FINAL PUD DRAINAGE REPORT

For

EAST STREET VILLAGE

533 & 565 East Street
Louisville, Colorado

December 2023

Prepared For:
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533 & 565 East Street
Louisville, Colorado

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EXHIBIT PLANS

Engineer's Statement:

"I hereby certify that this report (plan) for the Final PUD drainage design of East Street Village was prepared by me (or under my direct supervision) in accordance with the provisions of the City of Louisville Storm Drainage Design and Technical Criteria for the owners thereof."

Prepared for and on the behalf of The Sanitas Group, LLC

Curtis C. Stevens, Principal
Colorado Professional Engineer #40337

I. GENERAL LOCATION AND DESCRIPTION

A. Location

The proposed project site is located at 533 & 565 East Street and is in the Southeast quarter of Section 8, Township 1 South, Range 69 West of the 6th P.M., County of Boulder, City of Louisville, State of Colorado.

The project site consists of two parcels of land with a total area of 3.66-acres. The two parcels are described as:

1. Boulder County Assessor Tract 704 (533 East Street) with an area of 2.07-acres.
2. Boulder County Assessor Tract 704-A (565 East Street) with an area of 1.59-acres.

To the north of Tracts 704 and 704-A is a strip of land owned by the City of Louisville. Commercial properties in the Pine Street Plaza subdivision are located north of the City-owned strip of land. Single-family residences, including the Lombardi subdivision, are located south of Tracts 704 and 704-A.

As delineated on FEMA Flood Insurance Rate Map 08013CO582K, effective date 15 August 2019 [6], the project site is not impacted by the effective 100 -year (1% annual chance) regulatory floodplain.

B. Description of Property

The property is located on the west side of East Street and south of the Pine Street Plaza subdivision. The BNSF railway is adjacent to the west side of the site. Currently there are five driveway access points off of East Street with four providing access to Tract 704-A and one providing access to Tract 704. A strip of land (owned by the City of Louisville) containing a drainage ditch and a 60" rcp storm sewer (Drainageway B) is adjacent to the north side of Tracts 704 and 704-A.

As shown on the "*Existing Conditions Drainage Plan"* included in Appendix F of this report, Tract 704 is currently undeveloped with the exception of a single-family house located in the southeast corner of the parcel. Ground cover consists of grasses and trees. Tract 704-A is currently developed with

eight single-family homes, three detached garages and gravel driveways. Undeveloped areas consist of grasses and trees.

USDA Natural Resources Conservation Services classified the soils on the property as Ascalon sandy loam (AcA), having a Group B hydrologic soil rating [2].

The proposed development of the **East Street Village** site will include the construction of 21 residential townhome units and 15 single-family homes.

II. HISTORIC DRAINAGE

A. Major Basin Description

The project site is located within the Coal Creek drainage basin. A basinwide planning study was completed in 1982 titled *"Basinwide Major Drainageway Planning, City of Louisville/Boulder County Outfall System Plan"* (MDP) [3].

B. Sub-Basin Description

The project site is located within Drainageway B in the MDP which covers 211 acres of the southern residential area of Louisville, however runoff from the project site does not drain to the Drainageway B storm sewer. Most of the project site slopes to the northeast and drains to the existing ditch adjacent to the north side of the project site, then to the existing 30"x19" culvert in East Street. The southeasterly portion of the site drains in a northeasterly direction into East Street. Runoff in East Street flows through the detention pond in Outlot A in the Pine Street Plaza subdivision. All runoff from the project site ultimately drains into Coal Creek.

Initially, runoff from that portion of Drainageway B west of the BNSF railway was conveyed via a 36" rcp storm sewer located in Front Street between Pine Street and Elm Street, then east to the east side of Highway 42, to an open channel that paralleled the east side of Highway 42, ultimately discharging into Coal Creek. The 36" rcp storm sewer was replaced in the early 1990's with 54" and 60" rcp and the open channel portion of the drainageway was realigned. The Drainageway B storm sewer improvements are detailed in the *"Drainagway B Outfall Improvements"*, dated June 7, 1990 [4]. Runoff enters the Drainageway B storm sewer via inlets located along Front Street and Elm Street.

There are no storm sewer inlet connections to the Drainageway B storm sewer east of the BNSF railway. The Drainageway B storm sewer passes through a City-owned strip of land located between the subject property and the Pine Street Plaza subdivision. This strip of land also contains a drainage ditch that receives runoff from the subject property and from the southerly portion of the Pine Street Plaza subdivision. An existing 36" rcp storm sewer that runs under the BNSF railway east of Elm Street was plugged and abandoned as part of the "*Lafayette-Louisville Boundary Area Drainage Improvements: Phase II*" project, therefore no runoff is conveyed from the west side of the BNSF railway to the drainage ditch east of the BNSF railway. The drainage ditch drains to the east to a 30"x19" elliptical culvert that runs under East Street and drains to a swale on the east side of East Street. The swale drains to the north to the City's storm sewer system, then to the Empire Road ditch, and ultimately into Coal Creek. The Empire Road ditch was formerly designated Drainageway A-2 until the new Drainageway A-2 channel was completed in 2017 as part of the "*Lafayette-Louisville Boundary Area Drainage Improvements: Phase I Highway 42 to Coal Creek*" project.

The *"Lafayette-Louisville Boundary Outfall System Plan, Conceptual Design Report"* (OSP), dated May 2011 [5] presents conceptual design alternatives to achieve the goal of conveying the future conditions 100-year flow. The recommended plan improvements were within watersheds DWA and DW7. The project site is located within watershed DWB and sub-watershed S21 in the OSP. Figure B5 in the OSP shows sub-watershed S21 draining to Drainageway B, however, as described previously, the project site drains to the Empire Road ditch, then into Coal Creek. The conceptual design improvements presented in the OSP were the basis for the recently completed "*Lafayette-Louisville Boundary Area Drainage Improvements: Phase I Highway 42 to Coal Creek*" [6] and the "*Lafayette-Louisville Boundary Area Drainage Improvements: Phase II*" [7] projects.

There are no nearby irrigation facilities which will affect the local drainage. There is a ditch just south of the project site that may be used for irrigation purposes, however the site slopes to the northeast, away from the ditch, therefore the ditch will not affect the local drainage.

III. DRAINAGE DESIGN CRITERIA

A. Regulations

This Final PUD Drainage Report was prepared using the criteria outlined in the City of Louisville "*Storm Drainage and Technical Criteria Manual*", [Criteria] [1], the Mile High Flood District [MHFD] "*Urban Storm Drainage Criteria Manual, Volumes 1 and 2"* [6], and the Mile High Flood District "*Urban Storm Drainage Criteria Manual, Volume 3 – Best Management Practices*" [7].

B. Development Criteria Reference and Constraints

There are no known previous drainage studies for the site.

C. Hydrological Criteria

Hydrologic design was completed in accordance with the City of Louisville and MHFD requirements. The minor and major rainfall events used for site design are the 2-year and 100-year events, and the 2, 5, 10, and 100-year values were calculated. The rational method was utilized for runoff calculations, with rainfall intensities specific to the Louisville area. The proposed detention facilities will utilize the full spectrum detention approach with WQCV/EURV drain times and 100-year release rates in accordance with MHFD, USDCM Volume 2.

Detention, WQCV and EURV pond volumes along with the detention pond release rates were calculated using MHFD-Detention, Version 4.04.

D. Hydraulic Criteria

All detailed hydraulic calculations are in accordance with City of Louisville standards.

IV. DRAINAGE FACILITY DESIGN

A. General Concept

Seven sub-basins have been delineated as part of the detailed site analysis and are shown on the Proposed Conditions Drainage Plan included with this report. The majority of the site will be directed to the proposed onsite detention ponds via sheet flow, curb & gutter, and storm sewer. The proposed storm sewer system is sized to convey the 100-year storm event to the onsite detention ponds which will release via outlet structures, storm sewer pipe and weirs.

Sub-Basin Description

Existing conditions Basin A1x covers the westerly and northeasterly portions of the site, consisting of homes, garages, gravel driveways and parking areas and undeveloped areas. Runoff from Basin A1x generally drains to the northeast, into the drainage ditch located adjacent to the north side of the project site.

Existing conditions Basin A2x covers the southeasterly portion of the site, consisting of homes, garages, gravel driveways and parking spaces and undeveloped areas. Runoff from Basin A2x drains to the northeast into East Street, which drains to the north into the Pine Street Plaza detention pond.

Existing conditions Basin OS1 covers the BNSF railway right-of-way adjacent to the west side of Tract 704. Runoff from Basin OS1 drains easterly into Basin A1x. For the proposed conditions analysis Basin OS1 was split into two basins: Basins OS1 and OS2. Runoff from Basins OS1 and OS2 drain into Basins A1 and A2, respectively.

Existing conditions Basin OS2 covers the BNSF railway right-of-way and the City-owned strip of land adjacent to the north side of the project site. Runoff from Basin OS2 is conveyed to the east within a drainage ditch to the existing 30”x19” HERCP culvert in East Street. For the proposed conditions analysis Basin OS2 is renamed Basin OS3.

Proposed conditions Basin A1 covers the northerly portion of the site and consists of single-family homes, townhomes, garages, concrete streets and sidewalks, and landscape areas. Runoff from Basin A1 will be directed to Rain Garden A via sheet flow, curb & gutter and storm sewer.

Proposed conditions Basin A2 covers the southerly portion of the site consisting of single-family homes, townhomes, garages, concrete streets and sidewalks, and landscape areas. Runoff from Basin A2 will be directed to Rain Garden B via sheet flow, curb & gutter and storm sewer.

Proposed conditions Basin A3 consists of a small landscape area in the northeasterly portion of the site. Runoff from Basin A3 will drain to a grass swale that will replace the existing ditch to the north of the site. The grass swale will drain to the east to the culvert at East Street.

Proposed conditions Basin A4 is a strip of land along the east side of the site consisting of concrete sidewalks and landscape areas. Runoff from Basin A4 will drain to the east into East Street.

B. Specific Details

A combination rain garden/detention pond, labeled Rain Garden A on the Proposed Conditions Drainage Plan, will be located in the northeast corner of the site that will receive runoff from Basin A1. Offsite flow from Basin OS1 will flow through Rain Garden A. A second combination rain garden/detention pond, labeled Rain Garden B, will be located in the southeast corner of the site that will receive runoff from Basin A2. Offsite runoff from Basin OS2 will flow through Rain Garden B. The rain garden areas will be located around the perimeter of the structures with a lower middle portion for additional stormwater detention. Due to the proximity of the rain gardens to the adjacent structures, the rain gardens are designed for no infiltration and will contain an underdrain and impermeable liner. The rain garden outlet structures will contain circular orifices to restrict the release of the WQCV and EURV to the MHFD recommended drain times. Since the rain garden underdrain and outlet pipe will be lower than the adjacent drainage ditch, a connection to the Drainageway B 60" rcp storm sewer is proposed to serve as the outfall for the WQCV and EURV for both rain gardens, and the 100-year release for Rain Garden B. The 100-year release from Rain Garden A will be through a weir on the north side of the rain garden, draining into the adjacent drainage ditch, then following the historic drainage path to Coal Creek via the swale on the east side of East Street and the Empire Road ditch. The full flow capacity of the 60" rcp is approximately 182 cfs which occurs during the 100-year storm event. The peak outflow from the rain gardens releasing to the 60" rcp is 0.31 cfs and will precede the peak flow from Drainageway B since the project site is in the downstream portion of Drainageway B.

Detailed water quality design calculations and supporting data is provided in Appendix D of this report.

Construction Best Management Practices [BMPs] will be installed prior to and during construction, to restrict the amount of sediment transported offsite by either wind or water. Construction BMPs include vehicle tracking control at the construction entrance, silt fencing, concrete washouts and dust control.

Table 4.1: Site Imperviousness

	Pre-Construction	Post-Construction (Full site development)
Overall Site Imperviousness	12.4%	58.2%

Table 4.2: Storm Release Comparison

Location	100-year Major Design Storm	
	Peak Release Rate [cfs]	Allowable Release Rate[1] [cfs]
Rain Garden A	3.15	-
Rain Garden B	1.45	-
Basin A3 (Free Release)	0.05	-
Basin A4 (Free Release)	0.82	-
Overall Site[2]	**5.47**	5.49

[1] 100-year allowable release rate=90% predevelopment discharge per MHFD "*Urban Storm Drainage Criteria Manual*", Volume 2, Chapter 12-Storage

[2] See Design Point Summary – Onsite Flows in Appendix B

Table 4.3: Onsite Detention Pond Summary

Onsite Detention Ponds		
	Rain Garden A	Rain Garden B
WQCV Required [cf]	1,347	1,037
WQCV WSEL [ft] (1-ft depth)	5324.00	5326.20
EURV Required [cf]	5,532	4,312
EURV WSEL [ft]	5324.79	5326.41
100-Yr Stormwater Volume Required [cf]	8,276	6,360
100-Yr WSEL [ft]	5325.71	5327.35
Maximum 100-Yr Release Rate [cfs]	3.15	1.45
Max. Required Volume Req'd (100-Yr)	8,276	6,360

Volume Provided @ Emergency Spillway Elevation	7,668	9,431
Top of Pond = Volume (cf)	10,655	10,524

Table 4.4: Storm Runoff Comparison – Onsite and Offsite Flows

Design Point	5-year Minor Design Storm Runoff [cfs]			100-year Major Design Storm Runoff [cfs]		
	Existing Conditions	Proposed Conditions	Δ	Existing Conditions	Proposed Conditions	Δ
1	0.28	0.00	-0.28	7.40	6.20	-1.20
2	0.21	0.12	-0.09	2.16	0.82	-1.34
3	0.00	0.21	0.21	0.00	0.31	0.31

Design Point 1 represents flow to the existing 30"x19" culvert and swale located between East Street and SH 42.

Design Point 2 represents flow in East Street that drains north in East Street, then through the Pine Street Plaza detention pond.

Design Point 3 represents flow to the existing Drainageway B 60" RCP storm sewer.

V. CONCLUSIONS

A. Compliance with Standards

This Final PUD Drainage Report has been prepared in accordance with the standards and recommendations outlined in the *City of Louisville Storm Drainage Design and Technical Criteria* as well as the Mile High Flood District *Urban Storm Drainage Criteria Manual Volumes 1, 2, & 3.*

B. Drainage Concept

The drainage design for the proposed **East Street Village** project will control site runoff through the use of surface and subsurface improvements, including curb & gutter, storm sewer, and two onsite water quality and detention ponds. The detention ponds have been designed utilizing the MHFD-Detention v4.04 design spreadsheet as outlined in the MHFD *Urban Storm Drainage Criteria Manual, Volume 2*.

VI. REFERENCES

[1] "*Storm Drainage and Technical Criteria Manual*", City of Louisville, August, 2013.

[2] Soils Map, "*Web Soil Survey 3.0*", USDA Natural Resources Conservation Service, January 2022.

[3] *"Basinwide Major Drainageway Planning, City of Louisville/Boulder County Outfall System Plan"*, Water Resources Consultants, Inc., November, 1982.

[4] *"Drainageway B Outfall Improvements"*, Centennial Engineering, Inc., June 7, 1990.

[5] *"Lafayette-Louisville Boundary Outfall System Plan, Conceptual Design Report"*, McLaughlin Water Engineers LTD, May 2011.

[6] *"Lafayette-Louisville Boundary Area Drainage Improvements: Phase I Highway 42 to Coal Creek"*, Olsson Associates, January 11, 2017.

[7] *"Lafayette-Louisville Boundary Area Drainage Improvements: Phase II"*, Olsson Associates, January 11, 2017.

[8] *"Final Drainage Report and LOMR Narrative, Lafayette-Louisville Boundary Area Drainage Improvements Project"*, Olsson Associates, July 18, 2017.

[9] "Flood Insurance Rate Map", Federal Emergency Management Agency, Map Number 08013CO582K, effective date 15 August 2019.

[10] "*Storm Drainage Criteria Manual, Volumes 1 and 2*", Mile High Flood District", January 2016.

[11] "*Urban Storm Drainage Criteria Manual, Volume 3 – Best Management Practices*" Mile High Flood District", January 2016.

APPENDIX A

Maps, Tables, and Figures

Map Scale: 1:1,270 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 15 30 60 90

Feet
0 50 100 200 300

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 1:20,000.

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: Boulder County Area, Colorado
Survey Area Data: Version 18, Sep 2, 2021

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

Date(s) aerial images were photographed: Sep 25, 2018—Apr 9, 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
AcA	Ascalon sandy loam, 0 to 3 percent slopes	B	5.2	100.0%
Totals for Area of Interest			**5.2**	**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

APPENDIX B

Hydrology Calculations

Rational Method Calculations

Overall Site

Existing Conditions

Project: East Street Village
SG Project I.D.: B1396

Prepared By: MLM
Reviewed By: LRE
Date: 06/16/23

Basin Description: Overall Site

NRCS Soil Type: AcA, Ascalon sandy loam

NRCS Hydrologic Soil Rating: B

Basin Area= 3.70 [acres] = 161,077 [sf]

Surface Characteristics[1]	Sub-Area [sf]	Imp [%]	Runoff Coefficients[1]			
			C_2	C_5	C_{10}	C_{100}
Asphalt	0	100	0.84	0.86	0.86	0.89
Concrete Drives & Walks	1976	90	0.74	0.76	0.78	0.84
Roofs	11863	90	0.74	0.76	0.78	0.84
Gravel (packed)	11513	40	0.29	0.32	0.38	0.61
Lawns, sandy soil	135725	2	0.01	0.01	0.07	0.44

[1] MHFD *"Urban Storm Drainage Criteria Manual, Vol 1", Table 6-3, Table 6-5*

Weighted Percent Imperviousness : I [%] = 12.28 A_I = 19,774.79 [sf]

Weighted Runoff Coefficients:

C_2 = 0.09 C_5 = 0.10 C_{10} = 0.15 C_{100} = 0.49

Rational Method Calculations
Overall Site
Proposed Conditions

Prepared By: MLM
Project: East Street Village
Reviewed By: LRE
SG Project I.D.: B1396
Date: 06/16/23

Basin Description: Overall Site

NRCS Soil Type: AcA, Ascalon sandy loam **NRCS Hydrologic Soil Rating:** B

Basin Area= 3.70 [acres] = 161,077 [sf]

Surface Characteristics[1]	Sub-Area [sf]	Imp [%]	Runoff Coefficients[1]			
			C_2	C_5	C_{10}	C_{100}
Asphalt	0	100	0.84	0.86	0.86	0.89
Concrete Drives & Walks	48005	90	0.74	0.76	0.78	0.84
Roofs	54768	90	0.74	0.76	0.78	0.84
Gravel (packed)	0	40	0.29	0.32	0.38	0.61
Lawns, sandy soil	58304	2	0.01	0.01	0.07	0.44

[1] MHFD *"Urban Storm Drainage Criteria Manual, Vol 1", Table 6-3, Table 6-5*

Weighted Percent Imperviousness : I [%] = 58.15 A_I = 93,661.77 [sf]

Weighted Runoff Coefficients:

C_2 = 0.48 C_5 = 0.49 C_{10} = 0.52 C_{100} = 0.70

Rational Method Calculations

Basin OS1

Existing Conditions

Project: East Street Village
SG Project I.D.: B1396

Prepared By: MLM
Reviewed By: LRE
Date: 06/16/23

Basin Description: A portion of the Burlington Northern Railroad R.O.W. adjacent to the project site.

NRCS Soil Type: AcA, Ascalon sandy loam

NRCS Hydrologic Soil Rating: B

Basin Area= 0.44 [acres] = 19,046 [sf]

Surface Characteristics[1]	Sub-Area [sf]	Imp [%]	Runoff Coefficients[1]			
			C_2	C_5	C_{10}	C_{100}
Historic flow analysis	19046	2	0.01	0.01	0.07	0.44

[1] MHFD *"Urban Storm Drainage Criteria Manual, Vol 1", Table 6-3, Table 6-5*

Weighted Percent Imperviousness : I [%] = 2.00 A_i = 380.92 [sf]

Weighted Runoff Coefficients:

C_2 = 0.01 C_5 = 0.01 C_{10} = 0.07 C_{100} = 0.44

Time of Concentration:

Sheet Flow:

L_i [ft] = 50
S_i [%] = 2.00
t_i [min] = 11.01

Concentrated Flow:

L_{t1} [FT] =	0	L_{t2} [FT] = 0
S_{t1} [%] =	2.00	S_{t2} [%] = 2.00
C_{V1}[3] =	20.00	C_{V2}[3] = 20.00
V_{t1} [fps][4] =	2.83	V_{t2} [fps][4] = 2.83
t_{t1} [min] =	0.00	t_{t2} [min] = 0.00

[3] *UDFCD, Table 6-2*

[4] *UDFCD, Eqn 6-4*

t_t [min] = 0.00

Time of Concentration:

$t_c = t_i + t_t$ [min] = 11.01
t_c(minimum)= 5 min
Check for Urbanized Basins:
t_c[5] [min] = 25.66

t_c [min] = 11.0

[5] MH*FD "Drainage Criteria Manual, Vol 1", Eqn 6-5*

Rainfall Intensity[6]

I_2 [in/hr]= 2.09 I_5 [in/hr]= 2.84 I_{10} [in/hr]= 3.54 I_{100} [in/hr]= 6.64

[6] MH*FD "Drainage Criteria Manual, Vol 1", Eqn 5-1, NOAA Atlas 14*

Runoff - Rational Method Equation[7]

Q_2 [cfs]= 0.01 **Q_5 [cfs]= 0.01** **Q_{10} [cfs]= 0.11** **Q_{100} [cfs]= 1.28**

[7] MH*FD "Drainage Criteria Manual, Vol 1", Eqn 6-1*

Rational Method Calculations
Basin OS2
Existing Conditions

Project: East Street Village
SG Project I.D.: B1396

Prepared By: MLM
Reviewed By: LRE
Date: 06/16/23

Basin Description: A portion of the adjacent parcel of land north of the project site.

NRCS Soil Type: AcA, Ascalon sandy loam **NRCS Hydrologic Soil Rating:** B

Basin Area= 0.25 [acres] = 11,028 [sf]

Surface Characteristics[1]	Sub-Area [sf]	Imp [%]	Runoff Coefficients[1]			
			C_2	C_5	C_{10}	C_{100}
Historic flow analysis	11028	2	0.01	0.01	0.07	0.44

[1] MHFD *"Urban Storm Drainage Criteria Manual, Vol 1", Table 6-3, Table 6-5*

Weighted Percent Imperviousness : I [%] = 2.00 A_I = 220.57 [sf]

Weighted Runoff Coefficients:
C_2 = 0.01 C_5 = 0.01 C_{10} = 0.07 C_{100} = 0.44

Time of Concentration:

Sheet Flow:
L_i [ft] = 60
S_i [%] = 10.00
t_i [min] = 7.05

Concentrated Flow:

L_{t1} [FT] =	410	L_{t2} [FT] =	0
S_{t1} [%] =	0.70	S_{t2} [%] =	2.00
C_{V1}[3] =	15.00	C_{V2}[3] =	20.00
V_{t1} [fps][4] =	1.25	V_{t2} [fps][4] =	2.83
t_{t1} [min] =	5.44	t_{t2} [min] =	0.00

[3] *UDFCD, Table 6-2*
[4] *UDFCD, Eqn 6-4*

t_t [min] = 5.44

Time of Concentration:
$t_c = t_i + t_t$ [min] = 12.50
t_c(minimum)= 5 min
t_c [min] = 12.5
Check for Urbanized Basins:
t_c[5] [min] = 34.46

[5] MH*FD "Drainage Criteria Manual, Vol 1", Eqn 6-5*

Rainfall Intensity[6]
I_2 [in/hr]= 1.98 I_5 [in/hr]= 2.69 I_{10} [in/hr]= 3.35 I_{100} [in/hr]= 6.29

[6] MH*FD "Drainage Criteria Manual, Vol 1", Eqn 5-1, NOAA Atlas 14*

Runoff - Rational Method Equation[7]
Q_2 [cfs]= 0.01 **Q_5 [cfs]= 0.01** **Q_{10} [cfs]= 0.06** **Q_{100} [cfs]= 0.70**

[7] MH*FD "Drainage Criteria Manual, Vol 1", Eqn 6-1*

Rational Method Calculations

Basin OS1

Proposed Conditions

Project: East Street Village
SG Project I.D.: B1396

Prepared By: MLM
Reviewed By: LRE
Date: 06/16/23

Basin Description: A portion of the Burlington Northern Railroad R.O.W. adjacent to the project site.

NRCS Soil Type: AcA, Ascalon sandy loam

NRCS Hydrologic Soil Rating: B

Basin Area= 0.26 [acres] = 11,174 [sf]

Surface Characteristics[1]	Sub-Area [sf]	Imp [%]	Runoff Coefficients[1]			
			C_2	C_5	C_{10}	C_{100}
Historic flow analysis	11174	2	0.01	0.01	0.07	0.44

[1] MHFD *"Urban Storm Drainage Criteria Manual, Vol 1", Table 6-3, Table 6-5*

Weighted Percent Imperviousness : I [%] = 2.00 A_i = 223.48 [sf]

Weighted Runoff Coefficients:

C_2 = 0.01 C_5 = 0.01 C_{10} = 0.07 C_{100} = 0.44

Time of Concentration:

Sheet Flow:

L_i [ft] = 50
S_i [%] = 2.00
t_i [min] = 11.01

Concentrated Flow:

L_{t1} [FT] =	0	L_{t2} [FT] = 0
S_{t1} [%] =	2.00	S_{t2} [%] = 2.00
C_{V1}[3] =	20.00	C_{V2}[3] = 20.00
V_{t1} [fps][4] =	2.83	V_{t2} [fps][4] = 2.83
t_{t1} [min] =	0.00	t_{t2} [min] = 0.00

[3] *UDFCD, Table 6-2*
[4] *UDFCD, Eqn 6-4*

t_t [min] = 0.00

Time of Concentration:

$t_c = t_i + t_t$ [min] = 11.01
t_c(minimum)= 5 min
Check for Urbanized Basins:
t_c[5] [min] = 25.66

t_c [min] = 11.0

[5] MH*FD "Drainage Criteria Manual, Vol 1", Eqn 6-5*

Rainfall Intensity[6]

I_2 [in/hr]= 2.09 I_5 [in/hr]= 2.84 I_{10} [in/hr]= 3.54 I_{100} [in/hr]= 6.64

[6] MH*FD "Drainage Criteria Manual, Vol 1", Eqn 5-1, NOAA Atlas 14*

Runoff - Rational Method Equation[7]

Q_2 [cfs]= 0.01 **Q_5 [cfs]= 0.01** **Q_{10} [cfs]= 0.06** **Q_{100} [cfs]= 0.75**

[7] MH*FD "Drainage Criteria Manual, Vol 1", Eqn 6-1*

Rational Method Calculations
Basin OS2
Proposed Conditions

Project: East Street Village
SG Project I.D.: B1396

Prepared By: MLM
Reviewed By: LRE
Date: 06/16/23

Basin Description: A portion of the Burlington Northern Railroad R.O.W. adjacent to the project site.

