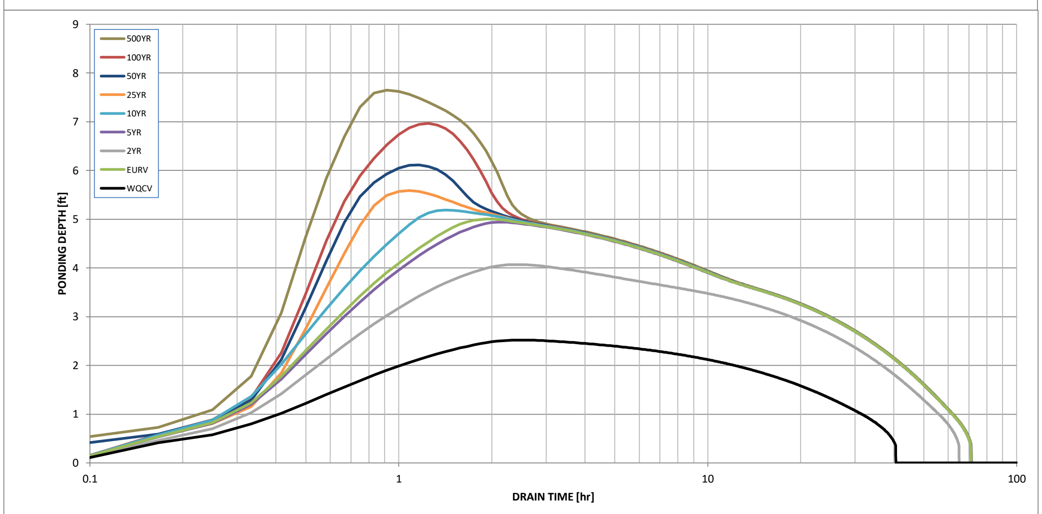
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

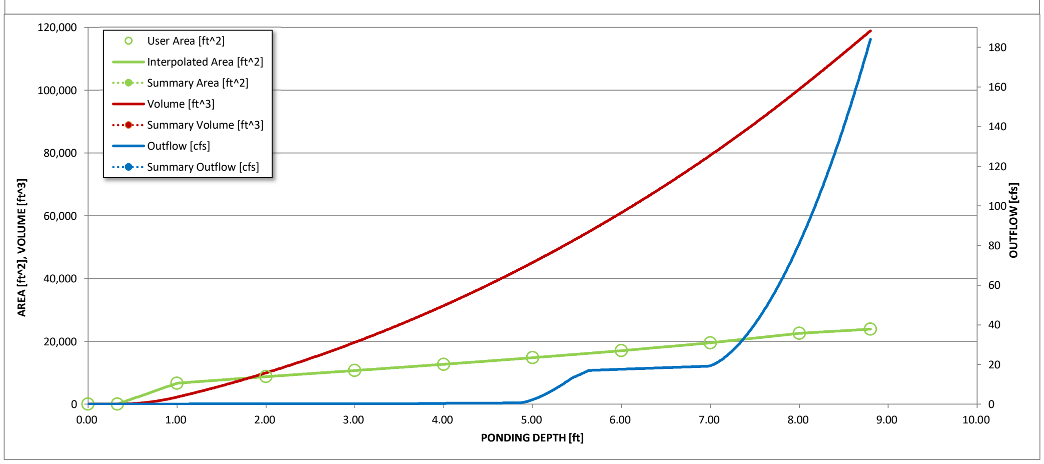
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	0.94	1.22	1.48	1.87	2.20	2.50	3.52
CUHP Runoff Volume (acre-ft) =	0.367	1.193	0.796	1.126	1.500	2.220	2.768	3.343	5.111
Inflow Hydrograph Volume (acre-ft) =	0.367	1.193	0.796	1.126	1.500	2.220	2.768	3.343	5.111
CUHP Predevelopment Peak Q (cfs) =	0.0	0.0	0.2	1.3	3.9	11.2	15.7	20.8	34.9
OPTIONAL Override Predevelopment Peak Q (cfs) =	0.0	0.0							
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.06	0.19	0.56	0.79	1.05	1.75
Peak Inflow Q (cfs) =	4.8	15.9	10.5	15.0	20.1	31.1	39.0	47.0	71.2
Peak Outflow Q (cfs) =	0.2	2.3	0.4	1.4	6.0	16.0	17.8	19.1	50.3
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	1.1	1.6	1.4	1.1	0.9	1.4
Structure Controlling Flow =	Plate	Overflow Weir 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	0.23	N/A	0.1	0.8	2.2	2.4	2.6	2.7
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	64	60	65	63	60	58	56	50
Time to Drain 99% of Inflow Volume (hours) =	**40**	68	63	68	68	67	66	65	62
Maximum Ponding Depth (ft) =	2.52	5.00	4.07	4.94	5.19	5.58	6.11	6.96	7.64
Area at Maximum Ponding Depth (acres) =	0.22	0.34	0.29	0.34	0.35	0.37	0.40	0.45	0.49
Maximum Volume Stored (acre-ft) =	0.339	1.036	0.738	1.012	1.098	1.241	1.440	1.798	2.122

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

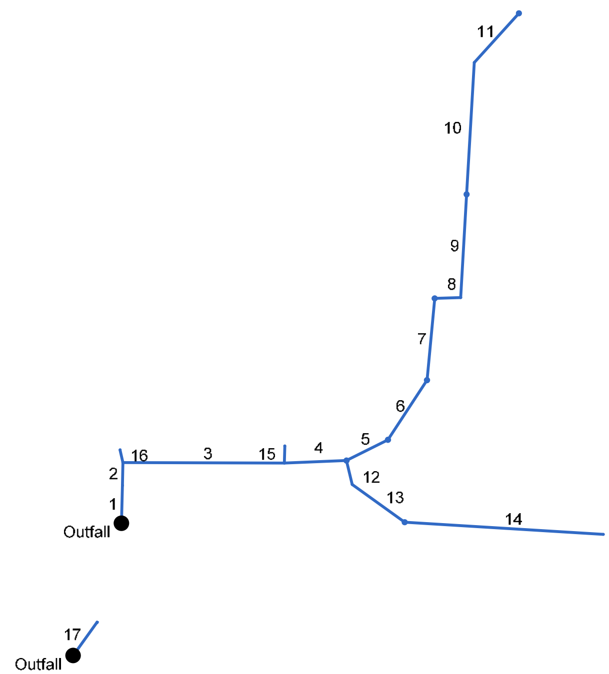
Inflow Hydrographs

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

Time Interval: 5.00 min

SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
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]
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	0.11	0.00	0.80
0:15:00	0.31	1.55	0.68	1.46	2.05	1.62	2.25	2.25	3.95
0:20:00	1.63	5.32	3.54	5.02	6.29	4.48	5.59	6.08	9.69
0:25:00	3.75	12.33	8.13	11.64	15.72	10.17	12.84	14.26	25.35
0:30:00	4.82	15.86	10.46	14.97	20.15	25.49	32.41	37.26	58.04
0:35:00	4.69	15.25	10.16	14.40	19.23	31.07	38.96	46.97	71.17
0:40:00	4.32	13.81	9.38	13.04	17.36	31.08	38.71	46.64	70.26
0:45:00	3.83	12.35	8.31	11.66	15.55	28.65	35.65	44.00	66.10
0:50:00	3.41	11.18	7.40	10.55	13.86	26.34	32.75	40.40	60.74
0:55:00	3.05	9.96	6.62	9.40	12.37	23.31	29.05	36.52	54.99
1:00:00	2.72	8.83	5.90	8.33	11.02	20.47	25.59	33.05	49.77
1:05:00	2.46	7.93	5.33	7.49	9.95	18.03	22.58	29.93	45.14
1:10:00	2.20	7.34	4.78	6.93	9.27	15.55	19.47	25.43	38.69
1:15:00	1.99	6.74	4.32	6.36	8.75	13.73	17.19	21.86	33.53
1:20:00	1.81	6.10	3.93	5.76	7.98	11.97	14.97	18.52	28.39
1:25:00	1.64	5.49	3.56	5.18	7.00	10.40	12.98	15.58	23.80
1:30:00	1.48	4.91	3.21	4.64	6.08	8.83	10.97	13.00	19.80
1:35:00	1.32	4.37	2.85	4.12	5.23	7.39	9.12	10.64	16.16
1:40:00	1.17	3.72	2.54	3.51	4.51	6.08	7.45	8.52	12.90
1:45:00	1.07	3.23	2.33	3.05	4.02	4.95	6.02	6.72	10.21
1:50:00	1.02	2.93	2.22	2.76	3.74	4.20	5.09	5.53	8.47
1:55:00	0.92	2.74	1.99	2.58	3.51	3.74	4.52	4.79	7.37
2:00:00	0.82	2.54	1.78	2.40	3.22	3.46	4.15	4.29	6.61
2:05:00	0.66	2.05	1.44	1.94	2.60	2.75	3.29	3.34	5.15
2:10:00	0.52	1.61	1.13	1.52	2.04	2.13	2.54	2.52	3.88
2:15:00	0.41	1.26	0.89	1.19	1.60	1.65	1.96	1.89	2.91
2:20:00	0.32	0.99	0.70	0.93	1.24	1.27	1.50	1.42	2.17
2:25:00	0.25	0.76	0.54	0.72	0.95	0.97	1.15	1.08	1.65
2:30:00	0.19	0.58	0.42	0.55	0.72	0.74	0.87	0.82	1.25
2:35:00	0.15	0.44	0.32	0.41	0.54	0.55	0.65	0.62	0.94
2:40:00	0.11	0.33	0.24	0.31	0.41	0.42	0.49	0.47	0.72
2:45:00	0.08	0.24	0.18	0.23	0.31	0.32	0.37	0.36	0.54
2:50:00	0.06	0.17	0.13	0.16	0.22	0.23	0.27	0.26	0.39
2:55:00	0.04	0.12	0.08	0.11	0.15	0.16	0.18	0.18	0.27
3:00:00	0.02	0.07	0.05	0.07	0.09	0.10	0.12	0.11	0.17
3:05:00	0.01	0.04	0.03	0.04	0.05	0.05	0.06	0.06	0.09
3:10:00	0.00	0.02	0.01	0.02	0.02	0.02	0.03	0.02	0.03
3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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

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



Project File: 5 Year.stm	Number of lines: 17	Date: 7/17/2020

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 - (42)	31.90	38x60	Ell	46.033	6889.19	6889.33	0.304	6890.57	6890.98	n/a	6890.98	End	Curb-
2	Pipe - (28)	31.90	38x60	Ell	28.000	6889.33	6889.41	0.286	6891.36	6891.06	n/a	6891.06	1	Curb-
3	Pipe - (25)	18.87	38x60	Ell	196.285	6889.71	6890.30	0.301	6891.44	6891.57	n/a	6891.57	2	Curb-
4	Pipe - (24)	12.12	38x60	Ell	75.693	6890.40	6890.63	0.304	6891.85	6891.64	n/a	6891.64	3	Manhole
5	Pipe - (30)	6.86	36	Cir	56.390	6890.93	6891.29	0.640	6891.66	6892.11	n/a	6892.11	4	Manhole
6	Pipe - (22)	6.86	30	Cir	87.034	6892.17	6892.98	0.931	6892.88	6893.85	n/a	6893.85	5	Manhole
7	Pipe - (21)	6.86	30	Cir	100.277	6893.28	6894.19	0.908	6893.99	6895.06	n/a	6895.06	6	Manhole
8	Pipe - (32)	6.86	24	Cir	31.680	6894.72	6895.35	1.988	6895.35	6896.28	n/a	6896.28	7	Curb-
9	Pipe - (20)	5.27	18	Cir	126.205	6895.86	6899.34	2.757	6896.43	6900.22	0.06	6900.22	8	Manhole
10	Pipe - (19)	3.03	15	Cir	161.371	6899.64	6903.82	2.590	6900.22	6904.52	0.29	6904.52	9	Curb-
11	Pipe - (39)	3.03	15	Cir	81.025	6904.16	6906.34	2.690	6904.62	6907.04	0.29	6907.04	10	Manhole
12	Pipe - (31)	2.70	24	Cir	29.978	6891.12	6891.27	0.500	6891.68	6891.84	n/a	6891.84	4	Curb-
13	Pipe - (37)	2.70	24	Cir	78.796	6891.37	6891.76	0.500	6891.93	6892.34	n/a	6892.34	12	Manhole
14	Pipe - (38)	2.70	24	Cir	241.933	6891.86	6893.12	0.521	6892.41	6893.69	n/a	6893.69	13	Grate
15	Pipe - (43)	0.20	15	Cir	20.877	6892.03	6894.22	10.492	6892.12	6894.39	n/a	6894.39	3	Generic
16	Pipe - (28) (3)	12.29	48	Cir	15.969	6889.21	6889.31	0.627	6891.06	6890.33	n/a	6890.33	2	Manhole
17	Pipe - (40)	0.40	24	Cir	49.961	6888.07	6888.32	0.500	6888.29	6888.54	0.07	6888.61	End	Grate

Project File: 5 Year.stm	Number of lines: 17	Run Date: 7/17/2020
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	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	46.033	0.00	0.00	0.00	0.00	0.00	0.0	10.4	0.0	31.90	83.22	5.56	38 x 60 e	0.30	6889.19	6889.33	6890.57	6890.98	6893.82	6895.31	Pipe - (42)
2	1	28.000	0.00	0.00	0.00	0.00	0.00	0.0	10.3	0.0	31.90	80.66	5.14	38 x 60 e	0.29	6889.33	6889.41	6891.36	6891.06	6895.31	6895.13	Pipe - (28)
3	2	196.285	0.00	0.00	0.00	0.00	0.00	0.0	8.1	0.0	18.87	82.68	4.67	38 x 60 e	0.30	6889.71	6890.30	6891.44	6891.57	6895.13	6896.57	Pipe - (25)
4	3	75.693	0.00	0.00	0.00	0.00	0.00	0.0	6.8	0.0	12.12	76.75	3.90	38 x 60 e	0.30	6890.40	6890.63	6891.85	6891.64	6896.57	6897.39	Pipe - (24)
5	4	56.390	0.00	0.00	0.00	0.00	0.00	0.0	4.8	0.0	6.86	53.35	4.77	36	0.64	6890.93	6891.29	6891.66	6892.11	6897.39	6897.88	Pipe - (30)
6	5	87.034	0.00	0.00	0.00	0.00	0.00	0.0	3.8	0.0	6.86	39.57	5.28	30	0.93	6892.17	6892.98	6892.88	6893.85	6897.88	6898.61	Pipe - (22)
7	6	100.277	0.00	0.00	0.00	0.00	0.00	0.0	2.6	0.0	6.86	39.07	5.26	30	0.91	6893.28	6894.19	6893.99	6895.06	6898.61	6899.94	Pipe - (21)
8	7	31.680	0.00	0.00	0.00	0.00	0.00	0.0	2.3	0.0	6.86	31.89	6.44	24	1.99	6894.72	6895.35	6895.35	6896.28	6899.94	6899.52	Pipe - (32)
9	8	126.205	0.00	0.00	0.00	0.00	0.00	0.0	1.6	0.0	5.27	17.44	6.75	18	2.76	6895.86	6899.34	6896.43	6900.22	6899.52	6903.38	Pipe - (20)
10	9	161.371	0.00	0.00	0.00	0.00	0.00	0.0	0.5	0.0	3.03	10.39	4.84	15	2.59	6899.64	6903.82	6900.22	6904.52	6903.38	6907.88	Pipe - (19)
11	10	81.025	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	3.03	10.59	5.86	15	2.69	6904.16	6906.34	6904.62	6907.04	6907.88	6908.90	Pipe - (39)
12	4	29.978	0.00	0.00	0.00	0.00	0.00	0.0	6.2	0.0	2.70	15.99	3.71	24	0.50	6891.12	6891.27	6891.68	6891.84	6897.39	6897.30	Pipe - (31)
13	12	78.796	0.00	0.00	0.00	0.00	0.00	0.0	4.7	0.0	2.70	15.99	3.71	24	0.50	6891.37	6891.76	6891.93	6892.34	6897.30	6897.98	Pipe - (37)
14	13	241.933	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	2.70	16.32	3.74	24	0.52	6891.86	6893.12	6892.41	6893.69	6897.98	6896.79	Pipe - (38)
15	3	20.877	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.20	20.92	3.68	15	10.49	6892.03	6894.22	6892.12	6894.39	6896.57	6895.66	Pipe - (43)
16	2	15.969	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	12.29	113.7	3.51	48	0.63	6889.21	6889.31	6891.06	6890.33	6895.13	0.00	Pipe - (28) (3)
17	End	49.961	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.40	16.00	2.16	24	0.50	6888.07	6888.32	6888.29	6888.54	6890.88	6890.03	Pipe - (40)

