Ph: 970-871-6772 · Fax: 970-879-8023 · P.O. Box 775966 · Steamboat Springs, Colorado 80477

Drainage Study & Stormwater Quality Plan
Lot 1 Indian Meadows Hotels Development Plan

Address: To be Determined

Draft: 05/23/2023
Final: 09/01/2023

Prepared by: Walter N. Magill, P.E.
Four Points Surveying & Engineering

P.O. Box 775966
Steamboat Springs, Colorado 80477
(970) 871-6772

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NOTE

City of Steamboat Springs plan review and approval is only for general conformance with City design criteria and City code. The City is not responsible for the accuracy and adequacy of the design, dimensions, and elevations that shall be confirmed and correlated at this job site. The City of Steamboat Springs assumes no responsibility for the completeness or accuracy of this document.

CERTIFICATION

I hereby affirm that this Drainage Report for the (name of project) was prepared by me (or under my direct supervision) for the owners thereof and is, to the best of my knowledge, in accordance with the provisions of the City of Steamboat Springs Storm Drainage Criteria and approved variances. I understand that the City of Steamboat Springs does not and will not assume liability for drainage facilities designed by others.

Walter N. Magill, P.E. 33743

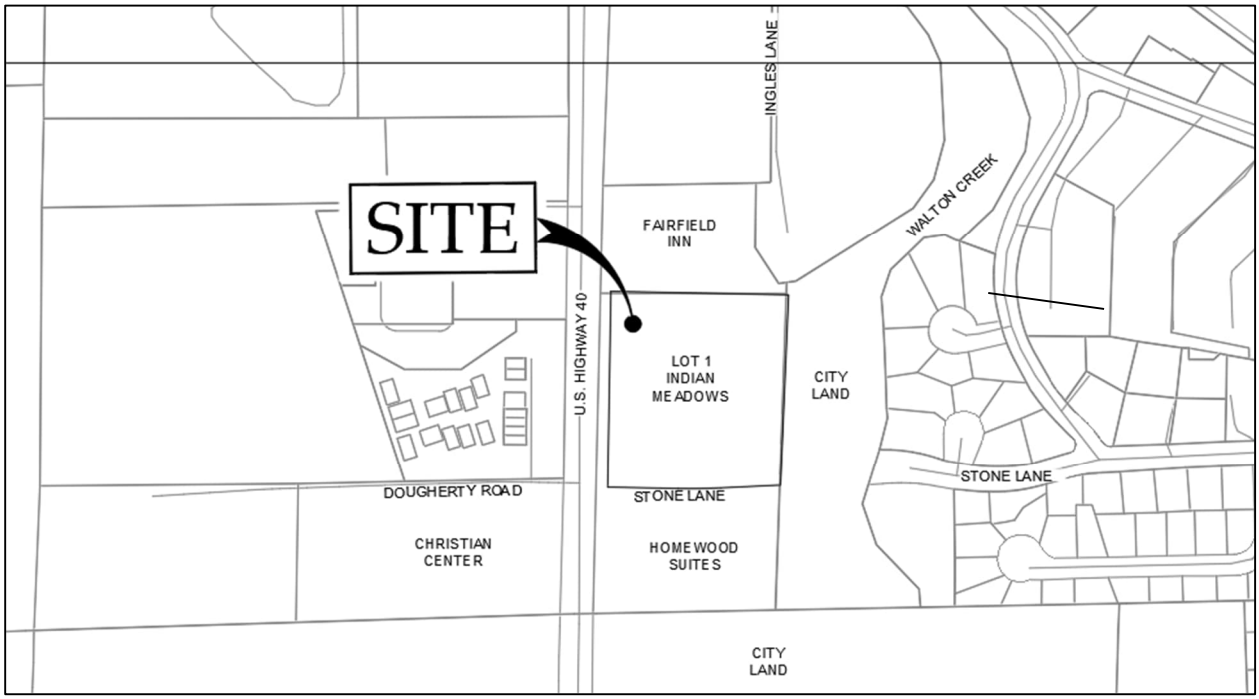
Date: 09-01-2023

1.0 Introduction

This report provides a detailed analysis of existing and proposed post-development drainage conditions and proposed water quality systems for the development at Lot 1 Indian Meadows. The proposed development consists of two commercial lodging facilities or hotels and all associated infrastructure. This report includes all data, engineering methods, assumptions, and calculations used by Four Points Surveying and Engineering (Four Points) to design the stormwater drainage system for the Project. Four Points prepared this report and performed engineering calculations and designs for the Project in accordance with the most recent version of the City of Steamboat Springs Drainage Criteria and Engineering Standards.

A. Location

Figure 1: Vicinity Map – Lot 1 Indian Meadows



B. Owner/Developer

Gray Stone, LLC (Bob Amin)

C. Drainage Reports for Adjacent Developments

Homewood Suites Hotel Final Drainage Study Report, March 2006. Owen Consulting Group, Inc. Larry C. Owen, P.E.

D. Stormwater Quality Purpose, Goal, and Special Requirements

The purpose of the stormwater quality plan is to design a conveyance and treatment system that aligns with the proposed Project and provides both functionality and aesthetics. Water quality treatment systems were incorporated across the development and into the landscaping. The goal

is to treat stormwater runoff from the developed impervious areas per City standards while maintaining a natural and aesthetically pleasing appeal.

2.0 Drainage Criteria and Methodology Used

A. Design Rainfall and Storm Frequency

Design rainfall: NOAA Atlas 14, Volume 8, Version 2 for Steamboat Springs, CO.

- Minor Event (5-year) 24-hour rainfall depth: 1.59 inches
- Major Event (100-year) 24-hour rainfall depth: 2.91 inches

B. Runoff Calculation Methodology

Runoff calculation method: Small basin peak flow runoff was analyzed using the Rational Method, shown in Eq-1.

Rational Method: **Q = CiA** (Eq-1)

Where: Q = runoff, CFS
C = runoff coefficient, dimensionless
i = rainfall intensity, inches per hour
A = basin area, acres

C. Stormwater Quality Design Standard

Proposed permanent stormwater treatment facilities will meet total suspended solids (TSS) design standards. TSS calculations were performed for all of the proposed bioretention facilities per City drainage engineering standards.

3.0 Existing Conditions

A. Ground Cover, Imperviousness, Topography and Size

- Vacant Lot with bare ground, native grasses, and wetlands vegetation
- 24-foot-wide paved vehicle access and 8-foot-wide pedestrian sidewalk to Fairfield Inn
- 5-10% imperviousness
- Flat to gentle sloping terrain, 5% slopes max
- Total lot size: 3.87 acres

B. Existing Stormwater Systems

Refer to the existing conditions drainage exhibit and existing drainage basin designations. Drainage from EB1 (the portion of the lot to be developed) generally sheet flows west to east across Lot 1 to wetlands that are present along the majority of the eastern property line (Design Points 1 and 2). No stormwater infrastructure is located within EB1. EB2 generally sheet flows east to west and into the US 40 roadside ditch and wetlands (Design Point 3). Flows between EB1 and EB2 are generally split by the existing Fairfield Inn access road. EB3 primarily consists of the Stone Lane right-of-way. Flows are directed into curb and gutter conveyance and into the Homewood Suites stormwater collection network to the south.

C. Notable Features

- Floodplain - FEMA Zone A (100-year base flood).
- Wetlands present to the east and west of the site beyond the development area.

D. Site Outfall and Ultimate Outfall Locations

EB1 outfalls into Walton Creek and ultimately the Yampa River.
EB2 outfalls into the U.S. 40 Roadside Ditch and ultimately the Yampa River.
EB3 outfalls into the Homewood Suites stormwater network and ultimately the Yampa River.

E. USDA NRCS Soil Type

A USDA NRCS Web Soil Survey was performed to determine basic soil characteristics within the project area. Soil types include:

- Slocum Loam → Hydrologic Soil Group Rating: B/D
- Venable → Hydrologic Soil Group Rating: B/D

Soils used in the drainage calculations were modeled as Hydrologic Soil Group (HSG) Rating C throughout the project area. This assumption was based on the Geotechnical Study produced by Northwest Colorado Consultants (NWCC) on March 21, 2022. This was a conservative approach to ensure that the proposed biofiltration BMPs were designed to their maximum design volume. No infiltration is proposed as a result of assuming existing soils are HSG type C.

F. Existing Easements

See existing conditions drainage exhibit for existing easements. There are no dedicated drainage easements within EB1.

G. FEMA Map Review and Walton Creek Split Flow Analysis.

FEMA flood map No. 08107C0883D effective 2/4/2005 was reviewed. Lot 1 is partially located within a FEMA designated floodplain AKA a special flood hazard area (SFHS) with designation Zone AE. Base flood elevations were revised and indicated on the drainage exhibits based on the Hampton Inn and Holiday Inn Express Walton Creek HEC-RAS Split Flow Model Analysis report by Wohnrade Civil Engineers, Inc. April 22, 2022. The report concludes that proposed development in the floodplain SFHA will not increase base flood elevations within Walton Creek and the surrounding area.

4.0 Proposed Conditions

Proposed development is two commercial lodging facilities or Hotels and all associated infrastructure including but not limited to: access roads, parking lots, stormwater conveyance, stormwater treatment, open spaces areas, and utilities. The hotels are designated as a Holiday Inn Express and Hotel B (yet to be named). The proposed development is typical of that of surrounding lodging facilities located along the east side of US 40 including Homewood Suites, Storm Peak Apartments, and Holiday Inn.

A. Ground Cover, Imperviousness, Topography and Size

- Total parcel area is approximately 3.87 acres.
- Total area of development is approximately 3.00 acres.

- Finished ground cover will consist of paving, multi-story hotels, landscaping, gravel, stone, and both maintained and unmaintained grasses.
- The proposed grading scheme will direct surface runoff to the proposed stormwater treatment BMPs which consist of bioretention systems.
- Impervious area: 68% (on average).
- Area to be treated: 3.03 acres.
- Impervious area to be treated: 2.51 acres (includes additional impervious area in the form of the existing Fairfield Inn Access Road and sidewalk).

B. Proposed Stormwater Systems

Bioretention facilities, valley pans, curb & gutter, stormwater inlets and stormwater piping will collect and convey all runoff to the four historical outfall points identified as Design Points 1-3 (DP1-DP3). Sheet flow from the access road and parking lot will be conveyed to one of the permanent water quality treatment BMPs that drains into the private storm-sewer collection network. The storm-sewer collection network shall consist of Nyloplast inlets connected via smooth wall HDPE stormwater pipe. No public stormwater infrastructure is proposed.

Runoff from the Storm Peak Apartments shall be conveyed and collected into the proposed bioretention facilities where runoff will infiltrate through porous media and into four-inch diameter perforated underdrains, before eventually entering the storm-sewer collection network.

Energy grades lines (EGL) and hydraulic grade lines (HGL) were developed for each run of storm-sewer to analyze surcharging conditions under the minor and major event flows. The storm-sewer collection network was designed to handle both the major and minor storm event without surcharging the inlet structures. The system will effectively convey peak flow runoff without inundating the biofiltration facilities.

Pipe velocities were analyzed for standards conformance. Storm sewer velocities were analyzed for the major event. Pipe velocity was found to be within the required standards. See Appendix K for a summary table of pipe flow velocities.

C. Outlets: Historic and Proposed Flow

Subbasin SB1 includes a 3:1 (horizontal to vertical) vegetated slope that discharges directly into the existing wetland on the eastern portion of the site, designated as Design Point 1 (DP1). There is no proposed water quality treatment for this subcatchment, however, no new impervious surfaces are proposed in this area. The subcatchment area is not susceptible to contaminated runoff as flows from the adjacent access road will travel via sheet flow directly to nearby bio-retention facilities. This subbasin consists entirely of vegetated slopes that drain via overland flow into an adjacent wetland to the east of the site.

Subbains SB2, SB3, SB4A, SB5, SB6, SB7, SB8, SB9, SB10A convey stormwater runoff through a treatment train of bioretention facilities (BF1 – BF4) prior to discharging to the eastern portion of the site into the existing wetland area, designated as Design Point 2 (DP2).

Subbasins SB4B, SB10B, SB11, SB12, SB13, and SB14 convey stormwater runoff to biofiltration facilities BF5 and BF6 and drain through a series of inlets (B-1 through B-3) and eventually to an existing wetland that is west of the site development, designated as Design Point 3 (DP3).

Subbasins SB15 and SB16 contain the existing roadside ditch and wetland area adjacent to US Highway 40. No new impervious or development grading is proposed within these subcatchments, and they will match predevelopment conditions. Therefore, no new water quality treatment is proposed.

Subbasin SB4C contains a small portion of the rooftop of the Holiday Inn Express that drains to the south via roof down-spouts. This area will also remain untreated as it was deemed impractical to add another bioretention facility to the south of the hotel to capture approximately 0.08 acres of rooftop. The rooftop runoff will not contain any pollutants indicated in the potential site contaminants section mentioned later in this report. Additionally, the runoff from this area would need to be directly discharged to the combination inlet that drains to the Homewood Suites BMP system which would result in additional flow and further analysis of the adjacent properties treatment system capacities.

D. Hydraulic Calculations

- Inlet capacity was analyzed using manufacturer capacity curves.
- Conveyance piping was analyzed with AutoCAD Storm Sewers software.

E. Major and Minor Flow Summary Table

Existing and proposed drainage was analyzed by dividing the lot into existing basins (e.g. EB1) and proposed sub-basins (e.g. SB1). Major and minor flows for each basin are summarized in the following table on the next page, Table 1.

Table 1: Major and Minor Flow Summary Table

Basin Condition	Area (acres)	Impervious Area (%)	Runoff	
			Q_5 (cfs)	Q_{100} (cfs)
EB1	2.96	5%	0.86	5.34
EB2	0.91	10%	0.64	3.60
EB3	0.39	80%	0.89	2.31
SB1	0.14	2%	0.08	0.58
SB2	0.44	76%	0.75	2.01
SB3	0.39	82%	0.79	2.03
SB4A	0.17	85%	0.34	0.86
SB4B	0.18	70%	0.18	0.51
SB4C	0.13	56%	0.14	0.43
SB5	0.24	92%	0.61	1.48
SB6	0.09	78%	0.16	0.42
SB7	0.12	84%	0.28	0.71
SB8	0.27	85%	0.60	1.52
SB9	0.32	82%	0.60	1.56
SB10A	0.20	87%	0.44	1.11
SB10B	0.19	73%	0.27	0.75
SB11	0.16	82%	0.38	0.99
SB12	0.20	90%	0.56	1.36
SB13	0.35	13%	0.17	0.89
SB14	0.33	11%	0.15	0.83

F. Proposed Easements

Drainage easements are proposed for all permanent water quality treatment BMPs. The drainage easements shall be accessible from the proposed 24-foot-wide new access to the hotels and 30-foot-wide shared access easement. Additionally, drainage easements along the west side of the hotels shall be accessible from the existing Storm Peak Apartments access road and easement.