NRCS Soil Type: AcA, Ascalon sandy loam

NRCS Hydrologic Soil Rating: B

Basin Area= 0.18 [acres] = 8,055 [sf]

Surface Characteristics[1]	Sub-Area [sf]	Imp [%]	Runoff Coefficients[1]			
			C_2	C_5	C_{10}	C_{100}
Historic flow analysis	8055	2	0.01	0.01	0.07	0.44

[1] MHFD *"Urban Storm Drainage Criteria Manual, Vol 1", Table 6-3, Table 6-5*

Weighted Percent Imperviousness : I [%] = 2.00 A_i = 161.10 [sf]

Weighted Runoff Coefficients:

C_2 = 0.01 C_5 = 0.01 C_{10} = 0.07 C_{100} = 0.44

Time of Concentration:

Sheet Flow:

L_i [ft] = 50
S_i [%] = 2.00
t_i [min] = 11.01

Concentrated Flow:

L_{t1} [FT] =	0	L_{t2} [FT] =	0
S_{t1} [%] =	2.00	S_{t2} [%] =	2.00
C_{V1}[3] =	20.00	C_{V2}[3] =	20.00
V_{t1} [fps][4] =	2.83	V_{t2} [fps][4] =	2.83
t_{t1} [min] =	0.00	t_{t2} [min] =	0.00

[3] *UDFCD, Table 6-2*
[4] *UDFCD, Eqn 6-4*

t_t [min] = 0.00

Time of Concentration:

$t_c = t_i + t_t$ [min] = 11.01
t_c(minimum)= 5 min
Check for Urbanized Basins:
t_c[5] [min] = 25.66

t_c [min] = 11.0

[5] MH*FD "Drainage Criteria Manual, Vol 1", Eqn 6-5*

Rainfall Intensity[6]

I_2 [in/hr]= 2.09 I_5 [in/hr]= 2.84 I_{10} [in/hr]= 3.54 I_{100} [in/hr]= 6.64

[6] MH*FD "Drainage Criteria Manual, Vol 1", Eqn 5-1, NOAA Atlas 14*

Runoff - Rational Method Equation[7]

Q_2 [cfs]= 0.00 **Q_5 [cfs]= 0.01** **Q_{10} [cfs]= 0.05** **Q_{100} [cfs]= 0.54**

[7] MH*FD "Drainage Criteria Manual, Vol 1", Eqn 6-1*

Rational Method Calculations
Basin OS3
Proposed Conditions

Project: East Street Village
SG Project I.D.: B1396

Prepared By: MLM
Reviewed By: LRE
Date: 06/16/23

Basin Description: A portion of the Burlington Northern Railroad R.O.W. adjacent to the project site.

NRCS Soil Type: AcA, Ascalon sandy loam

NRCS Hydrologic Soil Rating: B

Basin Area= 0.25 [acres] = 10,834 [sf]

Surface Characteristics[1]	Sub-Area [sf]	Imp [%]	Runoff Coefficients[1]			
			C_2	C_5	C_{10}	C_{100}
Asphalt	0	100	0.84	0.86	0.86	0.89
Concrete Drives & Walks	0	90	0.74	0.76	0.78	0.84
Roofs	0	90	0.74	0.76	0.78	0.84
Gravel (packed)	0	40	0.29	0.32	0.38	0.61
Lawns, sandy soil	10834	2	0.01	0.01	0.07	0.44

[1] MHFD *"Urban Storm Drainage Criteria Manual, Vol 1", Table 6-3, Table 6-5*

Weighted Percent Imperviousness : I [%] = 2.00 A_I = 216.68 [sf]

Weighted Runoff Coefficients:

C_2 = 0.01 C_5 = 0.01 C_{10} = 0.07 C_{100} = 0.44

Time of Concentration:

Sheet Flow:

L_i [ft] = 100
S_i [%] = 2.00
t_i [min] = 15.57

Concentrated Flow:

L_{t1} [FT] =	380	L_{t2} [FT] = 0
S_{t1} [%] =	2.00	S_{t2} [%] = 2.00
C_{V1}[3] =	15.00	C_{V2}[3] = 20.00
V_{t1} [fps][4] =	2.12	V_{t2} [fps][4] = 2.83
t_{t1} [min] =	2.99	t_{t2} [min] = 0.00

[3] *UDFCD, Table 6-2*
[4] *UDFCD, Eqn 6-4*

t_t [min] = 2.99

Time of Concentration:

$t_c = t_i + t_t$ [min] = 18.56
t_c(minimum)= 5 min
Check for Urbanized Basins:
t_c[5] [min] = 30.49

t_c [min] = 18.6

[5] MH*FD "Drainage Criteria Manual, Vol 1", Eqn 6-5*

Rainfall Intensity[6]

I_2 [in/hr]= 1.64 I_5 [in/hr]= 2.23 I_{10} [in/hr]= 2.78 I_{100} [in/hr]= 5.21

[6] MH*FD "Drainage Criteria Manual, Vol 1", Eqn 5-1, NOAA Atlas 14*

Runoff - Rational Method Equation[7]

Q_2 [cfs]= 0.00 **Q_5 [cfs]= 0.01** **Q_{10} [cfs]= 0.05** **Q_{100} [cfs]= 0.57**

[7] MH*FD "Drainage Criteria Manual, Vol 1", Eqn 6-1*

Rational Method Calculations

Basin A1x

Existing Conditions

Project: East Street Village
SG Project I.D.: B1396

Prepared By: MLM
Reviewed By: LRE
Date: 06/16/23

Basin Description:

NRCS Soil Type: AcA, Ascalon sandy loam

NRCS Hydrologic Soil Rating: B

Basin Area= 2.83 [acres] = 123,191 [sf]

Surface Characteristics[1]	Sub-Area [sf]	Imp [%]	Runoff Coefficients[1]			
			C_2	C_5	C_{10}	C_{100}
Asphalt	0	100	0.84	0.86	0.86	0.89
Concrete Drives & Walks	1226	90	0.74	0.76	0.78	0.84
Roofs	6999	90	0.74	0.76	0.78	0.84
Gravel (packed)	5295	40	0.29	0.32	0.38	0.61
Lawns, sandy soil	109671	2	0.01	0.01	0.07	0.44

[1] MHFD *"Urban Storm Drainage Criteria Manual, Vol 1", Table 6-3, Table 6-5*

Weighted Percent Imperviousness : I [%] = 9.51 A_i = 11,713.92 [sf]

Weighted Runoff Coefficients:

C_2 = 0.07 C_5 = 0.07 C_{10} = 0.13 C_{100} = 0.47

Time of Concentration:

Sheet Flow:

L_i [ft] = 416
S_i [%] = 2.10
t_i [min] = 29.43

Concentrated Flow:

L_{t1} [FT] =	0	L_{t2} [FT] =	0
S_{t1} [%] =	2.00	S_{t2} [%] =	2.00
C_{V1}[3] =	20.00	C_{V2}[3] =	20.00
V_{t1} [fps][4] =	2.83	V_{t2} [fps][4] =	2.83
t_{t1} [min] =	0.00	t_{t2} [min] =	0.00

[3] *UDFCD, Table 6-2*
[4] *UDFCD, Eqn 6-4*

t_t [min] = 0.00

Time of Concentration:

$t_c = t_i + t_t$ [min] = 29.43
t_c(minimum)= 5 min
t_c [min] = 29.4
Check for Urbanized Basins:
t_c[5] [min] = 24.38

[5] MH*FD "Drainage Criteria Manual, Vol 1", Eqn 6-5*

Rainfall Intensity[6]

I_2 [in/hr]= 1.28 I_5 [in/hr]= 1.73 I_{10} [in/hr]= 2.16 I_{100} [in/hr]= 4.05

[6] MH*FD "Drainage Criteria Manual, Vol 1", Eqn 5-1, NOAA Atlas 14*

Runoff - Rational Method Equation[7]

Q_2 [cfs]= 0.26 **Q_5 [cfs]= 0.36** **Q_{10} [cfs]= 0.80** **Q_{100} [cfs]= 5.42**

[7] MH*FD "Drainage Criteria Manual, Vol 1", Eqn 6-1*

Rational Method Calculations

Basin A2x

Existing Conditions

Project: East Street Village
SG Project I.D.: B1396

Prepared By: MLM
Reviewed By: LRE
Date: 06/16/23

Basin Description:

NRCS Soil Type: AcA, Ascalon sandy loam

NRCS Hydrologic Soil Rating: B

Basin Area= 0.87 [acres] = 37,885 [sf]

Surface Characteristics[1]	Sub-Area [sf]	Imp [%]	Runoff Coefficients[1]			
			C_2	C_5	C_{10}	C_{100}
Asphalt	0	100	0.84	0.86	0.86	0.89
Concrete Drives & Walks	750	90	0.74	0.76	0.78	0.84
Roofs	4864	90	0.74	0.76	0.78	0.84
Gravel (packed)	6218	40	0.29	0.32	0.38	0.61
Lawns, sandy soil	26053	2	0.01	0.01	0.07	0.44

[1] MHFD *"Urban Storm Drainage Criteria Manual, Vol 1", Table 6-3, Table 6-5*

Weighted Percent Imperviousness : I [%] = 21.28 A_I = 8,060.87 [sf]

Weighted Runoff Coefficients:

C_2 = 0.16 C_5 = 0.17 C_{10} = 0.23 C_{100} = 0.53

Time of Concentration:

Sheet Flow:

L_i [ft] = 288
S_i [%] = 2.00
t_i [min] = 22.50

Concentrated Flow:

L_{t1} [FT] =	0	L_{t2} [FT] = 0
S_{t1} [%] =	2.00	S_{t2} [%] = 2.00
C_{V1}[3] =	20.00	C_{V2}[3] = 20.00
V_{t1} [fps][4] =	2.83	V_{t2} [fps][4] = 2.83
t_{t1} [min] =	0.00	t_{t2} [min] = 0.00

[3] *UDFCD, Table 6-2*
[4] *UDFCD, Eqn 6-4*

t_t [min] = 0.00

Time of Concentration:

$t_c = t_i + t_t$ [min] = 22.50
t_c(minimum)= 5 min
t_c [min] = 22.5
Check for Urbanized Basins:
t_c[5] [min] = 22.38

[5] MHFD *"Drainage Criteria Manual, Vol 1", Eqn 6-5*

Rainfall Intensity[6]

I_2 [in/hr]= 1.49 I_5 [in/hr]= 2.01 I_{10} [in/hr]= 2.51 I_{100} [in/hr]= 4.71

[6] MHFD *"Drainage Criteria Manual, Vol 1", Eqn 5-1, NOAA Atlas 14*

Runoff - Rational Method Equation[7]

Q_2 [cfs]= 0.21 **Q_5 [cfs]= 0.30** **Q_{10} [cfs]= 0.49** **Q_{100} [cfs]= 2.16**

[7] MHFD *"Drainage Criteria Manual, Vol 1", Eqn 6-1*

Rational Method Calculations

Basin A1

Proposed Conditions

Project: East Street Village
SG Project I.D.: B1396

Prepared By: MLM
Reviewed By: LRE
Date: 06/16/23

Basin Description:

NRCS Soil Type: AcA, Ascalon sandy loam

NRCS Hydrologic Soil Rating: B

Basin Area= 1.99 [acres] = 86,659 [sf]

Surface Characteristics[1]	Sub-Area [sf]	Imp [%]	Runoff Coefficients[1]			
			C_2	C_5	C_{10}	C_{100}
Asphalt	0	100	0.84	0.86	0.86	0.89
Concrete Drives & Walks	24645	90	0.74	0.76	0.78	0.84
Roofs	31564	90	0.74	0.76	0.78	0.84
Gravel (packed)	0	40	0.29	0.32	0.38	0.61
Lawns, sandy soil	30450	2	0.01	0.01	0.07	0.44

[1] MHFD *"Urban Storm Drainage Criteria Manual, Vol 1", Table 6-3, Table 6-5*

Weighted Percent Imperviousness : I [%] = 59.08 A_I = 51,197.09 [sf]

Weighted Runoff Coefficients:

C_2 = 0.48 C_5 = 0.50 C_{10} = 0.53 C_{100} = 0.70

Time of Concentration:

Sheet Flow:

L_i [ft] = 39
S_i [%] = 2.00
t_i [min] = 5.38

Concentrated Flow:

L_{t1} [FT] =	457	L_{t2} [FT] =	0
S_{t1} [%] =	1.10	S_{t2} [%] =	2.00
C_{V1}[3] =	20.00	C_{V2}[3] =	15.00
V_{t1} [fps][4] =	2.10	V_{t2} [fps][4] =	2.12
t_{t1} [min] =	3.63	t_{t2} [min] =	0.00

[3] *UDFCD, Table 6-2*
[4] *UDFCD, Eqn 6-4*

t_t [min] = 3.63

Time of Concentration:

$t_c = t_i + t_t$ [min] = 9.02
t_c(minimum)= 5 min
Check for Urbanized Basins:
t_c[5] [min] = 20.16

t_c [min] = 9.0

[5] MH*FD "Drainage Criteria Manual, Vol 1", Eqn 6-5*

Rainfall Intensity[6]

I_2 [in/hr]= 2.26 I_5 [in/hr]= 3.07 I_{10} [in/hr]= 3.83 I_{100} [in/hr]= 7.18

[6] MH*FD "Drainage Criteria Manual, Vol 1", Eqn 5-1, NOAA Atlas 14*

Runoff - Rational Method Equation[7]

Q_2 [cfs]= 2.18 **Q_5 [cfs]= 3.03** **Q_{10} [cfs]= 4.04** **Q_{100} [cfs]= 9.99**

[7] MH*FD "Drainage Criteria Manual, Vol 1", Eqn 6-1*

Rational Method Calculations

Basin A2

Proposed Conditions

Project: East Street Village
SG Project I.D.: B1396

Prepared By: MLM
Reviewed By: LRE
Date: 06/16/23

Basin Description:

NRCS Soil Type: AcA, Ascalon sandy loam

NRCS Hydrologic Soil Rating: B

Basin Area= 1.50 [acres] = 65,429 [sf]

Surface Characteristics[1]	Sub-Area [sf]	Imp [%]	Runoff Coefficients[1]			
			C_2	C_5	C_{10}	C_{100}
Asphalt	0	100	0.84	0.86	0.86	0.89
Concrete Drives & Walks	20368	90	0.74	0.76	0.78	0.84
Roofs	23107	90	0.74	0.76	0.78	0.84
Gravel (packed)	0	40	0.29	0.32	0.38	0.61
Lawns, sandy soil	21954	2	0.01	0.01	0.07	0.44

[1] MHFD *"Urban Storm Drainage Criteria Manual, Vol 1", Table 6-3, Table 6-5*

Weighted Percent Imperviousness : I [%] = 60.47 A_I = 39,566.58 [sf]

Weighted Runoff Coefficients:

C_2 = 0.50 C_5 = 0.51 C_{10} = 0.54 C_{100} = 0.71

Time of Concentration:

Sheet Flow:

L_i [ft] = 39
S_i [%] = 2.00
t_i [min] = 5.28

Concentrated Flow:

L_{t1} [FT] =	397	L_{t2} [FT] =	0
S_{t1} [%] =	0.90	S_{t2} [%] =	2.00
C_{V1}[3] =	20.00	C_{V2}[3] =	15.00
V_{t1} [fps][4] =	1.90	V_{t2} [fps][4] =	2.12
t_{t1} [min] =	3.49	t_{t2} [min] =	0.00

[3] *UDFCD, Table 6-2*
[4] *UDFCD, Eqn 6-4*

t_t [min] = 3.49

Time of Concentration:

$t_c = t_i + t_t$ [min] = 8.77
t_c(minimum)= 5 min
Check for Urbanized Basins:
t_c[5] [min] = 19.71

t_c [min] = 8.8

[5] MHFD *"Drainage Criteria Manual, Vol 1", Eqn 6-5*

Rainfall Intensity[6]

I_2 [in/hr]= 2.29 I_5 [in/hr]= 3.10 I_{10} [in/hr]= 3.87 I_{100} [in/hr]= 7.25

[6] MHFD *"Drainage Criteria Manual, Vol 1", Eqn 5-1, NOAA Atlas 14*

Runoff - Rational Method Equation[7]

Q_2 [cfs]= 1.70 **Q_5 [cfs]= 2.37** **Q_{10} [cfs]= 3.15** **Q_{100} [cfs]= 7.69**

[7] MHFD *"Drainage Criteria Manual, Vol 1", Eqn 6-1*

Rational Method Calculations

Basin A3

Proposed Conditions

Project: East Street Village
SG Project I.D.: B1396

Prepared By: MLM
Reviewed By: LRE
Date: 06/16/23

Basin Description:

NRCS Soil Type: AcA, Ascalon sandy loam

NRCS Hydrologic Soil Rating: B

Basin Area= 0.01 [acres] = 585 [sf]

Surface Characteristics[1]	Sub-Area [sf]	Imp [%]	Runoff Coefficients[1]			
			C_2	C_5	C_{10}	C_{100}
Asphalt	0	100	0.84	0.86	0.86	0.89
Concrete Drives & Walks	0	90	0.74	0.76	0.78	0.84
Roofs	0	90	0.74	0.76	0.78	0.84
Gravel (packed)	0	40	0.29	0.32	0.38	0.61
Lawns, sandy soil	585	2	0.01	0.01	0.07	0.44

[1] MHFD *"Urban Storm Drainage Criteria Manual, Vol 1", Table 6-3, Table 6-5*

Weighted Percent Imperviousness : I [%] = 2.00 A_i = 11.70 [sf]

Weighted Runoff Coefficients:

C_2 = 0.01 C_5 = 0.01 C_{10} = 0.07 C_{100} = 0.44

Time of Concentration:

Sheet Flow:

L_i [ft] = 10
S_i [%] = 2.00
t_i [min] = 4.92

Concentrated Flow:

L_{t1} [FT] =	0	L_{t2} [FT] = 0
S_{t1} [%] =	2.00	S_{t2} [%] = 2.00
C_{V1}[3] =	20.00	C_{V2}[3] = 15.00
V_{t1} [fps][4] =	2.83	V_{t2} [fps][4] = 2.12
t_{t1} [min] =	0.00	t_{t2} [min] = 0.00

[3] *UDFCD, Table 6-2*
[4] *UDFCD, Eqn 6-4*

t_t [min] = 0.00

Time of Concentration:

$t_c = t_i + t_t$ [min] = 4.92
t_c(minimum)= 5 min
Check for Urbanized Basins:
t_c[5] [min] = 25.66

t_c [min] = 5.0

[5] MHFD *"Drainage Criteria Manual, Vol 1", Eqn 6-5*

Rainfall Intensity[6]

I_2 [in/hr]= 2.73 I_5 [in/hr]= 3.70 I_{10} [in/hr]= 4.61 I_{100} [in/hr]= 8.65

[6] MHFD *"Drainage Criteria Manual, Vol 1", Eqn 5-1, NOAA Atlas 14*

Runoff - Rational Method Equation[7]

Q_2 [cfs]= 0.00 **Q_5 [cfs]= 0.00** **Q_{10} [cfs]= 0.00** **Q_{100} [cfs]= 0.05**

[7] MHFD *"Drainage Criteria Manual, Vol 1", Eqn 6-1*

Rational Method Calculations

Basin A4

Proposed Conditions

Project: East Street Village
SG Project I.D.: B1396

Prepared By: MLM
Reviewed By: LRE
Date: 06/16/23

Basin Description:

NRCS Soil Type: AcA, Ascalon sandy loam

NRCS Hydrologic Soil Rating: B

Basin Area= 0.19 [acres] = 8,404 [sf]

Surface Characteristics[1]	Sub-Area [sf]	Imp [%]	Runoff Coefficients[1]			
			C_2	C_5	C_{10}	C_{100}
Asphalt	0	100	0.84	0.86	0.86	0.89
Concrete Drives & Walks	2991	90	0.74	0.76	0.78	0.84
Roofs	97	90	0.74	0.76	0.78	0.84
Gravel (packed)	0	40	0.29	0.32	0.38	0.61
Lawns, sandy soil	5316	2	0.01	0.01	0.07	0.44

[1] MHFD *"Urban Storm Drainage Criteria Manual, Vol 1", Table 6-3, Table 6-5*

Weighted Percent Imperviousness : I [%] = 34.33 A_i = 2,885.52 [sf]

Weighted Runoff Coefficients:

C_2 = 0.28 C_5 = 0.29 C_{10} = 0.33 C_{100} = 0.59

Time of Concentration:

Sheet Flow:

L_i [ft] = 73
S_i [%] = 2.80
t_i [min] = 8.89

Concentrated Flow:

L_{t1} [FT] =	0	L_{t2} [FT] = 0
S_{t1} [%] =	2.00	S_{t2} [%] = 2.00
C_{V1}[3] =	20.00	C_{V2}[3] = 15.00
V_{t1} [fps][4] =	2.83	V_{t2} [fps][4] = 2.12
t_{t1} [min] =	0.00	t_{t2} [min] = 0.00

[3] *UDFCD, Table 6-2*
[4] *UDFCD, Eqn 6-4*

t_t [min] = 0.00

Time of Concentration:

$t_c = t_i + t_t$ [min] = 8.89
t_c(minimum)= 5 min
Check for Urbanized Basins:
t_c[5] [min] = 20.16

t_c [min] = 8.9

[5] MHFD *"Drainage Criteria Manual, Vol 1", Eqn 6-5*

Rainfall Intensity[6]

I_2 [in/hr]= 2.28 I_5 [in/hr]= 3.08 I_{10} [in/hr]= 3.85 I_{100} [in/hr]= 7.22

[6] MHFD *"Drainage Criteria Manual, Vol 1", Eqn 5-1, NOAA Atlas 14*

Runoff - Rational Method Equation[7]

Q_2 [cfs]= 0.12 **Q_5 [cfs]= 0.17** **Q_{10} [cfs]= 0.25** **Q_{100} [cfs]= 0.82**

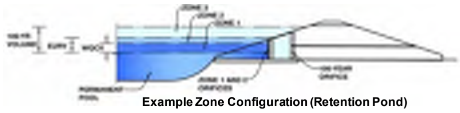
[7] MHFD *"Drainage Criteria Manual, Vol 1", Eqn 6-1*

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: East Street Village

Basin ID: Overall Site - Predevelopment Runoff Calculation



Example Zone Configuration (Retention Pond)

Watershed Information — **Flood Control Only**

Selected BMP Type =	**No BMP**			
Watershed Area =	3.70	acres		
Watershed Length =	416	ft		
Watershed Length to Centroid =	208	ft		
Watershed Slope =	0.021	ft/ft		
Watershed Imperviousness =	12.4%	percent		
Percentage Hydrologic Soil Group A =	0.0%	percent		
Percentage Hydrologic Soil Group B =	100.0%	percent		
Percentage Hydrologic Soil Groups C/D =	0.0%	percent		
Target WQCV Drain Time =	N/A	hours		
Location for 1-hr Rainfall Depths =	Louisville - City Hall			
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) =	0.025	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.044	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.8 in.) =	0.016	acre-feet		inches
5-yr Runoff Volume (P1 = 1.09 in.) =	0.031	acre-feet		inches
10-yr Runoff Volume (P1 = 1.35 in.) =	0.076	acre-feet		inches
25-yr Runoff Volume (P1 = 1.78 in.) =	0.215	acre-feet		inches
50-yr Runoff Volume (P1 = 2.14 in.) =	0.315	acre-feet		inches
100-yr Runoff Volume (P1 = 2.54 in.) =	0.453	acre-feet		inches
500-yr Runoff Volume (P1 = 3.63 in.) =	0.782	acre-feet		inches
Approximate 2-yr Detention Volume =	0.019	acre-feet		
Approximate 5-yr Detention Volume =	0.032	acre-feet		
Approximate 10-yr Detention Volume =	0.065	acre-feet		
Approximate 25-yr Detention Volume =	0.100	acre-feet		
Approximate 50-yr Detention Volume =	0.113	acre-feet		
Approximate 100-yr Detention Volume =	0.153	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (EURV-WQCV) =	0.019	acre-feet
Zone 2 Volume (100-year - Zone 1) =	0.133	acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.153	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	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 = 1.00 ft

THIS SPREADSHEET USED ONLY TO CALCULATE CUHP PREDEVELOPMENT PEAK Q

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)
Media Surface	--	0.00	--	--	--	0	0.000		
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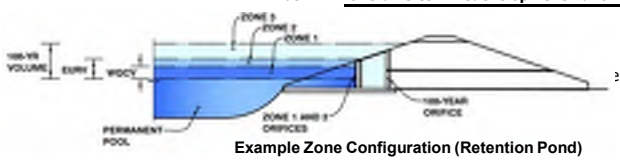
DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: East Street Village

Basin ID: Overall Site - Predevelopment Runoff Calculation



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (EURV - WQCV)	1.49	0.019	Circular Orifice
Zone 2 (100-year)	4.31	0.133	Weir&Pipe (Circular)
Zone 3			
Total (all zones)		0.153	

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

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft²
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

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

Invert of Lowest Orifice =	N/A	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft²
Depth at top of Zone using Orifice Plate =	N/A	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 =	N/A	inches	Elliptical Slot Area =	N/A	ft²

Calculated Parameters for Plate

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

	Row 1 (optional)	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)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Orifice Area (sq. inches)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

	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)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Orifice Area (sq. inches)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 1 Circular	Not Selected			Zone 1 Circular	Not Selected	
Invert of Vertical Orifice =	0.00		ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	0.00		ft²
Depth at top of Zone using Vertical Orifice =	1.49		ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	0.02		feet
Vertical Orifice Diameter =	0.50		inches				

Calculated Parameters for Vertical Orifice

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

	Zone 2 Weir	Not Selected			Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	1.49		ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	1.49		feet
Overflow Weir Front Edge Length =	2.00		feet	Overflow Weir Slope Length =	2.00		feet
Overflow Weir Grate Slope =	0.00		H:V	Grate Open Area / 100-yr Orifice Area =	4.31		
Horiz. Length of Weir Sides =	2.00		feet	Overflow Grate Open Area w/o Debris =	3.16		ft²
Overflow Grate Type =	Close Mesh Grate			Overflow Grate Open Area w/ Debris =	3.16		ft²
Debris Clogging % =	0%		%				

Calculated Parameters for Overflow Weir

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

	Zone 2 Circular	Not Selected			Zone 2 Circular	Not Selected	
Depth to Invert of Outlet Pipe =	0.00		ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	0.73		ft²
Circular Orifice Diameter =	11.60		inches	Outlet Orifice Centroid =	0.48		feet
				Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	4.50	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.34	feet
Spillway Crest Length =	10.00	feet	Stage at Top of Freeboard =	4.94	feet
Spillway End Slopes =	0.00	H:V	Basin Area at Top of Freeboard =	0.07	acres
Freeboard above Max Water Surface =	0.10	feet	Basin Volume at Top of Freeboard =	0.20	acre-ft

Calculated Parameters for Spillway

Routed Hydrograph Results

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

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.80	1.09	1.35	1.78	2.14	2.54	3.63
CUHP Runoff Volume (acre-ft) =	0.025	0.044	0.016	0.031	0.076	0.215	0.315	0.453	0.782
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.016	0.031	0.076	0.215	0.315	0.453	0.782
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.0	0.1	0.8	3.0	4.4	6.1	10.3
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.02	0.23	0.81	1.19	1.65	2.79
Peak Inflow Q (cfs) =									
Peak Outflow Q (cfs) =									
Ratio Peak Outflow to Predevelopment Q =									
Structure Controlling Flow =									
Max Velocity through Grate 1 (fps) =									
Max Velocity through Grate 2 (fps) =									
Time to Drain 97% of Inflow Volume (hours) =									
Time to Drain 99% of Inflow Volume (hours) =									
Maximum Ponding Depth (ft) =									
Area at Maximum Ponding Depth (acres) =									
Maximum Volume Stored (acre-ft) =									

THIS SPREADSHEET USED ONLY TO CALCULATE CUHP PREDEVELOPMENT PEAK Q

Design Point Summary
Onsite and Offsite Flows

Project: East Street Village
SG Project I.D.: B1396

Prepared By: MLM
Reviewed By: LRE
Date: 06/16/23

Existing Conditions			
Design Point	**Basin**	**Q2 [cfs]**	**Q100 [cfs]**
	A1x	0.26	5.42
	OS1	0.01	1.28
	OS2	0.01	0.70
DP 1		**0.28**	**7.40**
	A2x	0.21	2.16
DP 2		**0.21**	**2.16**
Overall Site	**Total**	**0.49**	**9.56**