Project File: 5 Year.stm | Number of lines: 17 | Run Date: 7/17/2020

NOTES:Intensity = 79.26 / (Inlet time + 14.60) ^ 0.84; 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	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf		Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf	Ave Sf	Enrgy loss		
	(in)	(cfs)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(ft)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(%)	(ft)	(K)	(ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1	38 60 e	31.90	6889.19	6890.57	1.38	5.16	6.18	0.38	6890.95	0.000	46.033	6889.33	6890.98	1.65**	6.47	4.93	0.38	6891.36	0.000	0.000	n/a	0.50	n/a
2	38 60 e	31.90	6889.33	6891.36	2.02	5.97	5.34	0.38	6891.73	0.000	28.000	6889.41	6891.06	1.65**	6.47	4.93	0.38	6891.44	0.000	0.000	n/a	1.50	n/a
3	38 60 e	18.87	6889.71	6891.44	1.73	3.73	5.06	0.28	6891.72	0.000	196.285	6890.30	6891.57	1.27**	4.41	4.27	0.28	6891.85	0.000	0.000	n/a	1.50	n/a
4	38 60 e	12.12	6890.40	6891.85	1.45	3.11	3.90	0.24	6892.09	0.000	75.693	6890.63	6891.64	1.01**	3.11	3.90	0.24	6891.88	0.000	0.000	n/a	0.99	n/a
5	36	6.86	6890.93	6891.66	0.73*	1.32	5.19	0.30	6891.95	0.000	56.390	6891.29	6892.11	0.82**	1.57	4.36	0.30	6892.41	0.000	0.000	n/a	0.56	n/a
6	30	6.86	6892.17	6892.88	0.71*	1.14	6.04	0.32	6893.19	0.000	87.034	6892.98	6893.85	0.87**	1.51	4.53	0.32	6894.17	0.000	0.000	n/a	0.52	n/a
7	30	6.86	6893.28	6893.99	0.71*	1.15	5.98	0.32	6894.31	0.000	100.277	6894.19	6895.06	0.87**	1.51	4.53	0.32	6895.38	0.000	0.000	n/a	0.99	n/a
8	24	6.86	6894.72	6895.35	0.63*	0.85	8.08	0.36	6895.71	0.000	31.680	6895.35	6896.28	0.93**	1.43	4.81	0.36	6896.64	0.000	0.000	n/a	1.50	n/a
9	18	5.27	6895.86	6896.43	0.57*	0.61	8.64	0.37	6896.79	0.000	126.205	6899.34	6900.22	0.88**	1.08	4.87	0.37	6900.59	0.000	0.000	n/a	0.15	0.06
10	15	3.03	6899.64	6900.22	0.58	0.56	5.39	0.29	6900.51	0.000	161.371	6903.82	6904.52	0.70**	0.71	4.29	0.29	6904.81	0.000	0.000	n/a	1.01	0.29
11	15	3.03	6904.16	6904.62	0.46*	0.41	7.44	0.29	6904.90	0.000	81.025	6906.34	6907.04	0.70**	0.71	4.29	0.29	6907.33	0.000	0.000	n/a	1.00	0.29
12	24	2.70	6891.12	6891.68	0.56*	0.71	3.79	0.21	6891.88	0.000	29.978	6891.27	6891.84	0.57**	0.74	3.64	0.21	6892.05	0.000	0.000	n/a	1.06	n/a
13	24	2.70	6891.37	6891.93	0.56*	0.71	3.79	0.21	6892.13	0.000	78.796	6891.76	6892.34	0.57**	0.74	3.64	0.21	6892.54	0.000	0.000	n/a	0.59	n/a
14	24	2.70	6891.86	6892.41	0.55*	0.70	3.84	0.21	6892.62	0.000	241.933	6893.12	6893.69	0.57**	0.74	3.64	0.21	6893.90	0.000	0.000	n/a	1.00	n/a
15	15	0.20	6892.03	6892.12	0.09*	0.04	5.39	0.06	6892.18	0.000	20.877	6894.22	6894.39	0.17**	0.10	1.96	0.06	6894.45	0.000	0.000	n/a	1.00	n/a
16	48	12.29	6889.21	6891.06	1.85	2.54	2.17	0.36	6891.42	0.000	15.969	6889.31	6890.33	1.02**	2.54	4.85	0.36	6890.70	0.000	0.000	n/a	1.00	n/a
17	24	0.40	6888.07	6888.29	0.22*	0.18	2.18	0.07	6888.36	0.517	49.961	6888.32	6888.54	0.22**	0.19	2.14	0.07	6888.61	0.488	0.502	0.251	1.00	0.07

Project File: 5 Year.stm | Number of lines: 17 | Run Date: 7/17/2020

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

Hydraflow HGL Computation Procedure

General Procedure:

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

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

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

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

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

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

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

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

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

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

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

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

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

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

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

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

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

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

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

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

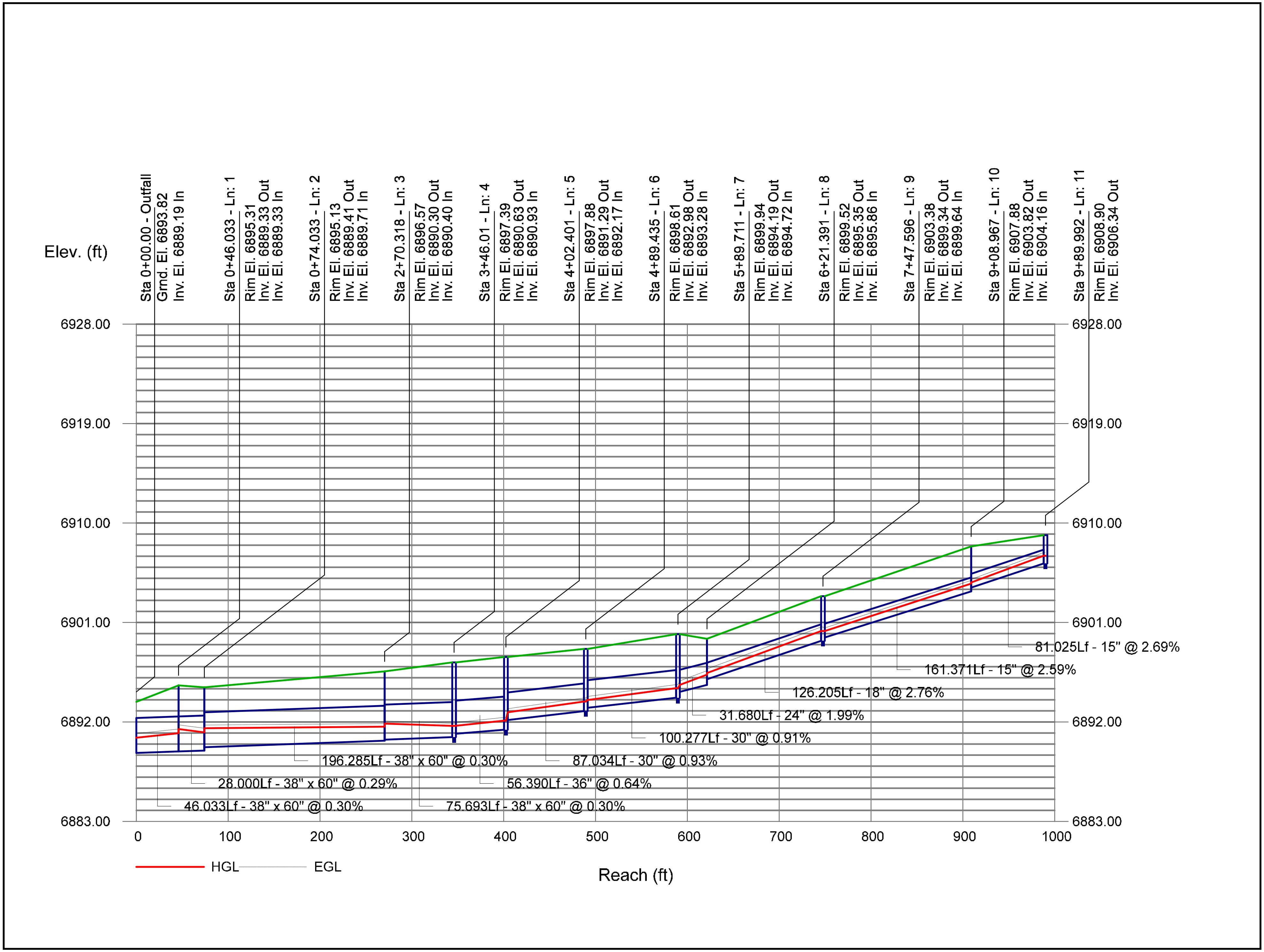
Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

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

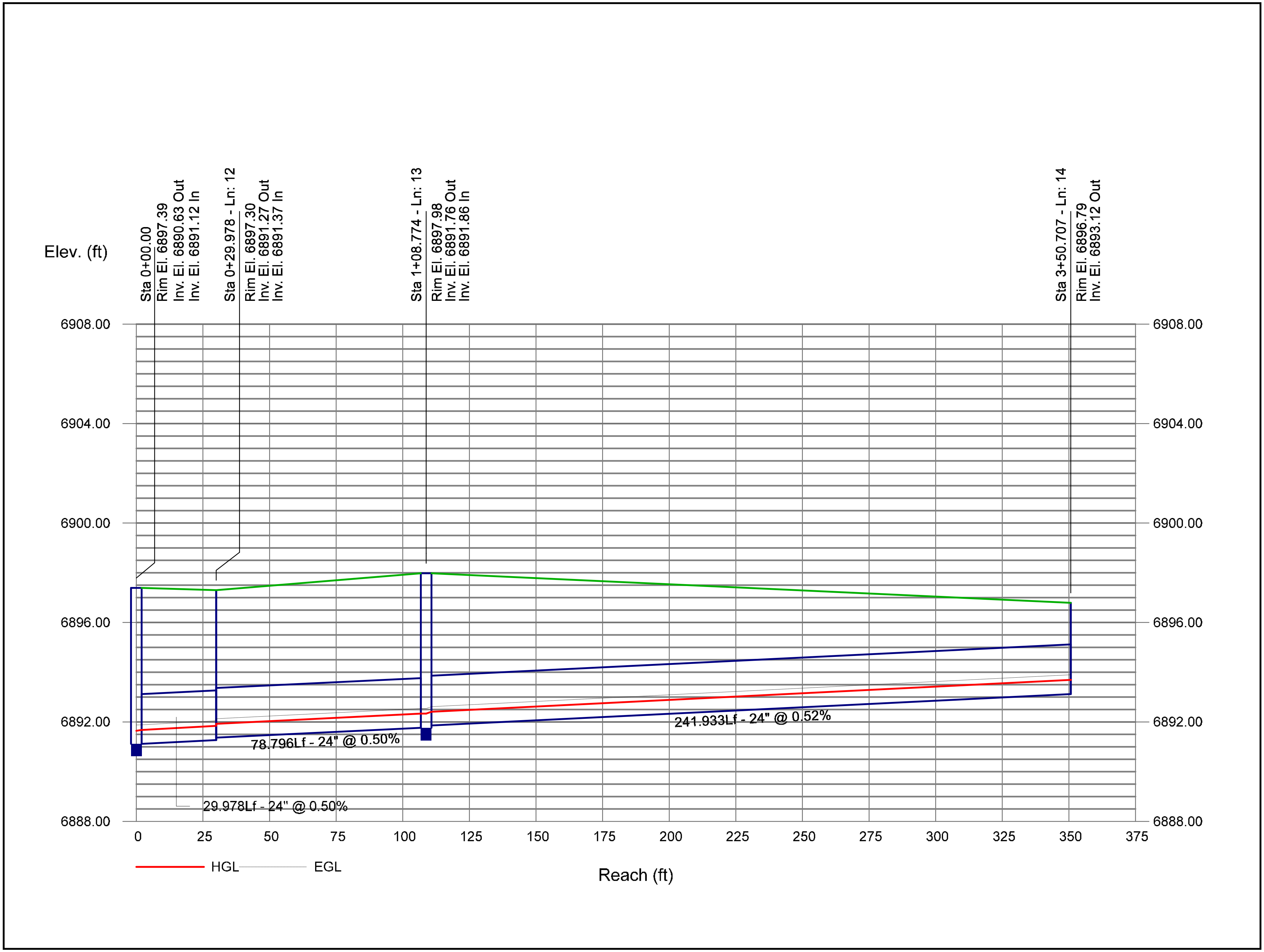
Storm Sewer Profile

Proj. file: 5 Year.stm

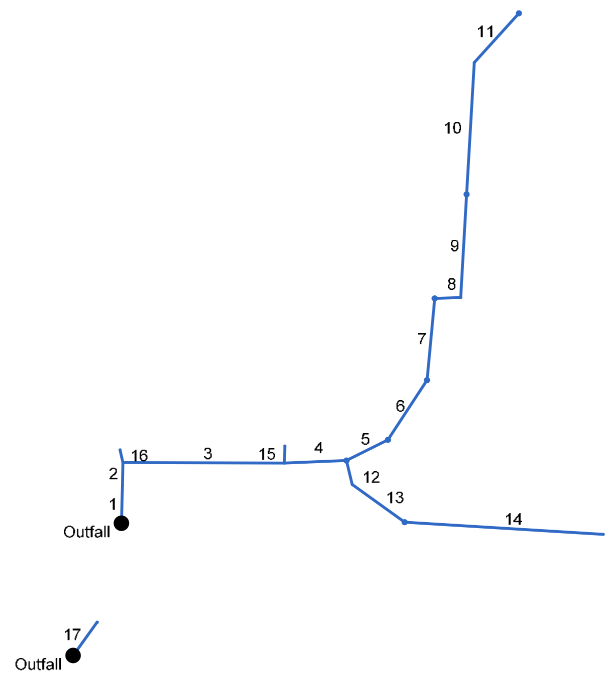


Storm Sewer Profile

Proj. file: 5 Year.stm



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



Project File: 100 Year.stm	Number of lines: 17	Date: 7/17/2020

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 - (42)	78.48	36x60	Ell	46.033	6889.19	6889.33	0.304	6891.56	6891.97	0.12	6891.97	End	Curb-Horiz
2	Pipe - (28)	78.48	36x60	Ell	28.000	6889.33	6889.41	0.286	6892.88*	6892.97*	0.91	6893.88	1	Curb-Horiz
3	Pipe - (25)	36.97	38x60	Ell	196.285	6889.71	6890.30	0.301	6894.57*	6894.69*	0.18	6894.87	2	Curb-Horiz
4	Pipe - (24)	22.84	38x60	Ell	75.693	6890.40	6890.63	0.304	6895.00*	6895.02*	0.05	6895.08	3	Manhole
5	Pipe - (30)	13.55	36	Cir	56.390	6890.93	6891.29	0.640	6895.08*	6895.10*	0.03	6895.13	4	Manhole
6	Pipe - (22)	13.55	30	Cir	87.034	6892.17	6892.98	0.931	6895.13	6895.21	0.07	6895.28	5	Manhole
7	Pipe - (21)	13.55	30	Cir	100.277	6893.28	6894.19	0.899	6895.28	6895.42	n/a	6895.42 j	6	Manhole
8	Pipe - (32)	13.55	24	Cir	31.680	6894.72	6895.35	1.988	6895.63	6896.67	0.88	6896.67	7	Curb-Horiz
9	Pipe - (20)	13.55	18	Cir	126.205	6895.86	6899.34	2.757	6896.85	6900.71	n/a	6900.71	8	Manhole
10	Pipe - (19)	8.91	15	Cir	161.371	6899.64	6903.82	2.590	6900.71	6904.97	0.89	6904.97	9	Curb-Horiz
11	Pipe - (39)	8.91	15	Cir	81.025	6904.16	6906.34	2.690	6905.04	6907.49	0.88	6907.49	10	Manhole
12	Pipe - (31)	3.80	24	Cir	29.978	6891.12	6891.27	0.500	6895.08*	6895.08*	0.01	6895.09	4	Curb-Horiz
13	Pipe - (37)	3.80	24	Cir	78.796	6891.37	6891.76	0.495	6895.09*	6895.12*	0.01	6895.13	12	Manhole
14	Pipe - (38)	3.80	24	Cir	241.933	6891.86	6893.07	0.500	6895.13*	6895.20*	0.02	6895.22	13	Grate
15	Pipe - (43)	1.10	15	Cir	20.877	6892.03	6894.22	10.492	6894.87	6894.84	0.05	6894.90	3	Generic
16	Pipe - (28) (3)	40.13	48	Cir	15.969	6889.21	6889.31	0.627	6893.88*	6893.89*	0.16	6894.05	2	Manhole
17	Pipe - (40)	19.10	24	Cir	49.961	6888.07	6888.32	0.500	6889.64	6890.19	0.61	6890.80	End	Grate