G. Off Site Flows

No significant off-site flows exist.

H. Impacts to Downstream Properties

There are no anticipated impacts to downstream properties due to the proposed development. Please reference *Summary of Preliminary Findings for Hampton Inn and Holiday Inn Express Walton Creek HEC-RAS Split Flow Analysis* provided as part of the development plan package.

I. Potential Site Contaminants

- Sediment, sand, grit, and salts
- Vehicular pollutants (Oils, antifreeze, carbon deposits, etc.)
- Fertilizers, nutrients, pesticides, and herbicides.

J. On-Site Stormwater Flows

On site flows will originate primarily from the cross access road, parking lot, paved walkways, and the hotel rooftops. Flows shall be managed as designed and depicted in the proposed conditions drainage exhibit (see attached sheets DR2, DR3, and DR4).

K. Water Quality Design Standard

The TSS design standards were used for each of the bioretention facilities. TSS removal was determined using the City's prescribed method. Table 2 below outlines the design variables for the bioretention facilities.

Table 2: Bioretention System Design Variables

Water Quality Feature Design Variables	BF1	BF2	BF3	BF4	BF5	BF6
Design Event	1.25 yr	1.25 yr	1.25 yr	1.25 yr	1.25 yr	1.25 yr
Total Area Treated (acres)	0.56	0.32	0.68	0.68	0.35	0.44
Imperviousness of Area Treated	83%	86%	81%	83%	75%	79%
C Values of Area Treated	0.63	0.66	0.60	0.63	0.54	0.59
Hydrologic Soil Types of Treatment Area	C	C	C	C	C	C
Design Treatment Area (ft^2)	475	325	550	660	790	900
Design Flow Rate (cfs)	0.47	0.33	0.52	0.56	0.32	0.43

L. Channels

There are no proposed drainage swales associated with the project. All on-site stormwater runoff will be conveyed to the proposed bioretention systems via sheet flow from the parking lot, access roads, sidewalks, and rooftops. The project complies with the Water Quality Capture Volume (WQCV) standard.

M. Inlets and Perforated Underdrains

Nyloplast inlets with dome grates are proposed within each of the six bioretention systems (varying in diameter, see construction plans). Each inlet has the capacity to capture the minor storm event with 100% efficiency. However, the goal of the bioretention systems will be to filter incoming flows through the bioretention media and into four-inch diameter perforated HDPE underdrains rather than through the nyloplast inlets. Additionally, orifice holes will be provided in some of the designated inlets to release the treated water within each of the bioretention facilities. Calculations for the orifice sizes are included in the appendices.

During larger storm events, exceeding the major 100-year design storm, the nyloplast inlets will begin to drain portions of the ponded area within the bioretention systems to limit the potential for overflow into the parking lot. The dome grates and orifice openings are proposed to limit

clogging that is commonly associated with the bioretention systems. For additional information, see the attached drainage exhibit sheets, DR2, DR3, and DR4.

N. Culverts

Four new drainage culverts will be utilized to convey treated on-site stormwater to off-site areas adjacent to the project site.

Culvert #1 consists of a new 24-inch diameter HDPE pipe that will be connected to inlet A-1 of the permanent storm-sewer network. Culvert #1 will discharge treated on-site flows to Design Point 2 and eventually the existing wetland that is located east of the site development.

Culverts #2, #3, and #4 consist of a new 6-inch diameter HDPE solid pipes that will be connected to inlets B-1, B-2, and B-3, respectively. These culverts help drain bioretention facilities 5 and 6 to the west of the site to the existing US Highway 40 roadside ditch (Design Point 3).

5.0 Construction Stormwater Management

The contractor and owner shall be required to obtain a state general permit for the discharge of construction site stormwater associated with the approximate 3.00 acres of development. The contractor shall be responsible for obtaining this permit prior to construction.

A detailed stormwater management plan prepared by a Colorado Professional Engineer shall be required for all phases of construction. The stormwater management plan should take into account the changing topography and conditions of the site throughout the construction process.

Lastly, it should be emphasized that Lot 1 discharges into delineated wetlands on City property that leads directly into Walton Creek a few hundred feet downstream of Design Point 2. This is a sensitive area and temporary stormwater control measures shall be properly implemented, inspected, and maintained throughout the entire construction phase and until at least 80% of final revegetation is achieved for the site.

6.0 Post Construction Stormwater Management

See Operation and Maintenance Plans provided in the appendices.

7.0 Concluding General Summary

Approximately 3.00 acres of land are proposed for the development of two commercial hotel establishments. Existing drainage patterns will be changed due to the extent of development but the historic outfall points will be maintained under the proposed conditions. Permanent drainage features for the Project include a combination of sheet flow, stormwater BMPs and a stormwater collection and conveyance network to manage stormwater runoff. Treated stormwater runoff will be discharged to three design points (DP1 – DP3). All parking lot and access roads of the development will receive water quality treatment via the bioretention systems and grass buffers.

A. Compliance

The proposed stormwater drainage system complies with City Drainage Criteria.

B. Historic and Proposed Site Flows

Peak proposed flows will be higher than historic peak flows. However, flows from the site immediately discharge into the Walton Creek floodplain and the increase in peak flow does not affect surrounding base flood elevations.

C. Proposed New Stormwater System Requirements

The proposed stormwater system shall effectively convey and treat all flows on site with proper installation and maintenance.

8.0 References

Urban Drainage and Flood Control District Criteria Manual, 2018.

NOAA Precipitation Frequency Server. NOAA Atlas 14, Volume 8, Version 2. www.NOAA.com

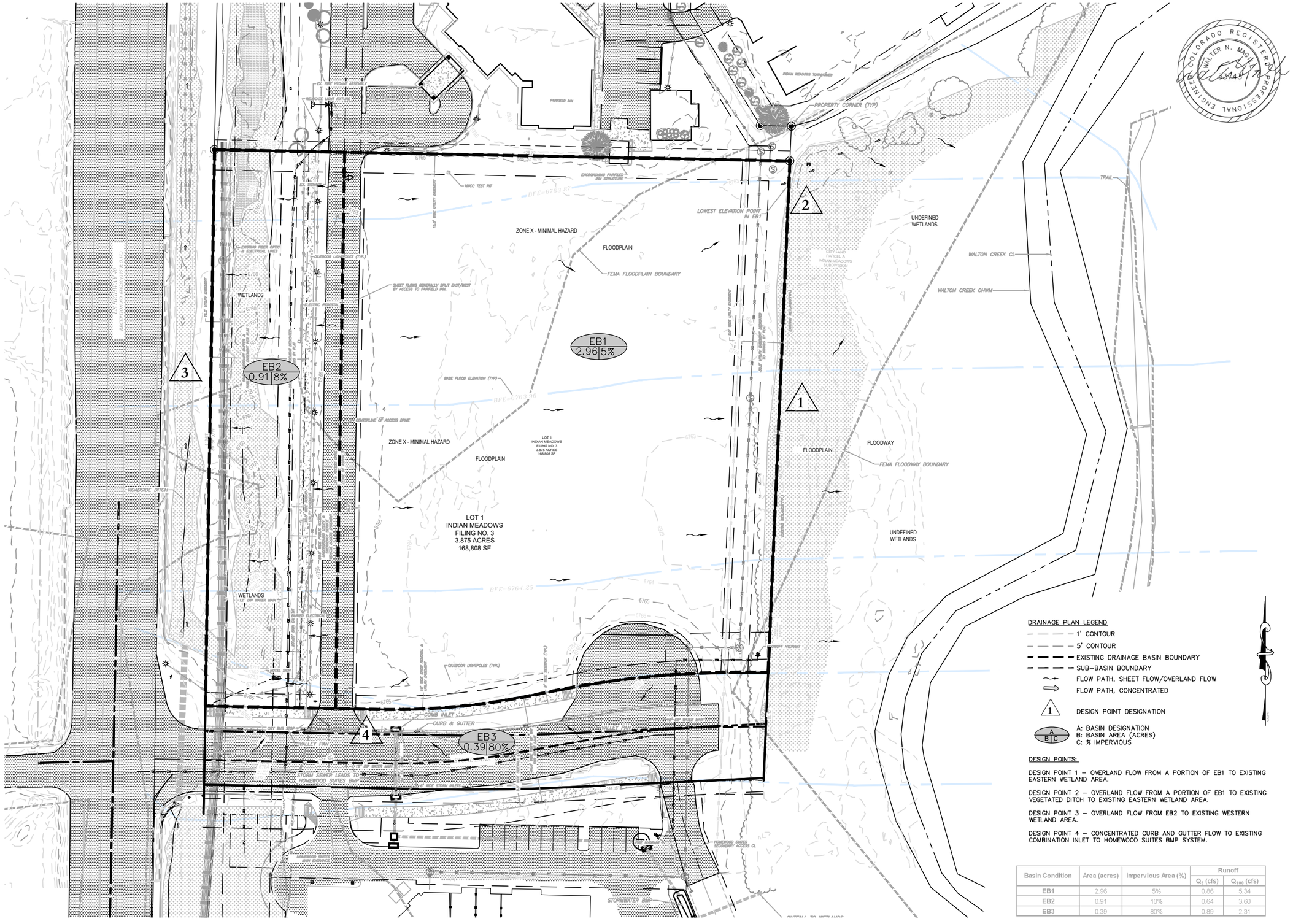
City of Steamboat Springs Engineering Drainage Criteria, Latest Version.

Summary of Preliminary Findings for the Hampton Inn and Holiday Inn Express – Walton Creek HEC-RAS Split Flow Analysis. Wohnrade Civil Engineers Inc., Mary B. Wohnrade, P.E.

9.0 Appendices

A. Existing Conditions Drainage Exhibit, DR1
B. Proposed Conditions Drainage Exhibit, DR2
C. Bioretention Profiles, DR3
D. Bioretention Notes and Specifications, DR4
E. USDA NRCS Web Soil Survey
F. Basin Runoff Calculations
G. BMP Design Spreadsheet Calculations for Bioretention
H. BMP Design Spreadsheet Calculations for TSS
I. Inlet Capacity Curve
J. Storm Sewer Capacity Calculations and EGL/HGL profiles
K. Standard forms No. 3, 4, & 5
L. Operation and Maintenance Plan for Stormwater BMPs and Conveyance Network

Appendix A: Existing Conditions Drainage Exhibit, DR1



DRAINAGE PLAN LEGEND

- 1' CONTOUR
- 5' CONTOUR
- EXISTING DRAINAGE BASIN BOUNDARY
- SUB-BASIN BOUNDARY
- FLOW PATH, SHEET FLOW/OVERLAND FLOW
- FLOW PATH, CONCENTRATED
- 1 — DESIGN POINT DESIGNATION
- A: BASIN DESIGNATION
  B: BASIN AREA (ACRES)
  C: % IMPERVIOUS

DESIGN POINTS:

DESIGN POINT 1 – OVERLAND FLOW FROM A PORTION OF EB1 TO EXISTING EASTERN WETLAND AREA.

DESIGN POINT 2 – OVERLAND FLOW FROM A PORTION OF EB1 TO EXISTING VEGETATED DITCH TO EXISTING EASTERN WETLAND AREA.

DESIGN POINT 3 – OVERLAND FLOW FROM EB2 TO EXISTING WESTERN WETLAND AREA.

DESIGN POINT 4 – CONCENTRATED CURB AND GUTTER FLOW TO EXISTING COMBINATION INLET TO HOMEWOOD SUITES BMP SYSTEM.

Basin Condition	Area (acres)	Impervious Area (%)	Runoff	
			Q_5 (cfs)	Q_{100} (cfs)
EB1	2.96	5%	0.86	5.34
EB2	0.91	10%	0.64	3.60
EB3	0.39	80%	0.89	2.31

COLORADO REGISTERED PROFESSIONAL ENGINEER
WALTER N. MAGILL
53448

FOUR POINTS SURVEYING ENGINEERING
410 S. Lincoln Ave, Unit 15
P.O. Box 775966
Steamboat Springs, CO 80487
(970)-871-6772
www.fourpointsse.com

No.	DATE	REVISIONS	INT

HOLIDAY INN EXPRESS & HOTEL B
CONSTRUCTION PLANS
INDIAN MEADOWS FIL. NO. 4
LOTS 1 AND 2
STEAMBOAT SPRINGS, CO 80487

HORIZONTAL SCALE
0 30' 60'
SCALE: 1" = 30'