Proposed Conditions			
Design Point	**Basin**	**Q2 [cfs]**	**Q100 [cfs]**
Rain Garden A*	A1	0.00	2.97
Rain Garden B*	A2	0.00	1.32
	A3	0.00	0.05
	OS1	0.00	0.75
	OS2	0.00	0.54
	OS3	0.00	0.57
DP 1		**0.00**	**6.20**
	A4	0.12	0.82
DP 2		**0.12**	**0.82**
Rain Garden A*	A1	0.13	0.18
Rain Garden B*	A2	0.08	0.13
DP 3		**0.21**	**0.31**
Overall Site	**Total**	**0.33**	**7.33**

* Rain garden/detention pond release rate

Design Point Summary
Onsite Flows

Project: East Street Village
SG Project I.D.: B1396

Prepared By: MLM
Reviewed By: LRE
Date: 06/16/23

Existing Conditions			
Design Point	**Basin**	**Q2 [cfs]**	**Q100 [cfs]**
	A1x	0.26	5.42
DP 1		**0.26**	**5.42**
	A2x	0.21	2.16
DP 2		**0.21**	**2.16**
Overall Site	**Total**	**0.47**	**7.58**

Proposed Conditions			
Design Point	**Basin**	**Q2 [cfs]**	**Q100 [cfs]**
Rain Garden A*	A1	0.00	2.97
Rain Garden B*	A2	0.00	1.32
	A3	0.00	0.05
DP 1		**0.00**	**4.34**
	A4	0.12	0.82
DP 2		**0.12**	**0.82**
Rain Garden A*	A1	0.13	0.18
Rain Garden B*	A2	0.08	0.13
DP 3		**0.21**	**0.31**
Overall Site	**Total**	**0.33**	**5.47**

< 90% Pre-Development Q_{100}

* Rain garden/detention pond release rate

Allowable Site 100-Year Release Rate*		
Total Project Area =	3.7	acres
Pre-Development Q_{100} =	6.1	cfs
90% Pre-Development Q_{100} =	**5.49**	**cfs**

* Per MHFD "*Urban Storm Drainage Criteria Manual*", Volume 2, Chapter 12 - Storage

APPENDIX C

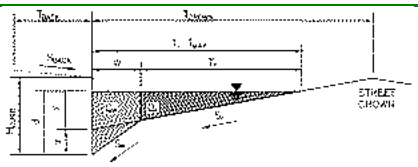
Hydraulic Calculations

MHFD-Inlet, Version 5.02 (August 2022)

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

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

Project: East Street Village
Inlet ID: Double No 16 Inlet



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	4.2	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	26.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.015	

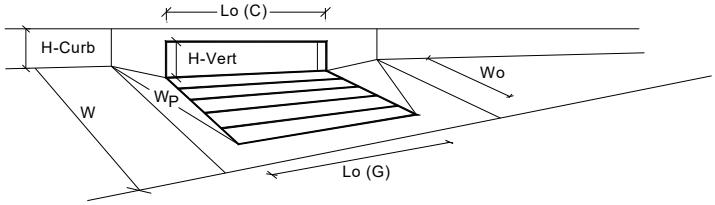
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.0	26.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	7.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

MINOR STORM Allowable Capacity is not applicable to Sump Condition
MAJOR STORM Allowable Capacity is not applicable to Sump Condition

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

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.02 (August 2022)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	2.00	2.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	2	2	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	4.6	7.0	inches
Grate Information		MINOR	MAJOR	☐ Override Depths
Length of a Unit Grate	L_o (G) =	3.00	3.00	feet
Width of a Unit Grate	W_o =	1.73	1.73	feet
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.31	0.31	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	0.50	0.50	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	3.60	3.60	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.60	0.60	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	3.00	3.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.50	6.50	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	5.25	5.25	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	0.00	0.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.70	3.70	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.66	0.66	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	0.41	0.61	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.22	0.42	ft
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.54	0.82	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	N/A	N/A	
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.54	0.82	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**3.62**	**11.88**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms (>Q Peak)	$Q_{PEAK\ REQUIRED}$ =	2.18	9.99	cfs

Inlet Capacity Calculations

Double Type 13 Inlet

Project: East Street Village
SG Project I.D.: B1396

Prepared By: MLM
Reviewed By: LRE
Date: 02/03/23

Type of Inlet: Inlet No. 8 - Double Type 13
Number of Inlets: 2

C_W =	3.00	
C_O =	0.67	
L =	3.30	ft
W =	1.92	ft
L_W =	10.44	ft
d =	0.52	ft
A_O =	4.44	ft^2
g =	32.2	ft/s^2
C_f-G =	0.5	(clogging factor for a single unit grate)

Weir Equation Valid For: $d < 1.79(A_O/L_W)$
Orifice Equation Valid For: $d > 1.79(A_O/L_W)$

$1.79(A_O/L_W)$ = 0.76 Weir Equation Valid

Weir Equation: $Q_i = C_W L_W d^{1.5}$ Equation ST-27, UDFCD USDCM Vol. 1, Ch. 6

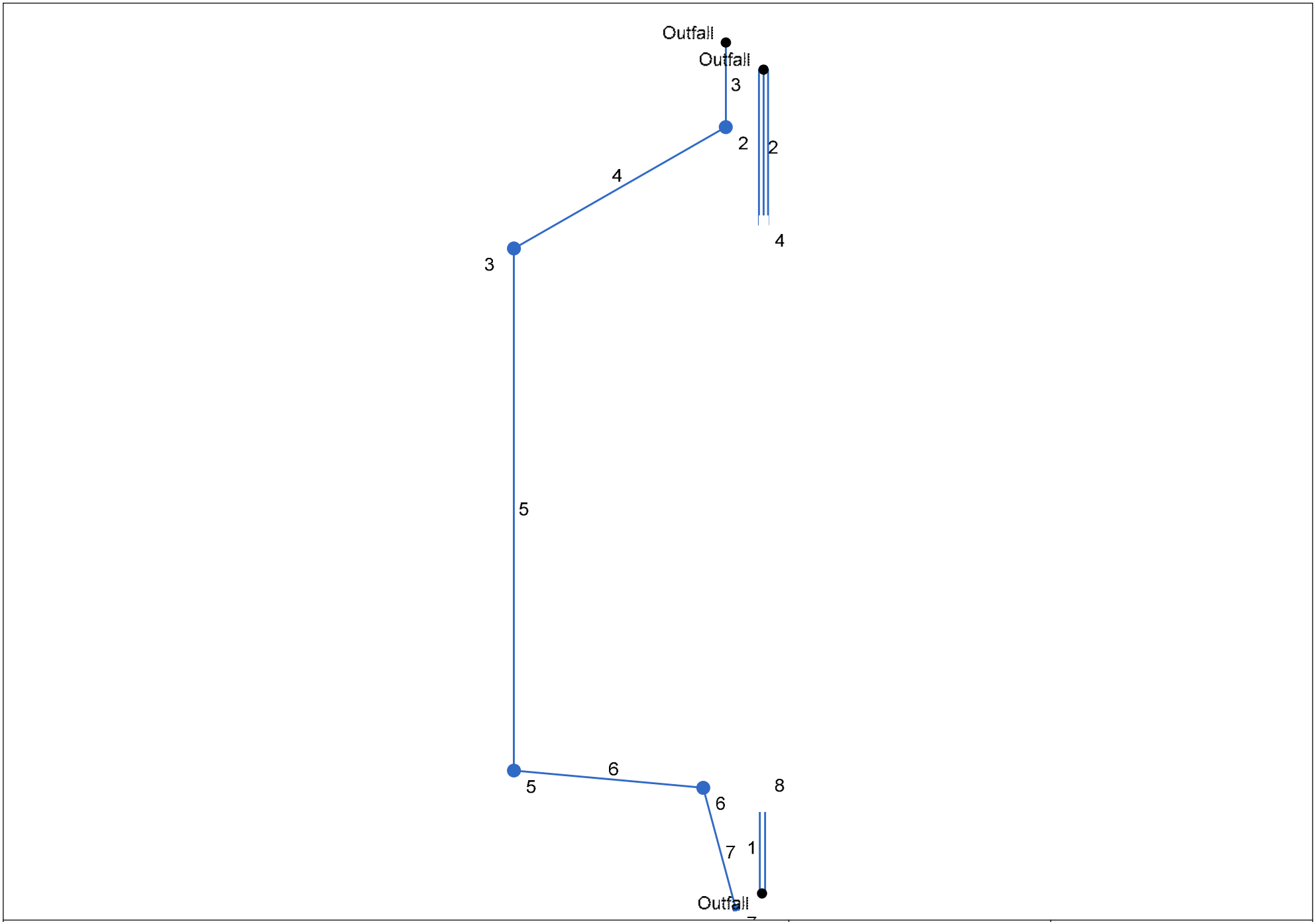
Q_i = 11.74 cfs Inlet No. 8: Q_{100}=7.69 cfs

Orifice Equation: $Q_i = C_O A_O (2gd)^{0.5}$ Equation ST-28, UDFCD USDCM Vol. 1, Ch. 6

Q_i = 17.20 cfs

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

Design Storm: 2-year



Project File: Proposed Storm Sewer - 2.stm	Number of lines: 7	Date: 2/6/2023

Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data								Line ID
	Dnstr Line No.	Line Length (ft)	Defl angle (deg)	Junc Type	Known Q (cfs)	Drng Area (ac)	Runoff Coeff (C)	Inlet Time (min)	Invert El Dn (ft)	Line Slope (%)	Invert El Up (ft)	Line Size (in)	Line Shape	N Value (n)	J-Loss Coeff (K)	Inlet/ Rim El (ft)	
1	End	30.179	-89.726	Grate	1.70	0.00	0.00	0.0	5325.20	0.50	5325.35	12	Cir(2b)	0.013	1.00	5327.57	Pipe - (137)
2	End	51.652	90.000	Comb	2.18	0.00	0.00	0.0	5323.00	0.50	5323.26	12	Cir(3b)	0.013	1.00	5326.00	Pipe - (136)
3	End	28.122	90.000	MH	0.00	0.00	0.00	0.0	5321.00	0.50	5321.14	12	Cir	0.013	0.89	5326.72	Pipe - (129)
4	3	81.096	60.207	MH	0.00	0.00	0.00	0.0	5321.14	0.51	5321.55	12	Cir	0.013	0.89	5327.08	Pipe - (130)
5	4	173.672	-60.207	MH	0.00	0.00	0.00	0.0	5321.55	0.50	5322.42	12	Cir	0.013	1.00	5328.83	Pipe - (131)
6	5	63.092	-84.787	MH	0.00	0.00	0.00	0.0	5322.41	0.51	5322.73	12	Cir	0.013	0.95	5327.80	Pipe - (132)
7	6	41.341	69.925	Grate	0.06	0.00	0.00	0.0	5322.73	0.51	5322.94	12	Cir	0.013	1.00	5326.42	Pipe - (133)

Structure Report

Struct No.	Structure ID	Junction Type	Rim Elev (ft)	Structure			Line Out			Line In		
				Shape	Length (ft)	Width (ft)	Size (in)	Shape	Invert (ft)	Size (in)	Shape	Invert (ft)
1	8	Grate	5327.57	Rect	6.00	3.00	12	Cir (2b)	5325.35			
2	4	Combination	5326.00	Rect	6.00	3.00	12	Cir (3b)	5323.26			
3	2	Manhole	5326.72	Cir	4.00	4.00	12	Cir	5321.14	12	Cir	5321.14
4	3	Manhole	5327.08	Cir	4.00	4.00	12	Cir	5321.55	12	Cir	5321.55
5	5	Manhole	5328.83	Cir	4.00	4.00	12	Cir	5322.42	12	Cir	5322.41
6	6	Manhole	5327.80	Cir	4.00	4.00	12	Cir	5322.73	12	Cir	5322.73
7	7	Grate	5326.42	Rect	2.00	2.00	12	Cir	5322.94			

Project File: Proposed Storm Sewer - 2.stm | Number of Structures: 7 | Run Date: 2/6/2023

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 - (137)	1.70	12	Cir(2b)	30.179	5325.20	5325.35	0.497	5326.20	5326.21	0.02	5326.23	End	Grate
2	Pipe - (136)	2.18	12	Cir(3b)	51.652	5323.00	5323.26	0.503	5324.00	5324.02	0.02	5324.04	End	Combination
3	Pipe - (129)	0.06	12	Cir	28.122	5321.00	5321.14	0.498	5322.00	5322.00	0.00	5322.00	End	Manhole
4	Pipe - (130)	0.06	12	Cir	81.096	5321.14	5321.55	0.505	5322.00	5322.00	0.00	5322.00	3	Manhole
5	Pipe - (131)	0.06	12	Cir	173.672	5321.55	5322.42	0.501	5322.00	5322.52	0.03	5322.55	4	Manhole
6	Pipe - (132)	0.06	12	Cir	63.092	5322.41	5322.73	0.507	5322.55	5322.83	0.03	5322.83	5	Manhole
7	Pipe - (133)	0.06	12	Cir	41.341	5322.73	5322.94	0.508	5322.84	5323.05	0.03	5323.07	6	Grate

Project File: Proposed Storm Sewer - 2.stm

Number of lines: 7

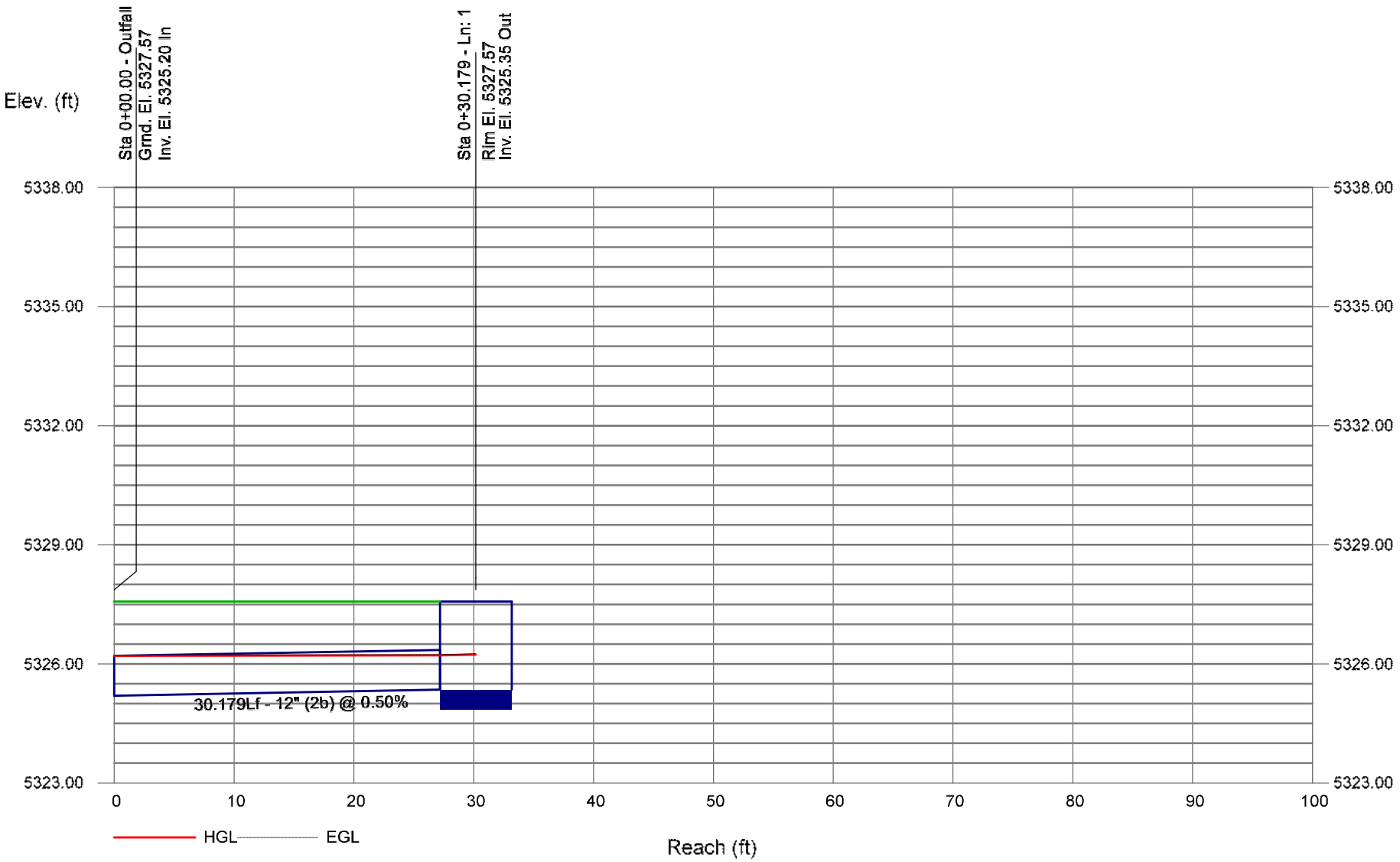
Run Date: 2/6/2023

NOTES: Return period = 2 Yrs.

Storm Sewer Profile

Design Storm: 2-year

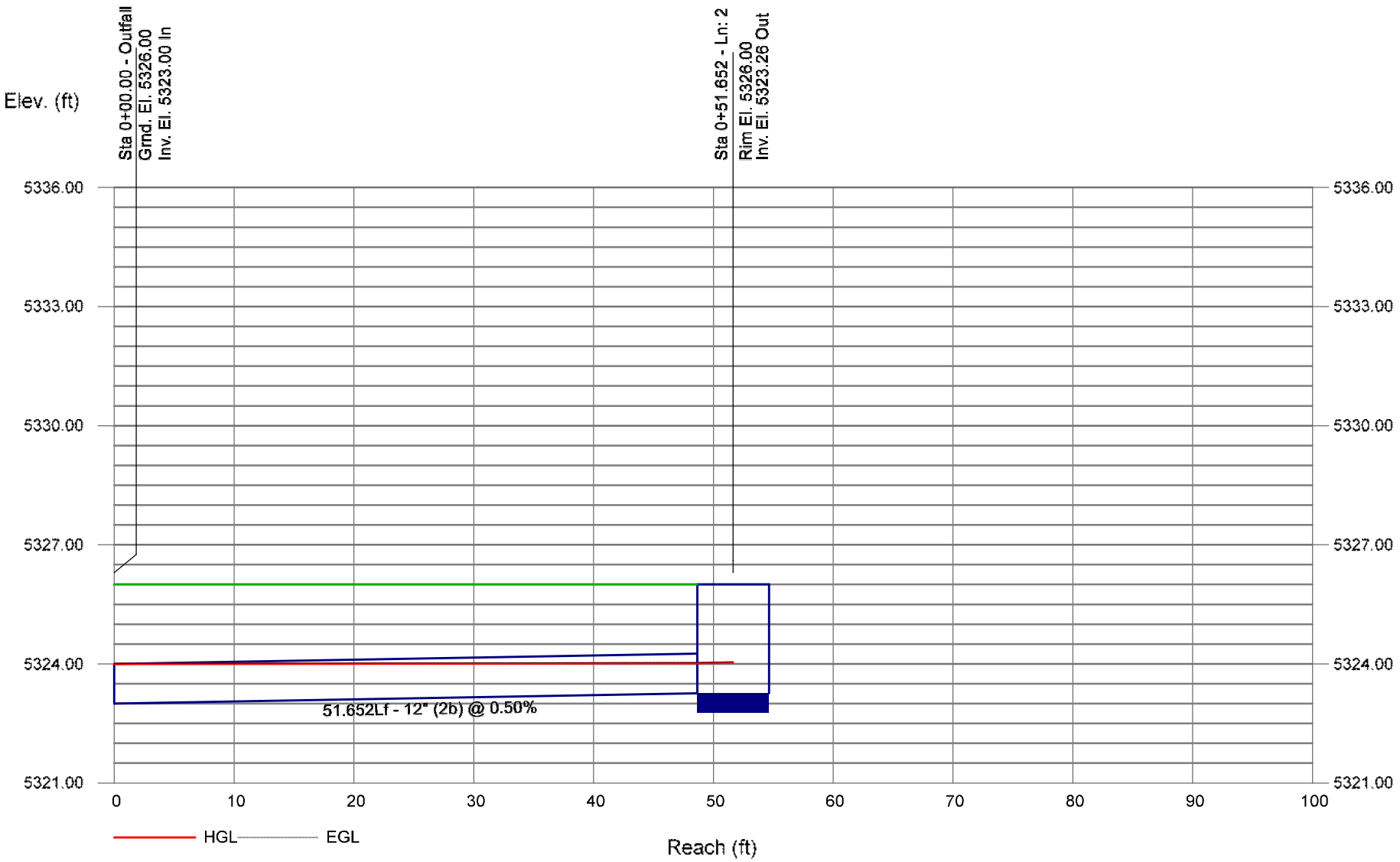
Proj. file: Proposed Storm Sewer - 2.stm



Storm Sewer Profile

Design Storm: 2-year

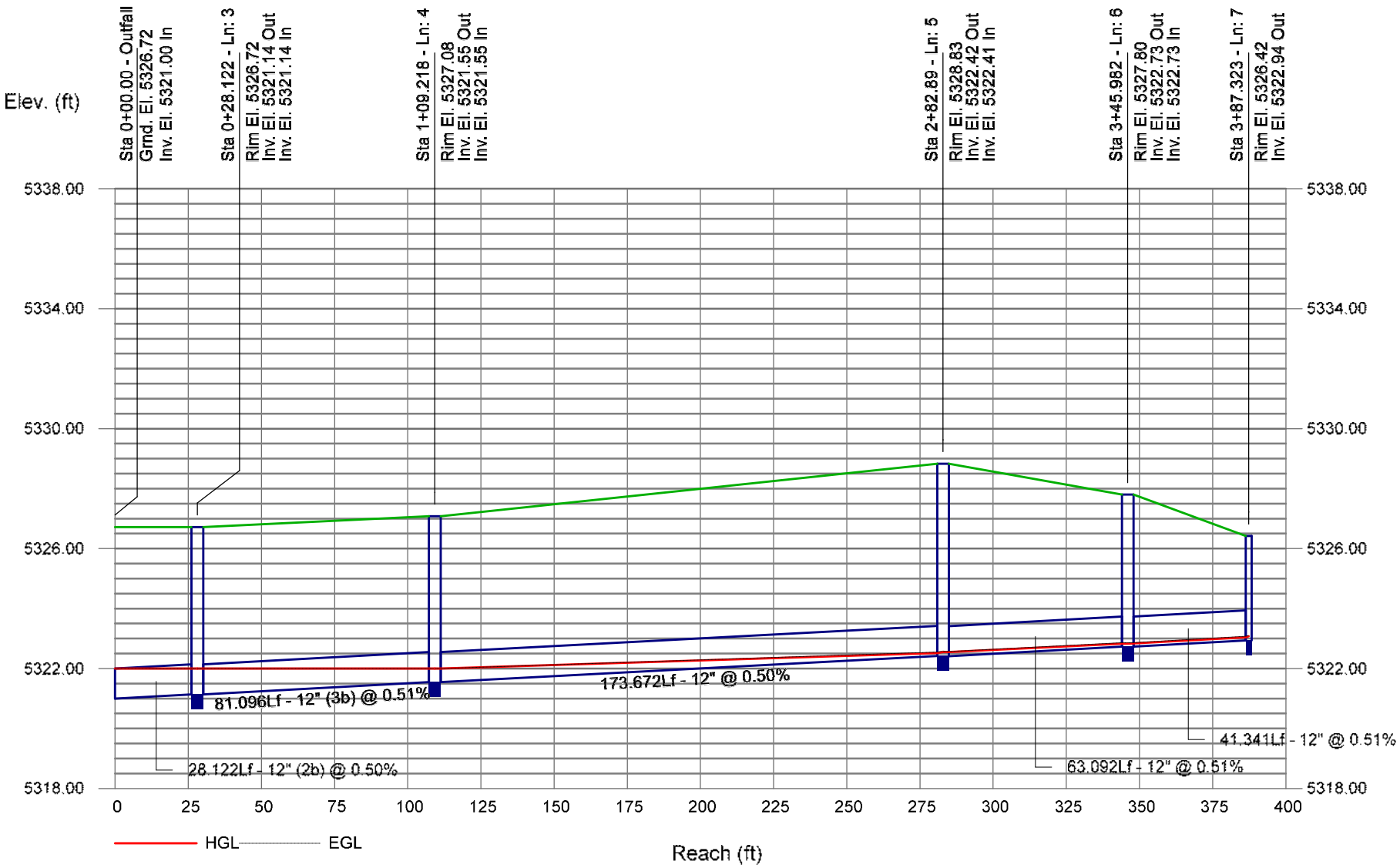
Proj. file: Proposed Storm Sewer - 2.stm



Storm Sewer Profile

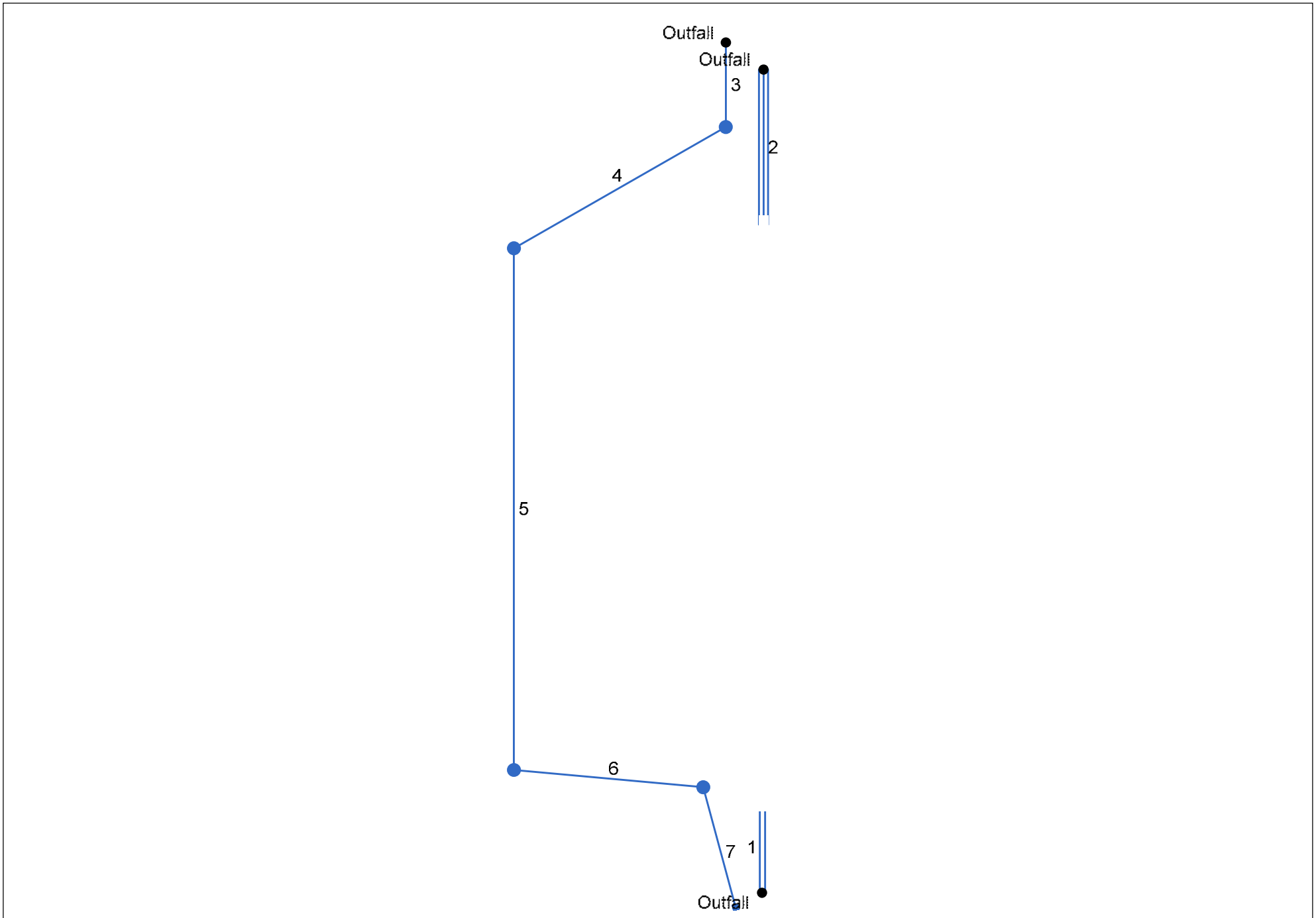
Design Storm: 2-year

Proj. file: Proposed Storm Sewer - 2.stm



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

Design Storm: 100-year



Project File: Proposed Storm Sewer - 100.stm	Number of lines: 7	Date: 6/19/2023

Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data								Line ID
	Dnstr Line No.	Line Length (ft)	Defl angle (deg)	Junc Type	Known Q (cfs)	Drng Area (ac)	Runoff Coeff (C)	Inlet Time (min)	Invert El Dn (ft)	Line Slope (%)	Invert El Up (ft)	Line Size (in)	Line Shape	N Value (n)	J-Loss Coeff (K)	Inlet/ Rim El (ft)	
1	End	30.179	-89.726	Grate	8.23	0.00	0.00	0.0	5325.20	0.50	5325.35	12	Cir(2b)	0.013	1.00	5327.57	Pipe - (137)
2	End	51.652	90.000	Comb	10.74	0.00	0.00	0.0	5323.00	0.50	5323.26	12	Cir(3b)	0.013	1.00	5326.00	Pipe - (136)
3	End	28.122	90.000	MH	0.00	0.00	0.00	0.0	5321.00	0.50	5321.14	12	Cir	0.013	0.89	5326.72	Pipe - (129)
4	3	81.096	60.207	MH	0.00	0.00	0.00	0.0	5321.14	0.51	5321.55	12	Cir	0.013	0.89	5327.08	Pipe - (130)
5	4	173.672	-60.207	MH	0.00	0.00	0.00	0.0	5321.55	0.50	5322.42	12	Cir	0.013	1.00	5328.83	Pipe - (131)
6	5	63.092	-84.787	MH	0.00	0.00	0.00	0.0	5322.41	0.51	5322.73	12	Cir	0.013	0.95	5327.80	Pipe - (132)
7	6	41.341	69.925	Grate	1.99	0.00	0.00	0.0	5322.73	0.51	5322.94	12	Cir	0.013	1.00	5326.42	Pipe - (133)