Project File: 100 Year.stm | Number of lines: 17 | Run Date: 7/17/2020

NOTES: Return period = 100 Yrs. ; *Surcharged (HGL above crown). ; 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	46.033	0.00	0.00	0.00	0.00	0.00	0.0	6.7	0.0	78.48	77.10	7.39	36 x 60 e	0.30	6889.19	6889.33	6891.56	6891.97	6893.82	6895.31	Pipe - (42)
2	1	28.000	0.00	0.00	0.00	0.00	0.00	0.0	6.6	0.0	78.48	74.73	6.66	36 x 60 e	0.29	6889.33	6889.41	6892.88	6892.97	6895.31	6895.13	Pipe - (28)
3	2	196.285	0.00	0.00	0.00	0.00	0.00	0.0	5.5	0.0	36.97	82.68	2.97	38 x 60 e	0.30	6889.71	6890.30	6894.57	6894.69	6895.13	6896.57	Pipe - (25)
4	3	75.693	0.00	0.00	0.00	0.00	0.00	0.0	4.8	0.0	22.84	76.75	1.84	38 x 60 e	0.30	6890.40	6890.63	6895.00	6895.02	6896.57	6897.39	Pipe - (24)
5	4	56.390	0.00	0.00	0.00	0.00	0.00	0.0	2.1	0.0	13.55	53.35	1.92	36	0.64	6890.93	6891.29	6895.08	6895.10	6897.39	6897.88	Pipe - (30)
6	5	87.034	0.00	0.00	0.00	0.00	0.00	0.0	1.6	0.0	13.55	39.57	2.85	30	0.93	6892.17	6892.98	6895.13	6895.21	6897.88	6898.61	Pipe - (22)
7	6	100.277	0.00	0.00	0.00	0.00	0.00	0.0	1.0	0.0	13.55	38.89	4.41	30	0.90	6893.28	6894.19	6895.28	6895.42	6898.61	6899.94	Pipe - (21)
8	7	31.680	0.00	0.00	0.00	0.00	0.00	0.0	0.8	0.0	13.55	31.89	7.94	24	1.99	6894.72	6895.35	6895.63	6896.67	6899.94	6899.52	Pipe - (32)
9	8	126.205	0.00	0.00	0.00	0.00	0.00	0.0	0.6	0.0	13.55	17.44	9.46	18	2.76	6895.86	6899.34	6896.85	6900.71	6899.52	6903.38	Pipe - (20)
10	9	161.371	0.00	0.00	0.00	0.00	0.00	0.0	0.2	0.0	8.91	10.39	7.76	15	2.59	6899.64	6903.82	6900.71	6904.97	6903.38	6907.88	Pipe - (19)
11	10	81.025	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	8.91	10.59	8.60	15	2.69	6904.16	6906.34	6905.04	6907.49	6907.88	6908.90	Pipe - (39)
12	4	29.978	0.00	0.00	0.00	0.00	0.00	0.0	4.4	0.0	3.80	15.99	1.21	24	0.50	6891.12	6891.27	6895.08	6895.08	6897.39	6897.30	Pipe - (31)
13	12	78.796	0.00	0.00	0.00	0.00	0.00	0.0	3.3	0.0	3.80	15.91	1.21	24	0.49	6891.37	6891.76	6895.09	6895.12	6897.30	6897.98	Pipe - (37)
14	13	241.933	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	3.80	16.00	1.21	24	0.50	6891.86	6893.07	6895.13	6895.20	6897.98	6896.79	Pipe - (38)
15	3	20.877	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	1.10	20.92	1.35	15	10.49	6892.03	6894.22	6894.87	6894.84	6896.57	6895.66	Pipe - (43)
16	2	15.969	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	40.13	113.7	3.19	48	0.63	6889.21	6889.31	6893.88	6893.89	6895.13	0.00	Pipe - (28) (3)
17	End	49.961	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	19.10	16.00	6.73	24	0.50	6888.07	6888.32	6889.64	6890.19	6890.88	6890.03	Pipe - (40)

Project File: 100 Year.stm | Number of lines: 17 | Run Date: 7/17/2020

NOTES:Intensity = 127.16 / (Inlet time + 17.80) ^ 0.82; 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
(1)	(in) (2)	(cfs) (3)	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)	(ft) (12)	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)	(K) (23)	(ft) (24)
1	36 60 e	78.48	6889.19	6891.56	2.37	10.25	7.66	0.79	6892.35	0.000	46.033	6889.33	6891.97	2.64**	11.02	7.12	0.79	6892.76	0.000	0.000	n/a	0.15	0.12
2	36 60 e	78.48	6889.33	6892.88	3.00	11.78	6.66	0.69	6893.57	0.315	28.000	6889.41	6892.97	3.00	11.78	6.66	0.69	6893.66	0.315	0.315	0.088	1.32	0.91
3	38 60 e	36.97	6889.71	6894.57	3.17	12.44	2.97	0.14	6894.70	0.060	196.285	6890.30	6894.69	3.17	12.44	2.97	0.14	6894.82	0.060	0.060	0.118	1.32	0.18
4	38 60 e	22.84	6890.40	6895.00	3.17	12.44	1.84	0.05	6895.06	0.027	75.693	6890.63	6895.02	3.17	12.44	1.84	0.05	6895.08	0.027	0.027	0.020	0.99	0.05
5	36	13.55	6890.93	6895.08	3.00	7.07	1.92	0.06	6895.13	0.041	56.390	6891.29	6895.10	3.00	7.07	1.92	0.06	6895.16	0.041	0.041	0.023	0.56	0.03
6	30	13.55	6892.17	6895.13	2.50	4.91	2.76	0.12	6895.25	0.109	87.034	6892.98	6895.21	2.23	4.61	2.94	0.13	6895.34	0.097	0.103	0.090	0.52	0.07
7	30	13.55	6893.28	6895.28	1.99	2.42	3.23	0.49	6895.76	0.000	100.277	6894.19	6895.42 j	1.24**	2.42	5.59	0.49	6895.91	0.000	0.000	n/a	0.99	0.48
8	24	13.55	6894.72	6895.63	0.91*	1.39	9.74	0.59	6896.22	0.000	31.680	6895.35	6896.67	1.32**	2.21	6.14	0.59	6897.26	0.000	0.000	n/a	1.50	0.88
9	18	13.55	6895.86	6896.85	0.99*	1.24	10.91	1.00	6897.85	0.000	126.205	6899.34	6900.71	1.37**	1.69	8.01	1.00	6901.71	0.000	0.000	n/a	0.15	n/a
10	15	8.91	6899.64	6900.71	1.07	1.12	7.98	0.88	6901.59	0.000	161.371	6903.82	6904.97	1.15**	1.18	7.54	0.88	6905.85	0.000	0.000	n/a	1.01	0.89
11	15	8.91	6904.16	6905.04	0.88*	0.92	9.67	0.88	6905.92	0.000	81.025	6906.34	6907.49	1.15**	1.18	7.54	0.88	6908.38	0.000	0.000	n/a	1.00	0.88
12	24	3.80	6891.12	6895.08	2.00	3.14	1.21	0.02	6895.10	0.028	29.978	6891.27	6895.08	2.00	3.14	1.21	0.02	6895.11	0.028	0.028	0.008	0.40	0.01
13	24	3.80	6891.37	6895.09	2.00	3.14	1.21	0.02	6895.12	0.028	78.796	6891.76	6895.12	2.00	3.14	1.21	0.02	6895.14	0.028	0.028	0.022	0.59	0.01
14	24	3.80	6891.86	6895.13	2.00	3.14	1.21	0.02	6895.15	0.028	241.933	6893.07	6895.20	2.00	3.14	1.21	0.02	6895.22	0.028	0.028	0.068	1.00	0.02
15	15	1.10	6892.03	6894.87	1.25	1.23	0.90	0.01	6894.88	0.029	20.877	6894.22	6894.84	0.62	0.61	1.80	0.05	6894.90	0.117	0.073	0.015	1.00	0.05
16	48	40.13	6889.21	6893.88	4.00	12.56	3.19	0.16	6894.04	0.078	15.969	6889.31	6893.89	4.00	12.57	3.19	0.16	6894.05	0.078	0.078	0.012	1.00	0.16
17	24	19.10	6888.07	6889.64	1.57*	2.65	7.22	0.81	6890.45	0.775	49.961	6888.32	6890.19	1.87	3.06	6.25	0.61	6890.80	0.616	0.695	0.347	1.00	0.61

Project File: 100 Year.stm | Number of lines: 17 | Run Date: 7/17/2020

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

Hydraflow HGL Computation Procedure

General Procedure:

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

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

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

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

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

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

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

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

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

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

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

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

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

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

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

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

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

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

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

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

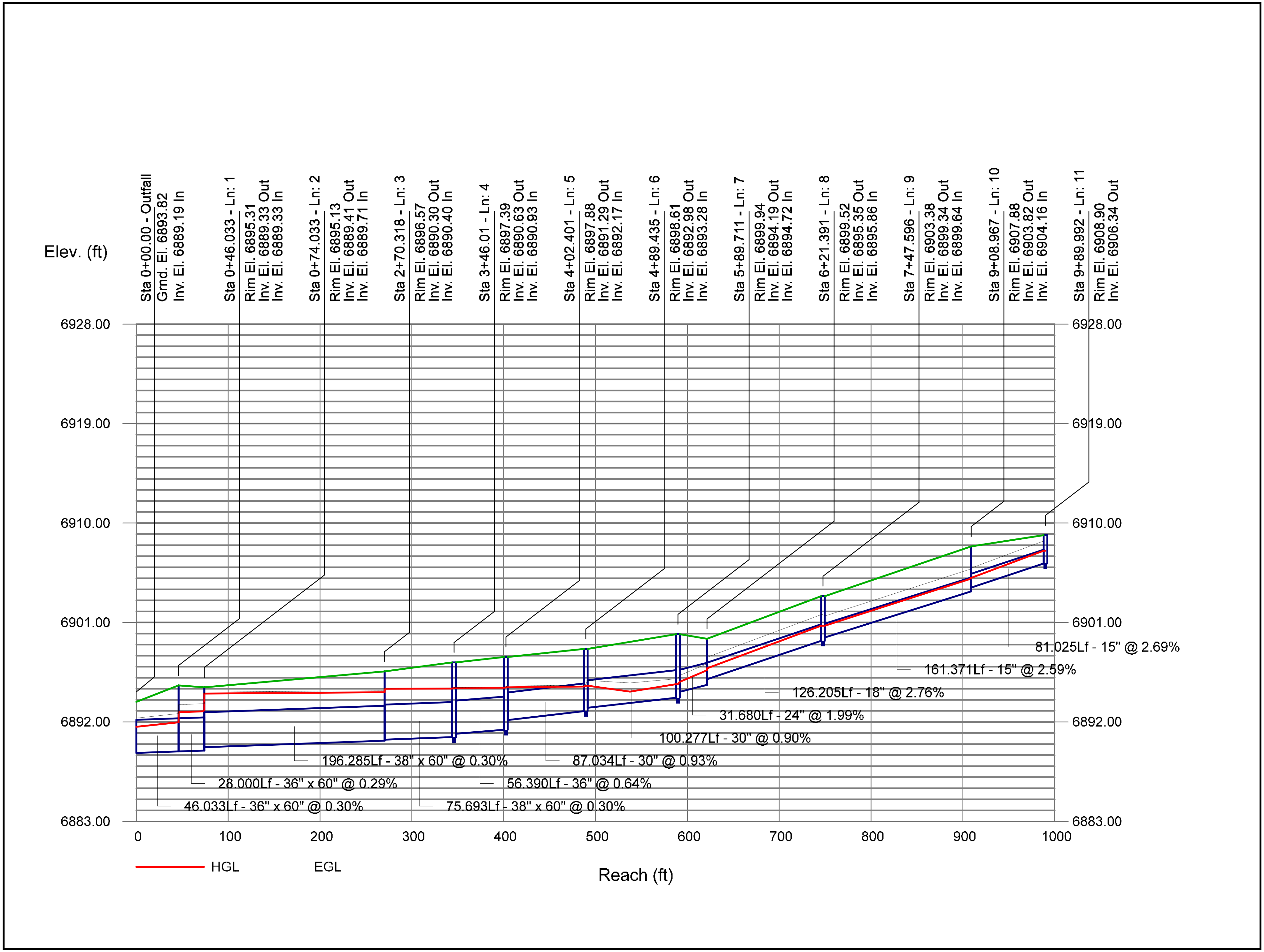
Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

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

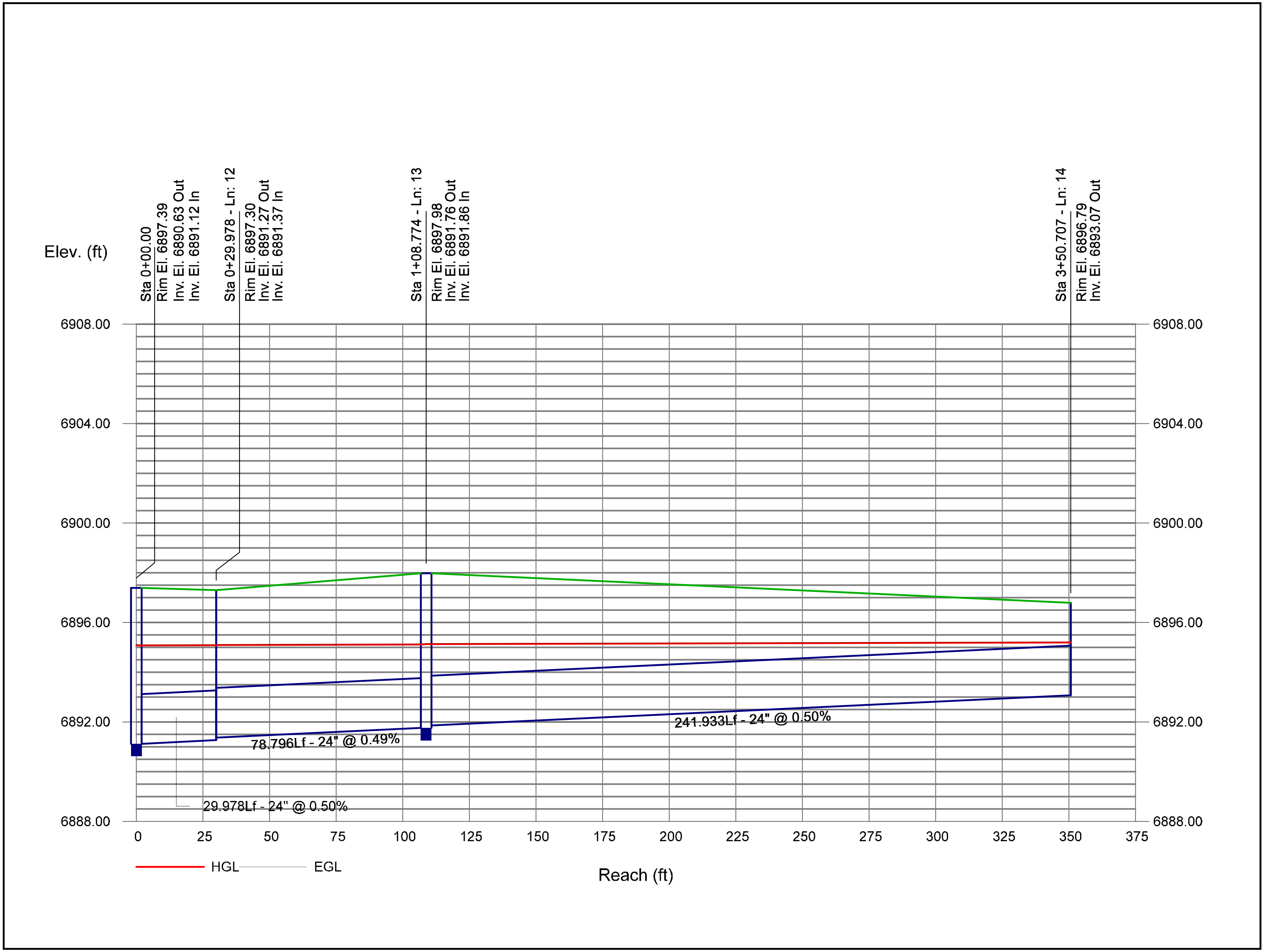
Storm Sewer Profile

Proj. file: 100 Year.stm



Storm Sewer Profile

Proj. file: 100 Year.stm



Worksheet Protected

Site-Level Low Impact Development (LID) Design Effective Impervious Calculator

LID Credit by Impervious Reduction Factor (IRF) Method

UD-BMP (Version 3.06, November 2016)