CONTOUR INTERVAL = 1FT

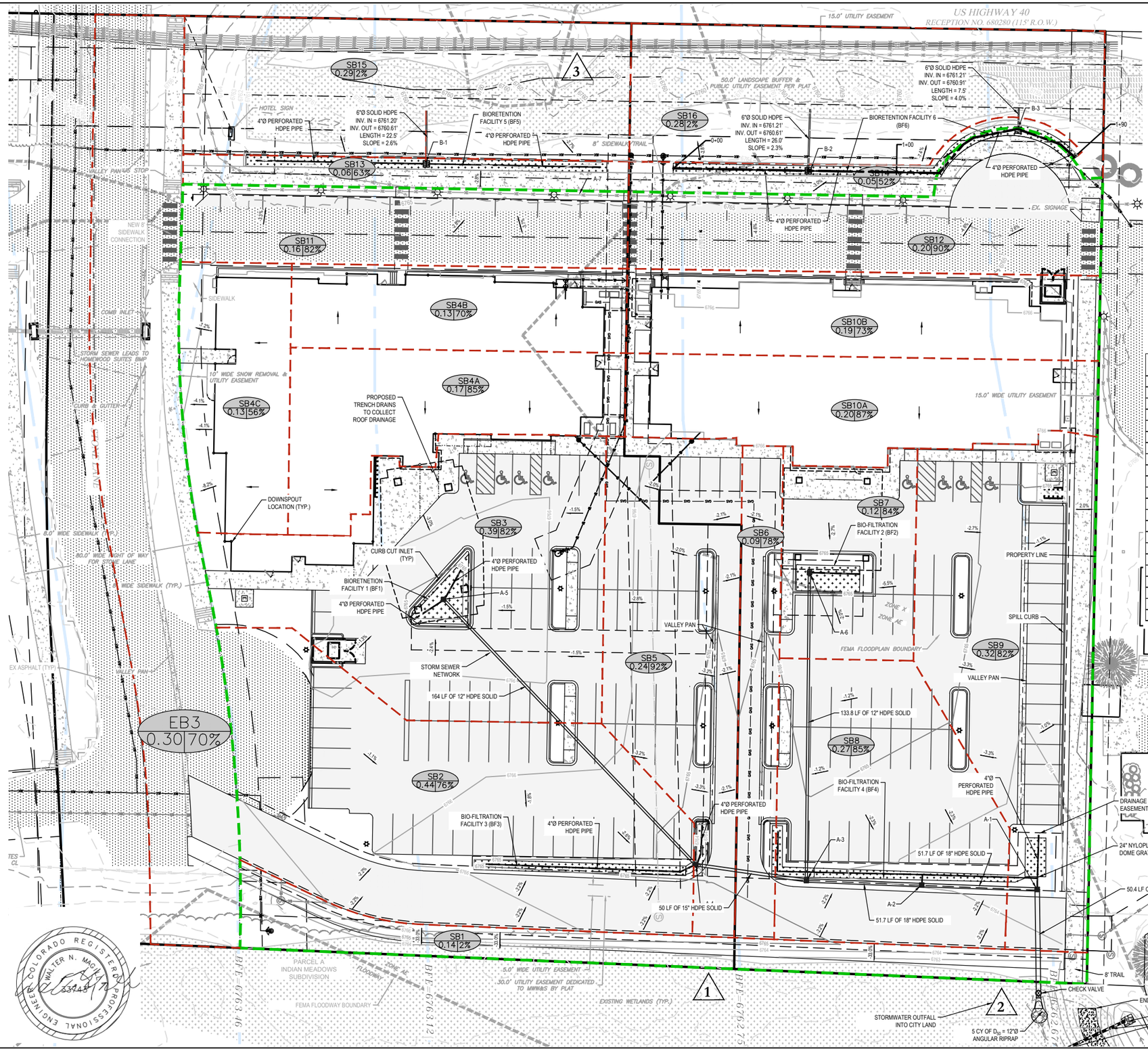
DATE: 9/1/2023
JOB #: 1448-005
DRAWN BY: AP/DSC/AAC
DESIGN BY: AP/DSC/AAC/WNM
REVIEW BY: FPSE

IF THIS DRAWING IS PRESENTED IN A FORMAT OTHER THAN 24" X 36", THE GRAPHIC SCALE SHOULD BE UTILIZED.

DRAWING: EXISTING CONDITIONS DRAINAGE

SHEET NO.
DR1

Appendix B: Proposed Conditions Drainage Exhibit, DR2



GRADING AND DRAINAGE PLAN LEGEND

- 1' PROPOSED CONTOUR
- 5' PROPOSED CONTOUR
- DEVELOPMENT BASIN BOUNDARY
- SUB-BASIN BOUNDARY
- 2.0% FLOW PATH, SHEET FLOW/OVERLAND FLOW
- FLOW PATH, CONCENTRATED
- 1 DESIGN POINT DESIGNATION
- A / B / C — A: BASIN DESIGNATION; B: BASIN AREA (ACRES); C: % IMPERVIOUS
- INLET
- STORM SEWER
- UNDERDRAIN
- WATER QUALITY (WQ) TREATMENT BMP

DESIGN POINTS:

DP1: EXISTING WETLAND LOCATED ON THE EASTERN EXTENTS OF THE DEVELOPMENT AREA.

DP2: 24 INCH DIAMETER CMP OUTFALL TO CITY OWNED LAND ON THE EASTERN EXTENTS OF THE DEVELOPMENT AREA.

DP3: EXISTING WETLAND LOCATED ON THE WESTERN EXTENTS OF THE DEVELOPMENT AREA.

Basin Condition	Area (acres)	Impervious Area (%)	Runoff	
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EB1	2.96	5%	0.86	5.34
EB2	0.91	10%	0.64	3.60
EB3	0.39	80%	0.89	2.31
SB1	0.14	2%	0.08	0.58
SB2	0.44	76%	0.75	2.01
SB3	0.39	82%	0.79	2.03
SB4A	0.17	85%	0.34	0.86
SB4B	0.18	70%	0.18	0.51
SB4C	0.13	56%	0.14	0.43
SB5	0.24	92%	0.61	1.48
SB6	0.09	78%	0.16	0.42
SB7	0.12	84%	0.28	0.71
SB8	0.27	85%	0.60	1.52
SB9	0.32	82%	0.60	1.56
SB10A	0.20	87%	0.44	1.11
SB10B	0.19	73%	0.27	0.75
SB11	0.16	82%	0.38	0.99
SB12	0.20	90%	0.56	1.36
SB13	0.06	67%	0.11	0.32
SB14	0.05	61%	0.09	0.26
SB15	0.29	2%	0.18	1.20
SB16	0.28	2%	1.04	1.16

COLORADO REGISTERED PROFESSIONAL ENGINEER — WALTER N. MAGLIANO — 53748

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HOLIDAY INN EXPRESS & HOTEL B
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INDIAN MEADOWS FIL. NO. 4
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HORIZONTAL SCALE
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DATE: 9/1/2023
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REVIEW BY: PPSE

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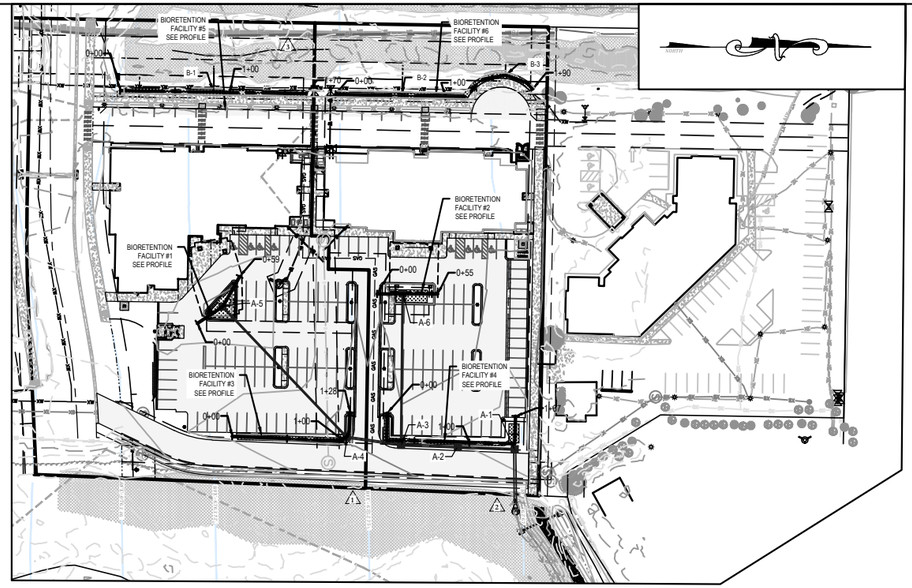
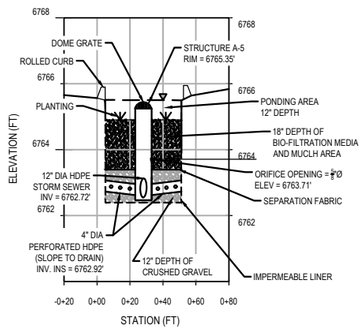
DRAWING: GRADING & DRAINAGE PLAN

SHEET NO.
DR2

Appendix C: Bioretention Profiles, DR3





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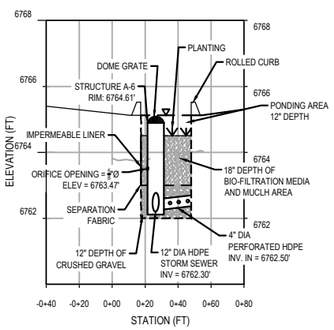

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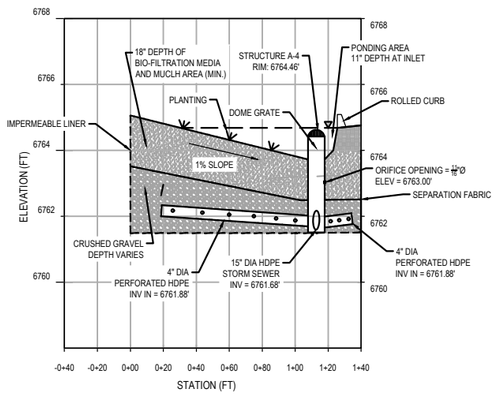
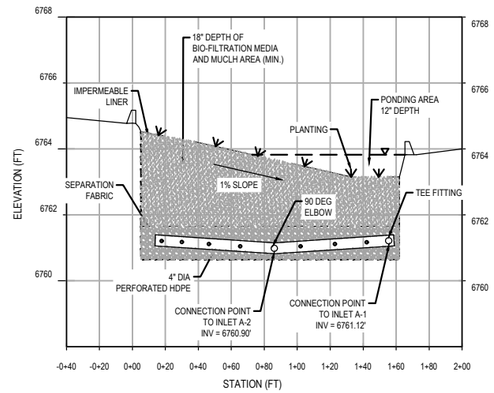
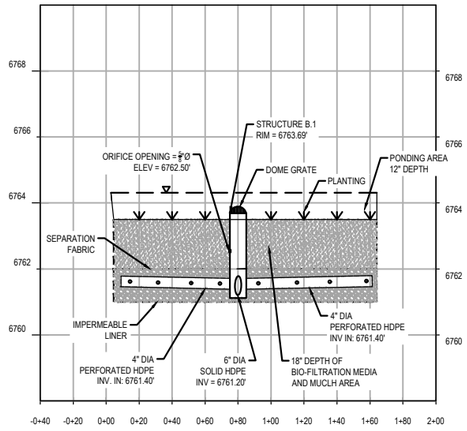


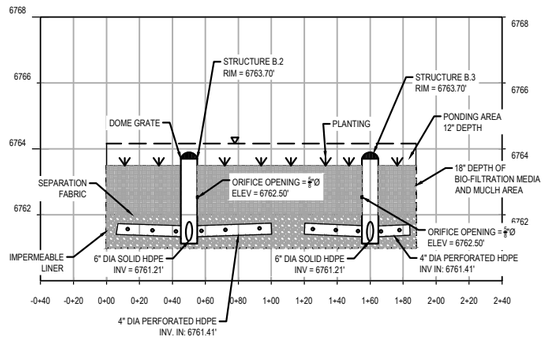
BIORETENTION FACILITY #3



BIORETENTION FACILITY #4



BIORETENTION FACILITY #5



BIORETENTION FACILITY #6

PROFILE SCALES:
HORIZONTAL: 1" = 40'
VERTICAL: 1" = 2'

FOUR POINTS SURVEYING ENGINEERING
410 S. Lincoln Ave, Unit 15
P.O. Box 775966
Steamboat Springs, CO 80487
(970)-871-6772
www.fourpointsse.com

No.	DATE	REVISIONS	INT

HOLIDAY INN EXPRESS & HOTEL B
CONSTRUCTION PLANS
INDIAN MEADOWS FIL. NO. 4
LOTS 1 AND 2
STEAMBOAT SPRINGS, CO 80487

HORIZONTAL SCALE
0 60' 120'
SCALE: 1" = 60'

CONTOUR INTERVAL = 1 FT

DATE: 9/1/2023
JOB #: 1448-005
DRAWN BY: AP/DSC/AAC
DESIGN BY: AP/DSC/AAC/WNM
REVIEW BY: FPSE

IF THIS DRAWING IS PRESENTED IN A FORMAT OTHER THAN 24" X 36", THE GRAPHIC SCALE SHOULD BE UTILIZED.

DRAWING:
BIORETENTION SYSTEM PROFILES

SHEET NO.
DR3

Appendix D: Bioretention Notes and Specifications, DR4

BIORETENTION NOTES:

TERMINOLOGY:

THE TERM BIORETENTION REFERS TO THE TREATMENT PROCESS ALTHOUGH IT IS ALSO FREQUENTLY USED TO DESCRIBE A BMP THAT PROVIDES BIOLOGICAL UPTAKE AND FILTRATION OF THE POLLUTANTS FOUND IN STORMWATER RUNOFF.

DESCRIPTION:

BIORETENTION IS A BEST MANAGEMENT PRACTICE (BMP) THAT UTILIZES BIORETENTION AS AN ENGINEERED, DEPRESSED LANDSCAPE AREA DESIGNED TO CAPTURE AND FILTER OR INFILTRATE THE WATER QUALITY CAPTURE VOLUME (WQCV). BMPs THAT UTILIZE BIORETENTION ARE FREQUENTLY REFERRED TO AS RAIN GARDENS OR POROUS LANDSCAPE DETENTION AREAS (PLDs).

THE DESIGN OF A BIORETENTION OR RAIN GARDEN SYSTEM MAY PROVIDE DETENTION FOR EVENTS EXCEEDING THAT OF THE WQCV. THERE ARE GENERALLY TWO WAYS TO ACHIEVE THIS. THE DESIGN CAN PROVIDE THE FLOOD CONTROL VOLUME ABOVE THE WQCV OR THE DESIGN CAN PROVIDE AND SLOWLY RELEASE THE FLOOD CONTROL VOLUME IN AN AREA DOWNSTREAM OF ONE OR MORE BIORETENTION SYSTEMS. SEE THE STORAGE CHAPTER IN VOLUME 2 OF THE URBAN STORM DRAINAGE CRITERIA MANUAL (USDCM) FOR ADDITIONAL INFORMATION.

SITE SELECTION:

THIS BMP ALLOWS WQCV TREATMENT WITHIN ONE OR MORE AREAS DESIGNATED FOR LANDSCAPE. IT IS AN EXCELLENT ALTERNATIVE TO EXTENDED DETENTION BASINS FOR SMALL SITES WITH LIMITED AVAILABLE AREA. A TYPICAL BIORETENTION SYSTEM SERVES A TRIBUTARY OR SUBBASIN AREA OF ONE IMPERVIOUS ACRE OR LESS, ALTHOUGH THEY CAN BE DESIGNED FOR LARGER TRIBUTARY AREAS. MULTIPLE INSTALLATIONS CAN BE USED WITHIN LARGER SITES. BIOFILTRATION SHOULD NOT BE USED WHEN A BASEFLOW IS ANTICIPATED OR WHEN GROUNDWATER HAS BEEN OBSERVED IN CLOSE PROXIMITY TO EXISTING GRADE ELEVATIONS. THE SYSTEMS ARE TYPICALLY SMALL AND MAY BE INSTALLED IN LOCATIONS SUCH AS:

- PARKING LOT ISLANDS
- STREET MEDIANS
- LANDSCAPE AREAS BETWEEN THE ROAD AND A DETACHED SIDEWALK
- PLANTER BOXES THAT COLLECT ROOF DRAINS

BIORETENTION REQUIRES A STABLE WATERSHED. DURING PHASED CONSTRUCTION, PROPER EROSION PREVENTION AND SEDIMENT CONTROL MEASURES SHALL BE INSTALLED TO ENSURE LADEN SEDIMENT DOES NOT DIRECTLY DISCHARGE INTO ADJACENT WATERBODIES.