Project File: Proposed Storm Sewer - 100.stm | Number of lines: 7 | Date: 6/19/2023

Structure Report

Struct No.	Structure ID	Junction Type	Rim Elev (ft)	Structure			Line Out			Line In		
				Shape	Length (ft)	Width (ft)	Size (in)	Shape	Invert (ft)	Size (in)	Shape	Invert (ft)
1	8	Grate	5327.57	Rect	6.00	3.00	12	Cir (2b)	5325.35			
2	4	Combination	5326.00	Rect	6.00	3.00	12	Cir (3b)	5323.26			
3	2	Manhole	5326.72	Cir	4.00	4.00	12	Cir	5321.14	12	Cir	5321.14
4	3	Manhole	5327.08	Cir	4.00	4.00	12	Cir	5321.55	12	Cir	5321.55
5	5	Manhole	5328.83	Cir	4.00	4.00	12	Cir	5322.42	12	Cir	5322.41
6	6	Manhole	5327.80	Cir	4.00	4.00	12	Cir	5322.73	12	Cir	5322.73
7	7	Grate	5326.42	Rect	2.00	2.00	12	Cir	5322.94			

Project File: Proposed Storm Sewer - 100.stm | Number of Structures: 7 | Run Date: 6/19/2023

Storm Sewer Summary Report

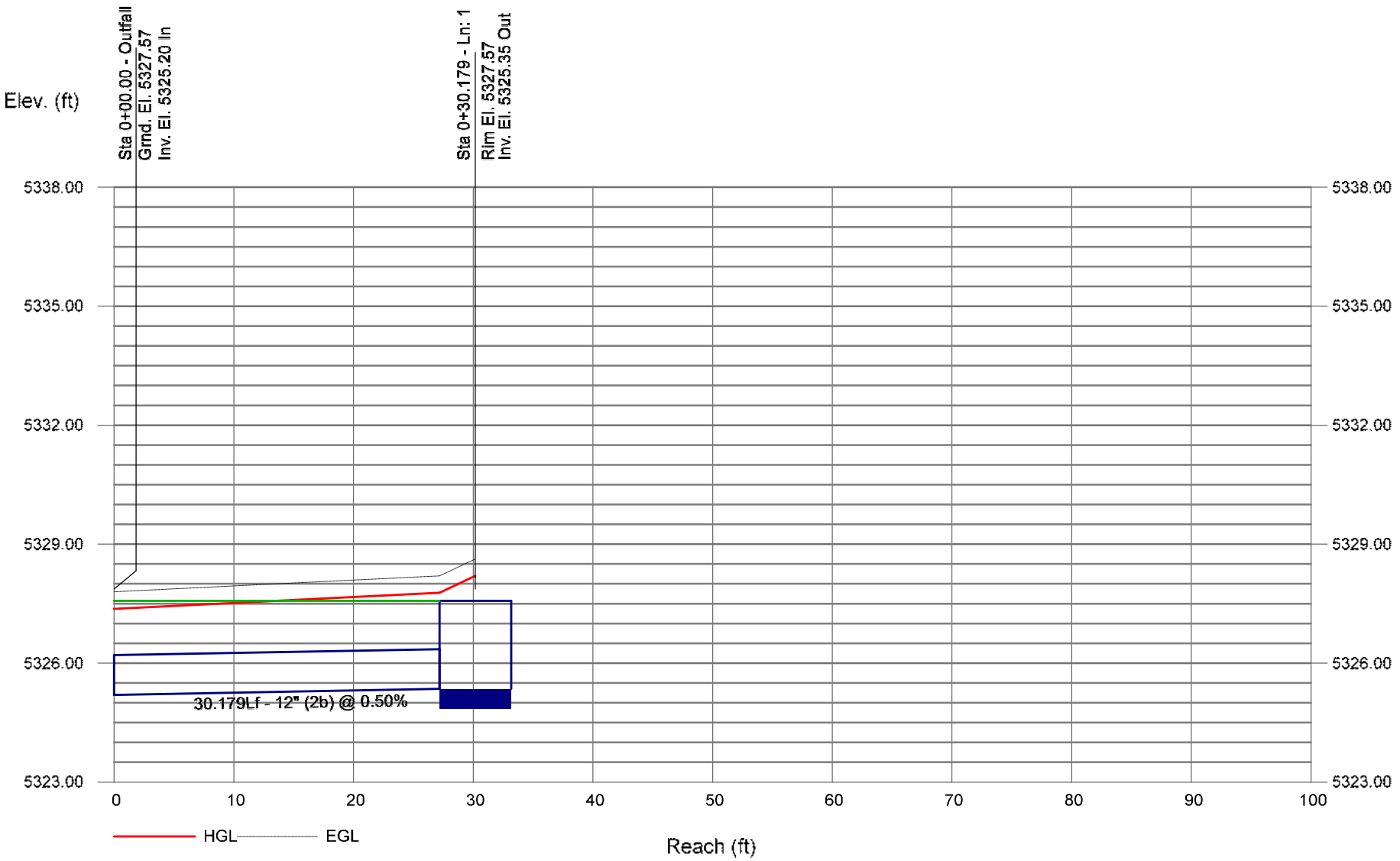
Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	Pipe - (137)	8.23	12	Cir(2b)	30.179	5325.20	5325.35	0.497	5327.37*	5327.77*	0.43	5328.20	End	Grate
2	Pipe - (136)	10.74	12	Cir(3b)	51.652	5323.00	5323.26	0.503	5325.71*	5326.23*	0.32	5326.56	End	Combination
3	Pipe - (129)	1.99	12	Cir	28.122	5321.00	5321.14	0.498	5325.71*	5325.80*	0.09	5325.89	End	Manhole
4	Pipe - (130)	1.99	12	Cir	81.096	5321.14	5321.55	0.505	5325.89*	5326.14*	0.09	5326.23	3	Manhole
5	Pipe - (131)	1.99	12	Cir	173.672	5321.55	5322.42	0.501	5326.23*	5326.77*	0.10	5326.87	4	Manhole
6	Pipe - (132)	1.99	12	Cir	63.092	5322.41	5322.73	0.507	5326.87*	5327.07*	0.09	5327.16	5	Manhole
7	Pipe - (133)	1.99	12	Cir	41.341	5322.73	5322.94	0.508	5327.16*	5327.29*	0.10	5327.39	6	Grate

Project File: Proposed Storm Sewer - 100.stm | Number of lines: 7 | Run Date: 6/19/2023

NOTES: Return period = 100 Yrs. ; *Surcharged (HGL above crown).

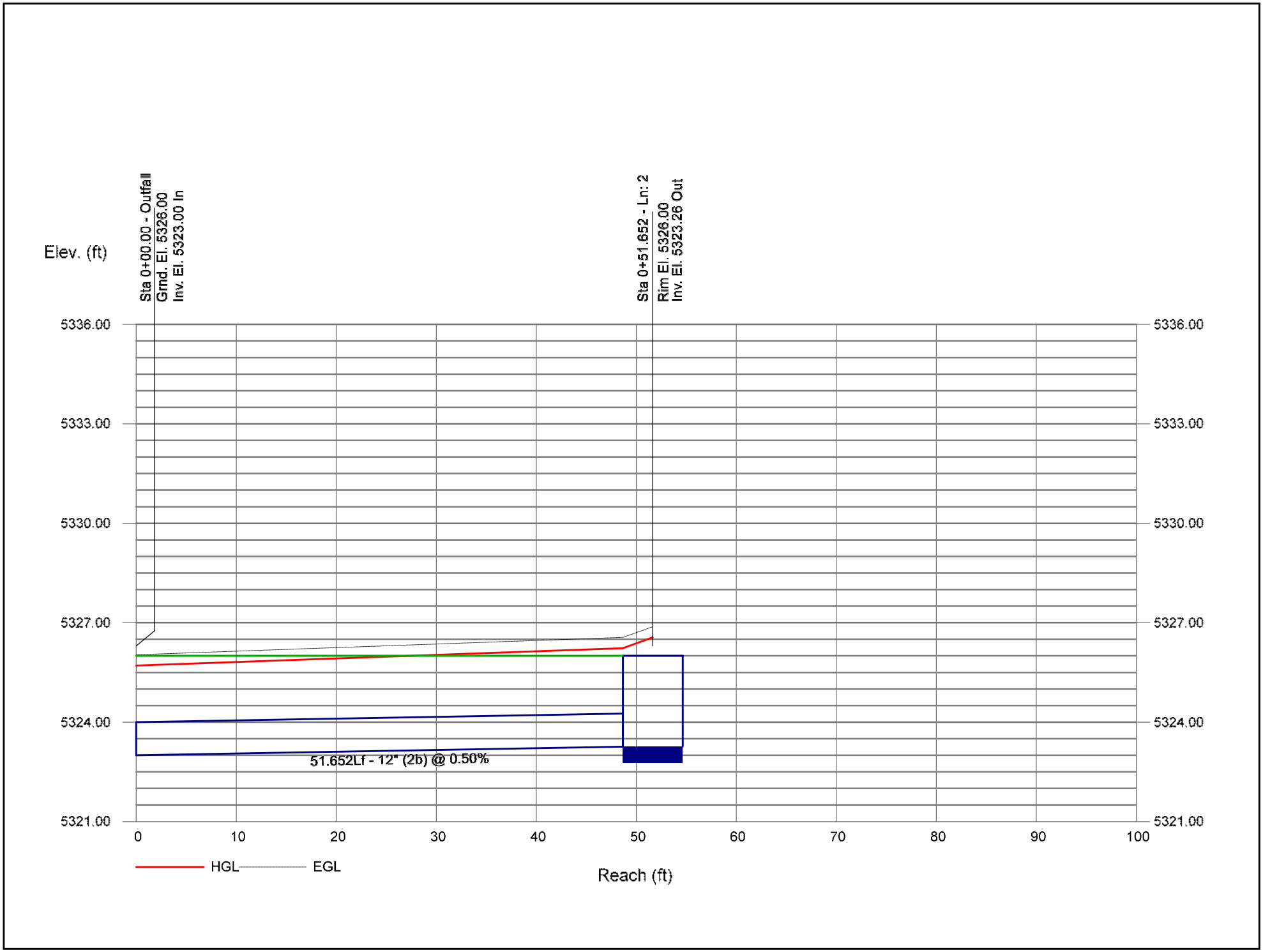
Storm Sewer Profile

Design Storm: 100-year Proj. file: Proposed Storm Sewer - 100.stm



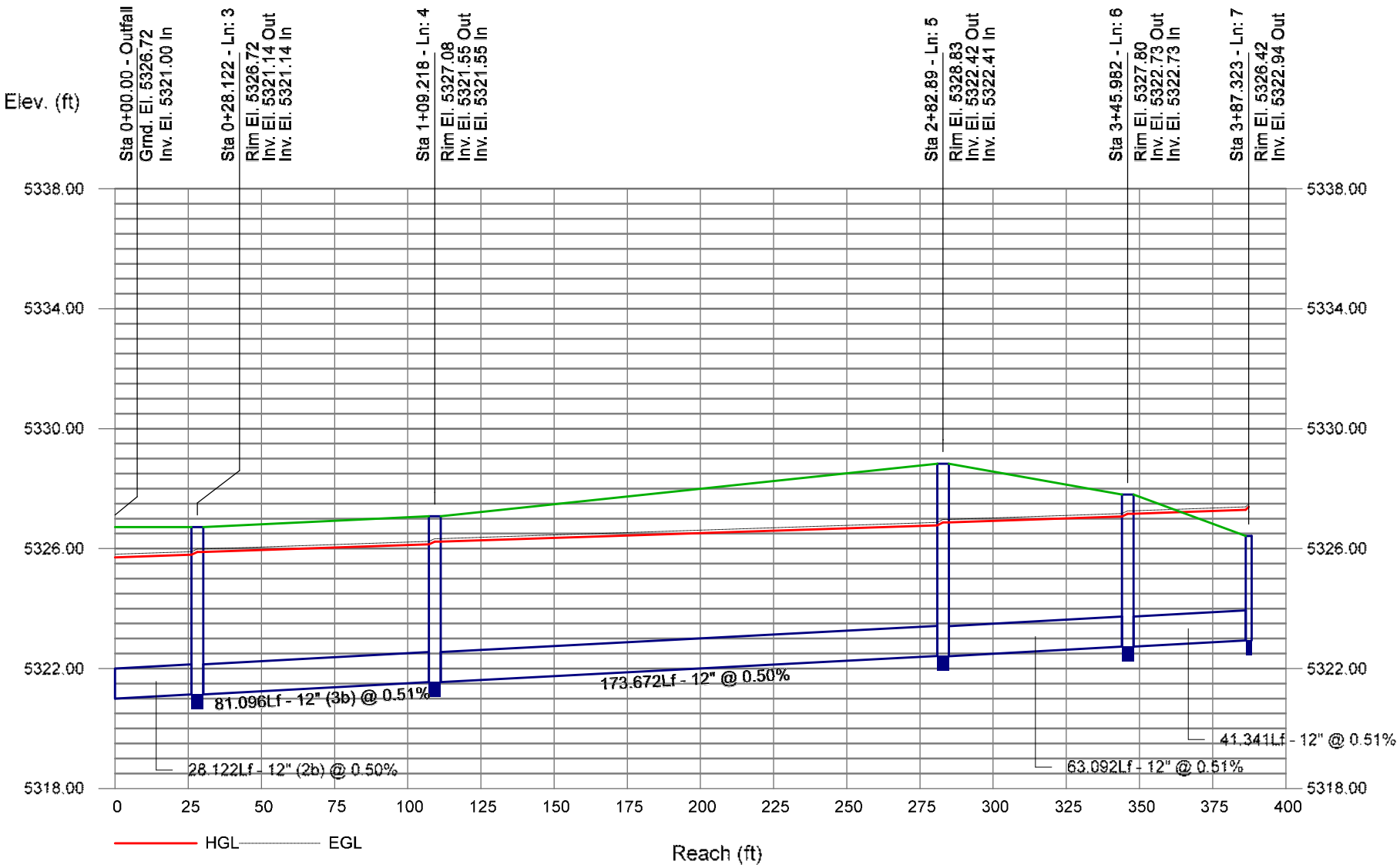
Storm Sewer Profile

Design Storm: 100-year Proj. file: Proposed Storm Sewer - 100.stm



Storm Sewer Profile

Design Storm: 100-year Proj. file: Proposed Storm Sewer - 100.stm



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Tuesday, Feb 7 2023

Existing East Street Culvert 30x19 HERCP

Invert Elev Dn (ft)	=	5323.17
Pipe Length (ft)	=	46.20
Slope (%)	=	0.56
Invert Elev Up (ft)	=	5323.43
Rise (in)	=	19.0
Shape	=	Elliptical
Span (in)	=	30.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Horizontal Ellipse Concrete
Culvert Entrance	=	Groove end projecting (H)
Coeff. K,M,c,Y,k	=	0.0045, 2, 0.0317, 0.69, 0.2

Embankment

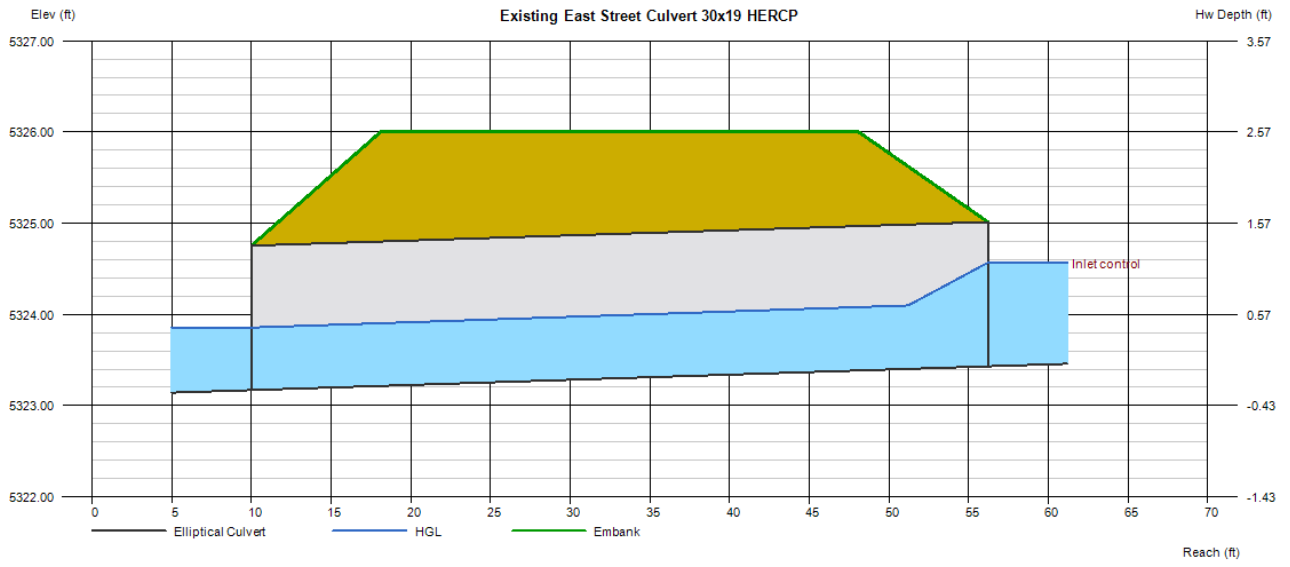
Top Elevation (ft)	=	5326.00
Top Width (ft)	=	30.00
Crest Width (ft)	=	10.00

Calculations

Qmin (cfs)	=	6.00
Qmax (cfs)	=	6.20 = Q_{100}
Tailwater Elev (ft)	=	Normal

Highlighted

Qtotal (cfs)	=	6.20 = Q_{100}
Qpipe (cfs)	=	6.20
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	4.81
Veloc Up (ft/s)	=	4.81
HGL Dn (ft)	=	5323.86
HGL Up (ft)	=	5324.13
Hw Elev (ft)	=	5324.57
Hw/D (ft)	=	0.72
Flow Regime	=	Inlet Control



Hydraulic Analysis Report

Project Data

Project Title: B1396 - East Street Village

Designer:

Project Date: Monday, June 27, 2022

Project Units: U.S. Customary Units

Notes:

Channel Analysis: North Private Street - Section 1 - 100yr Flow

Notes: Single-family homes on north side of street are 29 feet min. from street flowline.

Input Parameters

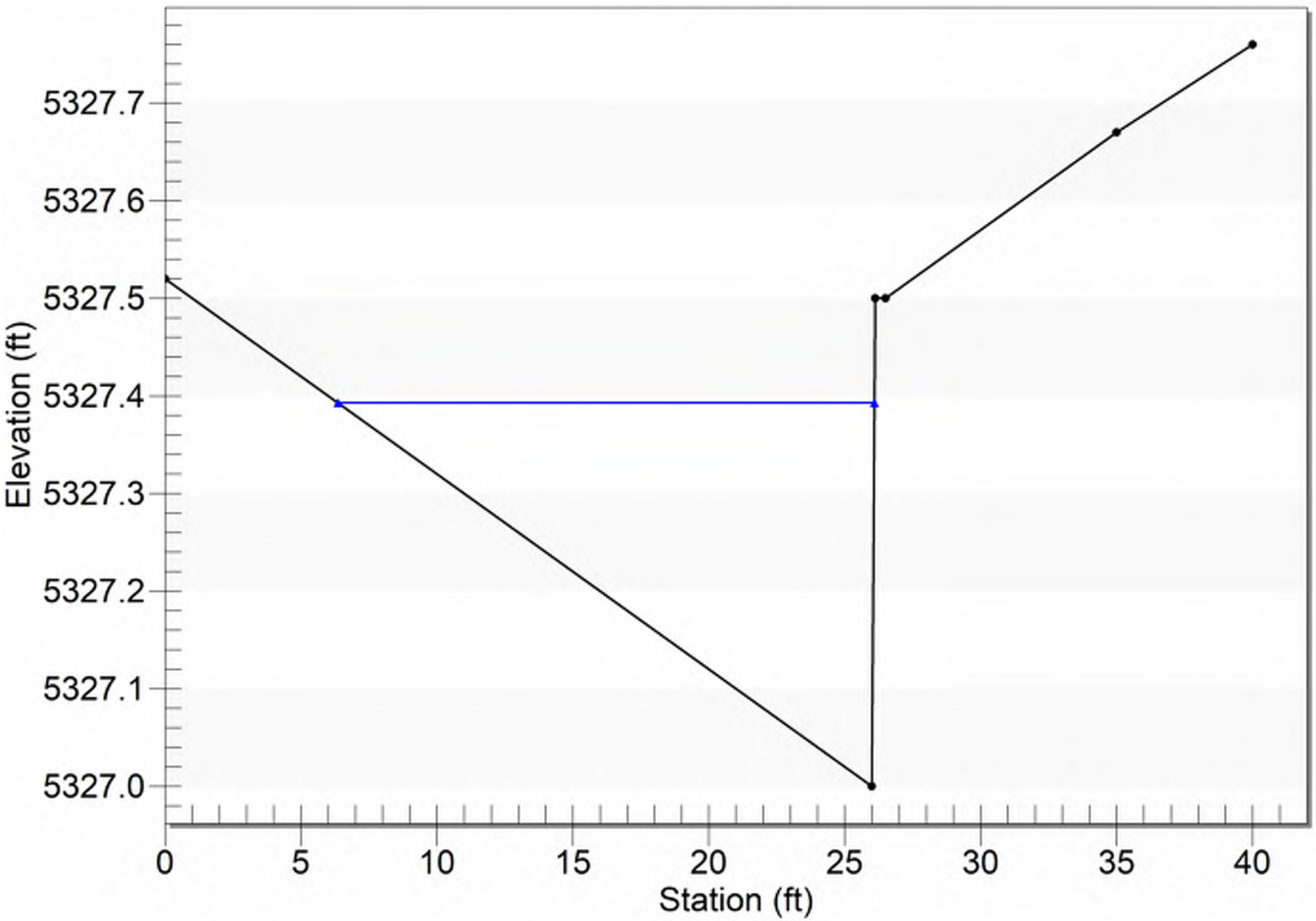
Channel Type: Custom Cross Section

Cross Section Data

Elevation (ft)	Elevation (ft)	Manning's n
0.00	5327.52	0.0150
26.00	5327.00	0.0150
26.12	5327.50	0.0150
26.50	5327.50	0.0200
35.00	5327.67	0.0150
40.00	5327.76	-----

North Private Street - Section 1

100-Year Flow



Longitudinal Slope: 0.0070 ft/ft

Flow: 10.7400 cfs

Result Parameters

Depth: 0.3928 ft

Area of Flow: 3.8756 ft^2

Wetted Perimeter: 20.0473 ft

Hydraulic Radius: 0.1933 ft

Average Velocity: 2.7712 ft/s

Top Width: 19.7337 ft

Froude Number: 1.1020

Critical Depth: 0.4082 ft

Critical Velocity: 2.5654 ft/s

Critical Slope: 0.0057 ft/ft

Critical Top Width: 20.51 ft

Calculated Max Shear Stress: 0.1716 lb/ft^2

Calculated Avg Shear Stress: 0.0844 lb/ft^2

Composite Manning's n Equation: Lotter method

Manning's n: 0.0150

Hydraulic Analysis Report

Project Data

Project Title: B1396 - East Street Village

Designer:

Project Date: Monday, June 27, 2022

Project Units: U.S. Customary Units

Notes:

Channel Analysis: North Private Street - Section 2 - 100yr Flow

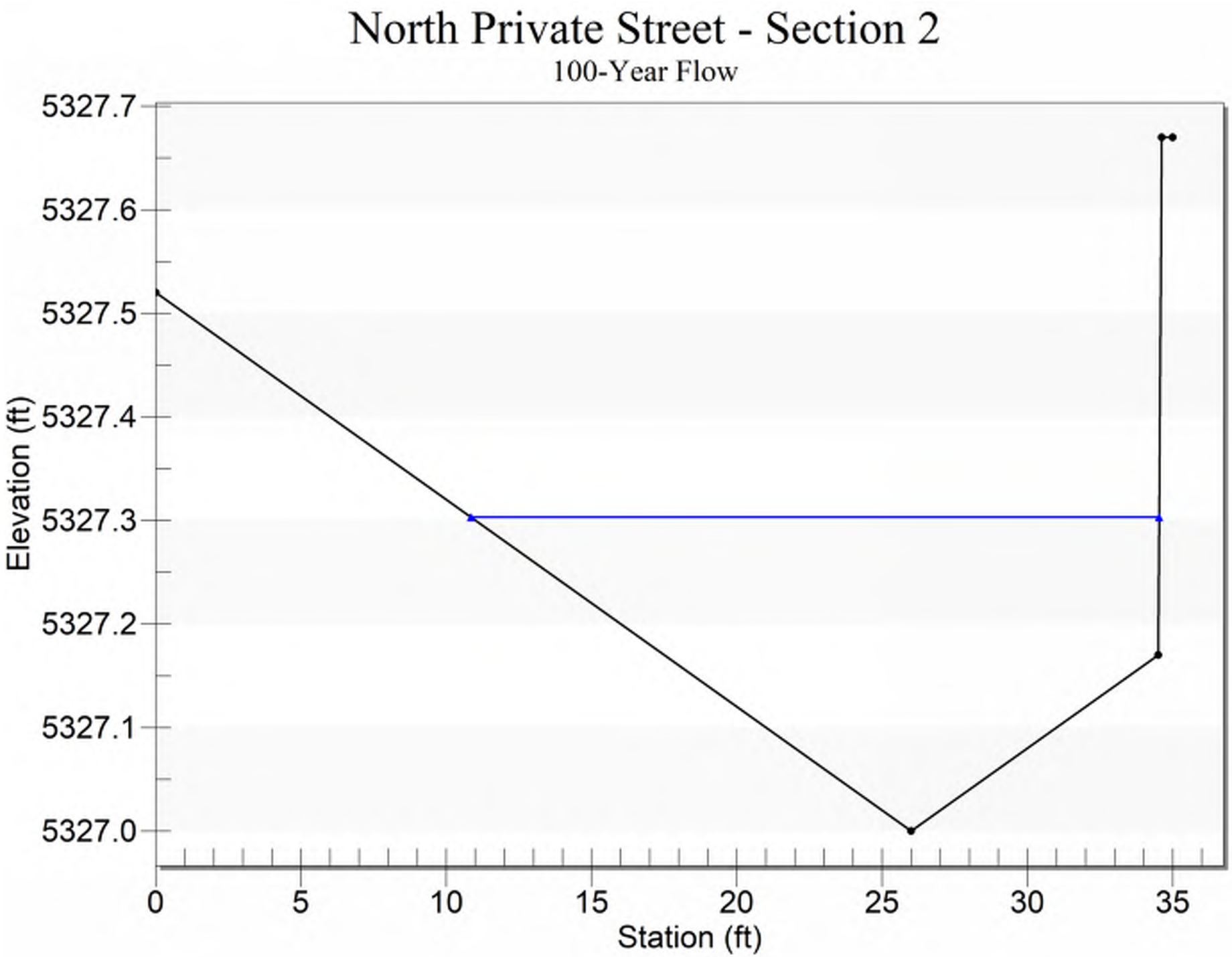
Notes: Single-family homes on north side of street are 29 feet min. from street flowline.