User Input

Calculated cells

***Design Storm: 1-Hour Rain Depth	WQCV Event	0.60	inches
***Minor Storm: 1-Hour Rain Depth	5-Year Event	1.35	inches
***Major Storm: 1-Hour Rain Depth	100-Year Event	2.60	inches
Optional User Defined Storm	CUHP		
(CUHP) NOAA 1 Hour Rainfall Depth and Frequency for User Defined Storm	100-Year Event	2.50	
Max Intensity for Optional User Defined Storm	2.495		

Designer: TBI
Company: HR GREEN
Date: May 12, 2020
Project: WOODMEN HEIGHTS COMMERCIAL CENTER FILING NO. 2
Location: Northwest of the intersection of East Woodmen Road and Marksheffel Road

SITE INFORMATION (USER-INPUT)

Sub-basin Identifier	**A**													
Receiving Pervious Area Soil Type	Sandy Loam													
Total Area (ac., Sum of DCIA, UIA, RPA, & SPA)	19.900													
Directly Connected Impervious Area (DCIA, acres)	11.020													
Unconnected Impervious Area (UIA, acres)	0.000													
Receiving Pervious Area (RPA, acres)	0.000													
Separate Pervious Area (SPA, acres)	8.880													
RPA Treatment Type: Conveyance (C), Volume (V), or Permeable Pavement (PP)	C													

CALCULATED RESULTS (OUTPUT)

Total Calculated Area (ac, check against input)	19.900													
Directly Connected Impervious Area (DCIA, %)	55.4%													
Unconnected Impervious Area (UIA, %)	0.0%													
Receiving Pervious Area (RPA, %)	0.0%													
Separate Pervious Area (SPA, %)	44.6%													
A_R (RPA / UIA)	0.000													
I_a Check	1.000													
f / I for WQCV Event:	1.7													
f / I for 5-Year Event:	0.5													
f / I for 100-Year Event:	0.3													
f / I for Optional User Defined Storm CUHP:	0.31													
IRF for WQCV Event:	1.00													
IRF for 5-Year Event:	1.00													
IRF for 100-Year Event:	1.00													
IRF for Optional User Defined Storm CUHP:	1.00													
Total Site Imperviousness: I_{total}	55.4%													
Effective Imperviousness for WQCV Event:	55.4%													
Effective Imperviousness for 5-Year Event:	55.4%													
Effective Imperviousness for 100-Year Event:	55.4%													
Effective Imperviousness for Optional User Defined Storm CUHP:	55.4%													

LID / EFFECTIVE IMPERVIOUSNESS CREDITS

WQCV Event CREDIT: Reduce Detention By:	0.0%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
This line only for 10-Year Event	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
100-Year Event CREDIT**: Reduce Detention By:	0.0%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
User Defined CUHP CREDIT: Reduce Detention By:	0.0%													

Total Site Imperviousness:	**55.4%**
Total Site Effective Imperviousness for WQCV Event:	**55.4%**
Total Site Effective Imperviousness for 5-Year Event:	**55.4%**
Total Site Effective Imperviousness for 100-Year Event:	**55.4%**
Total Site Effective Imperviousness for Optional User Defined Storm CUHP:	**55.4%**

Notes:

* Use Green-Ampt average infiltration rate values from Table 3-3.

** Flood control detention volume credits based on empirical equations from Storage Chapter of USDCM.

*** Method assumes that 1-hour rainfall depth is equivalent to 1-hour intensity for calculation purposed

APPENDIX D

Referenced Report Excerpts

2020 DRAINAGE, BRIDGE AND POND FEES
CITY OF COLORADO SPRINGS

Basin Name	DBPS Year	Drainage Fee/Acre	Bridge Fee/Acre	Pond Land Fee/Acre	Pond Facility Fee/Acre	Surcharge/ Acre
19th Street	1964	$4,191				
21st Street	1977	$6,397				
Bear Creek	1980	$4,117	$388			
Big Johnson, Crews	1991	$15,929	$1,309	$241		
Black Squirrel Creek	1989	$14,593	$1,667	$789		
Camp Creek	1964	$2,360				
Cottonwood Creek[1] ,[2]	2019	$14,356	$1,175			$752
Douglas Creek	1981	$13,327	$296			
Dry Creek[3]	1966	$0.00				
Elkhorn Basin[4]	n/a	$0.00				
Fishers Canyon[5]	1991	$0.00				
Fountain Creek[6]	n/a	VAR				
Jimmy Camp Creek	2015	$8,294			$2,703	
Kettle Creek[7] Old Ranch Trib.	2001	$0.00				
Little Johnson	1988	$13,902		$1,227		
Mesa	1986	$11,127				
Middle Tributary	1987	$7,275		$1,121		
Miscellaneous[8]	n/a	$12,381				
Monument Branch[12]	1987	$0.00				
North Rockrimmon	1973	$6,398				
Park Vista (MDDP)	2004	$17,820				
Peterson Field	1984	$13,442	$619			
Pine Creek[9]	1988	$0.00				
Pope's Bluff	1976	$4,260	$729			
Pulpit Rock	1968	$7,055				
Sand Creek[10]	1996	$13,309	$791	$1,070	$3,823	$1,386
Shooks Run[11]	1994	$0.00				
Smith Creek[12]	2002	$0.00				
South Rockrimmon	1976	$5,002				
Southwest Area	1984	$14,220				
Spring Creek	1968	$11,034				
Templeton Gap	1977	$7,227	$80			
Windmill Gulch	1992	$15,178	$282	$3,055		

All Drainage, Bridge and Detention Pond Facilities Fees adjusted by 4.0% over 2019 by City Council Resolution No. 153-19 on December 10, 2019 to be effective on January 1, 2020. Land Fees are based on the Park Land Dedication Fee which is currently $76,602/acre (0% change for inflation in 2019).

---

[1] The 2020 Cottonwood Creek drainage fee consists of a capital improvement fee of $11,287 per acre and land fee of $3,069 per acre for a total of $14,356 per acre. These fees are adjusted annually using different procedures but are combined for collection purposes. **The surcharge fee of $752/ac is due in cash; credits for prior facility construction cannot be used to offset this fee,** which is deposited into a separate City fund known as the "Cottonwood Creek Surcharge" fund.

[2] The Wolf Ranch portion of the Cottonwood Creek Drainage Basin was approved as a "no fee" basin **as to Drainage Fees only** by City Council on August 28, 2018 by Resolution No. 96-18

[3] Dry Creek is a closed basin per City Council Resolution No.118-08 on June 24, 2008

[4] Elkhorn Basin is a closed basin per the Annexation Agreements for the area.

[5] Fishers Canyon is a closed basin per City Council Resolution No. 74-08 on April 22, 2008.

[6]Pursuant to the recommendation of the Subdivision Storm Drainage Board adopted at its meeting of September 15, 1977, there are exempted and excluded from the provisions of this part construction of the main Fountain Creek Channel from the confluence of Fountain Creek with Monument Creek northwest to the City limits. Land developments taking place adjacent to Fountain Creek shall remain responsible for dedicating rights of way necessary for the channelization of Fountain Creek, and the developers shall continue to pay to the City as a condition of subdivision plat approval the applicable drainage fees. Drainage fees are required in accordance with the appropriate basin study.

[7] Kettle Creek Old Ranch Tributary is a closed basin per City Council Resolution 139-02 on August 27, 2002.

[8] Miscellaneous fee is assessed on unstudied areas and the Roswell and Westside Basins.

[9] Pine Creek is a closed basin per City Council Resolution No.236-88 on December 13, 1988.

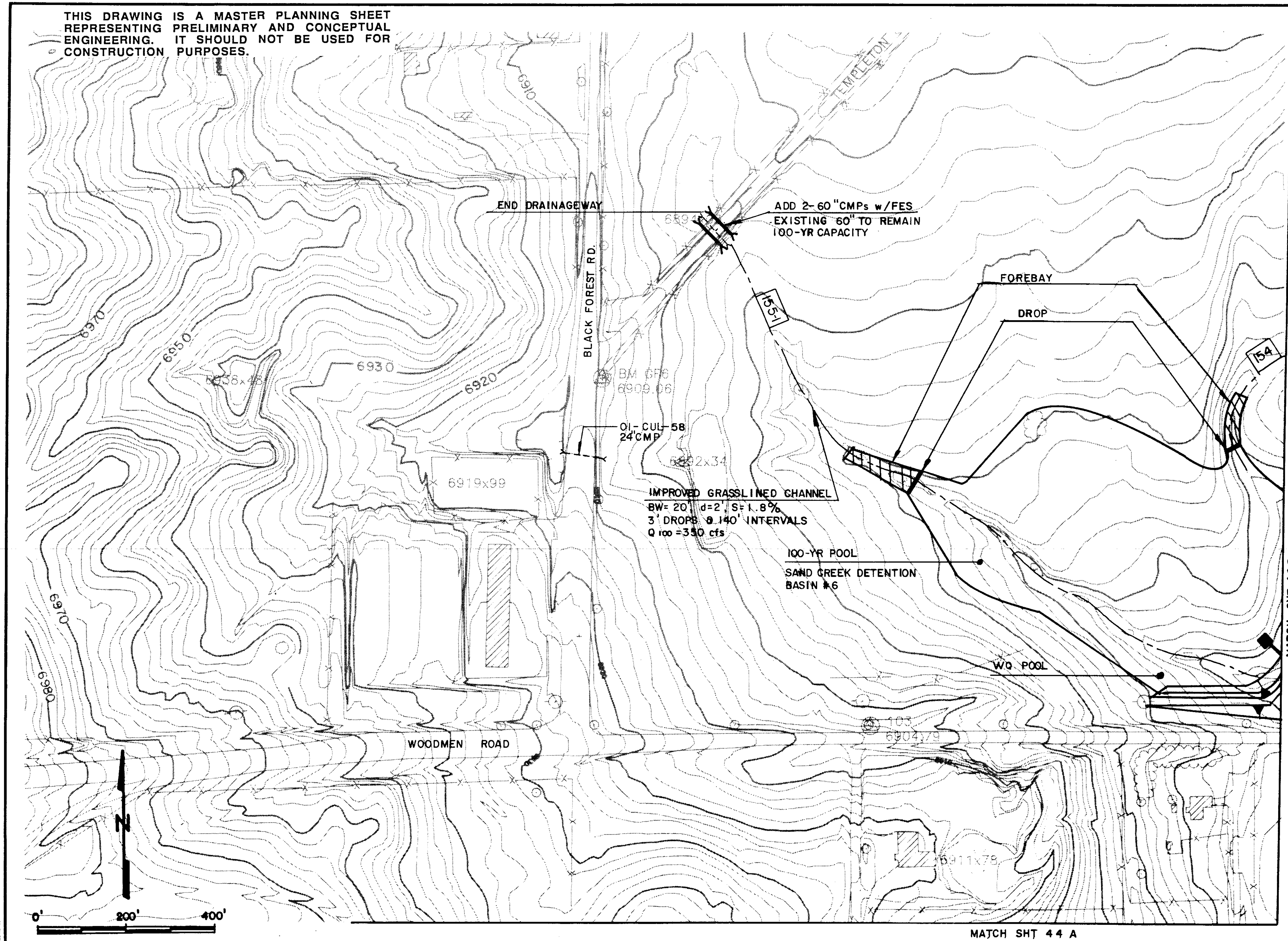
[10]Sand Creek Detention Pond #2 Surcharge (Ridgeview and Indigo Ranch) = $1,386/ac. for 2020. Sand Creek Pond fees include two components, one for facility construction costs ($3,823) and one for land dedication costs ($1,070), the total Pond fee within Sand Creek is $4,893/ac.

[11] Shooks Run is a closed basin pursuant to the recommendation of the Drainage Board, adopted at its meeting on October 15, 1963.

[12] Smith Creek is a closed basin per City Council Resolution 140-02 on August 27, 2002

[12] Monument Branch Basin is a closed basin per City Council Res. 177-10 on October 12, 2010

THIS DRAWING IS A MASTER PLANNING SHEET REPRESENTING PRELIMINARY AND CONCEPTUAL ENGINEERING. IT SHOULD NOT BE USED FOR CONSTRUCTION PURPOSES.