THE SURFACE OF A RAIN GARDEN SHOULD BE PRIMARILY FLAT. HOWEVER, TERRACED APPLICATION OF THESE FACILITIES HAVE BEEN SUCCESSFUL IN THE PAST. WHEN BIORETENTION SYSTEMS ARE LOCATED ADJACENT TO BUILDINGS OR PAVEMENT AREAS, PROTECTIVE MEASURES SHOULD BE IMPLEMENTED TO AVOID ADVERSE IMPACTS TO THESE STRUCTURES.

MAINTENANCE:

SEE THE OPERATIONS AND MAINTENANCE PLAN INCLUDED AS PART OF THE DRAINAGE REPORT.

ON-SITE SOIL CONDITIONS:

NORTHWEST COLORADO CONSULTANTS (NWCC) PRODUCED A GEOTECHNICAL STUDY FOR THE PROJECT ON MARCH 31, 2022. THE GEOTECHNICAL STUDY INCLUDED THE LOGGING OF FOUR TEST HOLES AND SIX TEST PITS. SOILS WERE OBSERVED ON-SITE AND LATER SAMPLED AND LAB TESTED FOR ADDITIONAL EVALUATION.

BASED ON THE ANTICIPATED GEOLOGIC SITE CONDITIONS, NWCC RECOMMENDED THAT A **SITE CLASS C** DESIGNATION SHOULD BE USED IN STRUCTURAL DESIGN CALCULATIONS IN ACCORDANCE WITH TABLE 20.3-1 IN CHAPTER 20 OF ASCE 7.

THEREFORE, FOUR POINTS SURVEYING AND ENGINEERING OPTED TO ELIMINATE THE POTENTIAL FOR INFILTRATING BMPs AS A RESULT OF THE GEOTECHNICAL STUDY FINDINGS. ALL OF THE SEVEN PROPOSED BIORETENTION SYSTEMS WILL BE NON-INFILTRATING AND WILL RELY ON UNDER-DRAIN SYSTEMS TO CAPTURE AND CONVEY STORMWATER TO THE INTENDED DESIGN OUTFALLS AND OFF-SITE DISCHARGE LOCATIONS.

NON-INFILTRATING BIORETENTION SYSTEMS:

NON-INFILTRATING BIORETENTION SYSTEMS INCLUDE AN UNDER-DRAIN AND AN IMPERVIOUS LINER THAT PREVENTS INFILTRATION OF STORMWATER INTO THE SUBGRADE SOILS. NON-INFILTRATING BIORETENTION SYSTEMS ARE APPROPRIATE FOR THIS PROJECT AS THE FACILITY IS LOCATED OVER POTENTIALLY EXPANSIVE SOILS OR BEDROCK THAT COULD SELL DUE TO INFILTRATION AND POTENTIALLY DAMAGE ADJACENT STRUCTURES (I.E. BUILDING FOUNDATIONS OR PAVEMENTS).

BASIN STORAGE VOLUME:

STORAGE VOLUMES ARE BASED ON A 12-HOUR DRAIN TIME. SEE THE ATTACHED BMP SIZING WORKSHEETS ATTACHED TO THIS DRAINAGE REPORT. DESIGN VOLUMES ARE CALCULATED FOLLOWING EQUATION B-1 OF THE USDCM MANUAL, VOLUME 3.

$V = (\frac{WQCV}{12}) * A$ (EQ. B-1)

WHERE:
V = DESIGN VOLUME (FT³)
A = AREA OF WATERSHED TRIBUTARY TO THE BIORETENTION SYSTEM (FT²)

BASIN GEOMETRY:

THE MAXIMUM PONDING DEPTH FOR THE PROJECT IS 12 INCHES. NYLOPLAST DOME GRATES WILL BE INSTALLED TO MANAGE OVERFLOW WITHIN THE PONDED AREA OF EACH BIORETENTION FACILITY. THIS WILL REDUCE THE POTENTIAL FOR EXCESS STORMWATER FROM OVERTOPPING THE CURBS AND BACKFLOWING INTO THE PROPOSED PARKING AREA. VERTICAL WALL GEOMETRIES WILL BE UTILIZED. SEE FIGURE B-3 GEOMEMBRANE LINER/CONCRETE CONNECTION DETAIL FOR ADDITIONAL INFORMATION. CURB CUTS ARE PROPOSED TO ALLOW THE PARKING LOT TO SUCCESSFULLY DRAIN INTO EACH OF THE INTENDED BMP SYSTEMS. MINIMUM FILTER AREAS WERE CALCULATED USING THE FOLLOWING EQUATION:

$A_F = 0.02AI$ (EQ. B-2)

WHERE:

AF = MINIMUM (FLAT) FILTER AREA (FT²)
A = AREA TRIBUTARY TO THE BIORETENTION SYSTEM (FT²)
I = IMPERVIOUSNESS OF TRIBUTARY AREA TO THE BIORETENTION SYSTEM (PERCENT EXPRESSED AS A DECIMAL).

GROWING MEDIUM:

PROVIDE A MINIMUM OF 18 INCHES OF GROWING MEDIUM TO ENABLE ESTABLISHMENT OF THE ROOTS OF THE VEGETATION. SEE THE SPECIFICATION TABLE BELOW FOR SPECIFICATIONS OF THE GROWING MEDIUM.

UNDER-DRAIN SYSTEM:

WHEN USING AN UNDER-DRAIN SYSTEM, PROVIDE A CONTROL ORIFICE TO DRAIN THE DESIGN VOLUME IN 12 HOURS OR MORE. USE A MINIMUM ORIFICE SIZE OF $\frac{3}{4}$ INCHES TO AVOID CLOGGING. THIS WILL PROVIDE DETENTION AND SLOW RELEASE OF THE WQCV, PROVIDING WATER QUALITY BENEFITS AND REDUCING IMPACTS TO DOWNSTREAM CHANNELS. SPACE UNDER-DRAIN PIPES A MAXIMUM OF 20 FEET ON CENTER. PROVIDE CLEANOUTS TO ENABLE MAINTENANCE OF THE UNDER-DRAIN SYSTEM. EACH NYLOPLAST INLET STRUCTURE WILL INCLUDE AN ORIFICE HOLE TO RELEASE EACH OF THE BIORETENTION SYSTEMS WITHIN THE 12 HOUR PERIOD. CALCULATIONS FOR THE ORIFICE SIZE HAVE BEEN PROVIDED IN THE ATTACHMENTS OF THE DRAINAGE REPORT.

THE UNDER-DRAIN SYSTEM SHOULD BE PLACED WITHIN A 6-INCH THICK SECTION OF CDOT CLASS B OR CLASS C FILTER MATERIAL MEETING THE GRADATION IN THE TABLE BELOW. USE SLOTTED (PERFORATED) PIPE THAT MEETS THE SLOT DIMENSIONS LISTED IN THE TABLE ON THE SPECIFICATIONS SHEET.

IMPERMEABLE GEOMEMBRANE LINER AND GEOTEXTILE SEPARATOR FABRIC:

FOR NON-INFILTRATING SYSTEMS, INSTALL A 30 MIL (MIN) PVC GEOMEMBRANE LINER, PER THE TABLE ON THE SPECIFICATIONS SHEET, ON THE BOTTOM AND SIDES OF THE BASIN, EXTENDING UP AT LEAST TO THE TOP OF THE UNDER-DRAIN LAYER. PROVIDE AT LEAST 9 INCHES (12 INCHES IF POSSIBLE) OF COVER OVER THE MEMBRANE WHERE IT IS TO BE ATTACHED TO THE WALL TO PROTECT THE MEMBRANE FROM UV DETERIORATION. THE GEOMEMBRANE SHOULD BE FIELD SEAMED USING A DUAL TRACK WELDER, WHICH ALLOWS FOR NON-DESTRUCTIVE TESTING OF ALMOST ALL FIELD SEAMS. A SMALL AMOUNT OF SINGLE TRACK IS ALLOWED IN LIMITED AREAS TO SEAM AROUND PIPE PERFORATIONS, TO PATCH SEAMS REMOVED FOR DESTRUCTIVE SEAM TESTING, AND FOR LIMITED REPAIRS. THE LINER SHOULD BE INSTALLED WITH SLACK TO PREVENT TEARING DUE TO BACKFILL, COMPACTION AND SETTLING.

PLACE CDOT CLASS B GEOTEXTILE SEPARATOR FABRIC ABOVE THE GEOMEMBRANE TO PROTECT IT FROM BEING PUNCTURED DURING THE PLACEMENT OF THE FILTER MATERIAL ABOVE THE LINER. IF THE SUBGRADE CONTAINS ANGULAR ROCKS OR OTHER MATERIAL THAT COULD PUNCTURE THE GEOMEMBRANE, SMOOTH-ROLL THE SURFACE TO CREATE A SUITABLE SURFACE. IF SMOOTH-ROLLING THE SURFACE DOES NOT PROVIDE A SUITABLE SURFACE, ALSO PLACE THE SEPARATOR FABRIC BETWEEN THE GEOMEMBRANE AND THE UNDERLYING SUBGRADE. THIS SHOULD ONLY BE DONE WHEN NECESSARY BECAUSE FABRIC PLACED UNDER THE GEOMEMBRANE CAN INCREASE SEEPAGE LOSSES THROUGH PINHOLES OR OTHER GEOMEMBRANE DEFECTS. CONNECT THE GEOMEMBRANE TO PERIMETER CONCRETE WALLS AROUND THE BASIN PERIMETER, CREATING A WATERTIGHT SEAL BETWEEN THE GEOMEMBRANE AND THE WALLS USING A CONTINUOUS BATTEN BAR AND ANCHOR CONNECTION (SEE FIGURE B-3 OF USDCM). WHERE THE NEED FOR THE IMPERMEABLE MEMBRANE IS NOT AS CRITICAL, THE MEMBRANE CAN BE ATTACHED WITH A NITRILE-BASED VINYL ADHESIVE. USE WATERTIGHT PVC BOOTS FOR UNDERDRAIN PIPE PENETRATIONS THROUGH THE LINER (SEE FIGURE B-2) OR THE TECHNIQUE SHOWN IN PHOTO B-3 OF THE USDCM.

INLET AND OUTLET CONTROL:

INLET CONTROL WILL BE MAINTAINED BY CURB CUT OPENINGS THAT ARE ORIENTATED IN THE DIRECTION OF THE PARKING LOT FLOW.

OULET CONTROL WILL BE MAINTAINED BY THE INSTALLATION OF THE NYLOPLAST GRATES. THE NYLOPLAST GRATES WILL HELP CAPTURE EXCESS VOLUMES WITHIN THE BIORTENTION SYSTEMS (DURING LARGER STORM EVENTS) AND REDUCE THE POTENTIAL FOR BACKFLOW INTO THE PARKING LOT AREA.

VEGETATION:

THE UDFCD RECOMMENDS THAT THE FILTER AREA SHALL BE VEGETATED WITH DROUGHT TOLERANT SPECIES THAT THRIVE IN SANDY SOILS. SEE THE SPECIFICATION SHEET FOR ADDITIONAL INFORMATION.

MIX SEED WELL AND BROADCAST, FOLLOWED BY HAND RAKING TO COVER SEED AND THEN MULCH. HYDRO-MULCHING CAN BE EFFECTIVE FOR THE LARGER BIORETENTION SYSTEMS. DO NOT PLACE SEED WHEN STANDING WATER OR SNOW IS PRESENT OR IF THE GROUND IS FROZEN. WEED CONTROL IS CRITICAL IN THE FIRST TWO TO THREE YEARS, ESPECIALLY WHEN STARTING WITH SEED.

WHEN USING SOD, SPECIFY SAND-GROWN SOD. DO NOT USE CONVENTIONAL SOD. CONVENTIONAL SOD IS GROWN IN CLAY SOIL THAT WILL SEAL THE FILTER AREA, GREATLY REDUCING THE OVERALL FUNCTION OF THE BMP.

WHEN USING AN IMPERMEABLE LINER, SELECT PLANTS WITH DIFFUSE (OR FIBROUS) ROOT SYSTEMS, NOT TAPROOTS. TAPROOTS CAN DAMAGE THE LINER AND/OR UNDER-DRAIN PIPE. AVOID TREES AND LARGE SHRUBS THAT MAY INTERFERE WITH RESTORATIVE MAINTENANCE. PLANT THESE OUTSIDE OF THE AREA OF GROWING MEDIUM. USE A CUTOFF WALL TO ENSURE THAT ROOTS DO NOT GROW INTO THE UNDER-DRAIN OR PLACES TRESS AND SHRUBS A CONSERVATIVE DISTANCE FROM THE UNDER-DRAIN.

IRRIGATION:

ON-SITE IRRIGATION IN THE FORM OF SPRINKLER SYSTEMS ARE NOT PROPOSED FOR THIS PROJECT. PLANTINGS SHALL BE WATERED AT AN APPROPRIATED RATE TO MAINTAIN VEGETATIVE GROWTH WITHIN THE BMP SYSTEMS. ADJUST WATERING SCHEDULES DURING THE GROWING SEASON (SPRING AND SUMMER MONTHS) TO PROVIDE THE MINIMUM WATER NECESSARY TO MAINTAIN PLANT HEALTH AND TO MAINTAIN THE AVAILABLE PORE SPACE FOR INFILTRATION.

AESTHETIC DESIGN:

IN ADDITION TO EFFECTIVE STORMWATER QUALITY TREATMENT, BIOFILTRATION CAN BE ATTRACTIVELY INCORPORATED INTO A SITE WITHIN ONE OR SEVERAL LANDSCAPE AREAS. AESTHETICALLY DESIGNED BIOFILTRATION WILL TYPICALLY EITHER REFLECT THE CHARACTER OF THEIR SURROUNDING OR BECOME DISTINCT FEATURES WITHIN THEIR SURROUNDINGS. SEE THE USDCM FOR ADDITIONAL CRITERIA RELATING TO AESTHETICS.