Input Parameters

Channel Type: Custom Cross Section

Cross Section Data

Elevation (ft)	Elevation (ft)	Manning's n
0.00	5327.52	0.0150
26.00	5327.00	0.0150
34.50	5327.17	0.0150
34.62	5327.67	0.0150
35.00	5327.67	-----


North Private Street - Section 2
100-Year Flow
5327.7
5327.6
5327.5
5327.4
5327.3
5327.2
5327.1
5327.0
Elevation (ft)
0
5
10
15
20
25
30
35
Station (ft)

Longitudinal Slope: 0.0070 ft/ft

Flow: 10.7400 cfs

Result Parameters

Depth: 0.3030 ft

Area of Flow: 4.1504 ft^2

Wetted Perimeter: 23.7915 ft

Hydraulic Radius: 0.1744 ft

Average Velocity: 2.5877 ft/s

Top Width: 23.6819 ft

Froude Number: 1.0893

Critical Depth: 0.3147 ft

Critical Velocity: 2.4244 ft/s

Critical Slope: 0.0058 ft/ft

Critical Top Width: 24.27 ft

Calculated Max Shear Stress: 0.1324 lb/ft^2

Calculated Avg Shear Stress: 0.0762 lb/ft^2

Composite Manning's n Equation: Lotter method

Manning's n: 0.0150

Channel Analysis: South Private Street - 100yr Flow

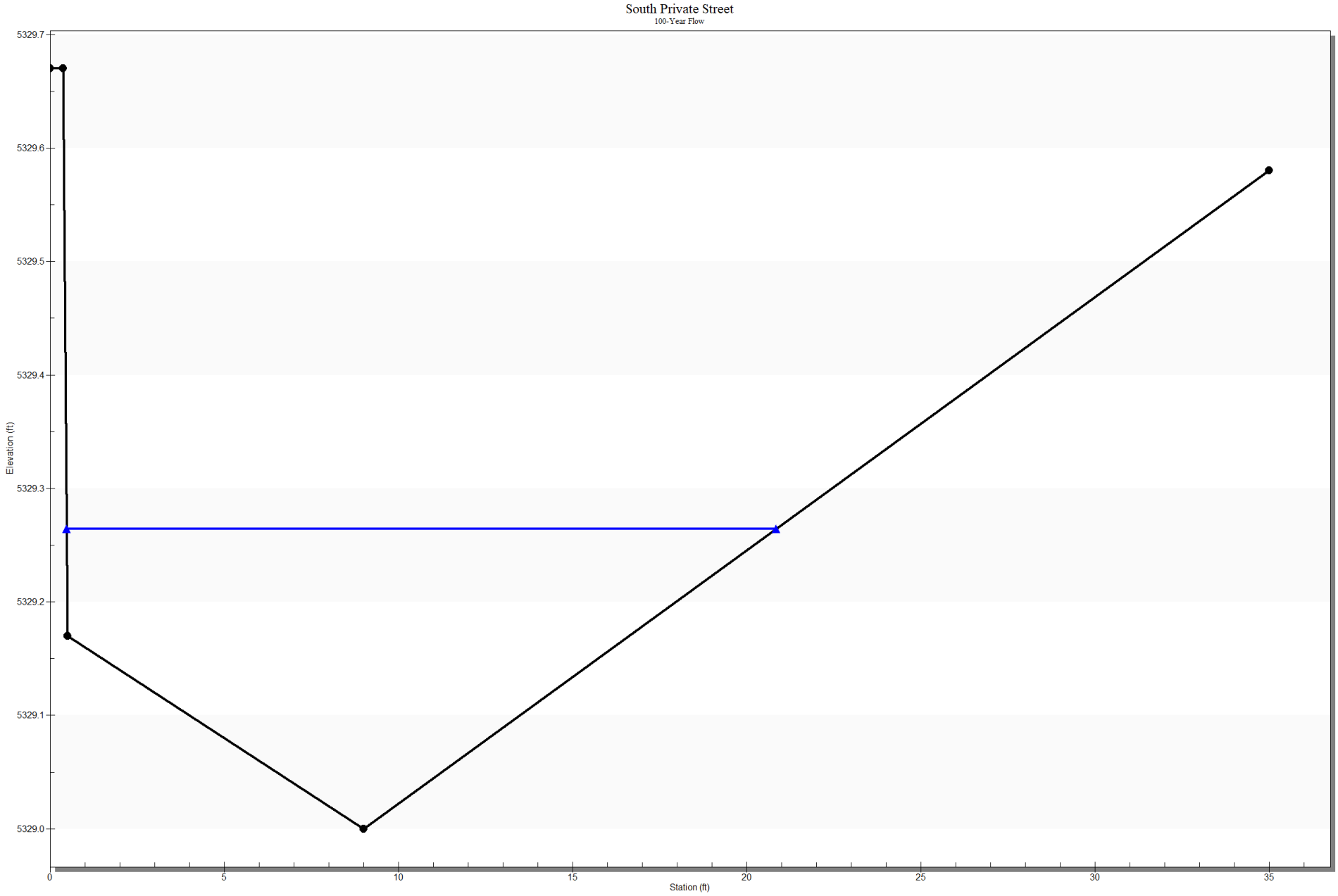
Notes: Single-family homes on south side of street are 29 feet min. from street flowline.

Input Parameters

Channel Type: Custom Cross Section

Cross Section Data

Elevation (ft)	Elevation (ft)	Manning's n
0.00	5329.67	0.0150
0.38	5329.67	0.0150
0.50	5329.17	0.0150
9.00	5329.00	0.0150
35.00	5329.58	-----


South Private Street
100-Year Flow
5329.7
5329.6
5329.5
5329.4
5329.3
5329.2
5329.1
5329.0
Elevation (ft)
0
5
10
15
20
25
30
35
Station (ft)

Longitudinal Slope: 0.0090 ft/ft

Flow: 8.2300 cfs

Result Parameters

Depth: 0.2641 ft

Area of Flow: 3.0876 ft^2

Wetted Perimeter: 20.4425 ft

Hydraulic Radius: 0.1510 ft

Average Velocity: 2.6655 ft/s

Top Width: 20.3643 ft

Froude Number: 1.2063

Critical Depth: 0.2866 ft

Critical Velocity: 2.3144 ft/s

Critical Slope: 0.0060 ft/ft

Critical Top Width: 21.38 ft

Calculated Max Shear Stress: 0.1483 lb/ft^2

Calculated Avg Shear Stress: 0.0848 lb/ft^2

Composite Manning's n Equation: Lotter method

Manning's n: 0.0150

Weir Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Feb 6 2023

North Private Street Overfow Weir

Rectangular Weir

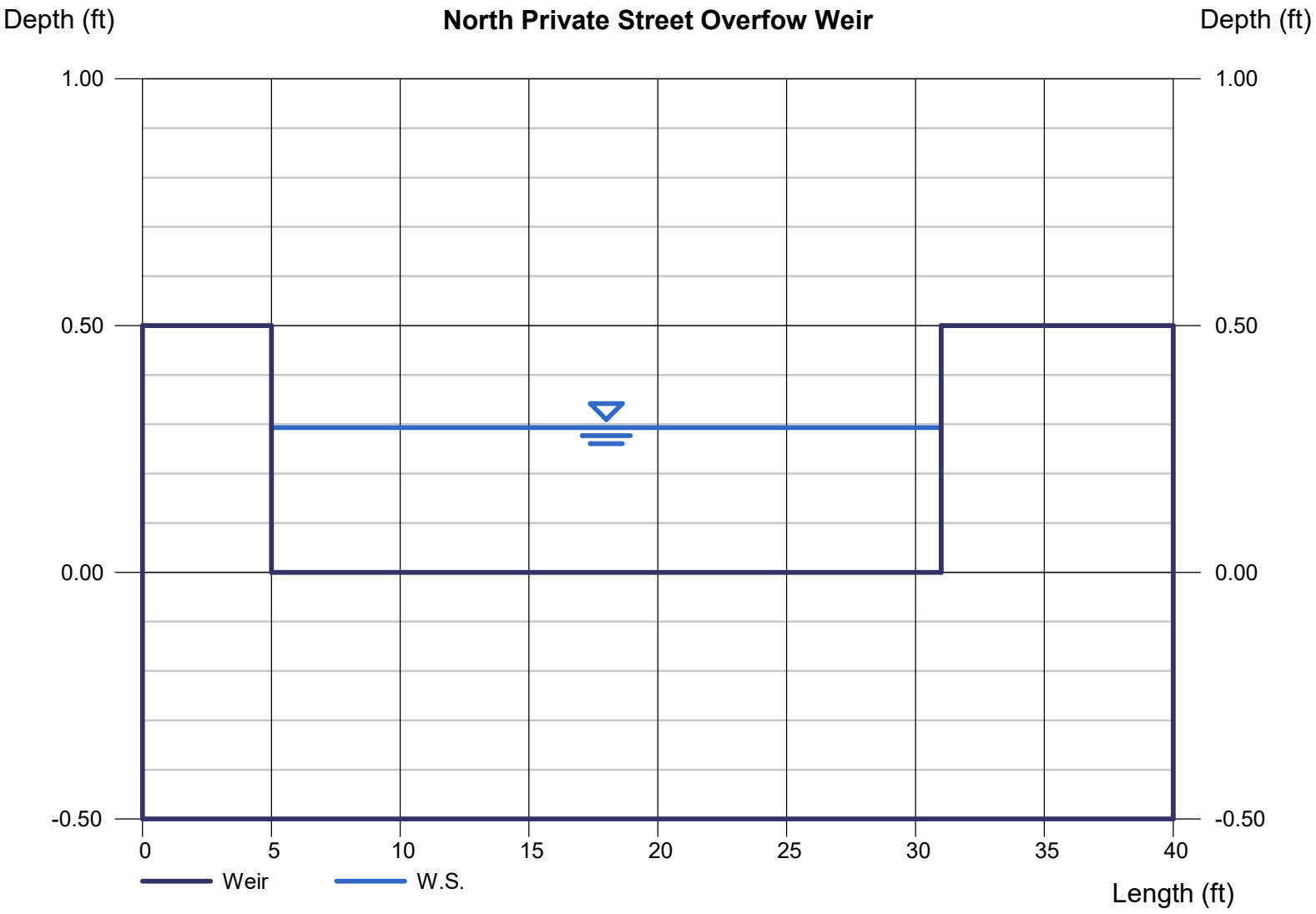
Crest	= Broad
Bottom Length (ft)	= 26.00
Total Depth (ft)	= 0.50

Calculations

Weir Coeff. Cw	= 2.60
Compute by:	Known Q
Known Q (cfs)	= 10.74

Highlighted

Depth (ft)	= 0.29
Q (cfs)	= 10.74
Area (sqft)	= 7.62
Velocity (ft/s)	= 1.41
Top Width (ft)	= 26.00



Weir Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Feb 6 2023

South Private Street Overfow Weir

Rectangular Weir

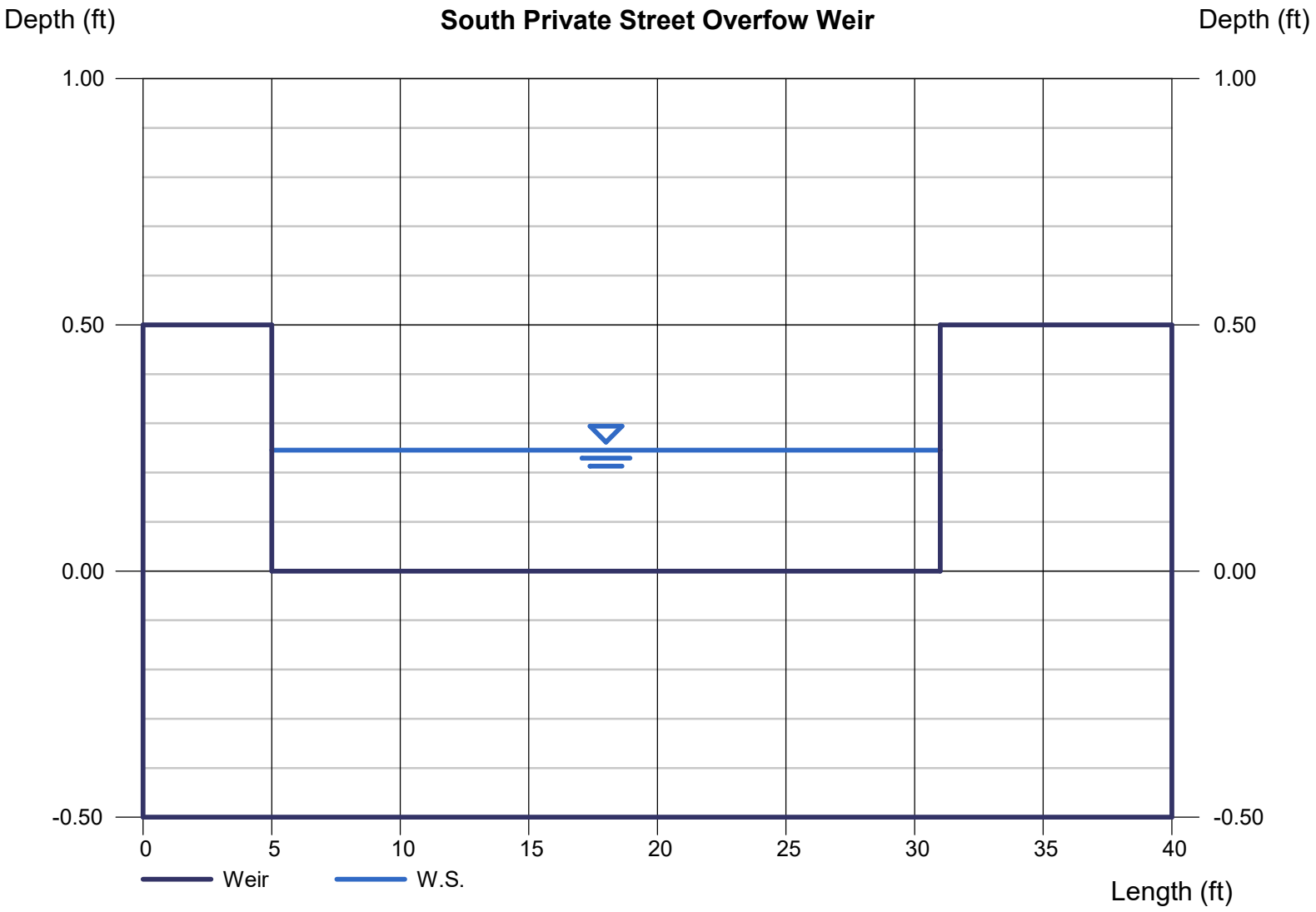
Crest	= Broad
Bottom Length (ft)	= 26.00
Total Depth (ft)	= 0.50

Calculations

Weir Coeff. Cw	= 2.60
Compute by:	Known Q
Known Q (cfs)	= 8.23

Highlighted

Depth (ft)	= 0.25
Q (cfs)	= 8.230
Area (sqft)	= 6.38
Velocity (ft/s)	= 1.29
Top Width (ft)	= 26.00



Weir Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Feb 6 2023

Rain Garden A Overfow Weir

Rectangular Weir

Crest	= Broad
Bottom Length (ft)	= 10.00
Total Depth (ft)	= 1.00

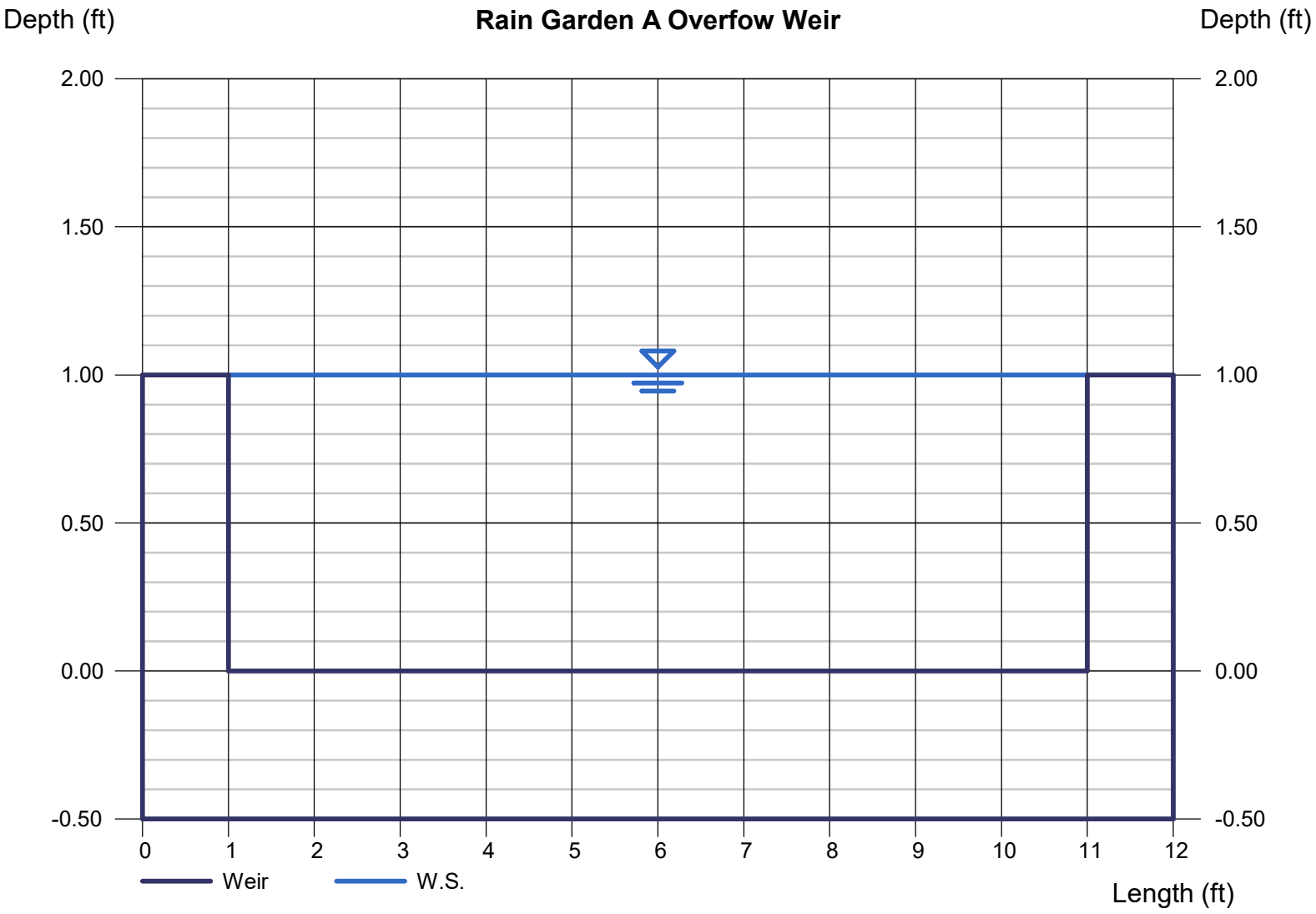
Calculations

Weir Coeff. Cw	= 2.60
Compute by:	Q vs Depth
No. Increments	= 4

Highlighted

Depth (ft)	= 1.00
Q (cfs)	= 26.00
Area (sqft)	= 10.00
Velocity (ft/s)	= 2.60
Top Width (ft)	= 10.00

Weir capacity is greater than the
2 x 100-year release = 12.40 cfs



APPENDIX D

Water Quality Calculations

Detention Pond: Stage-Storage
Rain Garden A

Project: East Street Village
SG Project I.D.: B1396

Prepared By: MLM
Reviewed By: LRE
Date: 02/03/23

Stage [ft]	Elevation [ft]	Contour Area [sf]	Incremental Storage Volume [cf]	Wall Volume Reduction [cf]	Cumulative Storage Volume [cf]	
0.00	5320.85	0	0		0	
0.05	5320.90	24	1		1	
0.10	5320.95	49	2		2	
0.15	5321.00	73	3		5	
0.25	5321.10	234	15		21	
0.35	5321.20	395	31		52	
0.45	5321.30	555	47		100	
0.55	5321.40	716	64		163	
0.65	5321.50	716	72		235	
0.75	5321.60	716	72		306	
0.85	5321.70	716	72		378	
0.95	5321.80	716	72		450	
1.05	5321.90	716	72		521	
1.15	5322.00	716	72		593	
1.25	5322.10	716	72		664	
1.35	5322.20	716	72		736	
1.45	5322.30	716	72		808	
1.55	5322.40	716	72		879	
1.65	5322.50	716	72		951	
1.75	5322.60	716	72		1022	
1.85	5322.70	716	72		1094	
1.95	5322.80	716	72		1166	
2.05	5322.90	716	72		1237	
2.15	5323.00	716	72		1309	**FG Rain Garden**
2.16	5323.01	2186	15		1323	
2.25	5323.10	2186	197	11	1509	
2.35	5323.20	2186	219	11	1717	
2.45	5323.30	2186	219	11	1924	
2.55	5323.40	2186	219	11	2132	
2.65	5323.50	2186	219	11	2339	
2.75	5323.60	2186	219	11	2546	
2.85	5323.70	2186	219	11	2754	
2.95	5323.80	2186	219	11	2961	
3.05	5323.90	2186	219	11	3169	
3.15	5324.00	2186	219	11	3376	**$WSEL_{WQCV}$ WQCV=1,347-cf**
3.25	5324.10	2186	219		3595	
3.26	5324.11	2377	23		3618	
3.35	5324.20	2533	221		3839	
3.45	5324.30	2688	261		4100	
3.55	5324.40	2844	277		4376	
3.65	5324.50	2999	292		4669	
3.75	5324.60	2999	300		4968	
3.85	5324.70	2999	300		5268	
3.95	5324.80	2999	300		5568	**$WSEL_{EURV}$ EURV=5,532-cf**
4.05	5324.90	2999	300		5868	
4.15	5325.00	2999	300		6168	
4.25	5325.10	2999	300		6468	
4.35	5325.20	2999	300		6768	
4.45	5325.30	2999	300		7068	
4.55	5325.40	2999	300		7368	
4.65	5325.50	2999	300		7668	**Top of Emergency Overflow Weir**
4.75	5325.60	2999	300		7967	
4.85	**5325.70**	**2999**	**300**		**8267**	**$WSEL_{100YR}$ V_{DET100}=8,276-cf**
4.95	5325.80	2999	300		8567	
5.05	5325.90	2999	300		8867	
5.15	5326.00	2999	300		9167	
5.25	5326.10	2849	292		9459	
5.30	5326.15	2999	146		9606	
5.35	5326.20	2999	150		9756	
5.45	5326.30	2999	300		10055	
5.55	5326.40	2999	300		10355	
5.65	5326.50	2999	300		10655	**Top of Wall**

Design Procedure Form: Rain Garden (RG)

UD-BMP (Version 3.07, March 2018)

Designer: MLM
Company: The Sanitas Group
Date: June 16, 2023
Project: East Street Village
Location: Basin A1 - Rain Garden A

1. Basin Storage Volume

A) Effective Imperviousness of Tributary Area, I_a (100% if all paved and roofed areas upstream of rain garden): I_a = 59.08 %

B) Tributary Area's Imperviousness Ratio ($i = I_a/100$): i = 0.591

C) Water Quality Capture Volume (WQCV) for a 12-hour Drain Time ($WQCV = 0.8 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i)$): WQCV = 0.19 watershed inches

D) Contributing Watershed Area (including rain garden area): Area = 86,659 sq ft

E) Water Quality Capture Volume (WQCV) Design Volume, Vol = (WQCV / 12) * Area: V_{WQCV} = 1,347 cu ft

F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm: d_6 = in

G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume: $V_{WQCV\ OTHER}$ = cu ft

H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired): $V_{WQCV\ USER}$ = cu ft

2. Basin Geometry

A) WQCV Depth (12-inch maximum): D_{WQCV} = 12 in

B) Rain Garden Side Slopes (Z = 4 min., horiz. dist per unit vertical) (Use "0" if rain garden has vertical walls): Z = 0.00 ft / ft

C) Mimimum Flat Surface Area: A_{Min} = 1024 sq ft

D) Actual Flat Surface Area: A_{Actual} = 1359 sq ft

E) Area at Design Depth (Top Surface Area): A_{Top} = 1359 sq ft

F) Rain Garden Total Volume ($V_T = ((A_{Top} + A_{Actual}) / 2) * Depth$): V_T = 1,359 cu ft

3. Growing Media

Choose One
- (●) 18" Rain Garden Growing Media
- ( ) Other (Explain):

4. Underdrain System

A) Are underdrains provided?