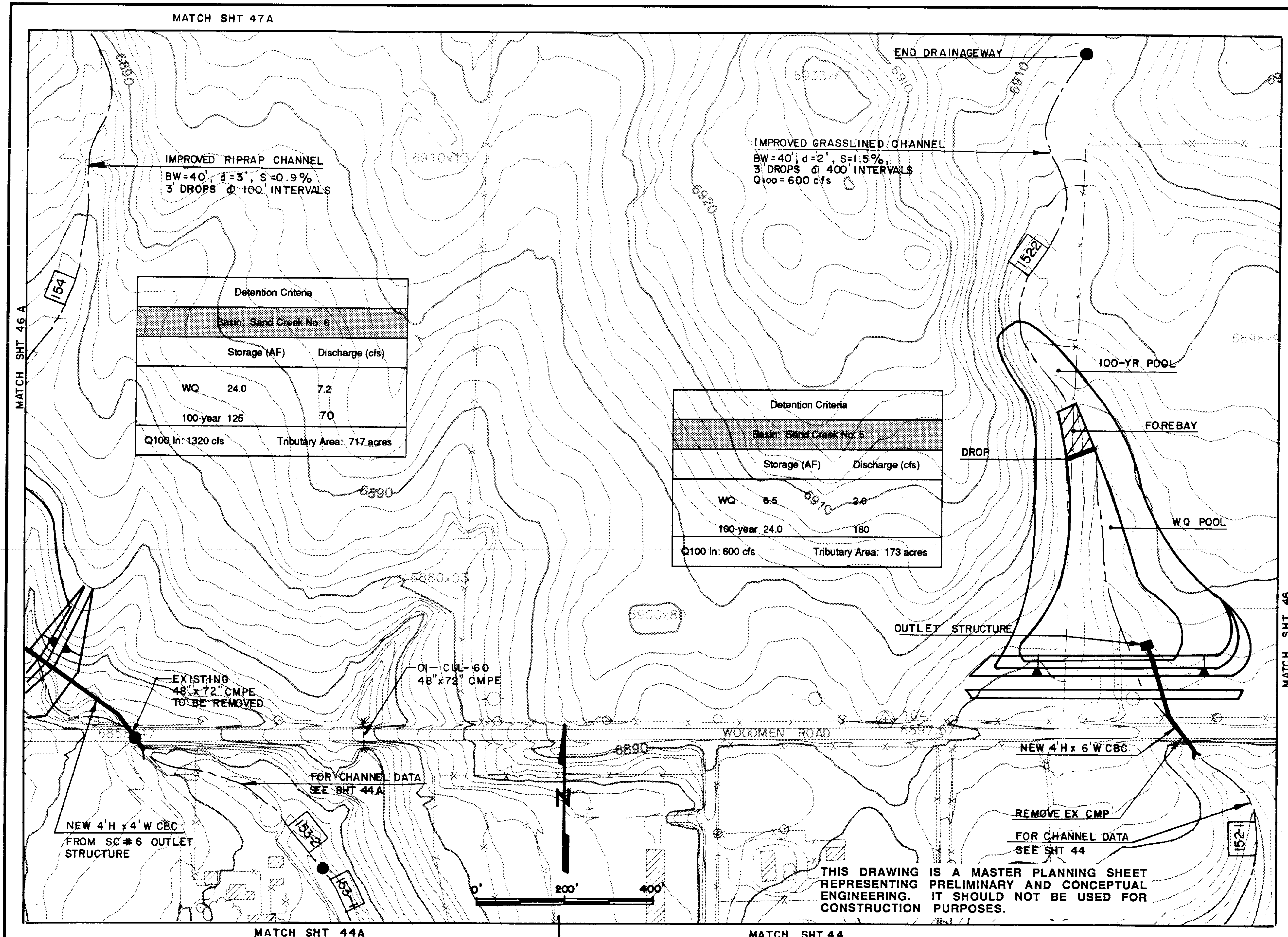


Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

SAND CREEK DRAINAGE BASIN PLANNING STUDY
PRELIMINARY DESIGN PLANS

Project No	90-04-09
Date:	12/92
Design:	RNW
Drawn:	EAK
Check:	RNW
Revisions:	

46A



Detention Criteria		
Basin: Sand Creek No. 6		
	Storage (AF)	Discharge (cfs)
WQ	24.0	7.2
100-year	125	70
Q100 In: 1320 cfs	Tributary Area: 717 acres	

Detention Criteria		
Basin: Sand Creek No. 5		
	Storage (AF)	Discharge (cfs)
WQ	6.5	2.0
100-year	24.0	180
Q100 In: 600 cfs	Tributary Area: 173 acres	

THIS DRAWING IS A MASTER PLANNING SHEET REPRESENTING PRELIMINARY AND CONCEPTUAL ENGINEERING. IT SHOULD NOT BE USED FOR CONSTRUCTION PURPOSES.

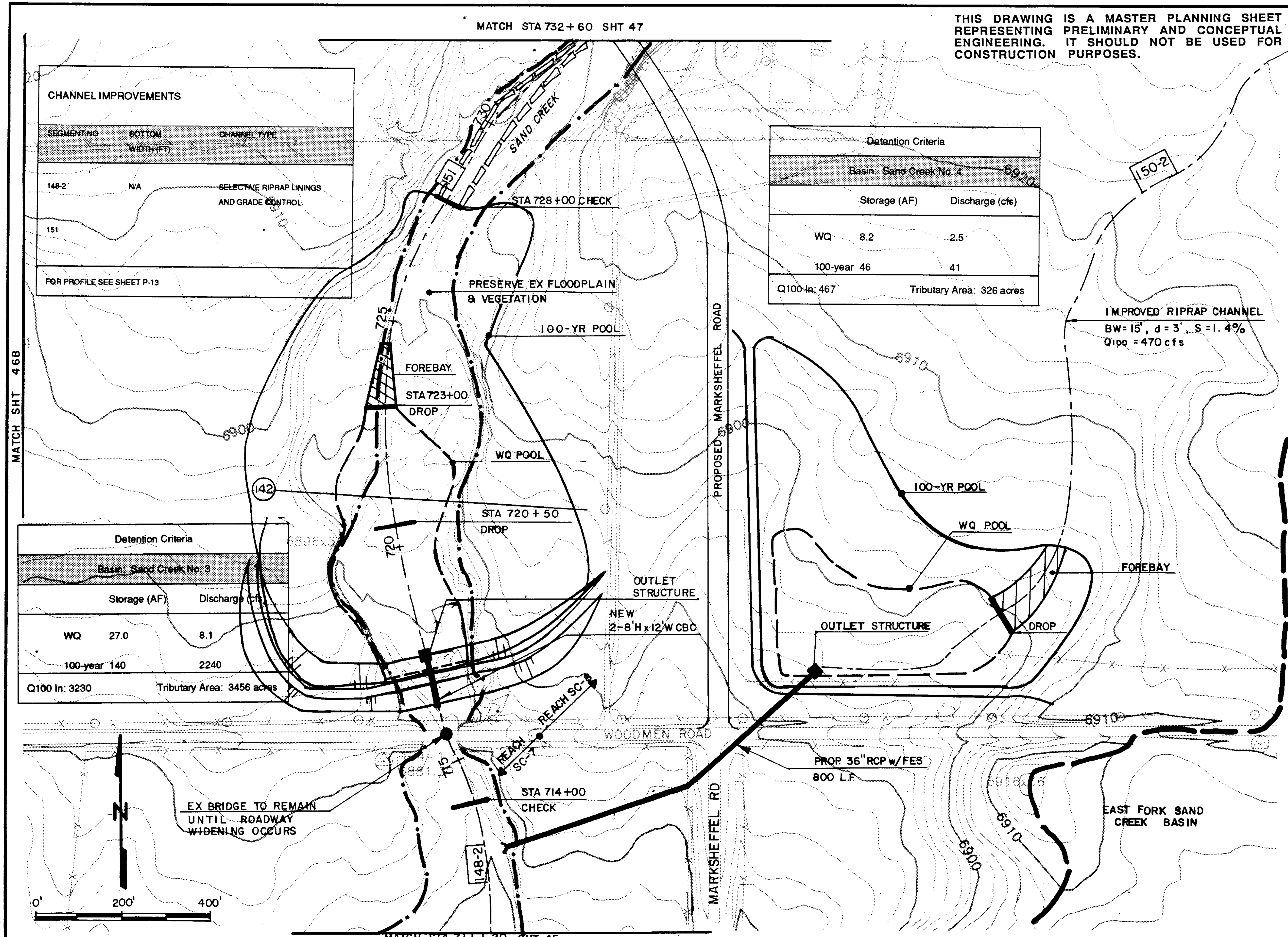
Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

SAND CREEK DRAINAGE BASIN PLANNING STUDY

PRELIMINARY DESIGN PLANS

Project No	90-04-09
Date:	12/92
Design:	RNW
Drawn:	EAK
Check.	RNW
Revisions:	

THIS DRAWING IS A MASTER PLANNING SHEET REPRESENTING PRELIMINARY AND CONCEPTUAL ENGINEERING. IT SHOULD NOT BE USED FOR CONSTRUCTION PURPOSES.



CHANNEL IMPROVEMENTS

SEGMENT NO	BOTTOM WIDTH (FT)	CHANNEL TYPE
148-2	N/A	SELECTIVE RIPRAP LININGS AND GRADE CONTROL
151		

FOR PROFILE SEE SHEET P-13

Detention Criteria

Basin: Sand Creek No. 4

	Storage (AF)	Discharge (cfs)
WQ	8.2	2.5
100-year	46	41

Q100 In: 467 Tributary Area: 326 acres

Detention Criteria

Basin: Sand Creek No. 3

	Storage (AF)	Discharge (cfs)
WQ	27.0	8.1
100-year	140	2240

Q100 In: 3230 Tributary Area: 3456 acres

Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

SAND CREEK DRAINAGE BASIN PLANNING STUDY

PRELIMINARY DESIGN PLANS

Project No	90-04-09
Date:	9-92
Design:	RNW
Drawn:	EAK
Check:	RNW
Revisions:	

GRADING, EROSION CONTROL & STORMWATER QUALITY PLAN

LEGEND

	EX MAJ CONT
	EX MIN CONT
	PROP MAJ CONT
	PROP MIN CONT
LP	LOW POINT
HP	HIGH POINT
EX	EXISTING
FL	FLOWLINE
TBC/TC	TOP OF CURB
FG	FINISH GRADE
(SF)	SILT FENCE
(SB)	SEDIMENT BASIN
(VTC)	VEHICLE TRACKING CONTROL
(IP)	INLET PROTECTION
	PROP. DRAINAGE SWALE

NARRATIVE NOTES:

1. LOCATION OF STOCKPILES SHALL BE DETERMINED BY THE CONTRACTOR.

2. LOCATION OF STORAGE EQUIPMENT AND TEMPORARY DISPOSAL AREAS SHALL BE DETERMINED BY THE CONTRACTOR.

3. FINAL STABILIZATION SHALL BE UPON THE COMPLETION OF ALL CONSTRUCTION ACTIVITIES. ALL AREAS DISTURBED WITH THE CONSTRUCTION BOUNDARY SHALL BE RESEEDED WITH NATIVE SEEDING.

4. SOIL TYPE WITHIN THE PROJECT SITE HAS BEEN INDICATED AS BLAKELAND FLUVAQUENTIC HAPLAQUOLLS (SOIL NO. 9). THIS SOIL SERIES HAS BEEN IS A HYDROLOGIC GROUP "A".

5. A MAJORITY OF THE SITE CONSISTS OF "FILL" TO RAISE SITE TO PROPOSED GRADE.

TIMING

ANTICIPATED STARTING AND COMPLETION TIME PERIOD FOR SITE GRADING:

APRIL 2012 – AUGUST 2012

EXPECTED DATE UPON WHICH FINAL STABILIZATION WILL BE COMPLETED

OCTOBER 2012

AREAS

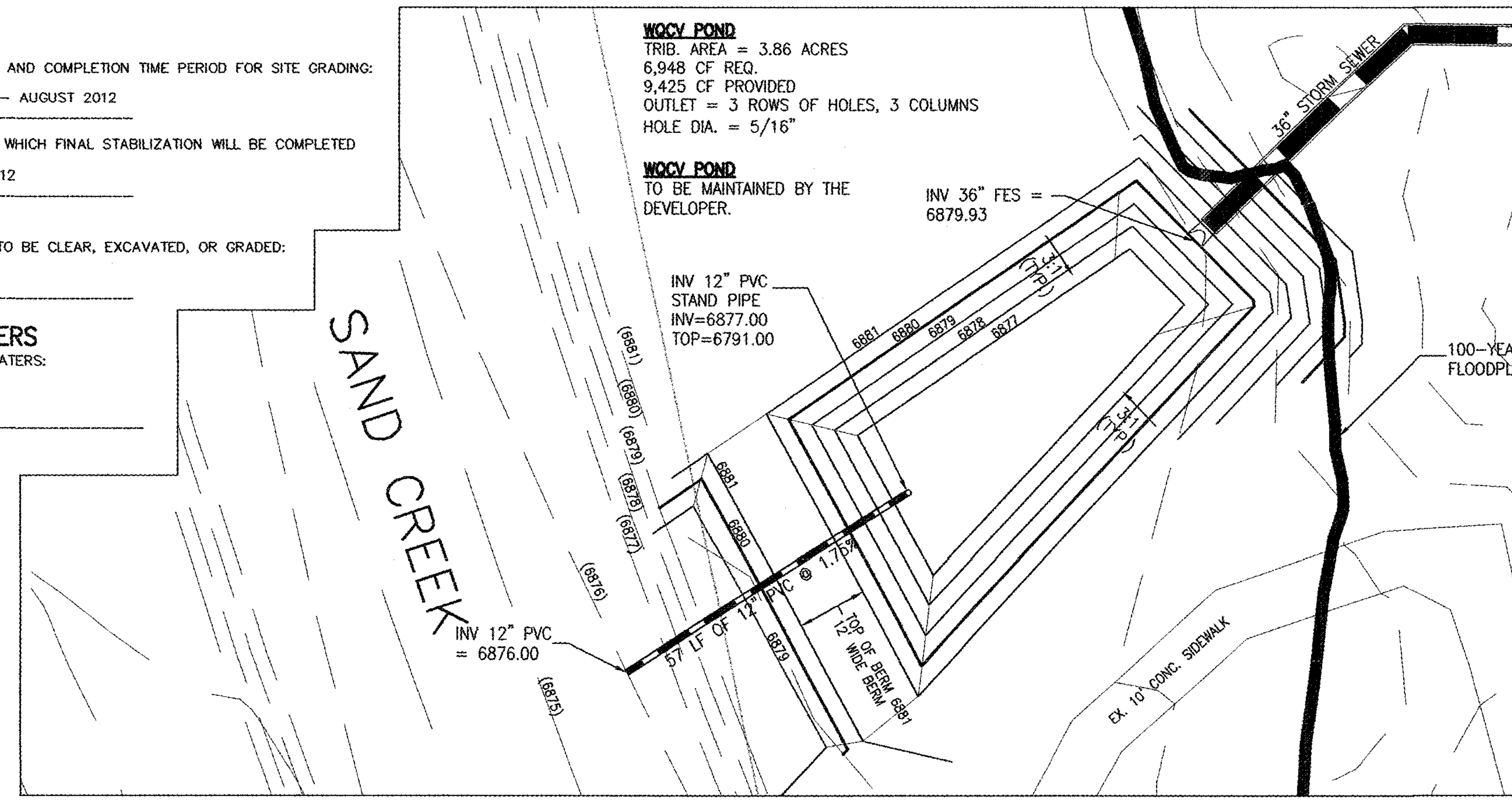
TOTAL AREA OF SITE TO BE CLEAR, EXCAVATED, OR GRADED:

7.93 AC

RECEIVING WATERS

NAME OF RECEIVING WATERS:

SAND CREEK



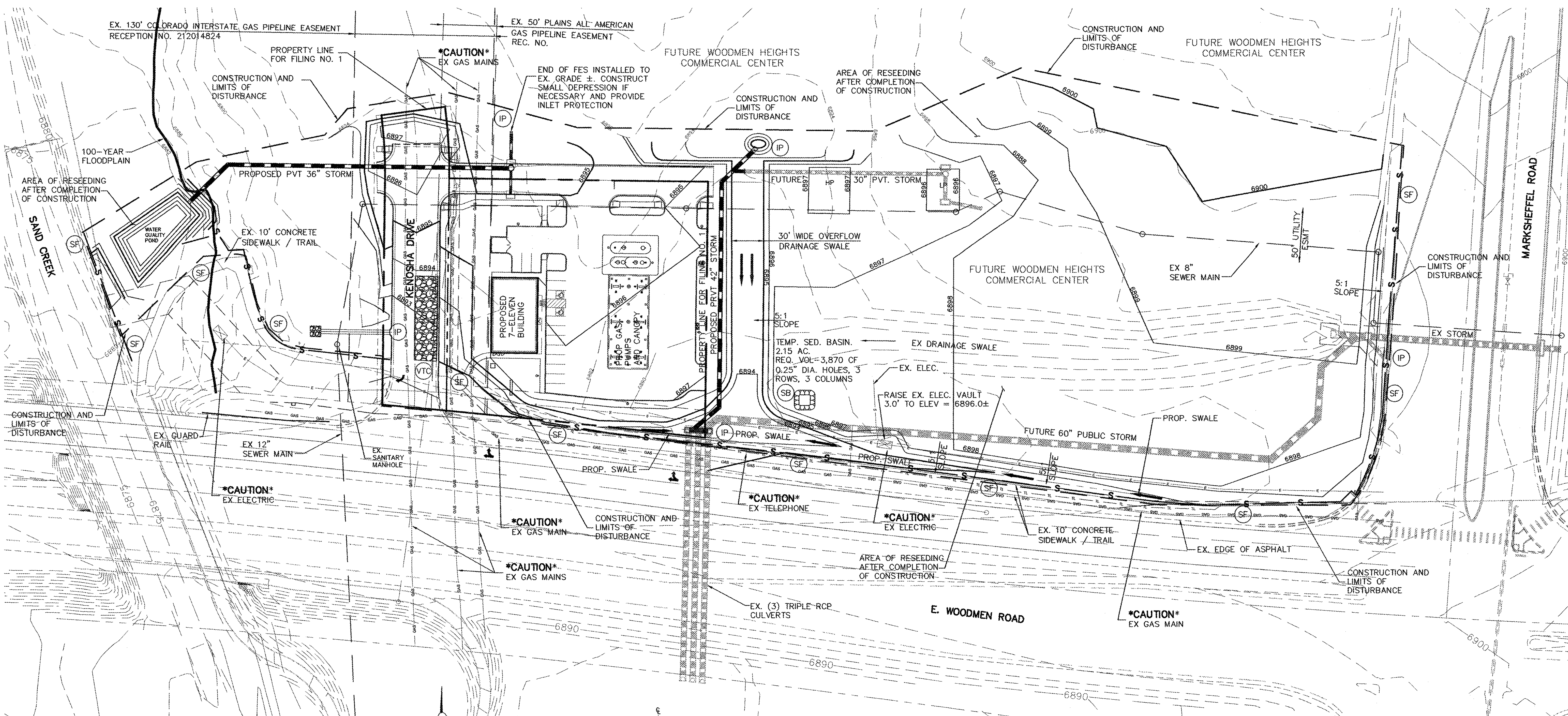
1" = 20'