CONSTRUCTION CONSIDERATIONS:

PROPER CONSTRUCTION OF BIOFILTRATION SYSTEMS INVOLVES CAREFUL ATTENTION TO MATERIAL SPECIFICATION, FINISHED GRADES, AND CONSTRUCTION DETAILS. IMPORTANT FACTORS TO IMPLEMENT INCLUDE:

- PROTECT AREAS FROM EXCESSIVE SEDIMENT LOADING DURING CONSTRUCTION. THIS IS THE MOST COMMON CAUSE OF CLOGGING OF BIOFILTRATION. THE PORTION OF THE SITE DRAINING TO THE RAIN GARDEN MUST BE STABILIZED BEFORE ALLOWING FLOW INTO THE RAIN GARDEN. THIS INCLUDES COMPLETION OF PAVING OPERATIONS.
- AVOID OVER COMPACTION OF AREA TO PRESERVE INFILTRATION RATES (NOT APPLICABLE TO NON-INFILTRATING SYSTEMS).
- PROVIDE CONSTRUCTION OBSERVATION TO ENSURE COMPLIANCE WITH DESIGN SPECIFICATIONS. IMPROPER INSTALLATION, PARTICULARLY RELATED TO FACILITY DIMENSIONS AND ELEVATIONS AND UNDER-DRAIN ELEVATIONS, IS A COMMON PROBLEM WITH BIORETENTION.
- WHEN USING AN IMPERMEABLE LINER, ENSURE ENOUGH SLACK IN THE LINER TO ALLOW FOR BACKFILL, COMPACTION, AND SETTLING WITHOUT TEARING THE LINER.
- PROVIDE NECESSARY QUALITY ASSURANCE AND QUALITY CONTROL (QA/QC) WHEN CONSTRUCTION AN IMPERMEABLE GEOMEMBRANE LINER SYSTEM, INCLUDING BUT NOT LIMITED TO FABRICATION TESTING, DESTRUCTIVE AND NON-DESTRUCTIVE TESTING OF FIELD SEAMS, OBSERVATION OF GEOMEMBRANE MATERIALS FOR TEARS OR OTHER DEFECTS, AND AIR LACE TESTING FOR LEAKS IN ALL FIELD SEAMS AND PENETRATIONS. QA/QC SHOULD BE OVERSEEN BY THE OWNERS REPRESENTATIVE AND REPORTED TO A PROFESSIONAL ENGINEER. FIELD REPORTING AND INSPECTION LOGS ARE REQUIRED DURING THE LINER INSTALLATION PROCESS. ALL DOCUMENTS SHALL BE TRANSMITTED TO THE PROFESSIONAL ENGINEER.
- PROVIDE ADEQUATE CONSTRUCTION STAKING TO ENSURE THAT THE SITE PROPERLY DRAINS INTO THE BMP SYSTEM, PARTICULARLY WITH RESPECT TO SURFACE DRAINAGE AWAY FROM ADJACENT BUILDINGS.

MISCELLANEOUS:

ALL NOTES AND SPECIFICATIONS ARE REFERENCED TO THE URBAN DRAINAGE AND FLOOD CONTROL DISTRICT, URBAN STORM DRAINAGE CRITERIA MANUAL, VOLUME 3, LATEST ADDITION.

TABLE 1: MATERIAL SPECIFICATION FOR BIORETENTION SYSTEMS

MATERIAL		SPECIFICATION			SUBMITTALS	TESTING	NOTES
BIORETENTION GROWING MEDIA	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 DIAMETER) CHEMICAL ATTRIBUTE AND NUTRIENT ANALYSIS pH = 6.8 - 7.5 ORGANIC MATTER <15% NITROGEN < 15 PPM PHOSPHOROUS < 15 PPM SALINITY < 6 MMHOS/CM			PARTICLE SIZE DISTRIBUTION AND NUTRIENT ANALYSIS REQUIRED		PERCENTAGES ARE IN WEIGHT.
	BIORETENTION ORGANICS	3 TO 5% SHREDDED MULCH (BY WEIGHT OF GROWING MEDIA)					BIORETENTION SOIL REQUIRED. AGED SIX MONTHS (MIN.).
LANDSCAPE MULCH		SHREDDED HARDWOOD					AGED SIX MONTHS (MIN.). NO WEED FABRIC ALLOWED
UNDERDRAIN AGGREGATE	CDOT FILTER MATERIAL (CLASS B OR C)		MASS PERCENT PASSING SQUARE MESH SIEVE		PARTICLE SIZE DISTRIBUTION REQUIRED.		
		SIEVE SIZE	CLASS B	CLASS C			
		37.5 mm (1.5")	100				
		19.0 mm (0.75")		100			
		4.75 mm (No. 4)	20-60	60-100			
		1.18 um (No. 16)	10-30				
		300 um (No. 50)	0-10	10-30			
		150 um (No. 100)		0-10			
		75 um (No. 200)	0-3	0-3			
UNDERDRAIN PIPE		PIPE DIAMETER AND TYPE	MAXIMUM SLOT WIDTH (INCHES)	MINIMUM OPEN AREA (PER FOOT)	REQUIRED	PIPE MUST CONFORM TO REQUIREMENTS OF ASTM DESIGNATION F949. THERE SHALL BE NO EVIDENCE OF SPLITTING, CRACKING, OR BREAKING WHEN THE PIPE IS TESTED PER ASTM TEST METHOD D2412 IN ACCORDANCE WITH F949 SECTION 7.5 AND ASTM F794 SECTION 8.5.	CONTECH A-2000 SLOTTED PIPE (OR APPROVED EQUAL)
		4-INCH SLOTTED PVC/HDPE	0.032	1.90 IN²			
		6-INCH SLOTTED PVC/HDPE	0.0320	1.98 IN²			
IMPERMEABLE LINER			THICKNESS 0.76 mm (30 mil)	TEST METHOD	REQUIRED	THERMAL WELDING REQUIRED FOR FULLY LINED FACILITIES (NOT A CURTAIN). LEAK TESTING IN THE FIELD REQUIRED.	
		THICKNESS, % TOLERANCE	±5	ASTM D 1593			
		TENSILE STRENGTH, kN/m (lb/in)	12.25 (70)	ASTM D8 82, METHOD B			
		MODULUS AT 100% ELONGATION, kN/m (lb/in)	5.25 (30)	ASTM D8 82 METHOD B			
		ULTIMATE ELONGATION, %	350	ASTM D8 82, METHOD B			
		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 D8 82, METHOD A			
		PINHOLES, NO. PER 8 m² (NO. PER 10 YD²)	1 (MAX)	N/A			
		BONDED SEAM STRENGTH, % OF TENSILE	80	N/A			

TABLE 2: NATIVE SEED MIX FOR BIO-RETENTION SYSTEMS

COMMON NAME	SCIENTIFIC NAME	VARIETY	PLS[2] (LBS/ACRE)	OUNCES PER ACRE
SAND BLUESTEM	ANDROPOGON HALLII	GARDEN	3.5	
SIDEOATS GRAMA	BOUTELOUA CURIPENDULA	BUTTE	3	
PRAIRIE SANDREED	CALAMOVILFA LONGIFOLIA	GOSHEN	3	
INDIAN RICEGRASS	ORYZOPSIS HYMENOIDES	PALOMA	3	
SWITCHGRASS	PANICUM VIRGATUM	BLACKWELL	4	
WESTERN WHEATGRASS	PASCOPYRUM SMITHII	ARIBA	3	
LITTLE BLUESTEM	SCHIZACHYRIUM SCOPARIUM	PATURA	3	
ALKALI SACATON	SPOROBOLUS AIROIDES		3	
SAND DROPSEED	SPOROBOLUS CRYPTANDRUS		3	
PASTURE SAGE[1]	ARTEMISIA FRIGIDA			2
BLUE ASTER	ASTER LAEVIS			4
BLANKET FLOWER	GAILLARDIA ARISTATA			8
PRAIRIE CONEFLOWER	RATIBIDA COLUMNIFERA			4
PURPLE PRAIRIECLOVER	DALEA (PETALOSTEMUM) PURPUREA			4
SUB-TOTALS			27.5	22
TOTAL LBS PER ACRE			**28.9**	

TABLE 3: PHYSICAL REQUIREMENTS FOR SEPARATOR FABRIC

PROPERTY	CLASS B		TEST METHOD
	ELONGATION <50%	ELONGATION > 50%	
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 < 0.3 mm (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

FOUR POINTS SURVEYING AND ENGINEERING
410 S. Lincoln Ave, Unit 15
P.O. Box 775966
Steamboat Springs, CO 80487
(970)-871-6772
www.fourpointsse.com

No.	DATE:	REVISIONS	INT

HOLIDAY INN EXPRESS & HOTEL B
CONSTRUCTION PLANS
INDIAN MEADOWS FIL. NO. 4
LOTS 1 AND 2
STEAMBOAT SPRINGS, CO 80487

HORIZONTAL SCALE

DATE: 9/1/2023
JOB #: 1448-005
DRAWN BY: AP/DSC/AAC
DESIGN BY: AP/DSC/AAC/WNM
REVIEW BY: FPSE

IF THIS DRAWING IS PRESENTED IN A FORMAT OTHER THAN 24" X 36", THE GRAPHIC SCALE SHOULD BE UTILIZED.

DRAWING: BIORETENTION NOTES AND SPECIFICATIONS

SHEET NO.
DR4

Appendix E: USDA NRCS Web Soil Survey

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

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

Custom Soil Resource Report for Routt Area, Colorado, Parts of Rio Blanco and Routt Counties

February 4, 2022

Custom Soil Resource Report
Soil Map

Map Scale: 1:1,080 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 Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Routt Area, Colorado, Parts of Rio Blanco and Routt Counties
Survey Area Data: Version 11, 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: May 8, 2012—Oct 5, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
25A	Toponas loam, 0 to 3 percent slopes	0.1	1.4%
49A	Slocum loam, gravelly substratum, 0 to 3 percent slopes	2.6	56.4%
AW	Venable, mucky peat, 0 to 3 percent slopes, frequently flooded	1.9	42.2%
Totals for Area of Interest		**4.5**	**100.0%**

Map Unit Descriptions

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

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

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate

Map Scale: 1:1,080 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

Table—Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
25A	Toponas loam, 0 to 3 percent slopes	B/D	0.1	1.4%
49A	Slocum loam, gravelly substratum, 0 to 3 percent slopes	B/D	2.6	56.4%
AW	Venable, mucky peat, 0 to 3 percent slopes, frequently flooded	B/D	1.9	42.2%
Totals for Area of Interest			**4.5**	**100.0%**

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Appendix F: Basin Runoff Calculations

RATIONAL METHOD RUNOFF ANALYSIS

Job #	1448-005	Date:	September 1, 2023
Job Name	Lot 1 Indian Meadows	Revised:	
Designed by:	DSC/WNM		

Existing Basin 1 (EB1)

BASIN CHARACTERISTICS				TIME OF CONCENTRATION								RESULTS				
	Area, ac	% imp	Soil Type	Overland Flow - Surface Type 1		Overland Flow - Surface Type 2		Channel Flow		Tc, min	Event	C	*i*, in/hr	A, acres	Q, cfs
Landscape	2.86	2%	C	Surface Imperviousness	0.05	Surface Imperviousness	0.02	Land Surface	Paved Areas and Shallow Swales	Minimum	1.25 YR	0.08	0.7	2.96	0.17
Asphalt Parking & Walkways	0.10	100%		Length, ft	300	Length, ft	0	Length, ft	0	Tc, min	2-YR	0.08	1.1	2.96	0.25
Roof	0.00	90%	P2	Slope, percent	1.0000	Slope, percent	30.0000	Slope, ft/ft	2.0000	5.0	5-YR	0.18	1.6	2.96	0.86
Gravel	0.00	40%	1.4	Runoff Coefficient	0.18	Runoff Coefficient	0.162	Conveyance Coefficient	20	Final	10-YR	0.28	2.0	2.96	1.67
Other	0.00	0%						Velocity, ft/s	28.3	Tc, min	25-YR	0.39	2.6	2.96	3.04
	2.96	5%		Ti, min=	28.7	Ti, min=	0.0	Tt, min=	0.0	**28.7**	**100-YR**	**0.52**	**3.5**	**2.96**	**5.34**

Existing Basin 2 (EB2)

BASIN CHARACTERISTICS				TIME OF CONCENTRATION								RESULTS				
	Area, ac	% imp	Soil Type	Overland Flow - Surface Type 1		Overland Flow - Surface Type 2		Channel Flow		Tc, min	Event	C	*i*, in/hr	A, acres	Q, cfs
Landscape	0.84	2%	C	Surface Imperviousness	0.1	Surface Imperviousness	0	Land Surface	Paved Areas and Shallow Swales	Minimum	1.25 YR	0.11	1.6	0.91	0.16
Asphalt Parking & Walkways	0.07	100%		Length, ft	100	Length, ft	0	Length, ft	0	Tc, min	2-YR	0.11	2.3	0.91	0.22
Roof	0.00	90%	P2	Slope, percent	15.0000	Slope, percent	2.0000	Slope, ft/ft	0.0200	5.0	5-YR	0.21	3.4	0.91	0.64
Gravel	0.00	0%	1.4	Runoff Coefficient	0.21	Runoff Coefficient	0.15	Conveyance Coefficient	20	Final	10-YR	0.30	4.3	0.91	1.18
Other	0.00	0%						Velocity, ft/s	2.8	Tc, min	25-YR	0.41	5.6	0.91	2.08
	0.91	10%		Ti, min=	6.5	Ti, min=	0.0	Tt, min=	0.0	**6.5**	**100-YR**	**0.53**	**7.5**	**0.91**	**3.60**

Existing Basin 3 (EB3)

BASIN CHARACTERISTICS				TIME OF CONCENTRATION								RESULTS				
	Area, ac	% imp	Soil Type	Overland Flow - Surface Type 1		Overland Flow - Surface Type 2		Channel Flow		Tc, min	Event	C	*i*, in/hr	A, acres	Q, cfs
Landscape	0.08	2%	C	Surface Imperviousness	0.8	Surface Imperviousness	0	Land Surface	Paved Areas and Shallow Swales	Minimum	1.25 YR	0.59	1.7	0.39	0.39
Asphalt Parking & Walkways	0.31	100%		Length, ft	50	Length, ft	0	Length, ft	100	Tc, min	2-YR	0.59	2.4	0.39	0.57
Roof	0.00	90%	P2	Slope, percent	2.0000	Slope, percent	2.0000	Slope, ft/ft	0.0200	5.0	5-YR	0.62	3.6	0.39	0.89
Gravel	0.00	0%	1.4	Runoff Coefficient	0.63	Runoff Coefficient	0.15	Conveyance Coefficient	20	Final	10-YR	0.66	4.6	0.39	1.19
Other	0.00	0%						Velocity, ft/s	2.8	Tc, min	25-YR	0.70	6.0	0.39	1.63
	0.39	80%		Ti, min=	4.7	Ti, min=	0.0	Tt, min=	0.6	**5.3**	**100-YR**	**0.74**	**8.0**	**0.39**	**2.31**