Choose One
- (●) YES
- ( ) NO

B) Underdrain system orifice diameter for 12 hour drain time

i) Distance From Lowest Elevation of the Storage Volume to the Center of the Orifice: y = 2.1 ft

ii) Volume to Drain in 12 Hours: Vol_{12} = 1,347 cu ft

iii) Orifice Diameter, 3/8" Minimum: D_O = 13/16 in

Design Procedure Form: Rain Garden (RG)

Designer: MLM
Company: The Sanitas Group
Date: June 16, 2023
Project: East Street Village
Location: Basin A1 - Rain Garden A

5. Impermeable Geomembrane Liner and Geotextile Separator Fabric A) Is an impermeable liner provided due to proximity of structures or groundwater contamination?	Choose One ○ YES ○ NO
6. Inlet / Outlet Control A) Inlet Control	Choose One ○ Sheet Flow- No Energy Dissipation Required ○ Concentrated Flow- Energy Dissipation Provided
7. Vegetation	Choose One ○ Seed (Plan for frequent weed control) ○ Plantings ○ Sand Grown or Other High Infiltration Sod
8. Irrigation A) Will the rain garden be irrigated?	Choose One ○ YES ○ NO

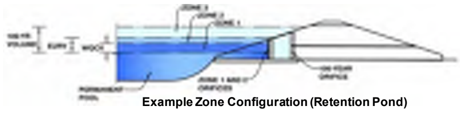
Notes:

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: **East Street Village**

Basin ID: **Basin A1 - Rain Garden A**



Example Zone Configuration (Retention Pond)

Watershed Information — **Flood Control Only**

Selected BMP Type =	**No BMP**	
Watershed Area =	1.99	acres
Watershed Length =	500	ft
Watershed Length to Centroid =	250	ft
Watershed Slope =	0.011	ft/ft
Watershed Imperviousness =	59.1%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	N/A	hours
Location for 1-hr Rainfall Depths =	Louisville - City Hall	

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) =	0.039	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.127	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.8 in.) =	0.069	acre-feet		inches
5-yr Runoff Volume (P1 = 1.09 in.) =	0.100	acre-feet		inches
10-yr Runoff Volume (P1 = 1.35 in.) =	0.136	acre-feet		inches
25-yr Runoff Volume (P1 = 1.78 in.) =	0.211	acre-feet		inches
50-yr Runoff Volume (P1 = 2.14 in.) =	0.269	acre-feet		inches
100-yr Runoff Volume (P1 = 2.54 in.) =	0.341	acre-feet		inches
500-yr Runoff Volume (P1 = 3.63 in.) =	0.526	acre-feet		inches
Approximate 2-yr Detention Volume =	0.066	acre-feet		
Approximate 5-yr Detention Volume =	0.096	acre-feet		
Approximate 10-yr Detention Volume =	0.132	acre-feet		
Approximate 25-yr Detention Volume =	0.165	acre-feet		
Approximate 50-yr Detention Volume =	0.183	acre-feet		
Approximate 100-yr Detention Volume =	0.212	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (EURV-WQCV) =	0.089	acre-feet
Zone 2 Volume (100-year - Zone 1) =	0.124	acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.212	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	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 Increement = 1.00 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)
Media Surface	--	0.00	--	--	--	0	0.000		
	--	0.15	--	--	--	73	0.002	5	0.000
	--	0.55	--	--	--	716	0.016	163	0.004
FG Rain Garden	--	2.15	--	--	--	716	0.016	1,309	0.030
	--	2.16	--	--	--	2,186	0.050	1,323	0.030
WQCV=1,347-cf	--	3.15	--	--	--	1,962	0.045	3,376	0.078
	--	3.25	--	--	--	2,420	0.056	3,595	0.083
	--	3.26	--	--	--	2,377	0.055	3,619	0.083
	--	3.65	--	--	--	2,999	0.069	4,667	0.107
EURV=5,532-cf, V_{DET100}=8,276-cf	--	5.65	--	--	--	2,999	0.069	10,665	0.245
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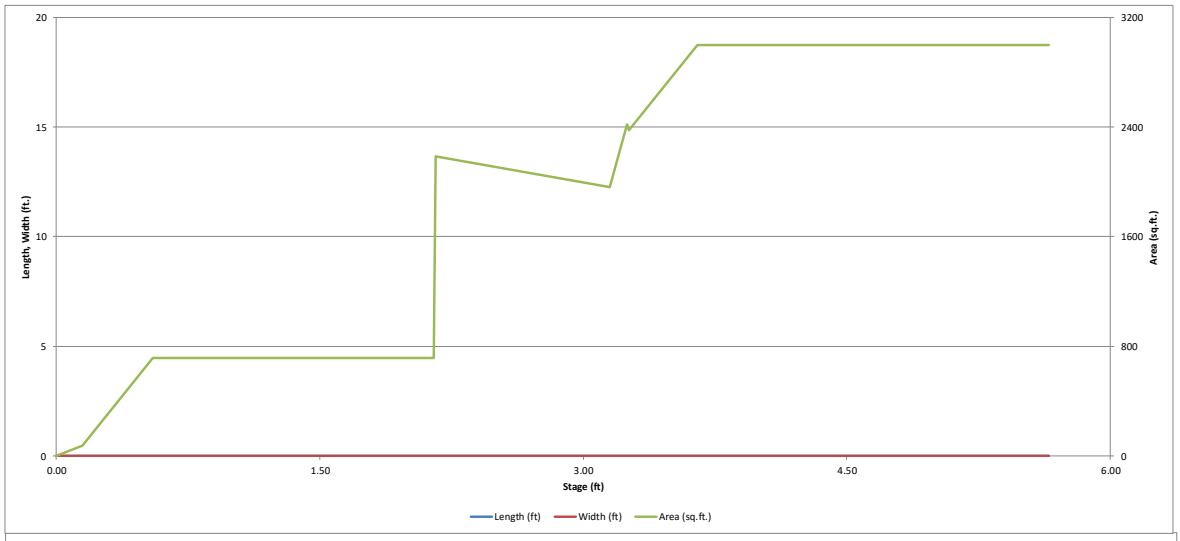
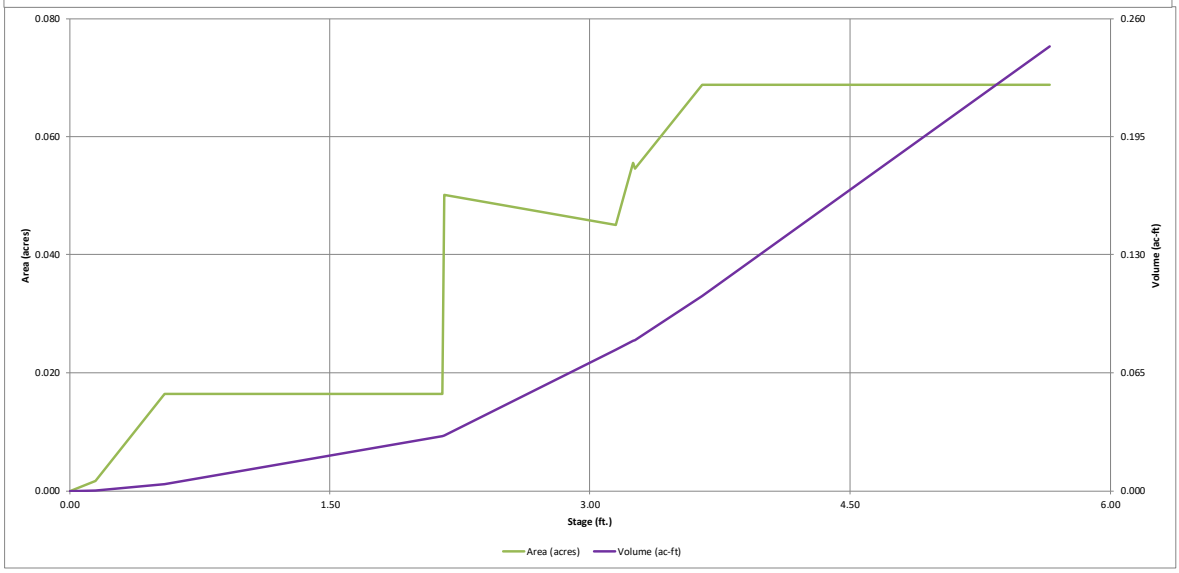
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)



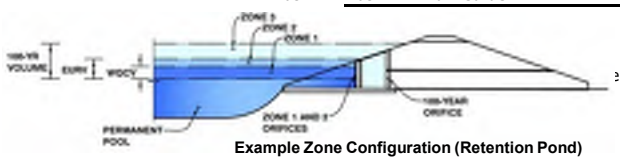


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: East Street Village

Basin ID: Basin A1 - Rain Garden A



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (EURV - WQCV)	3.37	0.089	Circular Orifice
Zone 2 (100-year)	5.18	0.124	Weir (No Pipe)
Zone 3			
Total (all zones)		0.212	

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

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft²
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

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

Invert of Lowest Orifice =	N/A	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft²
Depth at top of Zone using Orifice Plate =	N/A	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 =	N/A	inches	Elliptical Slot Area =	N/A	ft²

Calculated Parameters for Plate

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

	Row 1 (optional)	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)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Orifice Area (sq. inches)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

	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)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Orifice Area (sq. inches)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 1 Circular	Not Selected		Zone 1 Circular	Not Selected	
Invert of Vertical Orifice =	0.00		ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	0.02	ft²
Depth at top of Zone using Vertical Orifice =	3.37		ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	0.07	feet
Vertical Orifice Diameter =	1.75		inches			

Calculated Parameters for Vertical Orifice

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

	Zone 2 Weir	Not Selected		Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	4.65		ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	N/A	feet
Overflow Weir Bottom Length =	10.00		feet	Overflow Weir Slope Length =	N/A	feet
Overflow Weir Side Slopes =	0.00		H:V	Grate Open Area / 100-yr Orifice Area =	N/A	
Horiz. Length of Weir Sides =	N/A		feet	Overflow Grate Open Area w/o Debris =	N/A	ft²
Overflow Grate Type =	N/A			Overflow Grate Open Area w/ Debris =	N/A	ft²
Debris Clogging % =	N/A		%			

Calculated Parameters for Overflow Weir

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

	Not Selected	Not Selected		Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =	N/A		ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	N/A	ft²
Circular Orifice Diameter =	N/A		inches	Outlet Orifice Centroid =	N/A	feet
				Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=		ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	feet
Spillway Crest Length =		feet	Stage at Top of Freeboard =	feet
Spillway End Slopes =		H:V	Basin Area at Top of Freeboard =	acres
Freeboard above Max Water Surface =		feet	Basin Volume at Top of Freeboard =	acre-ft
Spillway position relative to Overflow Weir =				

Calculated Parameters for Spillway

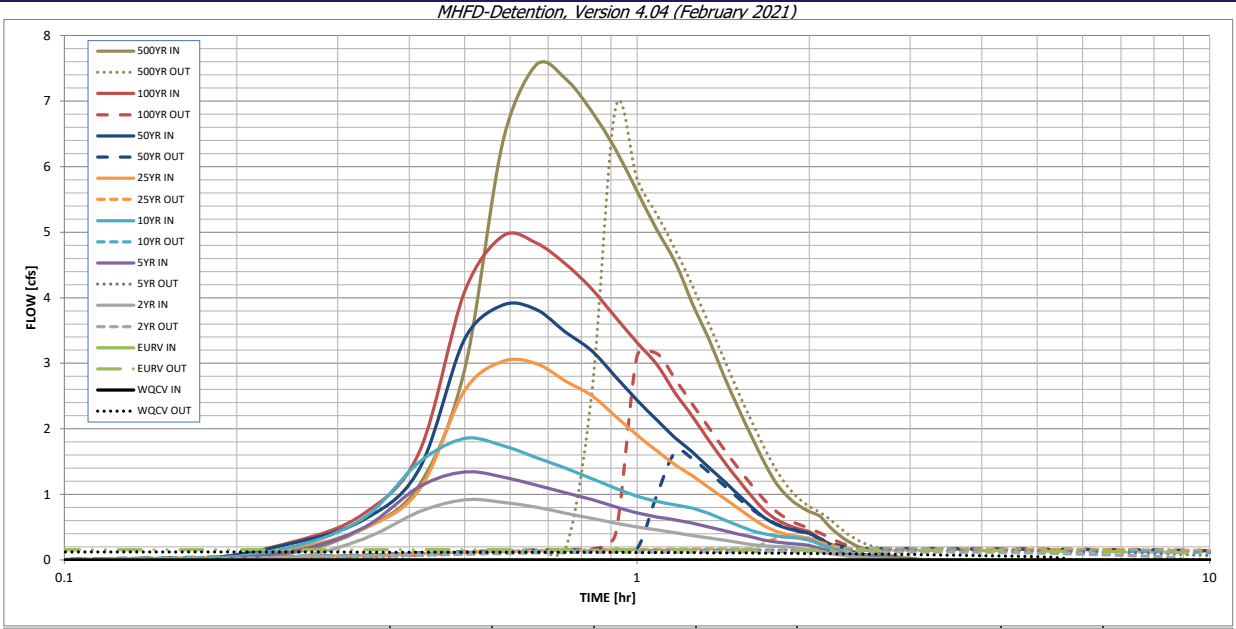
Routed Hydrograph Results

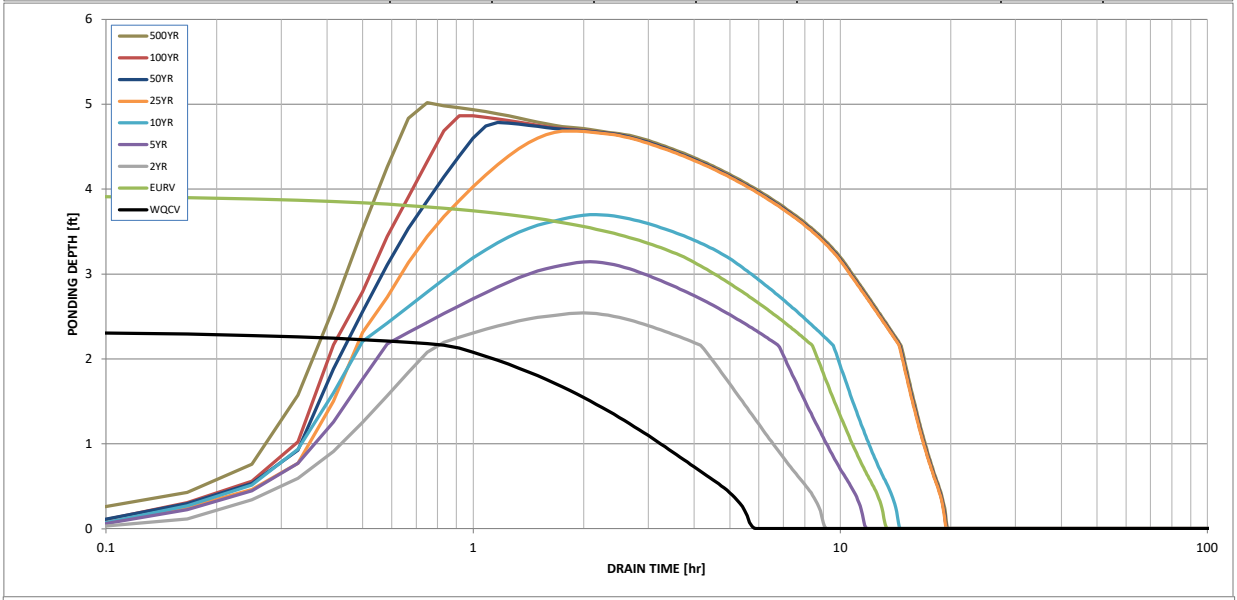
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

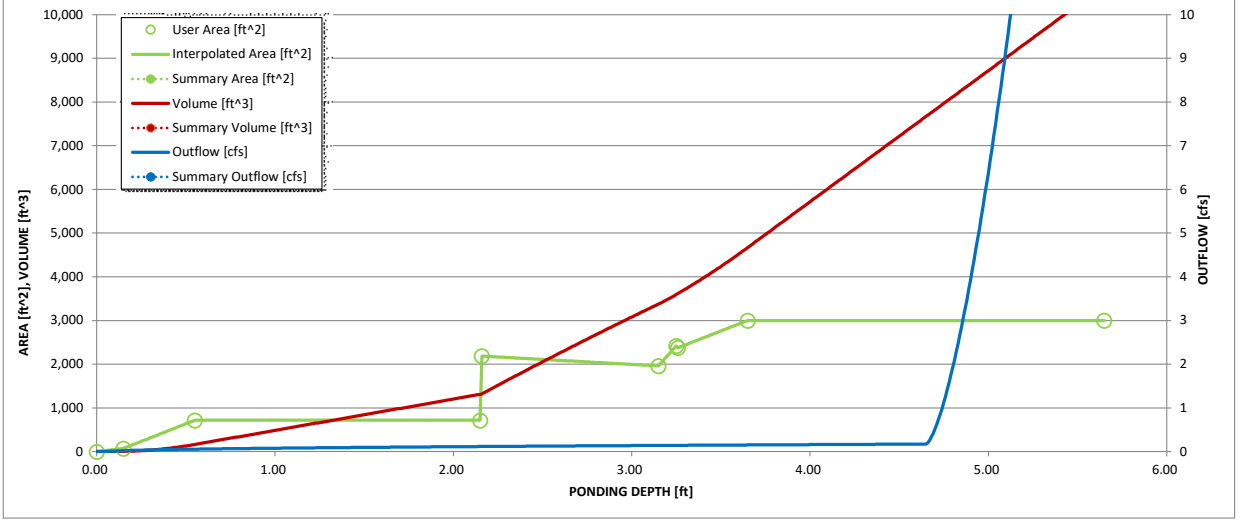
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.80	1.09	1.35	1.78	2.14	2.54	3.63
CUHP Runoff Volume (acre-ft) =	0.039	0.127	0.069	0.100	0.136	0.211	0.269	0.341	0.526
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.069	0.100	0.136	0.211	0.269	0.341	0.526
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.0	0.0	0.3	1.0	1.5	2.1	3.6
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.01	0.13	0.51	0.75	1.07	1.83
Peak Inflow Q (cfs) =	N/A	N/A	0.9	1.3	1.9	3.0	3.9	4.9	7.5
Peak Outflow Q (cfs) =	0.1	0.2	0.13	0.1	0.15	0.4	1.6	3.15	6.9
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	5.9	0.6	0.3	1.1	1.5	1.9
Structure Controlling Flow =	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
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) =	5	12	8	11	13	18	18	17	16
Time to Drain 99% of Inflow Volume (hours) =	**6**	13	9	11	14	19	19	18	18
Maximum Ponding Depth (ft) =	2.34	3.94	2.54	3.14	3.70	4.68	4.78	4.86	5.02
Area at Maximum Ponding Depth (acres) =	0.05	0.07	0.05	0.05	0.07	0.07	0.07	0.07	0.07
Maximum Volume Stored (acre-ft) =	0.039	0.127	0.049	0.077	0.110	0.178	0.185	0.190	0.201

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.10
	0:15:00	0.00	0.00	0.04	0.13	0.20	0.17	0.25	0.27	0.48
	0:20:00	0.00	0.00	0.32	0.49	0.64	0.48	0.62	0.71	1.14
	0:25:00	0.00	0.00	0.74	1.12	1.49	1.07	1.39	1.65	2.90
	0:30:00	0.00	0.00	0.92	1.34	1.85	2.59	3.37	4.09	6.39
	0:35:00	0.00	0.00	0.88	1.26	1.74	3.03	3.89	4.95	7.55
	0:40:00	0.00	0.00	0.81	1.14	1.56	3.00	3.82	4.84	7.34
	0:45:00	0.00	0.00	0.71	1.02	1.40	2.73	3.48	4.52	6.85
	0:50:00	0.00	0.00	0.63	0.92	1.24	2.51	3.19	4.13	6.27
	0:55:00	0.00	0.00	0.56	0.81	1.10	2.19	2.80	3.71	5.62
	1:00:00	0.00	0.00	0.50	0.72	0.97	1.91	2.44	3.32	5.03
	1:05:00	0.00	0.00	0.46	0.66	0.89	1.66	2.13	2.98	4.54
	1:10:00	0.00	0.00	0.41	0.61	0.84	1.45	1.86	2.54	3.90
	1:15:00	0.00	0.00	0.37	0.56	0.79	1.28	1.64	2.19	3.38
	1:20:00	0.00	0.00	0.34	0.50	0.71	1.11	1.42	1.83	2.82
	1:25:00	0.00	0.00	0.30	0.45	0.61	0.95	1.21	1.51	2.33
	1:30:00	0.00	0.00	0.27	0.40	0.52	0.79	1.00	1.23	1.89
	1:35:00	0.00	0.00	0.24	0.35	0.45	0.64	0.81	0.98	1.50
	1:40:00	0.00	0.00	0.21	0.30	0.40	0.52	0.65	0.76	1.17
	1:45:00	0.00	0.00	0.20	0.27	0.37	0.44	0.54	0.62	0.96
	1:50:00	0.00	0.00	0.20	0.25	0.35	0.39	0.48	0.53	0.83
	1:55:00	0.00	0.00	0.18	0.24	0.33	0.35	0.44	0.47	0.74
	2:00:00	0.00	0.00	0.16	0.22	0.30	0.33	0.41	0.43	0.67
	2:05:00	0.00	0.00	0.13	0.17	0.24	0.26	0.32	0.33	0.51
	2:10:00	0.00	0.00	0.10	0.14	0.19	0.20	0.24	0.25	0.38
	2:15:00	0.00	0.00	0.08	0.11	0.14	0.15	0.19	0.18	0.29
	2:20:00	0.00	0.00	0.06	0.08	0.11	0.12	0.14	0.14	0.22
	2:25:00	0.00	0.00	0.04	0.06	0.08	0.09	0.11	0.11	0.16
	2:30:00	0.00	0.00	0.03	0.05	0.06	0.07	0.08	0.08	0.12
	2:35:00	0.00	0.00	0.03	0.03	0.05	0.05	0.06	0.06	0.09
	2:40:00	0.00	0.00	0.02	0.03	0.03	0.04	0.04	0.05	0.07
	2:45:00	0.00	0.00	0.01	0.02	0.02	0.03	0.03	0.03	0.05
	2:50:00	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.02	0.03
	2:55:00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02
	3:00:00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	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

Detention Pond: Stage-Storage
Rain Garden B

Project: East Street Village
SG Project I.D.: B1396

Prepared By: MLM
Reviewed By: LRE
Date: 02/03/23

Stage [ft]	Elevation [ft]	Contour Area [sf]	Incremental Storage Volume [cf]	Wall Volume Reduction [cf]	Cumulative Storage Volume [cf]	
0.00	5323.10	0	0		0	
0.10	5323.20	167	8		8	
0.20	5323.30	334	25		33	
0.30	5323.40	501	42		75	
0.40	5323.50	668	58		134	
0.50	5323.60	835	75		209	
0.60	5323.70	1002	92		301	
0.70	5323.80	1002	100		401	
0.80	5323.90	1002	100		501	
0.90	5324.00	1002	100		601	
1.00	5324.10	1002	100		701	
1.10	5324.20	1002	100		802	
1.20	5324.30	1002	100		902	
1.30	5324.40	1002	100		1002	
1.40	5324.50	1002	100		1102	
1.50	5324.60	1002	100		1202	
1.60	5324.70	1002	100		1303	
1.70	5324.80	1002	100		1403	
1.80	5324.90	1002	100		1503	
1.90	5325.00	1002	100		1603	
2.00	5325.10	1002	100		1703	
2.10	5325.20	1002	100		1804	**FG Rain Garden**
2.11	5325.21	2187	16		1820	
2.20	5325.30	2187	197	13	2003	
2.30	5325.40	2187	219	13	2209	
2.40	5325.50	2187	219	13	2415	
2.50	5325.60	2187	219	13	2620	
2.60	5325.70	2187	219	13	2826	
2.70	5325.80	2187	219	13	3031	
2.80	5325.90	2187	219	13	3237	
2.90	5326.00	2187	219	13	3443	
3.00	5326.10	2187	219	13	3648	
3.10	5326.20	2187	219	13	3854	**$WSEL_{WQCV}$ WQCV=1,037-cf**
3.20	5326.30	2187	219		4073	
3.30	5326.40	2187	219		4291	**$WSEL_{EURV}$ EURV=4,312-cf**
3.40	5326.50	2187	219		4510	
3.50	5326.60	2187	219		4729	
3.60	5326.70	2187	219		4947	
3.70	5326.80	2187	219		5166	
3.80	5326.90	2187	219		5385	
3.90	5327.00	2187	219		5603	
4.00	5327.10	2187	219		5822	
4.10	5327.20	2187	219		6041	
4.20	5327.30	2187	219		6260	
4.30	**5327.40**	**2187**	**219**		**6478**	**$WSEL_{100YR}$ V_{DET100}=6,360-cf**
4.40	5327.50	2187	219		6697	
4.50	5327.60	2187	219		6916	
4.60	5327.70	2187	219		7134	
4.70	5327.80	2187	219		7353	
4.80	5327.90	2187	219		7572	
4.90	5328.00	2187	219		7790	
5.00	5328.10	2187	219		8009	
5.10	5328.20	2187	219		8228	
5.20	5328.30	2187	219		8447	
5.30	5328.40	2187	219		8665	
5.40	5328.50	2187	219		8884	
5.50	5328.60	2187	219		9103	
5.60	5328.70	2187	219		9321	
5.65	5328.75	2187	109		9431	**Top of Emergency Overflow Weir**
5.75	5328.85	2187	219		9649	
5.85	5328.95	2187	219		9868	
5.95	5329.05	2187	219		10087	
6.05	5329.15	2187	219		10305	
6.15	5329.25	2187	219		10524	**Top of Wall**

Design Procedure Form: Rain Garden (RG)

UD-BMP (Version 3.07, March 2018)

Designer: MLM
Company: The Sanitas Group
Date: June 16, 2023
Project: East Street Village
Location: Basin A2 - Rain Garden B

1. Basin Storage Volume

A) Effective Imperviousness of Tributary Area, I_a (100% if all paved and roofed areas upstream of rain garden): I_a = 60.47 %

B) Tributary Area's Imperviousness Ratio ($i = I_a/100$): i = 0.605

C) Water Quality Capture Volume (WQCV) for a 12-hour Drain Time ($WQCV = 0.8 * (0.91* i^3 - 1.19 * i^2 + 0.78 * i)$): WQCV = 0.19 watershed inches

D) Contributing Watershed Area (including rain garden area): Area = 65,429 sq ft

E) Water Quality Capture Volume (WQCV) Design Volume, Vol = (WQCV / 12) * Area: V_{WQCV} = 1,037 cu ft

F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm: d_6 = in

G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume: $V_{WQCV\ OTHER}$ = cu ft

H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired): $V_{WQCV\ USER}$ = cu ft

2. Basin Geometry

A) WQCV Depth (12-inch maximum): D_{WQCV} = 12 in

B) Rain Garden Side Slopes (Z = 4 min., horiz. dist per unit vertical) (Use "0" if rain garden has vertical walls): Z = 0.00 ft / ft

C) Mimimum Flat Surface Area: A_{Min} = 791 sq ft

D) Actual Flat Surface Area: A_{Actual} = 1054 sq ft

E) Area at Design Depth (Top Surface Area): A_{Top} = 1054 sq ft

F) Rain Garden Total Volume ($V_T = ((A_{Top} + A_{Actual}) / 2) * Depth$): V_T = 1,054 cu ft

3. Growing Media

Choose One
- (●) 18" Rain Garden Growing Media
- ( ) Other (Explain):

4. Underdrain System

A) Are underdrains provided?