0 5 10 20 40

Scale in Feet

EROSION CONTROL AND STORMWATER QUALITY COST ESTIMATE:

1605	LF SILT FENCE @ $2.50/LF=	$4013.00
6	EA INLET PROTECTION DEVICES @ $110/EA=	$660.00
1	EA VTC'S @ $1325/EA=	$1325.00
1	SEDIMENT BASIN	$3000.00
6.45	AC RESEEDING @ $525.00/AC=	$3387.00
SUBTOTAL:		$12,385.00
MAINTENANCE 40%		$4,954.00
TOTAL:		**$17,339.00**



FOR LOCATING & MARKING GAS, ELECTRIC, WATER & TELEPHONE LINES

FOR BURIED UTILITY INFORMATION

48 HRS BEFORE YOU DIG

CALL 1-800-922-1987

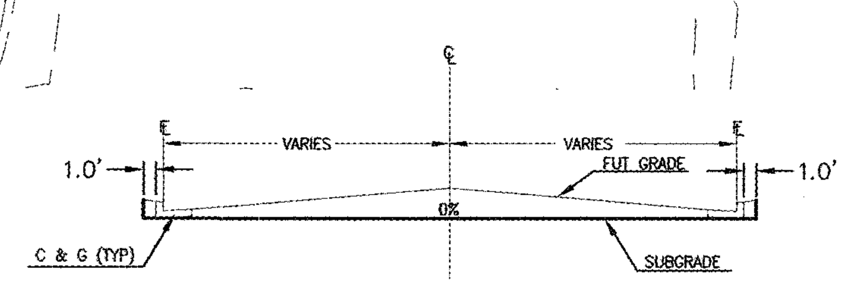
BENCHMARK:

A NO. 4 REBAR LOCATED APPROXIMATELY 1000 FT NORTH OF FOREST MEADOWS AVENUE, AND 200 FT EAST OF LOGWOOD ROAD. MARKED WITH LATH AS PT. NO. 43. N406651.166 E231909.019 ELEVATION=6923.27'

1" = 50'

0 25 50 100

Scale in Feet



STREET ROUGH CUT SECTION:

NOT TO SCALE

CITY OF COLORADO SPRINGS GRADING AND EROSION CONTROL REVIEW

THIS GRADING PLAN IS FILED IN ACCORDANCE WITH SECTION 7.7.1503 (ENACTED AS ORD. 82–56) OF THE CODE OF THE CITY OF COLORADO SPRINGS, 2001, AS AMENDED. EROSION CONTROL IS REVIEWED IN ACCORDANCE WITH THE DRAINAGE CRITERIA MANUAL, VOL. I (OCTOBER 1994) AND VOL. II (AUG. 2002); LATEST REVISIONS

FOR THE CITY ENGINEER — DATE: 4-24-12

WOODMEN HEIGHTS COMMERCIAL CENTER FILING NO. 1

GRADING, EROSION CONTROL, STORMWATER & QUALITY PLAN

PROJECT NO. 42-003 | FILE: G://PROJ/7 ELEVEN/DWG/CONST DWG | DATE: 04/16/12

DESIGNED BY: VAS | DRAWN BY: VAS | CHECKED BY: VAS

SCALE HORIZ: 1"=50' VERT: N/A

SHEET 2 OF 7

102 E. PIKES PEAK AVE, STE. 306 COLORADO SPRINGS, COLORADO 80903

v 719.955.5485 f 719.444.8427

CIVIL CONSULTANTS, INC.

VIRGIL A. SANCHEZ, COLORADO P.E. NO. 37160

FOR AND ON BEHALF OF M&S CIVIL CONSULTANTS, INC.

4-20-12

REVISIONS: NO. | DATE: | BY: | DESCRIPTION: | APPR'D. BY: | DATE:

CAUTION

THE ENGINEER PREPARING THESE PLANS WILL NOT BE RESPONSIBLE, OR LIABLE FOR, UNAUTHORIZED CHANGES TO OR USES OF THESE PLANS. ALL CHANGES TO THE PLANS MUST BE IN WRITING AND MUST BE APPROVED BY THE PREPARER OF THESE PLANS.

APPENDIX E

Hydraulic Program Comparison

Program: UDSEWER Math Model Interface 2.1.1.4 **Run Date:** 5/18/2020 2:42:58 PM	**UDSewer Results Summary** **Project Title:** New UDSEWER System Module **Project Description:** Default system

System Input Summary

Rainfall Parameters

Rainfall Return Period: 5
Rainfall Calculation Method: Formula

One Hour Depth (in):
Rainfall Constant "A": 28.5
Rainfall Constant "B": 10
Rainfall Constant "C": 0.786

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): 6888.55

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 1	6888.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH 1	6900.00	23.88	0.00	6.28	0.45	0.45	100.00	1.00	100.00	2.00

SWR 1 - 1										
MH 2 SWR 2 - 1	6900.00	23.88	0.00	6.28	0.45	0.45	100.00	1.00	100.00	2.00

Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	**Overland Time (min)**	**Gutter Time (min)**	**Basin Tc (min)**	**Intensity (in/hr)**	**Local Contrib (cfs)**	**Coeff. Area**	**Intensity (in/hr)**	**Manhole Tc (min)**	**Peak Flow (cfs)**	**Comment**
OUTFALL 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
MH 1 SWR 1 - 1	11.74	0.83	11.11	NaN	NaN	5.65	4.23	NaN	23.88	Surface Water Present (Downstream) Used UDFCD Tc Maximum
MH 2 SWR 2 - 1	11.74	0.83	11.11	NaN	NaN	2.83	8.45	NaN	23.88	Used UDFCD Tc Maximum

Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	**Sewer Length (ft)**	**Downstream Invert (ft)**	**Slope (%)**	**Upstream Invert (ft)**	**Mannings n**	**Bend Loss**	**Lateral Loss**	**Cross Section**	**Rise (ft or in)**	**Span (ft or in)**
MH 1 SWR 1 - 1	38.33	6888.55	0.5	6888.74	0.013	0.03	1.00	CIRCULAR	36.00 in	36.00 in
MH 2 SWR 2 - 1	30.19	6888.73	0.5	6888.88	0.013	0.05	1.00	CIRCULAR	36.00 in	36.00 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 1 SWR 1 - 1	47.29	6.69	18.89	6.35	18.11	6.71	1.08	Supercritical	23.88	0.00	
MH 2 SWR 2 - 1	47.29	6.69	18.89	6.35	18.11	6.71	1.08	Supercritical	23.88	0.00	

- A Froude number of 0 indicates that pressured 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 1 SWR 1 - 1	23.88	CIRCULAR	36.00 in	36.00 in	30.00 in	30.00 in	36.00 in	36.00 in	7.07	
MH 2 SWR 2 - 1	23.88	CIRCULAR	36.00 in	36.00 in	30.00 in	30.00 in	36.00 in	36.00 in	7.07	

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

Grade Line Summary:

Tailwater Elevation (ft): 6888.55

	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 1 SWR 1 - 1	6888.55	6888.74	0.00	0.00	6890.06	6890.31	6890.76	0.19	6890.94
MH 2 SWR 2 - 1	6888.73	6888.88	0.01	0.00	6890.44	6890.45	6890.95	0.13	6891.08

- 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

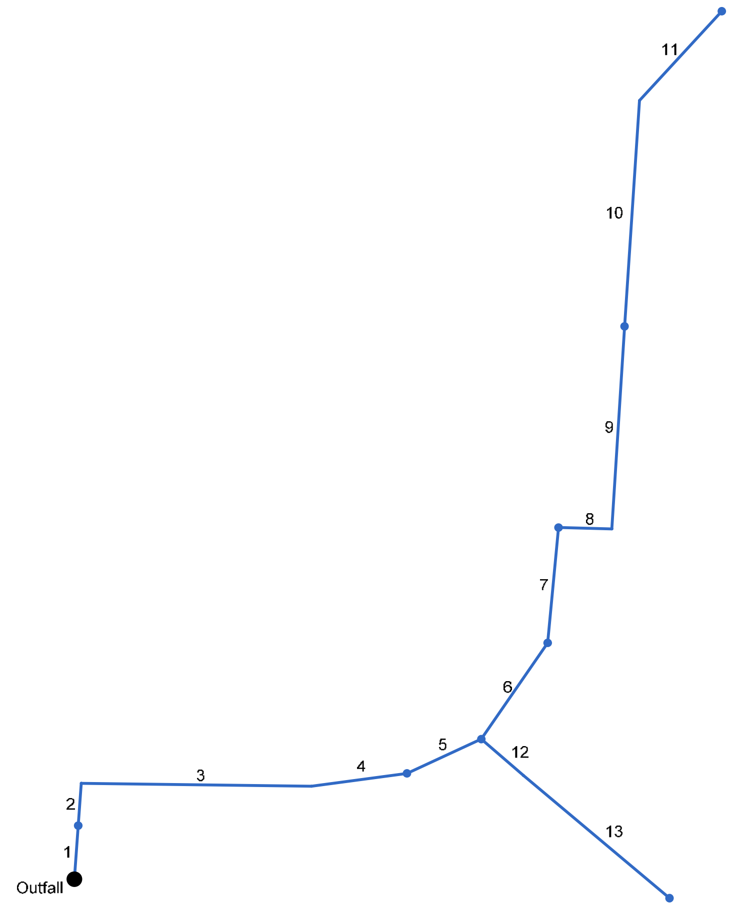
					Downstream			Upstream				
Element Name	Length (ft)	Wall (in)	Bedding (in)	Bottom Width (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Volume (cu. yd)	Comment
MH 1 SWR 1 - 1	38.33	4.00	6.00	6.67	0.00	0.83	0.00	20.52	12.09	7.93	95.23	Sewer Too Shallow
MH 2 SWR 2 - 1	30.19	4.00	6.00	6.67	20.54	12.10	7.94	20.24	11.95	7.79	142.33	

Total earth volume for sewer trenches = 238 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.

5 Year Event



Project File: 5 Year.stm	Number of lines: 13	Date: 5/18/2020

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf		Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf	Ave Sf	Enrgy loss		
	(in)	(cfs)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(ft)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(%)	(ft)	(K)	(ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1	36	23.88	6888.56	6891.05	2.49	3.75	3.81	0.63	6891.68	0.000	38.331	6888.74	6890.31	1.57**	3.75	6.36	0.63	6890.94	0.000	0.000	n/a	0.15	n/a
2	36	23.88	6888.73	6890.31	1.58	3.75	6.31	0.63	6890.94	0.000	30.190	6888.88	6890.45	1.57**	3.75	6.36	0.63	6891.08	0.000	0.000	n/a	1.50	n/a
3	36	23.14	6889.37	6890.85	1.48*	3.48	6.65	0.62	6891.47	0.000	163.347	6890.19	6891.74	1.55**	3.68	6.29	0.62	6892.35	0.000	0.000	n/a	0.50	n/a
4	36	19.65	6890.29	6891.74	1.45	3.30	5.82	0.55	6892.29	0.000	68.418	6890.63	6892.05	1.42**	3.30	5.96	0.55	6892.60	0.000	0.000	n/a	0.34	0.19
5	36	16.57	6891.00	6892.23	1.23*	2.73	6.08	0.50	6892.73	0.000	58.167	6891.29	6892.59	1.30**	2.94	5.64	0.50	6893.09	0.000	0.000	n/a	0.93	n/a
6	30	6.86	6892.17	6892.87	0.70*	1.12	6.14	0.32	6893.19	0.000	83.183	6892.98	6893.85	0.87**	1.51	4.53	0.32	6894.17	0.000	0.000	n/a	0.54	n/a
7	30	6.86	6893.60	6894.28	0.68*	1.07	6.39	0.32	6894.60	0.000	82.595	6894.50	6895.37	0.87**	1.51	4.53	0.32	6895.69	0.000	0.000	n/a	1.00	n/a
8	24	6.86	6894.85	6895.49	0.64*	0.87	7.91	0.36	6895.85	0.000	37.885	6895.56	6896.49	0.93**	1.43	4.81	0.36	6896.85	0.000	0.000	n/a	1.50	n/a
9	18	5.27	6895.86	6896.49	0.63	0.70	7.51	0.37	6896.86	0.000	144.663	6899.25	6900.13	0.88**	1.08	4.87	0.37	6900.50	0.000	0.000	n/a	0.15	0.06
10	15	3.03	6899.64	6900.13	0.49	0.45	6.72	0.29	6900.42	0.000	161.371	6903.82	6904.52	0.70**	0.71	4.29	0.29	6904.81	0.000	0.000	n/a	1.01	0.29
11	15	3.03	6904.16	6904.63	0.47*	0.42	7.27	0.29	6904.91	0.000	86.352	6906.34	6907.04	0.70**	0.71	4.29	0.29	6907.33	0.000	0.000	n/a	1.00	0.29
12	24	7.06	6891.50	6892.59	1.09	1.46	4.03	0.37	6892.96	0.000	39.510	6891.70	6892.64	0.94**	1.46	4.85	0.37	6893.01	0.000	0.000	n/a	0.50	0.18
13	24	7.06	6891.85	6892.78	0.93*	1.43	4.93	0.37	6893.15	0.000	135.713	6892.53	6893.47	0.94**	1.46	4.85	0.37	6893.84	0.000	0.000	n/a	0.65	0.24

5 Year Event	Number of lines: 13	Run Date: 5/18/2020

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

APPENDIX F

Variance Requests

HRGreen®

▷5619 DTC Parkway | Suite 1150 | Greenwood Village, CO 80111
Main 720.602.4999 + Fax 844.273.1057

▷HRGREEN.COM

July 14, 2020

Anna Bergmark

Stormwater Enterprise City of Colorado Springs

City Administration Building 30 S. Nevada Ave., Suite 401 Colorado Springs, CO 80903

Re: Woodmen Heights Commercial Center Filing No. 2

Dear Ms Bergmark,

On behalf of the Developer (All Pro Capital) we are requesting a variance for the above referenced project. This variance will not result in a change to the peak flows or a decrease in water quality in either Sand Creek or Fountain Creek.

Code Section:

DCM Volume 1 Chapter 9 Section 6.2 *"Inlets may not be used as junctions along trunk lines."*

DCM Volume 1 Chapter 9 Section 2.2 *"The ability of the storm sewer to convey the major storm event shall be based on its capacity when the hydraulic grade line elevation is at least 1 foot below the final grade elevation, measured from the lowest gutter flowline elevation at inlets."*

Reason for Variance:

In order to avoid conflict with existing utilities it is necessary to use inlet 10 as a junction. It is constrained by a water main to the south and future fire hydrant junction to the north.

Allowing inlets 4, 10, 11 and 12 to be used as a junction will allow the storm line to remain parallel with the proposed roadway and will eliminate the need for an additional structure and its associated maintenance.

The plans show the 100 year HGL for the Marksheffel Inlet (Inlet #3) at the top of pipe and only 0.7' below finished grade. The inlet will not surcharge during the 100 year event into Marksheffel however 1.0' below final grade was unable to be met. As discussed this inlet is installed and intended to function as an inlet to capture the water quality event only and a small inlet was installed. During the 100-year event the inlet captures approximately 3.5 cfs of 16.6 cfs which is conveyed toward this inlet. The bypass flow will be captured by the downstream inlet already in place directly downstream from this inlet for larger storm events. The site is constrained at this point and the pond outfall for maximum slope and pipe sizes to be used. As such mitigating measures such as putting pipes at minimal slopes and using the maximum available size for elliptical pipes, while still being able to outfall was used to minimize, to the maximum extent practical, the HGL within the storm sewer pipe.