RATIONAL METHOD RUNOFF ANALYSIS

Job #	1448-005	Date:	September 1, 2023
Job Name	Lot 1 Indian Meadows	Revised:	
Designed by:	DSC/WNM		

Sub Basin 1 (SB1)

BASIN CHARACTERISTICS				TIME OF CONCENTRATION								RESULTS				
	Area, ac	% imp	Soil Type	Overland Flow - Surface Type 1		Overland Flow - Surface Type 2		Channel Flow		Tc, min	Event	C	*i*, in/hr	A, acres	Q, cfs
Landscape	0.14	2%	C	Surface Imperviousness	0.02	Surface Imperviousness	0	Land Surface	Grassed Waterways	Minimum	1.25 YR	0.06	1.7	0.14	0.01
Asphalt Parking & Walkways	0.00	100%		Length, ft	25	Length, ft	0	Length, ft	0	Tc, min	2-YR	0.06	2.5	0.14	0.02
Roof	0.00	90%	P2	Slope, percent	10.0000	Slope, percent	2.0000	Slope, ft/ft	0.0100	5.0	5-YR	0.16	3.7	0.14	0.08
Gravel	0.00	0%	1.4	Runoff Coefficient	0.162	Runoff Coefficient	0.15	Conveyance Coefficient	15	Final	10-YR	0.26	4.7	0.14	0.17
Other	0.00	0%						Velocity, ft/s	1.5	Tc, min	25-YR	0.38	6.1	0.14	0.32
	0.14	2%		Ti, min=	3.9	Ti, min=	0.0	Tt, min=	0.0	**5.0**	**100-YR**	**0.51**	**8.2**	**0.14**	**0.58**

Sub Basin 2 (SB2)

BASIN CHARACTERISTICS				TIME OF CONCENTRATION								RESULTS				
	Area, ac	% imp	Soil Type	Overland Flow - Surface Type 1		Overland Flow - Surface Type 2		Channel Flow		Tc, min	Event	C	*i*, in/hr	A, acres	Q, cfs
Landscape	0.11	2%	C	Surface Imperviousness	0.8	Surface Imperviousness	0	Land Surface	Grassed Waterways	Minimum	1.25 YR	0.55	1.4	0.44	0.33
Asphalt Parking & Walkways	0.33	100%		Length, ft	200	Length, ft	0	Length, ft	0	Tc, min	2-YR	0.55	2.0	0.44	0.47
Roof	0.00	90%	P2	Slope, percent	2.0000	Slope, percent	1.0000	Slope, ft/ft	0.0100	5.0	5-YR	0.58	2.9	0.44	0.75
Gravel	0.00	0%	1.4	Runoff Coefficient	0.63	Runoff Coefficient	0.15	Conveyance Coefficient	15	Final	10-YR	0.62	3.7	0.44	1.02
Other	0.00	0%						Velocity, ft/s	1.5	Tc, min	25-YR	0.66	4.8	0.44	1.41
	0.44	76%		Ti, min=	9.5	Ti, min=	0.0	Tt, min=	0.0	**9.5**	**100-YR**	**0.71**	**6.4**	**0.44**	**2.01**

Sub Basin 3 (SB3)

BASIN CHARACTERISTICS				TIME OF CONCENTRATION								RESULTS				
	Area, ac	% imp	Soil Type	Overland Flow - Surface Type 1		Overland Flow - Surface Type 2		Channel Flow		Tc, min	Event	C	*i*, in/hr	A, acres	Q, cfs
Landscape	0.07	2%	C	Surface Imperviousness	0.8	Surface Imperviousness	0	Land Surface	Grassed Waterways	Minimum	1.25 YR	0.62	1.5	0.39	0.35
Asphalt Parking & Walkways	0.32	100%		Length, ft	150	Length, ft	0	Length, ft	0	Tc, min	2-YR	0.62	2.1	0.39	0.51
Roof	0.00	90%	P2	Slope, percent	2.0000	Slope, percent	1.0000	Slope, ft/ft	0.0100	5.0	5-YR	0.65	3.1	0.39	0.79
Gravel	0.00	0%	1.4	Runoff Coefficient	0.63	Runoff Coefficient	0.15	Conveyance Coefficient	15	Final	10-YR	0.69	4.0	0.39	1.06
Other	0.00	0%						Velocity, ft/s	1.5	Tc, min	25-YR	0.72	5.1	0.39	1.44
	0.39	82%		Ti, min=	8.2	Ti, min=	0.0	Tt, min=	0.0	**8.2**	**100-YR**	**0.76**	**6.8**	**0.39**	**2.03**

Sub Basin 4A (SB4A)

BASIN CHARACTERISTICS				TIME OF CONCENTRATION								RESULTS				
	Area, ac	% imp	Soil Type	Overland Flow - Surface Type 1		Overland Flow - Surface Type 2		Channel Flow		Tc, min	Event	C	*i*, in/hr	A, acres	Q, cfs
Landscape	0.01	2%	C	Surface Imperviousness	0.85	Surface Imperviousness	0.4	Land Surface	Paved Areas and Shallow Swales	Minimum	1.25 YR	0.65	1.4	0.17	0.15
Asphalt Parking & Walkways	0.00	100%		Length, ft	200	Length, ft	0	Length, ft	100	Tc, min	2-YR	0.65	2.0	0.17	0.22
Roof	0.16	90%	P2	Slope, percent	2.0000	Slope, percent	10.0000	Slope, ft/ft	0.0100	5.0	5-YR	0.68	3.0	0.17	0.34
Gravel	0.00	0%	1.4	Runoff Coefficient	0.68	Runoff Coefficient	0.35	Conveyance Coefficient	20	Final	10-YR	0.71	3.8	0.17	0.46
Other	0.00	0%						Velocity, ft/s	2.0	Tc, min	25-YR	0.75	4.9	0.17	0.62
	0.17	85%		Ti, min=	8.5	Ti, min=	0.0	Tt, min=	0.8	**9.3**	**100-YR**	**0.78**	**6.5**	**0.17**	**0.86**

RATIONAL METHOD RUNOFF ANALYSIS

Job #	1448-005	Date:	September 1, 2023
Job Name	Lot 1 Indian Meadows	Revised:	
Designed by:	DSC/WNM		

Sub Basin 4B (SB4B)

BASIN CHARACTERISTICS				TIME OF CONCENTRATION								RESULTS				
	Area, ac	% imp	Soil Type	Overland Flow - Surface Type 1		Overland Flow - Surface Type 2		Channel Flow		Tc, min	Event	C	*i*, in/hr	A, acres	Q, cfs
Landscape	0.03	2%	C	Surface Imperviousness	0.7	Surface Imperviousness	0.4	Land Surface	Paved Areas and Shallow Swales	Minimum	1.25 YR	0.50	1.2	0.13	0.08
Asphalt Parking & Walkways	0.01	100%		Length, ft	200	Length, ft	0	Length, ft	100	Tc, min	2-YR	0.50	1.8	0.13	0.11
Roof	0.09	90%	P2	Slope, percent	2.0000	Slope, percent	10.0000	Slope, ft/ft	0.0100	5.0	5-YR	0.53	2.6	0.13	0.18
Gravel	0.00	0%	1.4	Runoff Coefficient	0.53	Runoff Coefficient	0.35	Conveyance Coefficient	20	Final	10-YR	0.58	3.3	0.13	0.25
Other	0.00	0%						Velocity, ft/s	2.0	Tc, min	25-YR	0.63	4.3	0.13	0.35
	0.13	70%		Ti, min=	11.5	Ti, min=	0.0	Tt, min=	0.8	**12.3**	**100-YR**	**0.68**	**5.7**	**0.13**	**0.51**

Sub Basin 4C (SB4C)

BASIN CHARACTERISTICS				TIME OF CONCENTRATION								RESULTS				
	Area, ac	% imp	Soil Type	Overland Flow - Surface Type 1		Overland Flow - Surface Type 2		Channel Flow		Tc, min	Event	C	*i*, in/hr	A, acres	Q, cfs
Landscape	0.05	2%	C	Surface Imperviousness	0.55	Surface Imperviousness	0.4	Land Surface	Paved Areas and Shallow Swales	Minimum	1.25 YR	0.38	1.1	0.13	0.06
Asphalt Parking & Walkways	0.00	100%		Length, ft	200	Length, ft	0	Length, ft	100	Tc, min	2-YR	0.38	1.6	0.13	0.08
Roof	0.08	90%	P2	Slope, percent	2.0000	Slope, percent	10.0000	Slope, ft/ft	0.0100	5.0	5-YR	0.43	2.4	0.13	0.14
Gravel	0.00	0%	1.4	Runoff Coefficient	0.43	Runoff Coefficient	0.35	Conveyance Coefficient	20	Final	10-YR	0.49	3.1	0.13	0.20
Other	0.00	0%						Velocity, ft/s	2.0	Tc, min	25-YR	0.55	4.0	0.13	0.29
	0.13	56%		Ti, min=	13.5	Ti, min=	0.0	Tt, min=	0.8	**14.4**	**100-YR**	**0.62**	**5.3**	**0.13**	**0.43**

Sub Basin 5 (SB5)

BASIN CHARACTERISTICS				TIME OF CONCENTRATION								RESULTS				
	Area, ac	% imp	Soil Type	Overland Flow - Surface Type 1		Overland Flow - Surface Type 2		Channel Flow		Tc, min	Event	C	*i*, in/hr	A, acres	Q, cfs
Landscape	0.02	2%	C	Surface Imperviousness	0.9	Surface Imperviousness	0.4	Land Surface	Grassed Waterways	Minimum	1.25 YR	0.75	1.5	0.24	0.28
Asphalt Parking & Walkways	0.22	100%		Length, ft	200	Length, ft	0	Length, ft	0	Tc, min	2-YR	0.75	2.2	0.24	0.40
Roof	0.00	90%	P2	Slope, percent	2.0000	Slope, percent	10.0000	Slope, ft/ft	0.0100	5.0	5-YR	0.77	3.3	0.24	0.61
Gravel	0.00	0%	1.4	Runoff Coefficient	0.75	Runoff Coefficient	0.35	Conveyance Coefficient	15	Final	10-YR	0.80	4.2	0.24	0.80
Other	0.00	0%						Velocity, ft/s	1.5	Tc, min	25-YR	0.83	5.4	0.24	1.07
	0.24	92%		Ti, min=	7.1	Ti, min=	0.0	Tt, min=	0.0	**7.1**	**100-YR**	**0.85**	**7.2**	**0.24**	**1.48**

Sub Basin 6 (SB6)

BASIN CHARACTERISTICS				TIME OF CONCENTRATION								RESULTS				
	Area, ac	% imp	Soil Type	Overland Flow - Surface Type 1		Overland Flow - Surface Type 2		Channel Flow		Tc, min	Event	C	*i*, in/hr	A, acres	Q, cfs
Landscape	0.02	2%	C	Surface Imperviousness	0.8	Surface Imperviousness	0.4	Land Surface	Grassed Waterways	Minimum	1.25 YR	0.58	1.4	0.09	0.07
Asphalt Parking & Walkways	0.07	100%		Length, ft	200	Length, ft	0	Length, ft	0	Tc, min	2-YR	0.58	2.0	0.09	0.10
Roof	0.00	90%	P2	Slope, percent	2.0000	Slope, percent	10.0000	Slope, ft/ft	0.0100	5.0	5-YR	0.61	2.9	0.09	0.16
Gravel	0.00	0%	1.4	Runoff Coefficient	0.63	Runoff Coefficient	0.35	Conveyance Coefficient	15	Final	10-YR	0.64	3.7	0.09	0.22
Other	0.00	0%						Velocity, ft/s	1.5	Tc, min	25-YR	0.69	4.8	0.09	0.30
	0.09	78%		Ti, min=	9.5	Ti, min=	0.0	Tt, min=	0.0	**9.5**	**100-YR**	**0.73**	**6.4**	**0.09**	**0.42**

RATIONAL METHOD RUNOFF ANALYSIS

Job #	1448-005	Date:	September 1, 2023
Job Name	Lot 1 Indian Meadows	Revised:	
Designed by:	DSC/WNM		

Sub Basin 7 (SB7)

BASIN CHARACTERISTICS				TIME OF CONCENTRATION								RESULTS				
	Area, ac	% imp	Soil Type	Overland Flow - Surface Type 1		Overland Flow - Surface Type 2		Channel Flow		Tc, min	Event	C	*i*, in/hr	A, acres	Q, cfs
Landscape	0.02	2%	C	Surface Imperviousness	0.85	Surface Imperviousness	0.4	Land Surface	Grassed Waterways	Minimum	1.25 YR	0.64	1.6	0.12	0.13
Asphalt Parking & Walkways	0.10	100%		Length, ft	100	Length, ft	0	Length, ft	0	Tc, min	2-YR	0.64	2.3	0.12	0.18
Roof	0.00	90%	P2	Slope, percent	2.0000	Slope, percent	10.0000	Slope, ft/ft	0.0100	5.0	5-YR	0.67	3.5	0.12	0.28
Gravel	0.00	0%	1.4	Runoff Coefficient	0.68	Runoff Coefficient	0.35	Conveyance Coefficient	15	Final	10-YR	0.70	4.5	0.12	0.37
Other	0.00	0%						Velocity, ft/s	1.5	Tc, min	25-YR	0.74	5.7	0.12	0.51
	0.12	84%		Ti, min=	6.0	Ti, min=	0.0	Tt, min=	0.0	**6.0**	**100-YR**	**0.77**	**7.7**	**0.12**	**0.71**

Sub Basin 8 (SB8)

BASIN CHARACTERISTICS				TIME OF CONCENTRATION								RESULTS				
	Area, ac	% imp	Soil Type	Overland Flow - Surface Type 1		Overland Flow - Surface Type 2		Channel Flow		Tc, min	Event	C	*i*, in/hr	A, acres	Q, cfs
Landscape	0.04	2%	C	Surface Imperviousness	0.85	Surface Imperviousness	0.4	Land Surface	Grassed Waterways	Minimum	1.25 YR	0.66	1.5	0.27	0.27
Asphalt Parking & Walkways	0.23	100%		Length, ft	150	Length, ft	0	Length, ft	0	Tc, min	2-YR	0.66	2.2	0.27	0.39
Roof	0.00	90%	P2	Slope, percent	2.0000	Slope, percent	10.0000	Slope, ft/ft	0.0100	5.0	5-YR	0.69	3.2	0.27	0.60
Gravel	0.00	0%	1.4	Runoff Coefficient	0.68	Runoff Coefficient	0.35	Conveyance Coefficient	15	Final	10-YR	0.72	4.1	0.27	0.80
Other	0.00	0%						Velocity, ft/s	1.5	Tc, min	25-YR	0.75	5.3	0.27	1.09
	0.27	85%		Ti, min=	7.3	Ti, min=	0.0	Tt, min=	0.0	**7.3**	**100-YR**	**0.79**	**7.1**	**0.27**	**1.52**