Choose One
- (●) YES
- ( ) NO

B) Underdrain system orifice diameter for 12 hour drain time

i) Distance From Lowest Elevation of the Storage Volume to the Center of the Orifice: y = 2.15 ft

ii) Volume to Drain in 12 Hours: Vol_{12} = 1,037 cu ft

iii) Orifice Diameter, 3/8" Minimum: D_O = 3/4 in

Design Procedure Form: Rain Garden (RG)

Designer: MLM
Company: The Sanitas Group
Date: June 16, 2023
Project: East Street Village
Location: Basin A2 - Rain Garden B

5. Impermeable Geomembrane Liner and Geotextile Separator Fabric A) Is an impermeable liner provided due to proximity of structures or groundwater contamination?	Choose One ○ YES ○ NO
6. Inlet / Outlet Control A) Inlet Control	Choose One ○ Sheet Flow- No Energy Dissipation Required ○ Concentrated Flow- Energy Dissipation Provided
7. Vegetation	Choose One ○ Seed (Plan for frequent weed control) ○ Plantings ○ Sand Grown or Other High Infiltration Sod
8. Irrigation A) Will the rain garden be irrigated?	Choose One ○ YES ○ NO

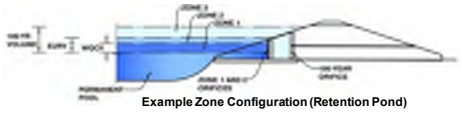
Notes:

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: East Street Village

Basin ID: Basin A2 - Rain Garden B



Example Zone Configuration (Retention Pond)

Watershed Information — **Flood Control Only**

Selected BMP Type =	No BMP	
Watershed Area =	1.50	acres
Watershed Length =	440	ft
Watershed Length to Centroid =	220	ft
Watershed Slope =	0.010	ft/ft
Watershed Imperviousness =	60.5%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	N/A	hours
Location for 1-hr Rainfall Depths =	Louisville - City Hall	

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) =	0.030	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	0.099	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 0.8 in.) =	0.053	acre-feet	inches
5-yr Runoff Volume (P1 = 1.09 in.) =	0.077	acre-feet	inches
10-yr Runoff Volume (P1 = 1.35 in.) =	0.104	acre-feet	inches
25-yr Runoff Volume (P1 = 1.78 in.) =	0.161	acre-feet	inches
50-yr Runoff Volume (P1 = 2.14 in.) =	0.205	acre-feet	inches
100-yr Runoff Volume (P1 = 2.54 in.) =	0.259	acre-feet	inches
500-yr Runoff Volume (P1 = 3.63 in.) =	0.398	acre-feet	inches
Approximate 2-yr Detention Volume =	0.051	acre-feet	
Approximate 5-yr Detention Volume =	0.074	acre-feet	
Approximate 10-yr Detention Volume =	0.102	acre-feet	
Approximate 25-yr Detention Volume =	0.127	acre-feet	
Approximate 50-yr Detention Volume =	0.141	acre-feet	
Approximate 100-yr Detention Volume =	0.163	acre-feet	

Define Zones and Basin Geometry

Zone 1 Volume (EURV-WQCV) =	0.069	acre-feet
Zone 2 Volume (100-year - Zone 1) =	0.094	acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.163	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	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	

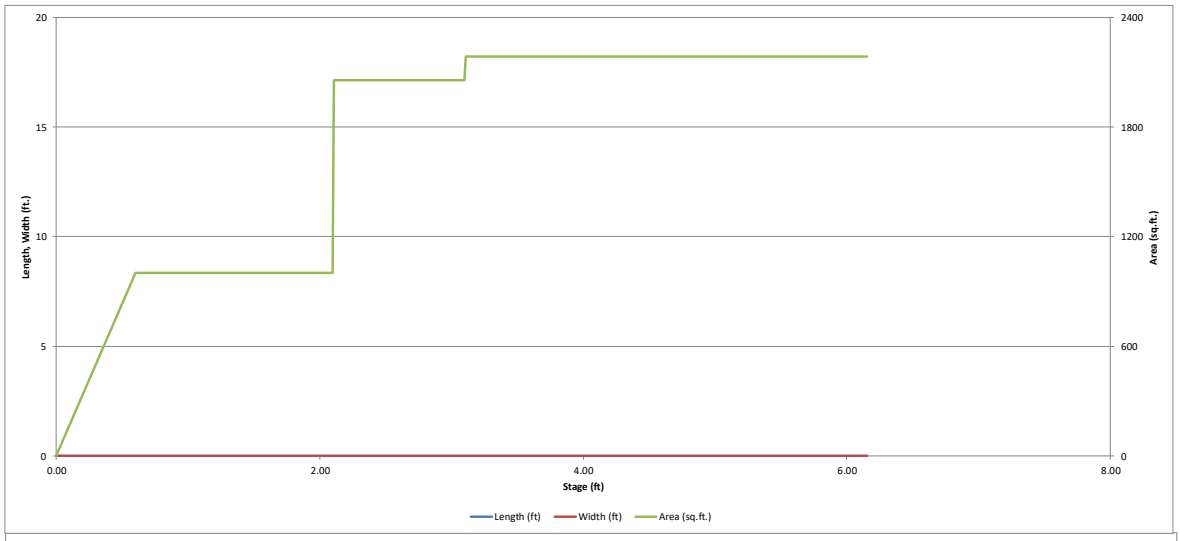
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	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

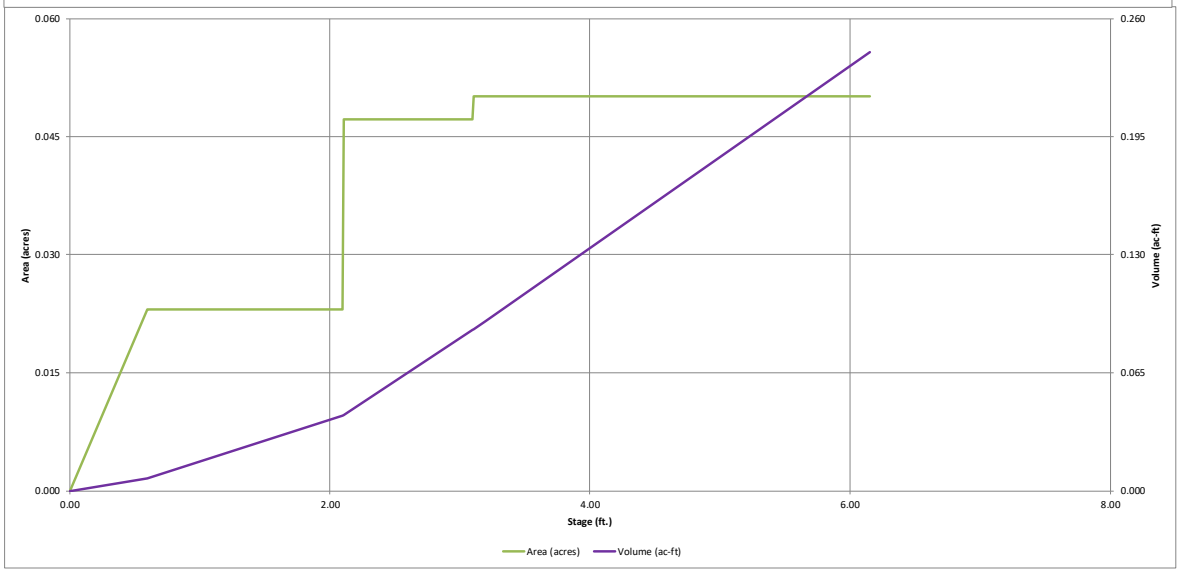
Depth Increment = 1.00 ft

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)
Media Surface	--	0.00	--	--	--	0	0.000		
	--	0.60	--	--	--	1,002	0.023	301	0.007
FG Rain Garden	--	2.10	--	--	--	1,002	0.023	1,804	0.041
	--	2.11	--	--	--	2,056	0.047	1,819	0.042
WQCV=1,037-cf	--	3.10	--	--	--	2,056	0.047	3,854	0.088
	--	3.11	--	--	--	2,187	0.050	3,875	0.089
	--	3.20	--	--	--	2,187	0.050	4,072	0.093
EURV=4,312-cf, V_{PRT100}=6,360-cf	--	6.15	--	--	--	2,187	0.050	10,524	0.242

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)



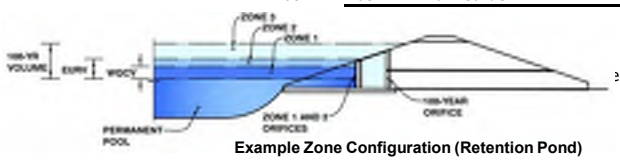


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: East Street Village

Basin ID: Basin A2 - Rain Garden B



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (EURV - WQCV)	2.69	0.069	Circular Orifice
Zone 2 (100-year)	4.59	0.094	Weir&Pipe (Circular)
Zone 3			
Total (all zones)		0.163	

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

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft²
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

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

Invert of Lowest Orifice =	N/A	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft²
Depth at top of Zone using Orifice Plate =	N/A	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 =	N/A	inches	Elliptical Slot Area =	N/A	ft²

Calculated Parameters for Plate

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

	Row 1 (optional)	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)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Orifice Area (sq. inches)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

	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)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Orifice Area (sq. inches)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 1 Circular	Not Selected		Zone 1 Circular	Not Selected	
Invert of Vertical Orifice =	0.00		ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	0.01	ft²
Depth at top of Zone using Vertical Orifice =	2.69		ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	0.06	feet
Vertical Orifice Diameter =	1.50		inches			

Calculated Parameters for Vertical Orifice

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

	Zone 2 Weir	Not Selected		Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.32		ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	3.32	feet
Overflow Weir Front Edge Length =	2.00		feet	Overflow Weir Slope Length =	2.00	feet
Overflow Weir Grate Slope =	0.00		H:V	Grate Open Area / 100-yr Orifice Area =	21.05	
Horiz. Length of Weir Sides =	2.00		feet	Overflow Grate Open Area w/o Debris =	3.16	ft²
Overflow Grate Type =	Close Mesh Grate			Overflow Grate Open Area w/ Debris =	3.16	ft²
Debris Clogging % =	0%		%			

Calculated Parameters for Overflow Weir

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

	Zone 2 Circular	Not Selected		Zone 2 Circular	Not Selected	
Depth to Invert of Outlet Pipe =	0.00		ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	0.15	ft²
Circular Orifice Diameter =	5.25		inches	Outlet Orifice Centroid =	0.22	feet
				Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.65	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.13 feet
Spillway Crest Length =	25.00	feet	Stage at Top of Freeboard =	5.88 feet
Spillway End Slopes =	0.00	H:V	Basin Area at Top of Freeboard =	0.05 acres
Freeboard above Max Water Surface =	0.10	feet	Basin Volume at Top of Freeboard =	0.23 acre-ft

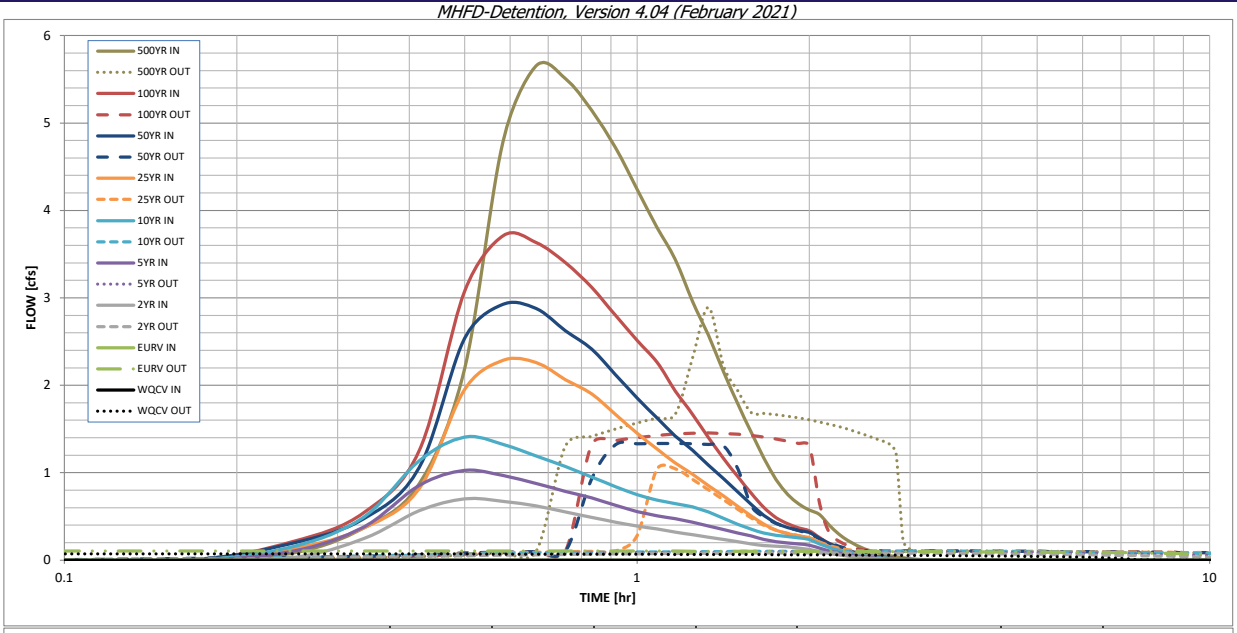
Calculated Parameters for Spillway

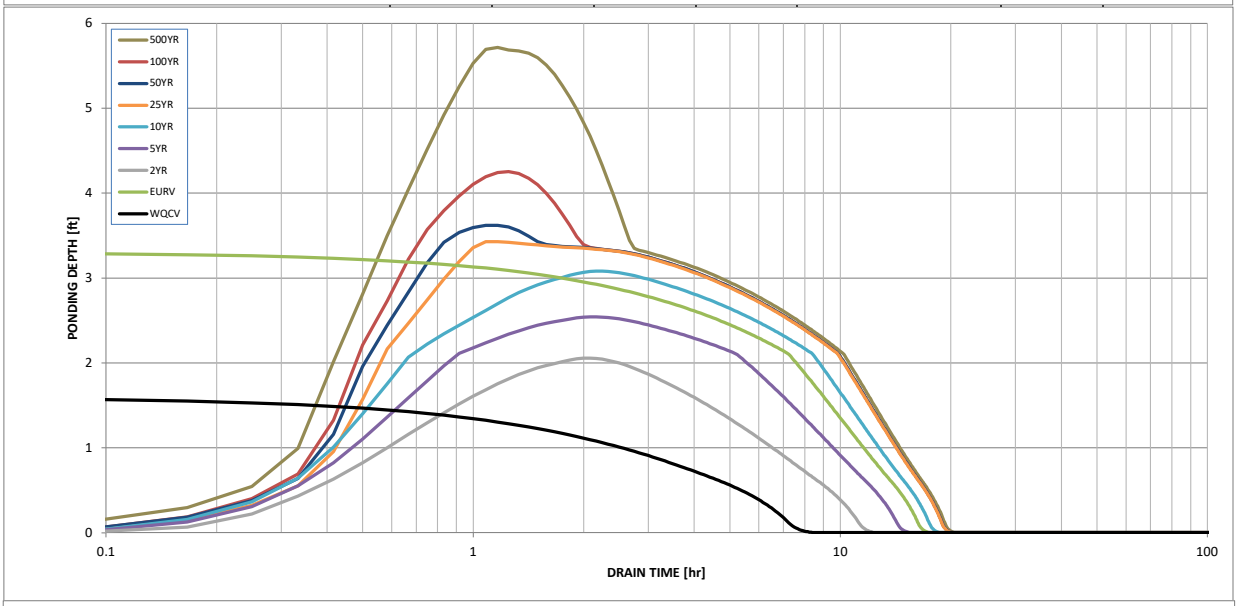
Routed Hydrograph Results *The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).*

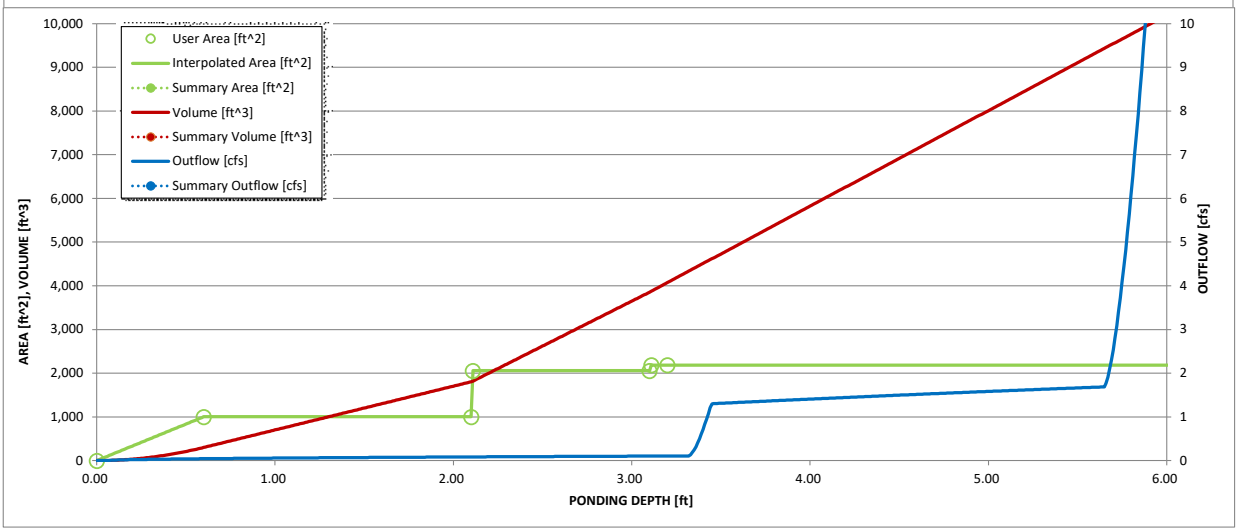
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.80	1.09	1.35	1.78	2.14	2.54	3.63
CUHP Runoff Volume (acre-ft) =	0.030	0.099	0.053	0.077	0.104	0.161	0.205	0.259	0.398
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.053	0.077	0.104	0.161	0.205	0.259	0.398
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.0	0.0	0.2	0.7	1.1	1.6	2.7
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.01	0.13	0.50	0.73	1.05	1.79
Peak Inflow Q (cfs) =	N/A	N/A	0.7	1.0	1.4	2.3	2.9	3.7	5.7
Peak Outflow Q (cfs) =	0.1	0.1	0.08	0.1	0.10	1.0	1.3	1.45	2.9
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	5.3	0.5	1.4	1.2	0.9	1.1
Structure Controlling Flow =	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.3	0.4	0.4	0.5
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) =	7	15	11	13	16	17	17	16	16
Time to Drain 99% of Inflow Volume (hours) =	**7**	16	11	14	17	18	18	18	18
Maximum Ponding Depth (ft) =	1.61	3.31	2.06	2.54	3.08	3.43	3.62	4.25	5.71
Area at Maximum Ponding Depth (acres) =	0.02	0.05	0.02	0.05	0.05	0.05	0.05	0.05	0.05
Maximum Volume Stored (acre-ft) =	0.030	0.099	0.040	0.062	0.087	0.105	0.115	0.146	0.219

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
	0:15:00	0.00	0.00	0.03	0.10	0.15	0.13	0.19	0.21	0.37
	0:20:00	0.00	0.00	0.25	0.38	0.49	0.37	0.47	0.54	0.87
	0:25:00	0.00	0.00	0.57	0.86	1.14	0.82	1.06	1.25	2.19
	0:30:00	0.00	0.00	0.70	1.03	1.41	1.95	2.54	3.08	4.79
	0:35:00	0.00	0.00	0.67	0.97	1.32	2.28	2.93	3.71	5.65
	0:40:00	0.00	0.00	0.62	0.88	1.19	2.26	2.88	3.63	5.51
	0:45:00	0.00	0.00	0.55	0.79	1.07	2.06	2.62	3.40	5.15
	0:50:00	0.00	0.00	0.49	0.71	0.95	1.90	2.41	3.12	4.72
	0:55:00	0.00	0.00	0.44	0.63	0.84	1.67	2.12	2.80	4.24
	1:00:00	0.00	0.00	0.39	0.56	0.75	1.45	1.85	2.51	3.81
	1:05:00	0.00	0.00	0.36	0.51	0.69	1.27	1.63	2.26	3.44
	1:10:00	0.00	0.00	0.32	0.47	0.65	1.11	1.42	1.93	2.96
	1:15:00	0.00	0.00	0.29	0.43	0.61	0.98	1.26	1.67	2.57
	1:20:00	0.00	0.00	0.26	0.39	0.55	0.85	1.09	1.40	2.15
	1:25:00	0.00	0.00	0.24	0.35	0.48	0.73	0.93	1.16	1.78
	1:30:00	0.00	0.00	0.21	0.31	0.41	0.61	0.78	0.95	1.46
	1:35:00	0.00	0.00	0.19	0.28	0.35	0.50	0.63	0.76	1.17
	1:40:00	0.00	0.00	0.17	0.24	0.31	0.41	0.51	0.60	0.92
	1:45:00	0.00	0.00	0.16	0.21	0.29	0.34	0.42	0.49	0.75
	1:50:00	0.00	0.00	0.15	0.20	0.27	0.30	0.37	0.42	0.64
	1:55:00	0.00	0.00	0.14	0.18	0.26	0.28	0.34	0.37	0.57
	2:00:00	0.00	0.00	0.12	0.17	0.23	0.26	0.32	0.34	0.52
	2:05:00	0.00	0.00	0.10	0.14	0.19	0.20	0.25	0.26	0.40
	2:10:00	0.00	0.00	0.08	0.11	0.15	0.16	0.19	0.19	0.30
	2:15:00	0.00	0.00	0.06	0.08	0.11	0.12	0.15	0.14	0.22
	2:20:00	0.00	0.00	0.05	0.06	0.09	0.09	0.11	0.11	0.17
	2:25:00	0.00	0.00	0.04	0.05	0.06	0.07	0.08	0.08	0.13
	2:30:00	0.00	0.00	0.03	0.04	0.05	0.05	0.06	0.06	0.10
	2:35:00	0.00	0.00	0.02	0.03	0.04	0.04	0.05	0.05	0.07
	2:40:00	0.00	0.00	0.02	0.02	0.03	0.03	0.04	0.04	0.05
	2:45:00	0.00	0.00	0.01	0.01	0.02	0.02	0.03	0.03	0.04
	2:50:00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.03
	2:55:00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	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

Orifice Calculations

Rain Garden A Outlet Structure

Project: East Street Village
SG Project I.D.: B1396

Prepared By: MLM
Reviewed By: LRE
Date: 02/03/23

Orifice 1: Rain Garden A EURV Control

C_d =	0.60		
d =	1.75	inches	
A =	0.017	ft^2	
g =	32.2	ft/s^2	
h =	5.03	ft	(100-yr depth)

Orifice Equation: $Q_i = C_d A (2gh)^{0.5}$

Q_i = 0.18 cfs

Orifice 2: Rain Garden B EURV Control

C_d =	0.60		
d =	1.50	inches	
A =	0.012	ft^2	
g =	32.2	ft/s^2	
h =	5.03	ft	(100-yr depth)

Orifice Equation: $Q_i = C_d A (2gh)^{0.5}$

Q_i = 0.13 cfs

APPENDIX E

BMP Maintenance

4.7 Sediment Removal

Remove sediment as needed based on inspection. Frequency depends on site-specific conditions. For planning purposes, it can be estimated that 3 to 10% of the swale length or buffer interface length will require sediment removal on an annual basis.

- **For Grass Buffers**: Using a shovel, remove sediment at the interface between the impervious area and buffer.

- **For Grass Swales**: Remove accumulated sediment near culverts and in channels to maintain flow capacity. Spot replace the grass areas as necessary.

Reseed and/or patch damaged areas in buffer, sideslopes, and/or channel to maintain healthy vegetative cover. This should be conducted as needed based on inspection. Over time, and depending on pollutant loads, a portion of the buffer or swale may need to be rehabilitated due to sediment deposition. Periodic sediment removal will reduce the frequency of revegetation required. Expect turf replacement for the buffer interface area every 10 to 20 years.

5.0 Bioretention (Rain Garden or Porous Landscape Detention)

The primary maintenance objective for bioretention, also known as porous landscape detention, is to keep vegetation healthy, remove sediment and trash, and ensure that the facility is draining properly. The growing medium may need to be replaced eventually to maintain performance. This section summarizes key maintenance considerations for bioretention.

5.1 Inspection

Inspect the infiltrating surface at least twice annually following precipitation events to determine if the bioretention area is providing acceptable infiltration. Bioretention facilities are designed with a maximum depth for the WQCV of one foot and soils that will typically drain the WQCV over approximately 12 hours. If standing water persists for more than 24 hours after runoff has ceased, clogging should be further investigated and remedied. Additionally, check for erosion and repair as necessary.

5.2 Debris and Litter Removal

Remove debris and litter from the infiltrating surface to minimize clogging of the media. Remove debris and litter from the overflow structure.

5.3 Mowing and Plant Care

- **All vegetation**: Maintain healthy, weed-free vegetation. Weeds should be removed before they flower. The frequency of weeding will depend on the planting scheme and cover. When the growing media is covered with mulch or densely vegetated, less frequent weeding will be required.

- **Grasses**: When started from seed, allow time for germination and establishment of grass prior to mowing. If mowing is required during this period for weed control, it should be accomplished with hand-held string trimmers to minimize disturbance to the seedbed. After established, mow as desired or as needed for weed control. Following this period, mowing of native/drought tolerant grasses may stop or be reduced to maintain a length of no less than 6 inches. Mowing of manicured grasses may vary from as frequently as weekly during the summer, to no mowing during the winter. See Section 4.4 for additional guidance on mowing.

5.4 Irrigation Scheduling and Maintenance

Adjust irrigation throughout the growing season to provide the proper irrigation application rate to maintain healthy vegetation. Less irrigation is typically needed in early summer and fall, while more irrigation is needed during the peak summer months. Native grasses and other drought tolerant plantings should not typically require routine irrigation after establishment, except during prolonged dry periods.

Check for broken sprinkler heads and repair them, as needed. Completely drain the irrigation system before the first winter freeze each year. Upon reactivation of the irrigation system in the spring, inspect all components and replace damaged parts, as needed.

5.5 Replacement of Wood Mulch

Replace wood mulch only when needed to maintain a mulch depth of up to approximately 3 inches. Excess mulch will reduce the volume available for storage.

5.6 Sediment Removal and Growing Media Replacement

If ponded water is observed in a bioretention cell more than 24 hours after the end of a runoff event, check underdrain outfall locations and clean-outs for blockages. Maintenance activities to restore infiltration capacity of bioretention facilities will vary with the degree and nature of the clogging. If clogging is primarily related to sediment accumulation on the filter surface, infiltration may be improved by removing excess accumulated sediment and scarifying the surface of the filter with a rake. If the clogging is due to migration of sediments deeper into the pore spaces of the media, removal and replacement of all or a portion of the media may be required. The frequency of media replacement will depend on site-specific pollutant loading characteristics. Based on experience to date in the metro Denver area, the required frequency of media replacement is not known. To date UDFCD is not aware of any rain gardens constructed to the recommendations of these criteria that have required full replacement of the growing media. Although surface clogging of the media is expected over time, established root systems promote infiltration. This means that mature vegetation that covers the filter surface should increase the life span of the growing media, serving to promote infiltration even as the media surface clogs.

Rain Garden A is located in the northeast corner of the East Street Village site and Rain Garden B is located in the southeast corner of the site. Both rain gardens contain steps for maintenance access.