Plan Reference:

See attached plan sheet – WOODMEN HEIGHTS COMMERCIAL CENTER FILING NO. 2 STORM PLAN AND PROFILE – Sheets ST1 & ST3.

Please contact me with any additional questions or concerns.

Sincerely,

COLORADO LICENSED PROFESSIONAL ENGINEER
CHRISTIAN M. MCFARLAND
44947
07-14-20

Chris McFarland, PE

HR GREEN, INC

NORTH

0 1000
500

HR GREEN Xrefs: xgt-1-DH01

DRAWN BY: TBI
APPROVED: CMM
CAD DATE: 5/12/2020
CAD FILE: J:\2019\191850\CAD\Dwgs\C\01-VICINITY MAP

JOB DATE: 5/12/2020
JOB NUMBER: 191850

BAR IS ONE INCH ON OFFICIAL DRAWINGS.
0 1"
IF NOT ONE INCH, ADJUST SCALE ACCORDINGLY.

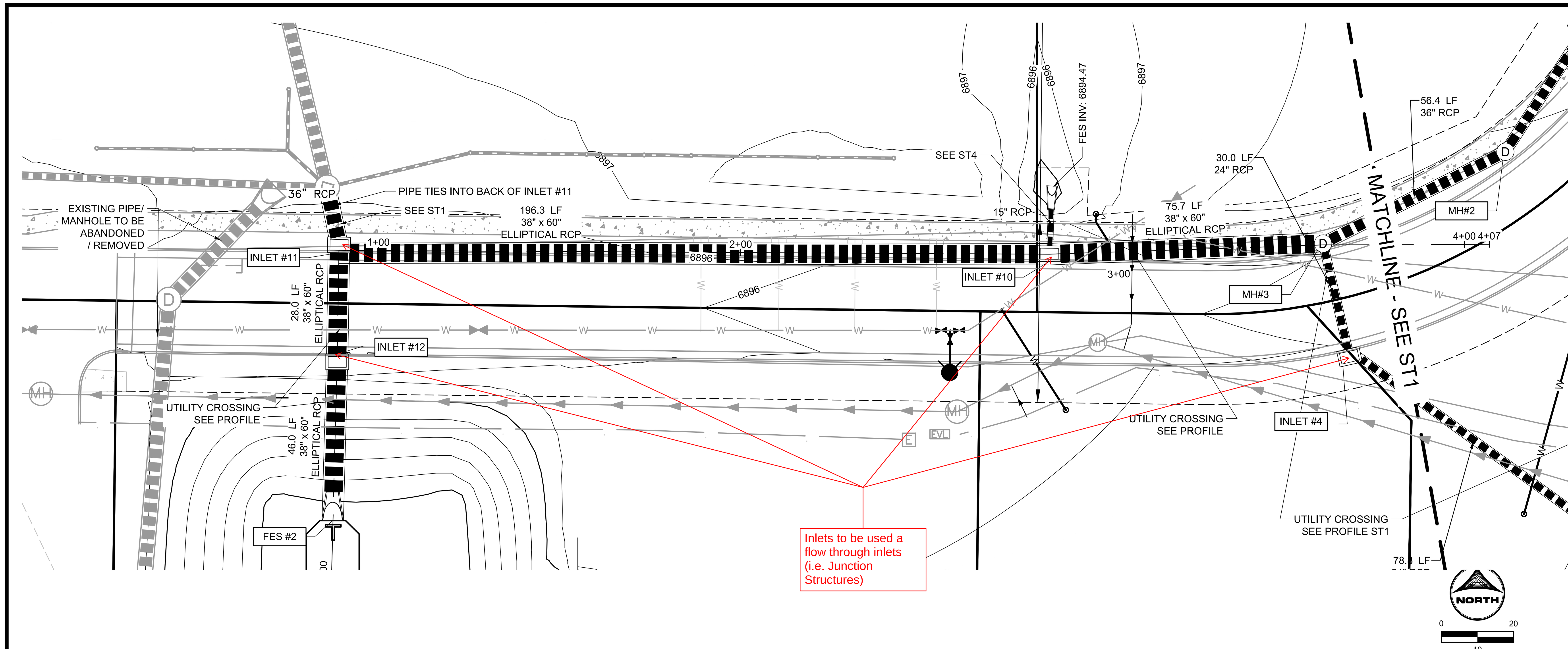
NO.	DATE	BY	REVISION DESCRIPTION

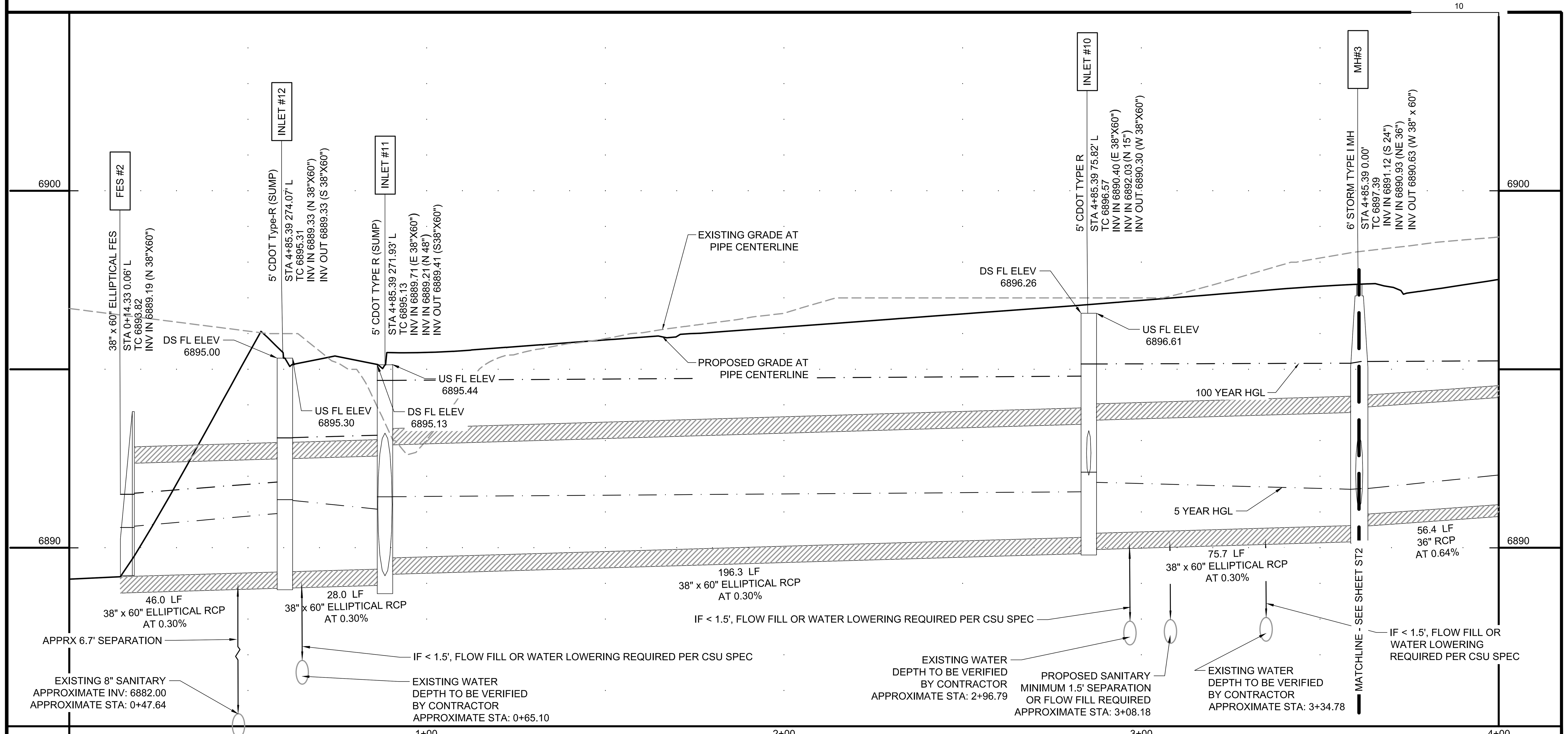
HRGreen.com
HRGreen

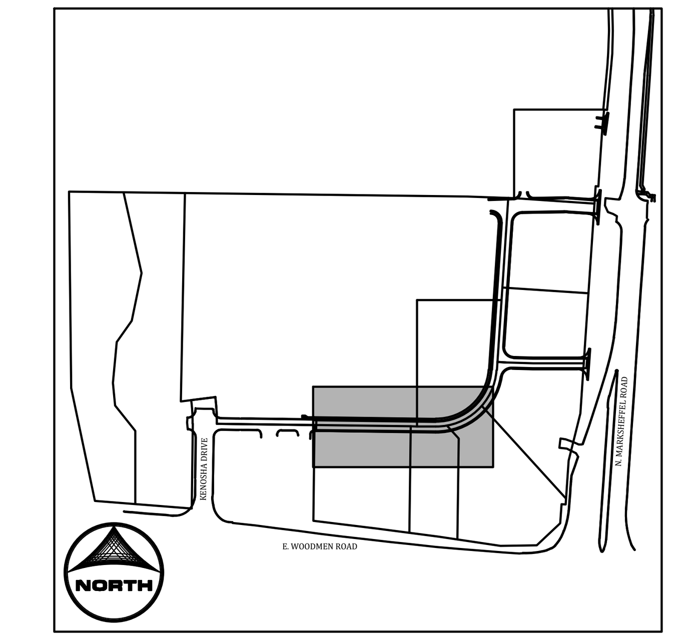
WOODMEN HEIGHTS COMMERCIAL CENTER FILING NO. 2
ALL PRO CAPITAL, INC.
COLORADO SPRINGS, COLORADO

VICINITY MAP

SHEET
VM1
1







KEYMAP

PROJECT LEGEND:

- PROPERTY LINE
- ROAD CENTERLINE
- RIGHT-OF-WAY LINE
- PROPOSED DETENTION BASIN
- POTENTIAL WALL
- STORM SEWER
- STORM INLET TYPE R
- STORM MANHOLE
- STORM END SECTION
- WATERMAIN
- WATER VALVE
- SANITARY SEWER
- SANITARY SERVICE
- SANITARY MANHOLE
- LIGHT POLE
- FIRE HYDRANT
- EX. STORM SEWER
- EX. STORM INLET TYPE R
- EX. STORM MANHOLE
- EX. STORM END SECTION
- EX. WATERMAIN
- EX. WATER VALVE
- EX. SANITARY SEWER
- EX. SANITARY SERVICE
- EX. SANITARY MANHOLE

NOTES:

1) ALL MAINLINE SANITARY SEWER SHOWN SHALL BE 8" PVC PUBLIC SANITARY SEWER WITHIN A PROPOSED ACCESS AND UTILITY EASEMENT.
2) ALL RCP PIPES MUST BE MINIMUM CLASS III.
3) ALL STORM SEWER PLACED MUST BE TRACEABLE, AS PER COS STD. D.37.
4) STORM SEWER IS PRIVATE UNLESS OTHERWISE NOTED.
5) ALL STORM MANHOLES 5' UNLESS OTHERWISE NOTED.
8) ANY PRIVATE OR PUBLIC STORM SEWER CONNECTIONS MUST BE INSPECTED BY ENGINEERING DEVELOPMENT REVIEW INSPECTOR.
9) ALL WATERLINE IS 8" UNLESS OTHERWISE NOTED.
10) INLETS 10, 11 AND 12 TO BE CUSTOM INLETS WITH MODIFIED BASE TO ACCEPT LARGER DIAMETER PIPE.

STREET DESIGN FOR CITY ENGINEERING:

UTILITY GRADE REVIEW:__________
DATE:__________
CURB AND GUTTER REVIEW:__________
DATE:__________
FINAL REVIEW:__________
DATE:__________
DRAINAGE DESIGN:__________
DATE:__________

THIS IS FILED IN ACCORDANCE WITH SECTION 7.7.906 (DRAINAGE ORDINANCE) OF THE CODE OF THE CITY OF COLORADO SPRINGS, 2001 AS AMENDED.

811 UNCC CALL BEFORE YOU DIG 811 OR 1-800-922-1987 Utility Notification Center of Colorado

HR GREEN Xrefs: 01-XV-DSGN; 01-XC-ROW; xgt-1-DH01; 01-xc-dsgn; 01-xv-util; 01-XC-UTIL; 01-xg-keymap-ut; 01-xc-esmt

DRAWN BY:	TBI	JOB DATE:	7/14/2020
APPROVED:	CMM	JOB NUMBER:	191850
CAD DATE:	7/14/2020		
CAD FILE:	J:\2019\191850\CAD\Dwgs\C\01-STORM PLAN AND PROFILE		

BAR IS ONE INCH ON OFFICIAL DRAWINGS. 0 1" IF NOT ONE INCH, ADJUST SCALE ACCORDINGLY.