Sub Basin 9 (SB9)

BASIN CHARACTERISTICS				TIME OF CONCENTRATION								RESULTS				
	Area, ac	% imp	Soil Type	Overland Flow - Surface Type 1		Overland Flow - Surface Type 2		Channel Flow		Tc, min	Event	C	*i*, in/hr	A, acres	Q, cfs
Landscape	0.06	2%	C	Surface Imperviousness	0.8	Surface Imperviousness	0.4	Land Surface	Grassed Waterways	Minimum	1.25 YR	0.61	1.4	0.32	0.27
Asphalt Parking & Walkways	0.26	100%		Length, ft	200	Length, ft	0	Length, ft	0	Tc, min	2-YR	0.61	2.0	0.32	0.39
Roof	0.00	90%	P2	Slope, percent	2.0000	Slope, percent	10.0000	Slope, ft/ft	0.0100	5.0	5-YR	0.64	2.9	0.32	0.60
Gravel	0.00	0%	1.4	Runoff Coefficient	0.63	Runoff Coefficient	0.35	Conveyance Coefficient	15	Final	10-YR	0.68	3.7	0.32	0.81
Other	0.00	0%						Velocity, ft/s	1.5	Tc, min	25-YR	0.72	4.8	0.32	1.10
	0.32	82%		Ti, min=	9.5	Ti, min=	0.0	Tt, min=	0.0	**9.5**	**100-YR**	**0.76**	**6.4**	**0.32**	**1.56**

Sub Basin 10A (SB10A)

BASIN CHARACTERISTICS				TIME OF CONCENTRATION								RESULTS				
	Area, ac	% imp	Soil Type	Overland Flow - Surface Type 1		Overland Flow - Surface Type 2		Channel Flow		Tc, min	Event	C	*i*, in/hr	A, acres	Q, cfs
Landscape	0.01	2%	C	Surface Imperviousness	0.9	Surface Imperviousness	0.4	Land Surface	Paved Areas and Shallow Swales	Minimum	1.25 YR	0.68	1.5	0.20	0.20
Asphalt Parking & Walkways	0.02	100%		Length, ft	200	Length, ft	0	Length, ft	100	Tc, min	2-YR	0.68	2.1	0.20	0.29
Roof	0.17	90%	P2	Slope, percent	2.0000	Slope, percent	10.0000	Slope, ft/ft	0.0100	5.0	5-YR	0.70	3.2	0.20	0.44
Gravel	0.00	0%	1.4	Runoff Coefficient	0.75	Runoff Coefficient	0.35	Conveyance Coefficient	20	Final	10-YR	0.73	4.0	0.20	0.59
Other	0.00	0%						Velocity, ft/s	2.0	Tc, min	25-YR	0.77	5.2	0.20	0.79
	0.20	87%		Ti, min=	7.1	Ti, min=	0.0	Tt, min=	0.8	**7.9**	**100-YR**	**0.80**	**6.9**	**0.20**	**1.11**

RATIONAL METHOD RUNOFF ANALYSIS

Job #	1448-005	Date:	September 1, 2023
Job Name	Lot 1 Indian Meadows	Revised:	
Designed by:	DSC/WNM		

Sub Basin 10B (SB10B)

BASIN CHARACTERISTICS				TIME OF CONCENTRATION								RESULTS				
	Area, ac	% imp	Soil Type	Overland Flow - Surface Type 1		Overland Flow - Surface Type 2		Channel Flow		Tc, min	Event	C	*i*, in/hr	A, acres	Q, cfs
Landscape	0.04	2%	C	Surface Imperviousness	0.7	Surface Imperviousness	0.4	Land Surface	Paved Areas and Shallow Swales	Minimum	1.25 YR	0.52	1.2	0.19	0.12
Asphalt Parking & Walkways	0.02	100%		Length, ft	200	Length, ft	0	Length, ft	100	Tc, min	2-YR	0.52	1.8	0.19	0.17
Roof	0.13	90%	P2	Slope, percent	2.0000	Slope, percent	10.0000	Slope, ft/ft	0.0100	5.0	5-YR	0.55	2.6	0.19	0.27
Gravel	0.00	0%	1.4	Runoff Coefficient	0.53	Runoff Coefficient	0.35	Conveyance Coefficient	20	Final	10-YR	0.59	3.3	0.19	0.38
Other	0.00	0%						Velocity, ft/s	2.0	Tc, min	25-YR	0.64	4.3	0.19	0.52
	0.19	73%		Ti, min=	11.5	Ti, min=	0.0	Tt, min=	0.8	**12.3**	**100-YR**	**0.69**	**5.7**	**0.19**	**0.75**

Sub Basin 11 (SB11)

BASIN CHARACTERISTICS				TIME OF CONCENTRATION								RESULTS				
	Area, ac	% imp	Soil Type	Overland Flow - Surface Type 1		Overland Flow - Surface Type 2		Channel Flow		Tc, min	Event	C	*i*, in/hr	A, acres	Q, cfs
Landscape	0.03	2%	C	Surface Imperviousness	0.8	Surface Imperviousness	0.4	Land Surface	Paved Areas and Shallow Swales	Minimum	1.25 YR	0.61	1.7	0.16	0.17
Asphalt Parking & Walkways	0.13	100%		Length, ft	50	Length, ft	0	Length, ft	0	Tc, min	2-YR	0.61	2.5	0.16	0.25
Roof	0.00	90%	P2	Slope, percent	2.0000	Slope, percent	10.0000	Slope, ft/ft	0.0100	5.0	5-YR	0.64	3.7	0.16	0.38
Gravel	0.00	0%	1.4	Runoff Coefficient	0.63	Runoff Coefficient	0.35	Conveyance Coefficient	20	Final	10-YR	0.68	4.7	0.16	0.51
Other	0.00	0%						Velocity, ft/s	2.0	Tc, min	25-YR	0.72	6.1	0.16	0.70
	0.16	82%		Ti, min=	4.7	Ti, min=	0.0	Tt, min=	0.0	**5.0**	**100-YR**	**0.76**	**8.2**	**0.16**	**0.99**

Sub Basin 12 (SB12)

BASIN CHARACTERISTICS				TIME OF CONCENTRATION								RESULTS				
	Area, ac	% imp	Soil Type	Overland Flow - Surface Type 1		Overland Flow - Surface Type 2		Channel Flow		Tc, min	Event	C	*i*, in/hr	A, acres	Q, cfs
Landscape	0.02	2%	C	Surface Imperviousness	0.9	Surface Imperviousness	0.4	Land Surface	Paved Areas and Shallow Swales	Minimum	1.25 YR	0.73	1.7	0.20	0.25
Asphalt Parking & Walkways	0.18	100%		Length, ft	50	Length, ft	0	Length, ft	0	Tc, min	2-YR	0.73	2.5	0.20	0.36
Roof	0.00	90%	P2	Slope, percent	2.0000	Slope, percent	10.0000	Slope, ft/ft	0.0100	5.0	5-YR	0.75	3.7	0.20	0.56
Gravel	0.00	0%	1.4	Runoff Coefficient	0.75	Runoff Coefficient	0.35	Conveyance Coefficient	20	Final	10-YR	0.78	4.7	0.20	0.73
Other	0.00	0%						Velocity, ft/s	2.0	Tc, min	25-YR	0.81	6.1	0.20	0.98
	0.20	90%		Ti, min=	3.5	Ti, min=	0.0	Tt, min=	0.0	**5.0**	**100-YR**	**0.84**	**8.2**	**0.20**	**1.36**

Sub Basin 13 (SB13)

BASIN CHARACTERISTICS				TIME OF CONCENTRATION								RESULTS				
	Area, ac	% imp	Soil Type	Overland Flow - Surface Type 1		Overland Flow - Surface Type 2		Channel Flow		Tc, min	Event	C	*i*, in/hr	A, acres	Q, cfs
Landscape	0.02	2%	C	Surface Imperviousness	0.7	Surface Imperviousness	0.4	Land Surface	Paved Areas and Shallow Swales	Minimum	1.25 YR	0.47	1.7	0.06	0.05
Asphalt Parking & Walkways	0.04	100%		Length, ft	5	Length, ft	0	Length, ft	0	Tc, min	2-YR	0.47	2.5	0.06	0.07
Roof	0.00	90%	P2	Slope, percent	2.0000	Slope, percent	10.0000	Slope, ft/ft	0.0100	5.0	5-YR	0.51	3.7	0.06	0.11
Gravel	0.00	0%	1.4	Runoff Coefficient	0.53	Runoff Coefficient	0.35	Conveyance Coefficient	20	Final	10-YR	0.56	4.7	0.06	0.16
Other	0.00	0%						Velocity, ft/s	2.0	Tc, min	25-YR	0.61	6.1	0.06	0.22
	0.06	67%		Ti, min=	1.8	Ti, min=	0.0	Tt, min=	0.0	**5.0**	**100-YR**	**0.66**	**8.2**	**0.06**	**0.32**

RATIONAL METHOD RUNOFF ANALYSIS

Job #	1448-005	Date:	September 1, 2023
Job Name	Lot 1 Indian Meadows	Revised:	
Designed by:	DSC/WNM		

Sub Basin 14 (SB14)

BASIN CHARACTERISTICS				TIME OF CONCENTRATION								RESULTS				
	Area, ac	% imp	Soil Type	Overland Flow - Surface Type 1		Overland Flow - Surface Type 2		Channel Flow		Tc, min	Event	C	*I*, in/hr	A, acres	Q, cfs
Landscape	0.02	2%	C	Surface Imperviousness	0.6	Surface Imperviousness	0.4	Land Surface	Paved Areas and Shallow Swales	Minimum	1.25 YR	0.41	1.7	0.05	0.04
Asphalt Parking & Walkways	0.03	100%		Length, ft	5	Length, ft	0	Length, ft	0	Tc, min	2-YR	0.41	2.5	0.05	0.05
Roof	0.00	90%	P2	Slope, percent	2.0000	Slope, percent	10.0000	Slope, ft/ft	0.0100	5.0	5-YR	0.46	3.7	0.05	0.09
Gravel	0.00	0%	1.4	Runoff Coefficient	0.46	Runoff Coefficient	0.35	Conveyance Coefficient	20	Final	10-YR	0.51	4.7	0.05	0.12
Other	0.00	0%						Velocity, ft/s	2.0	Tc, min	25-YR	0.57	6.1	0.05	0.17
	0.05	61%		Ti, min=	2.0	Ti, min=	0.0	Tt, min=	0.0	**5.0**	**100-YR**	**0.64**	**8.2**	**0.05**	**0.26**

Sub Basin 15 (SB15)

BASIN CHARACTERISTICS				TIME OF CONCENTRATION								RESULTS				
	Area, ac	% imp	Soil Type	Overland Flow - Surface Type 1		Overland Flow - Surface Type 2		Channel Flow		Tc, min	Event	C	*I*, in/hr	A, acres	Q, cfs
Landscape	0.29	2%	C	Surface Imperviousness	0.02	Surface Imperviousness	0.4	Land Surface	Paved Areas and Shallow Swales	Minimum	1.25 YR	0.06	1.7	0.29	0.03
Asphalt Parking & Walkways	0.00	100%		Length, ft	30	Length, ft	0	Length, ft	0	Tc, min	2-YR	0.06	2.5	0.29	0.04
Roof	0.00	90%	P2	Slope, percent	10.0000	Slope, percent	10.0000	Slope, ft/ft	0.0100	5.0	5-YR	0.16	3.7	0.29	0.18
Gravel	0.00	0%	1.4	Runoff Coefficient	0.162	Runoff Coefficient	0.35	Conveyance Coefficient	20	Final	10-YR	0.26	4.7	0.29	0.36
Other	0.00	0%						Velocity, ft/s	2.0	Tc, min	25-YR	0.38	6.1	0.29	0.67
	0.29	2%		Ti, min=	4.3	Ti, min=	0.0	Tt, min=	0.0	**5.0**	**100-YR**	**0.51**	**8.2**	**0.29**	**1.20**

Sub Basin 16 (SB16)

BASIN CHARACTERISTICS				TIME OF CONCENTRATION								RESULTS				
	Area, ac	% imp	Soil Type	Overland Flow - Surface Type 1		Overland Flow - Surface Type 2		Channel Flow		Tc, min	Event	C	*I*, in/hr	A, acres	Q, cfs
Landscape	0.28	2%	C	Surface Imperviousness	0.02	Surface Imperviousness	0.4	Land Surface	Paved Areas and Shallow Swales	Minimum	1.25 YR	0.06	1.7	0.28	0.03
Asphalt Parking & Walkways	0.00	100%		Length, ft	30	Length, ft	0	Length, ft	0	Tc, min	2-YR	0.06	2.5	0.28	0.04
Roof	0.00	90%	P2	Slope, percent	10.0000	Slope, percent	10.0000	Slope, ft/ft	0.0100	5.0	5-YR	0.16	3.7	0.28	0.17
Gravel	0.00	0%	1.4	Runoff Coefficient	0.162	Runoff Coefficient	0.35	Conveyance Coefficient	20	Final	10-YR	0.26	4.7	0.28	0.35
Other	0.00	0%						Velocity, ft/s	2.0	Tc, min	25-YR	0.38	6.1	0.28	0.65
	0.28	2%		Ti, min=	4.3	Ti, min=	0.0	Tt, min=	0.0	**5.0**	**100-YR**	**0.51**	**8.2**	**0.28**	**1.16**

RATIONAL METHOD RUNOFF ANALYSIS

Job #	1448-005	Date:	September 1, 2023
Job Name	Lot 1 Indian Meadows	Revised:	
Designed by:	DSC/WNM		