APPENDIX F

Drainage Plans
Rain Garden Details
Typical Street Sections

EAST ST VILLAGE

421-533 EAST ST - FINAL PLANNED UNIT DEVELOPMENT
CITY OF LOUISVILLE, COUNTY OF BOULDER, STATE OF COLORADO
CASE #PUPL-0427-2022

The Sanitas Group
901 FRONT ST, SUITE 350
LOUISVILLE, CO 80027
303.981.9238

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2842 W 44th
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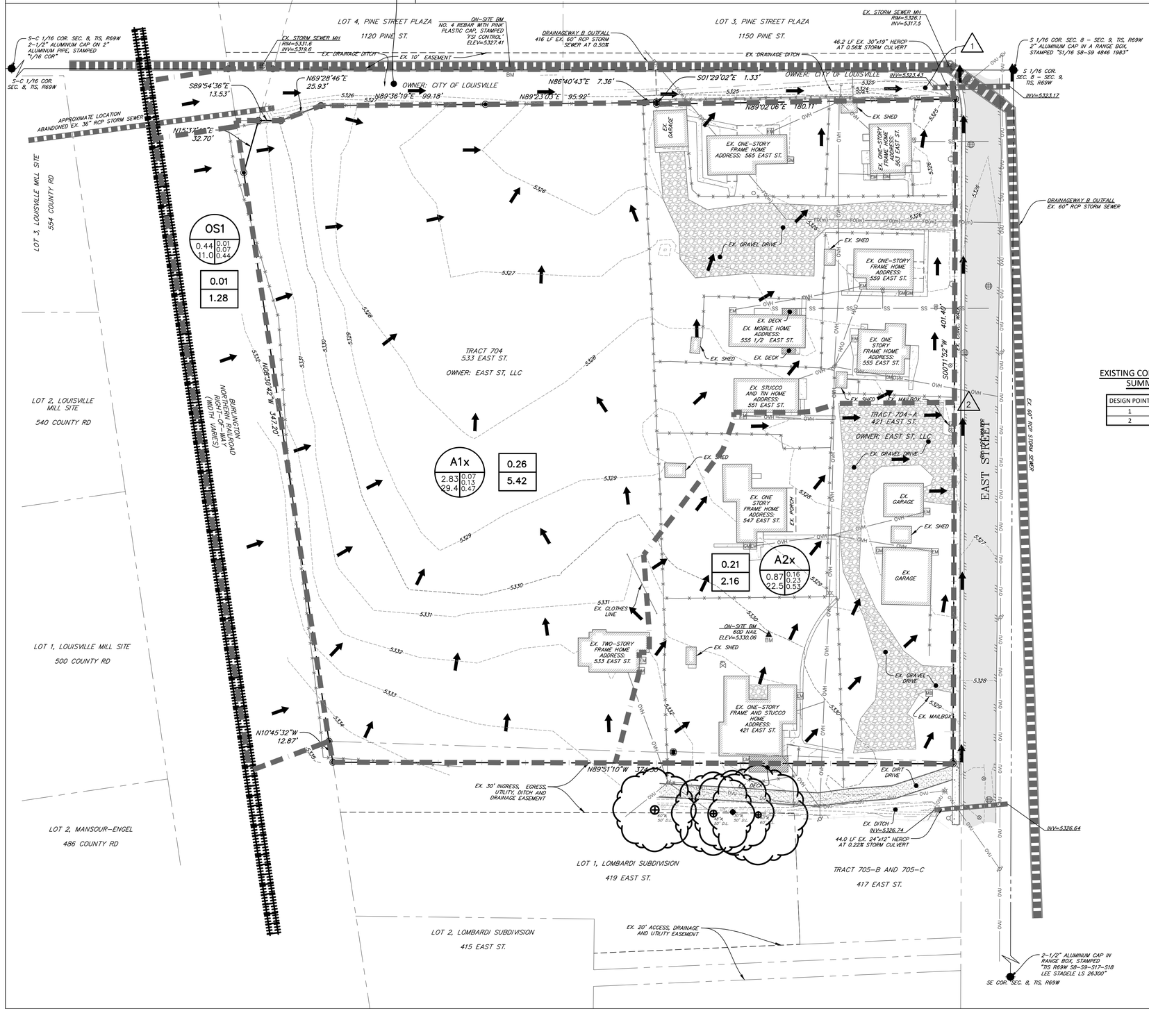

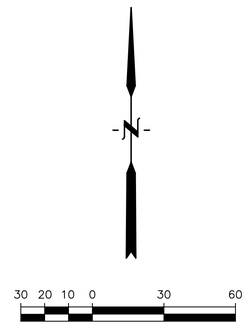

LEGEND

- PROPERTY BOUNDARY
- ADJACENT PROPERTY BOUNDARY
- EX. FENCE
- EX. MAJOR CONTOUR 5328
- EX. MINOR CONTOUR 5330
- EX. SPOT ELEVATION 29.62
- EX. STORM SEWER ST
- EX. UTILITY MANHOLE
- EX. OVERHEAD UTILITIES OVU
- EX. UTILITY POLE
- EX. TREES
- EX. ASPHALT PAVEMENT
- EX. CONCRETE
- EXISTING STORM STRUCTURE DESIGNATOR A
- DRAINAGE BASIN BOUNDARY
- DRAINAGE BASIN ID ID
- DRAINAGE BASIN DESIGNATOR AREA C2 C10 C100 Tc
- BASIN AREA [AC]
- TIME OF CONCENTRATION [MIN]
- RUNOFF COEFFICIENTS
- MINOR STORM RUNOFF Q2
- DRAINAGE BASIN STORM RUNOFF [CFS]
- MAJOR STORM RUNOFF Q100
- STORM WATER FLOW DIRECTION
- DESIGN POINT 1

EXISTING CONDITIONS RUNOFF SUMMARY TABLE

DESIGN POINT	Q2 [CFS]	Q100 [CFS]
1	0.28	7.40
2	0.21	2.16

EXISTING CONDITIONS SURVEY NOTES

1. THE EXISTING CONDITIONS BASED ON ALTA/NSPS LAND TITLE SURVEY PREPARED BY FLATIRONS, INC. DATED 10/17/2017, JOB NO. 17-69,495 AND ALTA/NSPS LAND TITLE SURVEY PREPARED BY FLATIRONS, INC. DATED 03/19/2021, JOB NO. 21-76,231.
2. THE LOCATION OF THE UTILITIES SHOWN HEREON ARE BASED ON THE FIELD SURVEY BY FLATIRONS, INC. THE LOCATIONS OF THE UNDERGROUND UTILITIES SHOWN HEREON ARE BASED ON SAID SURVEY AND INFORMATION PROVIDED BY OTHERS (WHICH MAY INCLUDE CITY OF BOULDER GIS DATA, THE UTILITY OWNER OR UTILITY LOCATING SERVICES). THE SANITAS GROUP, LLC IS NOT RESPONSIBLE FOR UTILITY INFORMATION PROVIDED BY OTHERS. THE SANITAS GROUP, LLC RECOMMENDS THAT THE LOCATION OF THE UTILITIES BE FIELD VERIFIED PRIOR TO ANY DIGGING ON, OR ADJACENT TO THE SUBJECT PROPERTY.
3. EXISTING TREE LOCATIONS ARE BASED ON THE FIELD SURVEY BY FLATIRONS, INC.
4. BASIS OF BEARINGS: A BEARING OF NORTH 89°54'36" WEST ALONG THE NORTH LINE OF THE SOUTHEAST QUARTER OF THE SOUTHEAST QUARTER OF SECTION 8, T1S, R69W OF THE 6TH P.M.
5. THE SUBJECT PROPERTY CONTAINS A GROSS AREA OF 159,074 SQUARE FEET (3.65 ACRES), MORE OR LESS.
6. BENCHMARK: A GPS DERIVED ELEVATION WAS ESTABLISHED AT AN ONSITE BENCHMARK BETWEEN THE NORTHEAST AND NORTHWEST CORNERS OF THE SUBJECT PROPERTY, BEING A SET NO. 4 REBAR WITH PINK PLASTIC CAP, STAMPED "FSI CONTROL". ELEVATION = 5327.41 FEET, NAVD88 DATUM.

FLOOD PLAIN NOTES

1. ACCORDING TO THE CURRENT FEMA FLOOD INSURANCE RATE MAP NUMBER 08013C0582K DATED AUGUST 15, 2019, THE SUBJECT PROPERTY IS OUTSIDE OF THE 100-YEAR REGULATORY FLOODPLAIN.

ISSUED

NO.	DESCRIPTION	DATE	NO.	DESCRIPTION	DATE
1	PRELIMINARY PUD	07-28-2022			
2	PRELIMINARY PUD	02-10-2023			
3	PRELIMINARY PUD	05-30-2023			
4	PRELIMINARY PUD	08-08-2023			
5	FINAL PUD	12-12-2023			

EXISTING CONDITIONS DRAINAGE PLAN | SHEET: **DR-1**

SCALE: **1" = 30'** | **DATE: 08 AUG 2023**

EAST ST VILLAGE

421-533 EAST ST - FINAL PLANNED UNIT DEVELOPMENT
CITY OF LOUISVILLE, COUNTY OF BOULDER, STATE OF COLORADO
CASE #PUPL-0427-2022

The Sanitas Group
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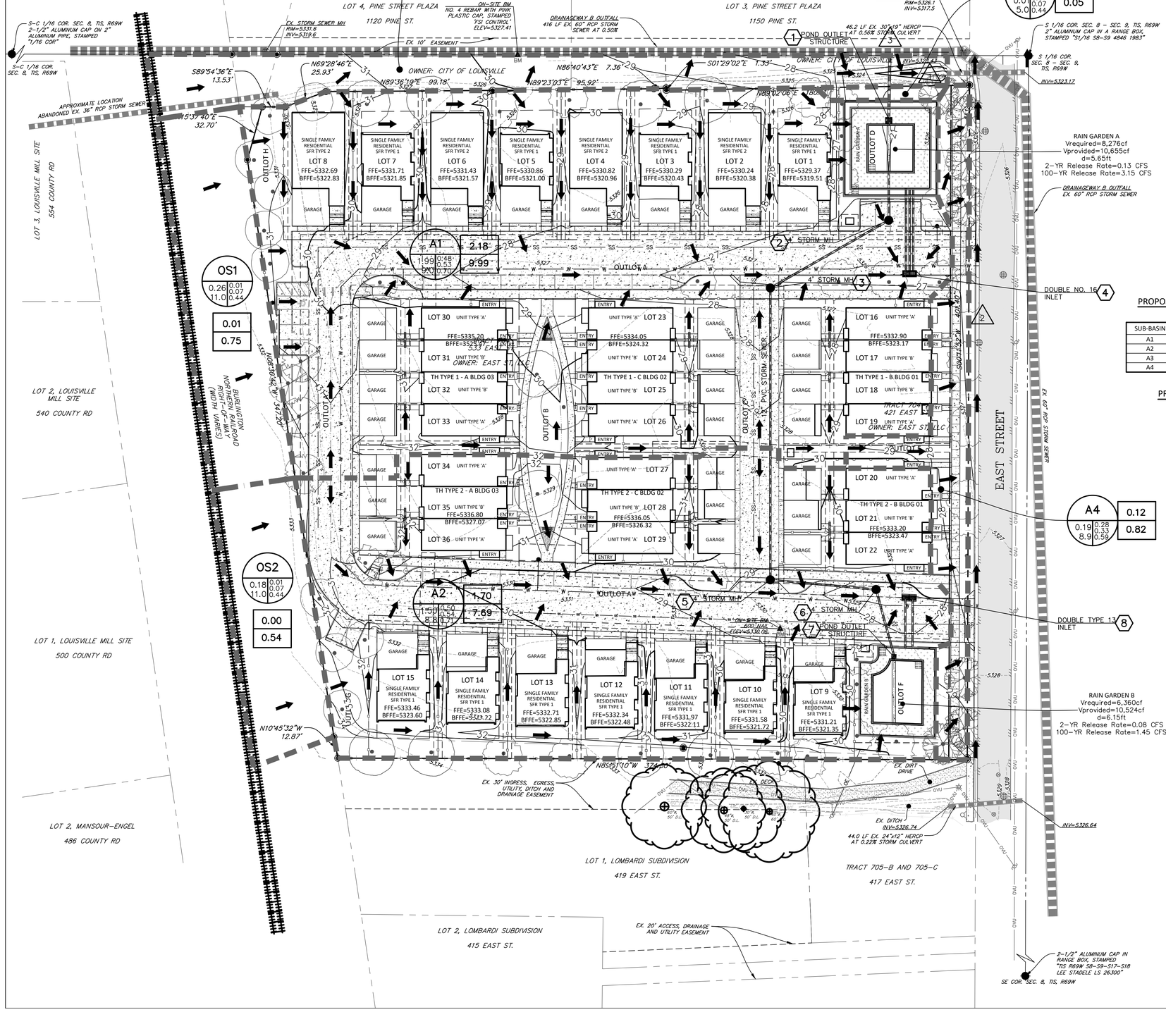

LEGEND

- PROPERTY BOUNDARY
- ADJACENT PROPERTY BOUNDARY
- EX. FENCE
- EX. MAJOR CONTOUR
- EX. MINOR CONTOUR
- EX. SPOT ELEVATION
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- EX. STORM SEWER
- EX. UTILITY MANHOLE
- EX. OVERHEAD UTILITIES
- EX. UTILITY POLE
- EX. TREES
- EX. ASPHALT PAVEMENT
- PROPOSED ASPHALT PAVEMENT
- EX. CONCRETE
- PROPOSED CONCRETE
- EXISTING STORM STRUCTURE DESIGNATOR
- PROPOSED STORM STRUCTURE DESIGNATOR
- DRAINAGE BASIN BOUNDARY
- DRAINAGE BASIN ID
- DRAINAGE BASIN DESIGNATOR
- BASIN AREA [AC]
- TIME OF CONCENTRATION [MIN]
- RUNOFF COEFFICIENTS
- MINOR STORM RUNOFF
- DRAINAGE BASIN STORM RUNOFF [CFS]
- MAJOR STORM RUNOFF
- STORM WATER FLOW DIRECTION
- DESIGN POINT

PROPOSED CONDITIONS SUB-BASIN RUNOFF SUMMARY TABLE

SUB-BASIN	AREA [ACRES]	I [%]	Q2 [CFS]	Q100 [CFS]
A1	1.99	59.1	2.18	9.99
A2	1.50	60.5	1.70	7.69
A3	0.01	2.0	0.00	0.05
A4	0.19	34.3	0.12	0.82

PROPOSED CONDITIONS RUNOFF SUMMARY TABLE

DESIGN POINT	Q2 [CFS]	Q100 [CFS]
1	0.00	6.20
2	0.12	0.82
3	0.21	0.31

EXISTING CONDITIONS SURVEY NOTES

1. THE EXISTING CONDITIONS BASED ON ALTA/NSPS LAND TITLE SURVEY PREPARED BY FLATIRONS, INC. DATED 10/17/2017, JOB NO. 17-69,495 AND ALTA/NSPS LAND TITLE SURVEY PREPARED BY FLATIRONS, INC. DATED 03/19/2021, JOB NO. 21-76,231.
2. THE LOCATION OF THE UTILITIES SHOWN HEREON ARE BASED ON THE FIELD SURVEY BY FLATIRONS, INC. THE LOCATIONS OF THE UNDERGROUND UTILITIES SHOWN HEREON ARE BASED ON SAID SURVEY AND INFORMATION PROVIDED BY OTHERS (WHICH MAY INCLUDE CITY OF BOULDER GIS DATA, THE UTILITY OWNER OR UTILITY LOCATING SERVICES). THE SANITAS GROUP, LLC IS NOT RESPONSIBLE FOR UTILITY INFORMATION PROVIDED BY OTHERS. THE SANITAS GROUP, LLC RECOMMENDS THAT THE LOCATION OF THE UTILITIES BE FIELD VERIFIED PRIOR TO ANY DIGGING ON, OR ADJACENT TO THE SUBJECT PROPERTY.
3. EXISTING TREE LOCATIONS ARE BASED ON THE FIELD SURVEY BY FLATIRONS, INC.
4. BASIS OF BEARINGS: A BEARING OF NORTH 89°54'36" WEST ALONG THE NORTH LINE OF THE SOUTHEAST QUARTER OF THE SOUTHEAST QUARTER OF SECTION 8, T1S, R69W OF THE 6TH P.M.
5. THE SUBJECT PROPERTY CONTAINS A GROSS AREA OF 159,074 SQUARE FEET (3.65 ACRES), MORE OR LESS.
6. BENCHMARK: A GPS DERIVED ELEVATION WAS ESTABLISHED AT AN ONSITE BENCHMARK BETWEEN THE NORTHEAST AND NORTHWEST CORNERS OF THE SUBJECT PROPERTY, BEING A SET NO. 4 REBAR WITH PINK PLASTIC CAP, STAMPED "FSI CONTROL" ELEVATION = 5327.41 FEET, NAVD88 DATUM.

FLOOD PLAIN NOTES

1. ACCORDING TO THE CURRENT FEMA FLOOD INSURANCE RATE MAP NUMBER 08013C0582K DATED AUGUST 15, 2019, THE SUBJECT PROPERTY IS OUTSIDE OF THE 100-YEAR REGULATORY FLOODPLAIN.

ISSUED

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4	PRELIMINARY PUD	08-08-2023			
5	FINAL PUD	12-12-2023			

PROPOSED CONDITIONS DRAINAGE PLAN | SHEET: **DR-2**

SCALE: **1" = 30'** | **DATE: 08 AUG 2023**

EAST ST VILLAGE

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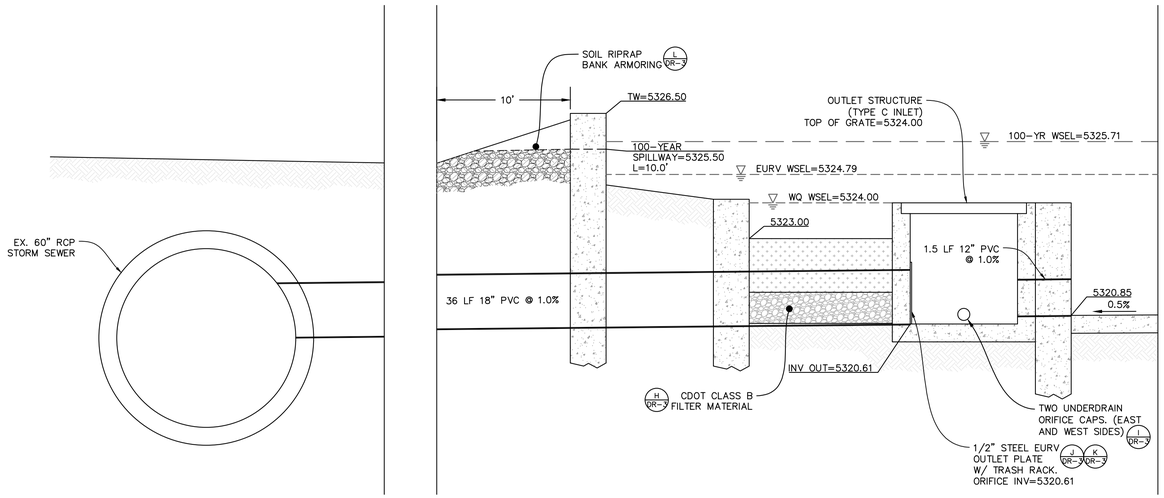
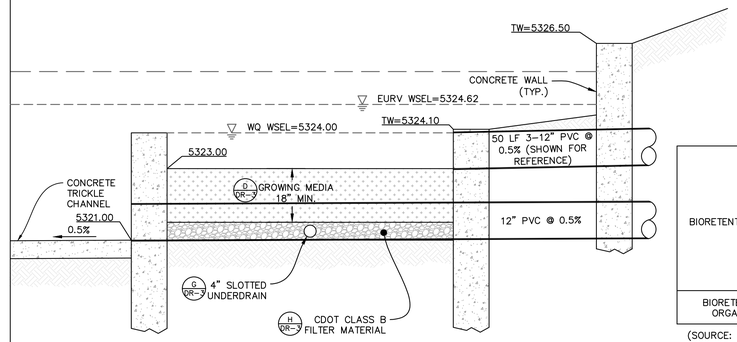


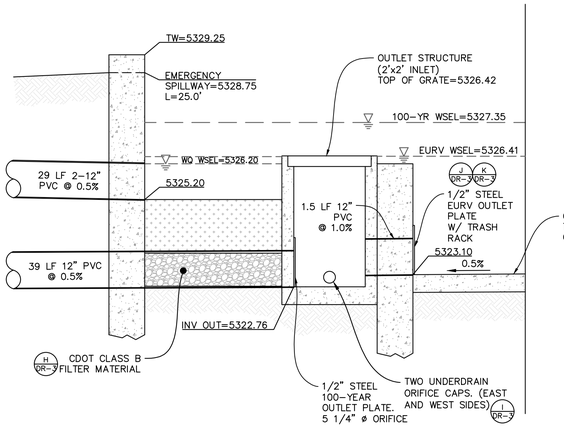
RAIN GARDEN A SECTION AT OUTLET (A/—)
NO SCALE



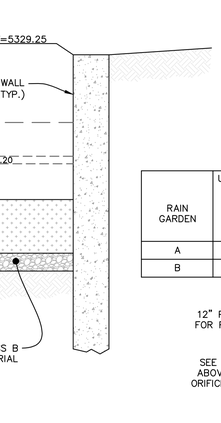
BIORETENTION SOIL	PARTICLE SIZE DISTRIBUTION 80-90% SAND (0.05 - 2.0 MM DIAMETER) 3-17% SILT (0.002 - 0.5 MM DIAMETER) 3-17% CLAY (<0.002 MM DIAMETER) CHEMICAL ATTRIBUTE AND NUTRIENT ANALYSIS pH 6.8 - 7.5 ORGANIC MATTER < 1.5% NITROGEN < 15 PPM PHOSPHORUS < 15 PPM SALINITY < 6 MMHO/CM
BIORETENTION ORGANICS	3 TO 5% SHREDDED MULCH (BY WEIGHT OF GROWING MEDIA)

(SOURCE: UDFCD TABLE B-1) NOTE: SEE LANDSCAPE PLANS FOR SOIL MIX MEETING RAIN GARDEN GROWING MEDIA REQUIREMENTS LISTED ABOVE. CONTRACTOR SHALL PROVIDE SOIL MIX SUBMITTAL FOR REVIEW PRIOR TO INSTALLATION.

RAIN GARDEN GROWING MEDIA (SOIL + ORGANICS) (D/—)



RAIN GARDEN B SECTION AT OUTLET (B/—)
NO SCALE



PIPE DIA.	SLOT LENGTH	MAX. SLOT WIDTH	SLOT CENTERS	OPEN AREA (PER FOOT)
4"	1-1/16"	0.032"	0.413"	1.90-IN^2
6"	1-3/8"	0.032"	0.516"	1.98-IN^2

DIMENSIONS ARE DEPENDENT UPON MANUFACTURES. SOME VARIATION FROM DIMENSIONS NOTED ABOVE IS ACCEPTABLE AND EXPECTED. (SOURCE: UDFCD TABLE PPS-2)

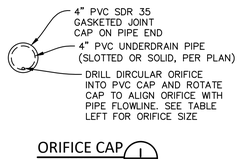
DIMENSIONS FOR SLOTTED UNDERDRAIN PIPE (G/—)

SIEVE SIZE	% PASSING
1.5"	100
No. 4	20 TO 60
No. 16	10 TO 30
No. 50	0 TO 10
No. 200	0 TO 3

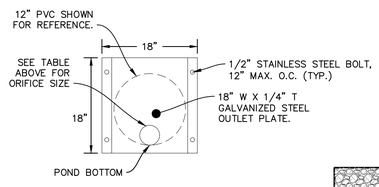
CDOT CLASS B FILTER MATERIAL (SOURCE: UDFCD TABLE B-1)

CDOT CLASS B FILTER MATERIAL GRADATION (H/—)

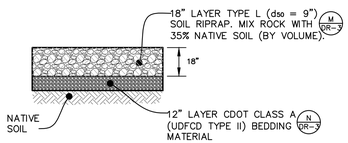
RAIN GARDEN	UNDERDRAIN ORIFICE DIAMETER (2 EA. RAIN GARDEN)	EURV OUTLET PLATE ORIFICE DIAMETER	100-YEAR OUTLET PLATE ORIFICE DIAMETER
A	13/32"	1 3/4" AND 1 1/2"	N/A
B	3/8"	1 1/2"	5 1/4"



ORIFICE CAP (I/—)
NO SCALE
FOR USE AT RAIN GARDEN UNDERDRAIN OUTLETS



OUTLET PLATE (J/—)



SOIL RIPRAP DETAIL (L/—)

PROPERTY	THICKNESS 0.76MM (30 MIL)	TEST METHOD
THICKNESS, % TOLERANCE	± 5	ASTM D 1593
TENSILE STRENGTH, kN/m (lbs/in) WIDTH	12.25 (70)	ASTM D 882, METHOD B
MODULUS AT 100% ELONGATION, kN/m (lbs/in)	5.25 (30)	ASTM D 882, METHOD B
ULTIMATE ELONGATION, %	350	ASTM D 882, METHOD A
TEAR RESISTANCE, N (lbs)	38 (8.5)	ASTM D 1004
LOW TEMPERATURE IMPACT, °C (°F)	-29 (-20)	ASTM D 1790
VOLATILE LOSS, % MAX.	0.7	ASTM D 1203, METHOD A
PINHOLES, NO. PER 8 m^2 (NO. PER 10 sq. yds) MAX.	1	N/A
BONDED SEAM STRENGTH, % OF TENSILE STRENGTH	80	N/A

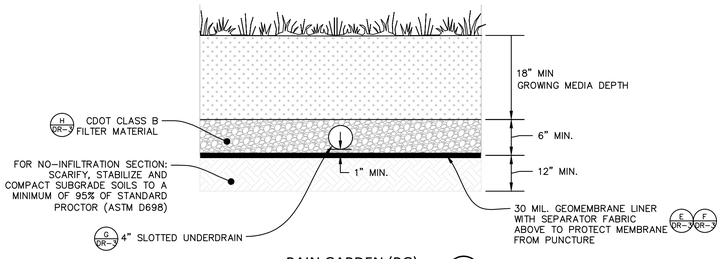
(SOURCE: UDFCD TABLE PPS-4: "PHYSICAL REQUIREMENTS FOR GEOMEMBRANE)

PHYSICAL REQUIREMENTS FOR GEOMEMBRANE (E/—)

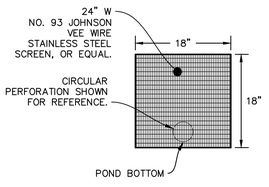
PROPERTY	CLASS B ELONGATION <50%	CLASS B ELONGATION >50%	TEST METHOD
GRAB STRENGTH, N (lbs)	800 (180)	510 (115)	ASTM D 4632
PUNCTURE RESISTANCE, N (lbs)	310 (70)	180 (40)	ASTM D 4833
TRAPEZOIDAL TEAR STRENGTH, N (lbs)	310 (70)	180 (40)	ASTM D 4533
APPARENT OPENING SIZE, MM (US SIEVE SIZE)	AOS < 0.3MM (US SIEVE SIZE No. 50)		ASTM D 4751
PERMITTIVITY, SEC^{-1}	0.02 DEFAULT VALUE, MUST ALSO BE GREATER THAN THAT OF SOIL		ASTM D 4491
PERMEABILITY, CM/SEC	K FABRIC > K SOIL FOR ALL CLASSES		ASTM D 4491
ULTRAVIOLET DEGRADATION AT 500 HOURS	50% STRENGTH RETAINED FOR ALL CLASSES		ASTM D 4355

(SOURCE: UDFCD TABLE PPS-3: "PHYSICAL REQUIREMENTS FOR SEPARATOR FABRIC)

PHYSICAL REQUIREMENTS FOR SEPARATOR FABRIC (F/—)



RAIN GARDEN (RG) NO-INFILTRATION SECTION (C/—)
NO SCALE



TRASH RACK (K/—)

ROCK SIZE	% SMALLER THAN GIVEN SIZE BY WT.
15"	70 TO 100
12"	50 TO 70
9"	35 TO 50
3"	2 TO 10

(SOURCE: MHFD FIGURE 8-34)

TYPE L (d50=9") RIPRAP GRADATION (M/—)

SIEVE SIZE	% PASSING
3"	90 TO 100
3/4"	20 TO 90
No. 4	0 TO 20
No. 200	0 TO 3

CDOT CLASS A FILTER MATERIAL FOR USE RIPRAP BEDDING COURSE. (SOURCE: MHFD FIGURE 8-34)

CDOT CLASS A FILTER MATERIAL GRADATION (N/—)

ISSUED					
NO.	DESCRIPTION	DATE	NO.	DESCRIPTION	DATE
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RAIN GARDEN DETAILS | SHEET: **DR-3**
SCALE: **NOT TO SCALE** | **DATE: 08 AUG 2023**

EAST ST VILLAGE

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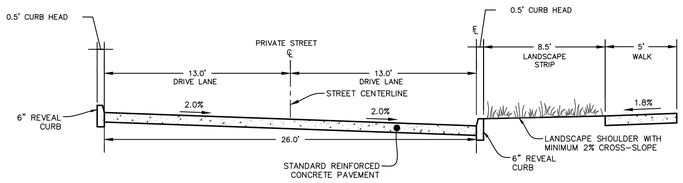
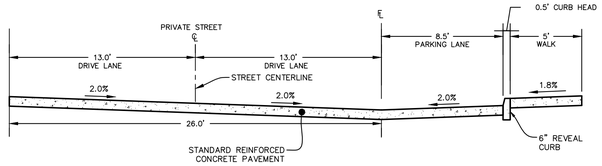


PRIVATE STREET
TYPICAL SECTION 1 (A/—)
DETACHED WALK
NO SCALE



PRIVATE STREET
TYPICAL SECTION 2 (B/—)
PARKING LANE
NO SCALE

ISSUED					
NO.	DESCRIPTION	DATE	NO.	DESCRIPTION	DATE
1	PRELIMINARY PUD	07-28-2022			
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3	PRELIMINARY PUD	05-30-2023			
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TYPICAL STREET SECTIONS | SHEET: **DR-4**
SCALE: **NOT TO SCALE** | **DATE: 08 AUG 2023**