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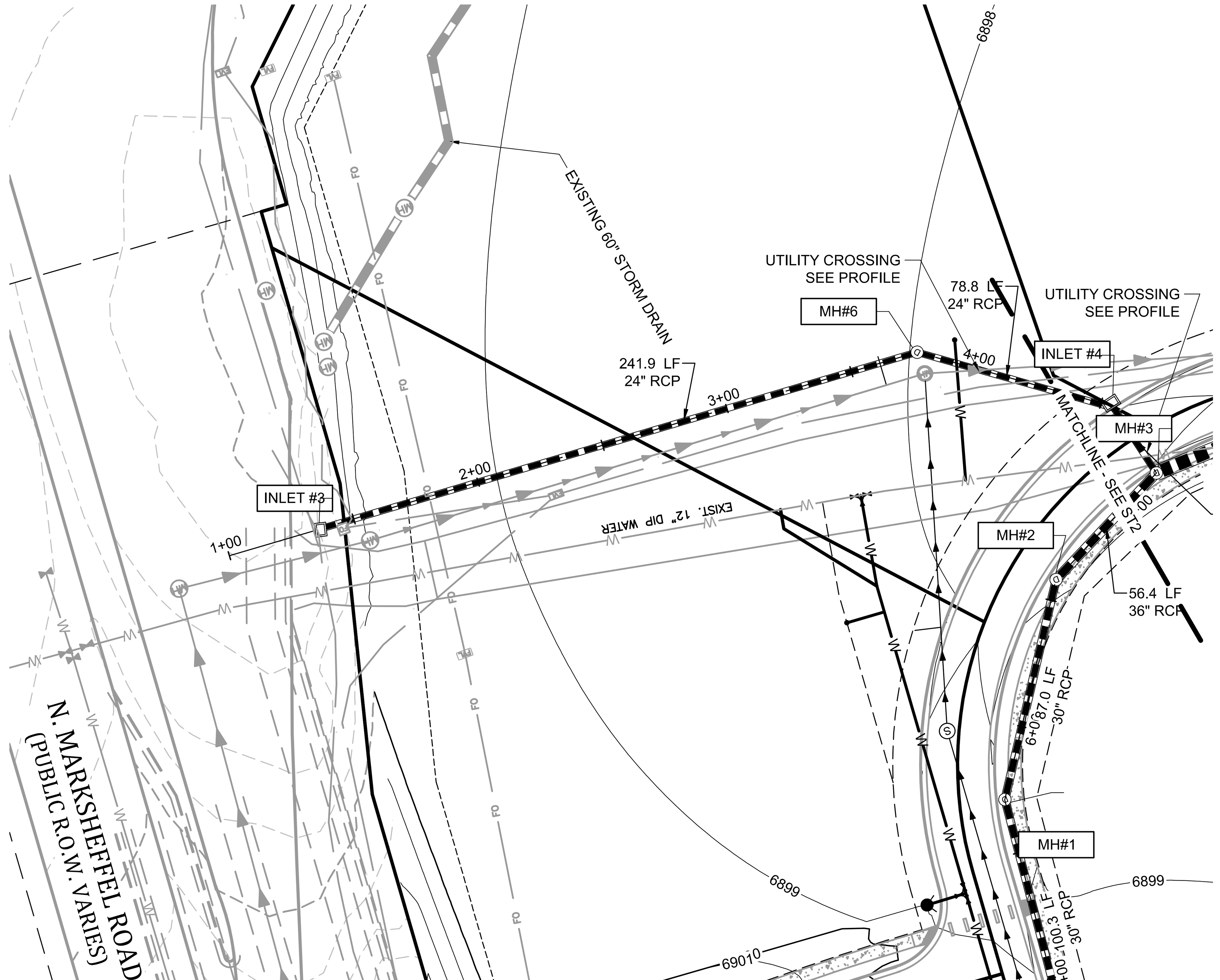
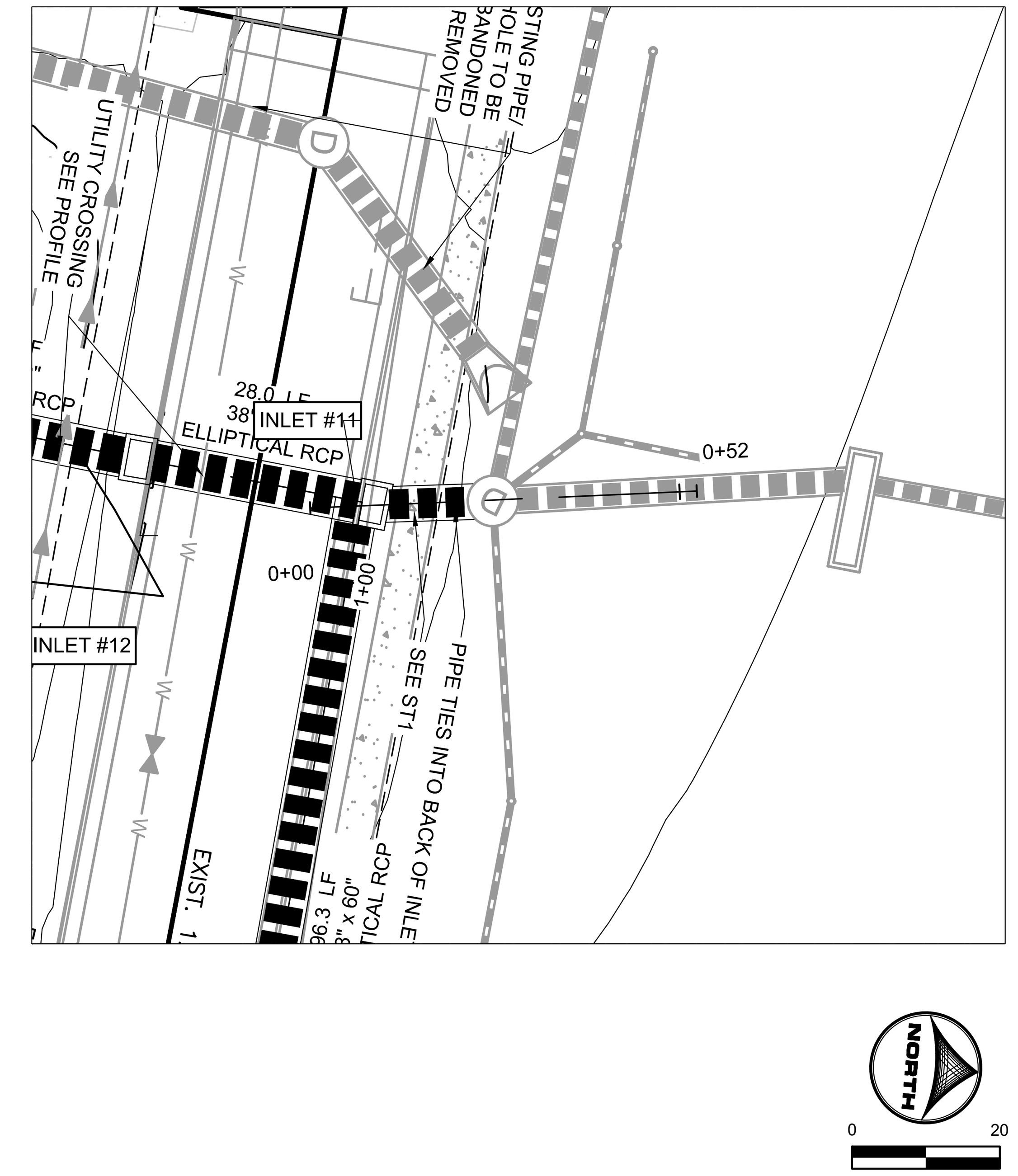
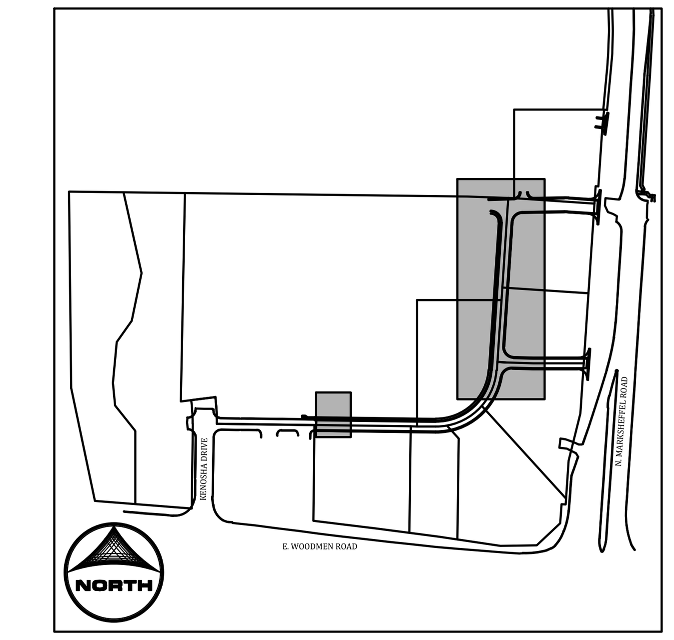
ALL PRO CAPITAL, INC.
COLORADO SPRINGS, COLORADO

CONSTRUCTION DOCUMENTS
STORM PLAN AND PROFILE

SHEET ST3



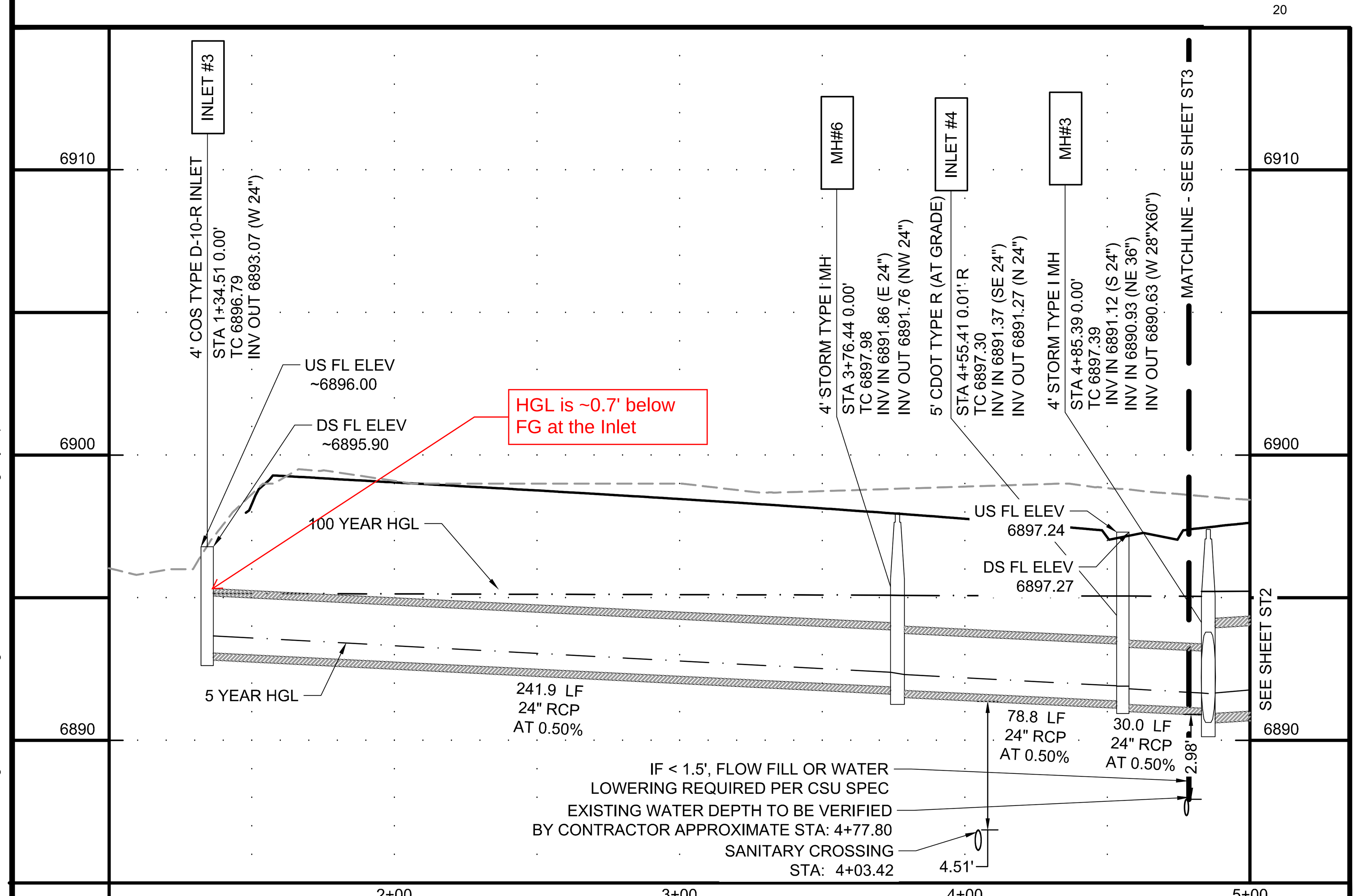


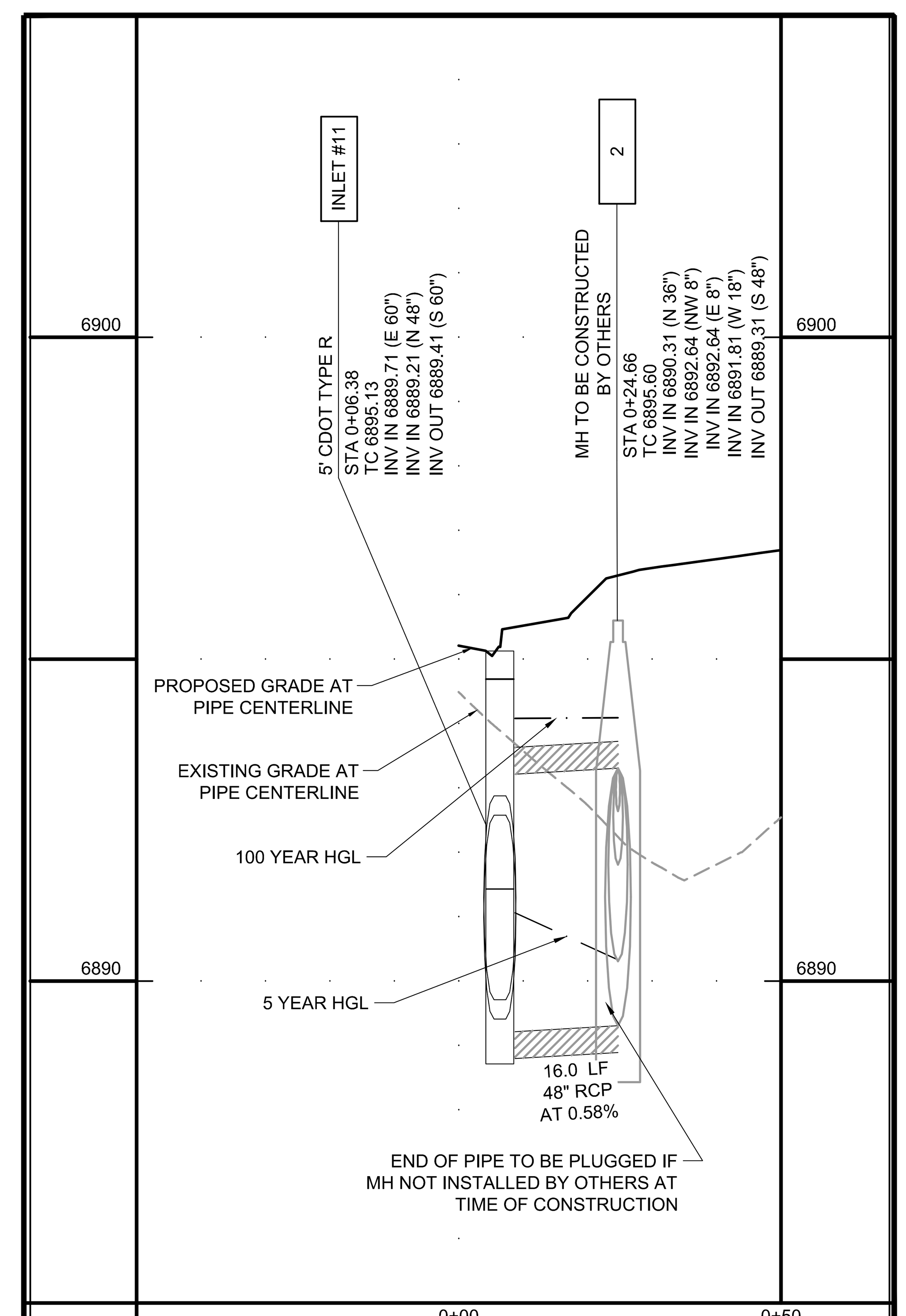


KEYMAP

PROJECT LEGEND:

- PROPERTY LINE
- ROAD CENTERLINE
- RIGHT-OF-WAY LINE
- PROPOSED DETENTION BASIN
- POTENTIAL WALL
- STORM SEWER
- STORM INLET TYPE R
- STORM MANHOLE
- STORM END SECTION
- WATERMAIN
- WATER VALVE
- SANITARY SEWER
- SANITARY SERVICE
- SANITARY MANHOLE
- LIGHT POLE
- FIRE HYDRANT
- EX. STORM SEWER
- EX. STORM INLET TYPE R
- EX. STORM MANHOLE
- EX. STORM END SECTION
- EX. WATERMAIN
- EX. WATER VALVE
- EX. SANITARY SEWER
- EX. SANITARY SERVICE
- EX. SANITARY MANHOLE





NOTES:

1) ALL MAINLINE SANITARY SEWER SHOWN SHALL BE 8" PVC PUBLIC SANITARY SEWER WITHIN A PROPOSED ACCESS AND UTILITY EASEMENT.
2) ALL RCP PIPES MUST BE MINIMUM CLASS III.
3) ALL STORM SEWER PLACED MUST BE TRACEABLE, AS PER COS STD. D.37.
4) STORM SEWER IS PRIVATE UNLESS OTHERWISE NOTED.
5) ALL STORM MANHOLES 5' UNLESS OTHERWISE NOTED.
8) ANY PRIVATE OR PUBLIC STORM SEWER CONNECTIONS MUST BE INSPECTED BY ENGINEERING DEVELOPMENT REVIEW INSPECTOR.
9) ALL WATERLINE IS 8" UNLESS OTHERWISE NOTED.
10) INLETS 10, 11 AND 12 TO BE CUSTOM INLETS WITH MODIFIED BASE TO ACCEPT LARGER DIAMETER PIPE.

STREET DESIGN FOR CITY ENGINEERING:

UTILITY GRADE REVIEW:____________

DATE:____________

CURB AND GUTTER REVIEW:____________

DATE:____________

FINAL REVIEW:____________

DATE:____________

DRAINAGE DESIGN:____________

DATE:____________

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DRAWN BY: TBI	JOB DATE: 7/15/2020	BAR IS ONE INCH ON OFFICIAL DRAWINGS. 0 1" IF NOT ONE INCH, ADJUST SCALE ACCORDINGLY.	
APPROVED: CMM	JOB NUMBER: 191850		
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SHEET ST1