COMBINED SUB-BASIN CALCS FOR STORM SEWER AND BIORETENTION DESIGN

SB3 and SB4A To Bioretention Facility 1

BASIN CHARACTERISTICS				TIME OF CONCENTRATION								RESULTS			
	Area, ac	% imp	Soil Type	Overland Flow - Surface Type 1		Overland Flow - Surface Type 2		Channel Flow		Tc, min	Event	C	*i*, in/hr	A, acres	Q, cfs
Landscape	0.08	2%	C	Surface Imperviousness	0.85	Surface Imperviousness	0.4	Land Surface	Paved Areas and Shallow Swales	Minimum	1.25 YR	0.63	1.3	0.56	0.47
Asphalt Parking & Walkways	0.32	100%		Length, ft	300	Length, ft	0	Length, ft	0	Tc, min	2-YR	0.63	1.9	0.56	0.67
Roof	0.16	90%	P2	Slope, percent	2.0000	Slope, percent	10.0000	Slope, ft/ft	0.0100	5.0	5-YR	0.66	2.8	0.56	1.04
Gravel	0.00	0%	1.4	Runoff Coefficient	0.68	Runoff Coefficient	0.35	Conveyance Coefficient	20	Final	10-YR	0.69	3.6	0.56	1.40
Other	0.00	0%						Velocity, ft/s	2.0	Tc, min	25-YR	0.73	4.6	0.56	1.90
	0.56	83%		Ti, min=	10.4	Ti, min=	0.0	Tt, min=	0.0	**10.4**	**100-YR**	**0.77**	**6.2**	**0.56**	**2.67**

SB7 and SB10A To Bioretention Facility 2

BASIN CHARACTERISTICS				TIME OF CONCENTRATION								RESULTS			
	Area, ac	% imp	Soil Type	Overland Flow - Surface Type 1		Overland Flow - Surface Type 2		Channel Flow		Tc, min	Event	C	*i*, in/hr	A, acres	Q, cfs
Landscape	0.03	2%	C	Surface Imperviousness	0.8	Surface Imperviousness	0.4	Land Surface	Paved Areas and Shallow Swales	Minimum	1.25 YR	0.66	1.6	0.32	0.33
Asphalt Parking & Walkways	0.12	100%		Length, ft	100	Length, ft	0	Length, ft	0	Tc, min	2-YR	0.66	2.3	0.32	0.48
Roof	0.17	90%	P2	Slope, percent	2.0000	Slope, percent	10.0000	Slope, ft/ft	0.0100	5.0	5-YR	0.69	3.4	0.32	0.74
Gravel	0.00	0%	1.4	Runoff Coefficient	0.63	Runoff Coefficient	0.35	Conveyance Coefficient	20	Final	10-YR	0.72	4.3	0.32	0.98
Other	0.00	0%						Velocity, ft/s	2.0	Tc, min	25-YR	0.75	5.5	0.32	1.33
	0.32	86%		Ti, min=	6.7	Ti, min=	0.0	Tt, min=	0.0	**6.7**	**100-YR**	**0.79**	**7.4**	**0.32**	**1.86**

SB2 and SB5 To Bioretention Faciliy 3

BASIN CHARACTERISTICS				TIME OF CONCENTRATION								RESULTS			
	Area, ac	% imp	Soil Type	Overland Flow - Surface Type 1		Overland Flow - Surface Type 2		Channel Flow		Tc, min	Event	C	*i*, in/hr	A, acres	Q, cfs
Landscape	0.13	2%	C	Surface Imperviousness	0.85	Surface Imperviousness	0.4	Land Surface	Paved Areas and Shallow Swales	Minimum	1.25 YR	0.61	1.4	0.68	0.60
Asphalt Parking & Walkways	0.55	100%		Length, ft	200	Length, ft	0	Length, ft	0	Tc, min	2-YR	0.61	2.1	0.68	0.86
Roof	0.00	90%	P2	Slope, percent	2.0000	Slope, percent	10.0000	Slope, ft/ft	0.0100	5.0	5-YR	0.64	3.1	0.68	1.34
Gravel	0.00	0%	1.4	Runoff Coefficient	0.68	Runoff Coefficient	0.35	Conveyance Coefficient	20	Final	10-YR	0.67	3.9	0.68	1.79
Other	0.00	0%						Velocity, ft/s	2.0	Tc, min	25-YR	0.71	5.0	0.68	2.44
	0.68	81%		Ti, min=	8.5	Ti, min=	0.0	Tt, min=	0.0	**8.5**	**100-YR**	**0.75**	**6.7**	**0.68**	**3.45**

RATIONAL METHOD RUNOFF ANALYSIS

Job #	1448-005	Date:	September 1, 2023
Job Name	Lot 1 Indian Meadows	Revised:	
Designed by:	DSC/WNM		

SB6, SB8 and SB9 To Bioretention Facility 4

BASIN CHARACTERISTICS				TIME OF CONCENTRATION								RESULTS				
	Area, ac	% imp	Soil Type	Overland Flow - Surface Type 1		Overland Flow - Surface Type 2		Channel Flow		Tc, min	Event	C	I, in/hr	A, acres	Q, cfs
Landscape	0.12	2%	C	Surface Imperviousness	0.85	Surface Imperviousness	0.4	Land Surface	Paved Areas and Shallow Swales	Minimum	1.25 YR	0.63	1.3	0.68	0.56
Asphalt Parking & Walkways	0.56	100%		Length, ft	300	Length, ft	0	Length, ft	0	Tc, min	2-YR	0.63	1.9	0.68	0.81
Roof	0.00	90%	P2	Slope, percent	2.0000	Slope, percent	10.0000	Slope, ft/ft	0.0100	5.0	5-YR	0.66	2.8	0.68	1.26
Gravel	0.00	0%	1.4	Runoff Coefficient	0.68	Runoff Coefficient	0.35	Conveyance Coefficient	20	Final	10-YR	0.69	3.6	0.68	1.69
Other	0.00	0%						Velocity, ft/s	2.0	Tc, min	25-YR	0.73	4.6	0.68	2.29
	0.68	83%		Ti, min=	10.4	Ti, min=	0.0	Tt, min=	0.0	**10.4**	**100-YR**	**0.77**	**6.2**	**0.68**	**3.23**

SB4B, SB11, and SB13 to Bioretention Facility 5

BASIN CHARACTERISTICS				TIME OF CONCENTRATION								RESULTS				
	Area, ac	% imp	Soil Type	Overland Flow - Surface Type 1		Overland Flow - Surface Type 2		Channel Flow		Tc, min	Event	C	I, in/hr	A, acres	Q, cfs
Landscape	0.08	2%	C	Surface Imperviousness	0.8	Surface Imperviousness	0.4	Land Surface	Paved Areas and Shallow Swales	Minimum	1.25 YR	0.54	1.7	0.35	0.32
Asphalt Parking & Walkways	0.18	100%		Length, ft	70	Length, ft	0	Length, ft	0	Tc, min	2-YR	0.54	2.4	0.35	0.45
Roof	0.09	90%	P2	Slope, percent	2.0000	Slope, percent	10.0000	Slope, ft/ft	0.0100	5.0	5-YR	0.58	3.6	0.35	0.72
Gravel	0.00	0%	1.4	Runoff Coefficient	0.63	Runoff Coefficient	0.35	Conveyance Coefficient	20	Final	10-YR	0.62	4.6	0.35	0.98
Other	0.00	0%						Velocity, ft/s	2.0	Tc, min	25-YR	0.66	5.9	0.35	1.36
	0.35	75%		Ti, min=	5.6	Ti, min=	0.0	Tt, min=	0.0	**5.6**	**100-YR**	**0.71**	**7.8**	**0.35**	**1.94**

SB10B, SB12, and SB14 to Bioretention Facility 6

BASIN CHARACTERISTICS				TIME OF CONCENTRATION								RESULTS				
	Area, ac	% imp	Soil Type	Overland Flow - Surface Type 1		Overland Flow - Surface Type 2		Channel Flow		Tc, min	Event	C	I, in/hr	A, acres	Q, cfs
Landscape	0.08	2%	C	Surface Imperviousness	0.8	Surface Imperviousness	0.4	Land Surface	Paved Areas and Shallow Swales	Minimum	1.25 YR	0.59	1.7	0.44	0.43
Asphalt Parking & Walkways	0.23	100%		Length, ft	70	Length, ft	0	Length, ft	0	Tc, min	2-YR	0.59	2.4	0.44	0.62
Roof	0.13	90%	P2	Slope, percent	2.0000	Slope, percent	10.0000	Slope, ft/ft	0.0100	5.0	5-YR	0.62	3.6	0.44	0.97
Gravel	0.00	0%	1.4	Runoff Coefficient	0.63	Runoff Coefficient	0.35	Conveyance Coefficient	20	Final	10-YR	0.65	4.6	0.44	1.31
Other	0.00	0%						Velocity, ft/s	2.0	Tc, min	25-YR	0.69	5.9	0.44	1.79
	0.44	79%		Ti, min=	5.6	Ti, min=	0.0	Tt, min=	0.0	**5.6**	**100-YR**	**0.74**	**7.8**	**0.44**	**2.54**

Appendix G: BMP Design Spreadsheets for Bioretention

Design Procedure Form: Rain Garden (RG)

UD-BMP (Version 3.07, March 2018)

Designer: David Clemmer EIT & Walter Magill PE
Company: Four Points Surveying and Engineering
Date: August 23, 2023
Project: 1448-005 - Lot 1 Indian Meadows
Location: Bioretention Facility 1 (BF1)

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 = 83.0 %

B) Tributary Area's Imperviousness Ratio ($i = I_a/100$): i = 0.830

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 = 0.28 watershed inches

D) Contributing Watershed Area (including rain garden area): Area = 24,394 sq ft

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

F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm: d_6 = 0.34 in

G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume: $V_{WQCV\ OTHER}$ = 447 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} = 405 sq ft

D) Actual Flat Surface Area: A_{Actual} = 475 sq ft

E) Area at Design Depth (Top Surface Area): A_{Top} = 475 sq ft

F) Rain Garden Total Volume ($V_T = ((A_{Top} + A_{Actual}) / 2) * Depth$): V_T = 475 cu ft

3. Growing Media

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

Soil Specification to comply with Mile High Flood District (MHFD) Manual Volume 3, latest addition

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 = 0.5 ft

ii) Volume to Drain in 12 Hours: Vol_{12} = 447 cu ft

iii) Orifice Diameter, 3/8" Minimum: D_O = 5/8 in

Design Procedure Form: Rain Garden (RG)

Designer: David Clemmer EIT & Walter Magill PE
Company: Four Points Surveying and Engineering
Date: August 23, 2023
Project: 1448-005 - Lot 1 Indian Meadows
Location: Bioretention Facility 1 (BF1)

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 **PROVIDE A 30 MIL (MIN) PVC LINER WITH CDOT CLASS B GEOTEXTILE ABOVE IT. USE THE SAME GEOTEXTILE BELOW THE LINER IF THE SUBGRADE IS ANGULAR**
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 No irrigation system currently proposed

Notes:

Design Procedure Form: Rain Garden (RG)

UD-BMP (Version 3.07, March 2018)

Designer: David Clemmer EIT & Walter Magill PE
Company: Four Points Surveying and Engineering
Date: August 23, 2023
Project: 1448-005 - Lot 1 Indian Meadows
Location: Bioretention Facility BF2

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 = 86.0 %

B) Tributary Area's Imperviousness Ratio ($i = I_a/100$): i = 0.860

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 = 0.30 watershed inches

D) Contributing Watershed Area (including rain garden area): Area = 13,940 sq ft

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

F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm: d_6 = 0.34 in

G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume: $V_{WQCV\ OTHER}$ = 272 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} = 240 sq ft

D) Actual Flat Surface Area: A_{Actual} = 325 sq ft

E) Area at Design Depth (Top Surface Area): A_{Top} = 325 sq ft

F) Rain Garden Total Volume ($V_T = ((A_{Top} + A_{Actual}) / 2) * Depth$): V_T = 325 cu ft

3. Growing Media

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

Soil Specification to comply with Mile High Flood District (MHFD) Manual Volume 3, latest addition

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 = 0.2 ft

ii) Volume to Drain in 12 Hours: Vol_{12} = 272 cu ft

iii) Orifice Diameter, 3/8" Minimum: D_O = 5/8 in

Design Procedure Form: Rain Garden (RG)

Designer: David Clemmer EIT & Walter Magill PE
Company: Four Points Surveying and Engineering
Date: August 23, 2023
Project: 1448-005 - Lot 1 Indian Meadows
Location: Bioretention Facility BF2

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 **PROVIDE A 30 MIL (MIN) PVC LINER WITH CDOT CLASS B GEOTEXTILE ABOVE IT. USE THE SAME GEOTEXTILE BELOW THE LINER IF THE SUBGRADE IS ANGULAR**
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 No irrigation system currently proposed

Notes:

Design Procedure Form: Rain Garden (RG)

UD-BMP (Version 3.07, March 2018)

Designer: David Clemmer EIT & Walter Magill PE
Company: Four Points Surveying and Engineering
Date: August 23, 2023
Project: 1448-005 - Lot 1 Indian Meadows
Location: Bioretention Facility BF3

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 = 81.0 %

B) Tributary Area's Imperviousness Ratio ($i = I_a/100$): i = 0.810

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 = 0.27 watershed inches

D) Contributing Watershed Area (including rain garden area): Area = 29,621 sq ft

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

F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm: d_6 = 0.34 in

G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume: $V_{WQCV\ OTHER}$ = 523 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} = 480 sq ft

D) Actual Flat Surface Area: A_{Actual} = 550 sq ft

E) Area at Design Depth (Top Surface Area): A_{Top} = 550 sq ft

F) Rain Garden Total Volume ($V_T = ((A_{Top} + A_{Actual}) / 2) * Depth$): V_T = 550 cu ft

3. Growing Media

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

Soil Specification to comply with Mile High Flood District (MHFD) Manual Volume 3, latest addition

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 = 0.5 ft

ii) Volume to Drain in 12 Hours: Vol_{12} = 523 cu ft

iii) Orifice Diameter, 3/8" Minimum: D_O = 11/16 in

Design Procedure Form: Rain Garden (RG)

Designer: David Clemmer EIT & Walter Magill PE
Company: Four Points Surveying and Engineering
Date: August 23, 2023
Project: 1448-005 - Lot 1 Indian Meadows
Location: Bioretention Facility BF3

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 **PROVIDE A 30 MIL (MIN) PVC LINER WITH CDOT CLASS B GEOTEXTILE ABOVE IT. USE THE SAME GEOTEXTILE BELOW THE LINER IF THE SUBGRADE IS ANGULAR**
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 No irrigation system currently proposed

Notes:

Design Procedure Form: Rain Garden (RG)

UD-BMP (Version 3.07, March 2018)

Designer: David Clemmer EIT & Walter Magill PE
Company: Four Points Surveying and Engineering
Date: August 25, 2023
Project: 1448-005 - Lot 1 Indian Meadows
Location: Bioretention Facility BF4

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 = 83.0 %

B) Tributary Area's Imperviousness Ratio ($i = I_a/100$): i = 0.830

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 = 0.28 watershed inches

D) Contributing Watershed Area (including rain garden area): Area = 29,621 sq ft

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

F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm: d_6 = 0.34 in

G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume: $V_{WQCV\ OTHER}$ = 543 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} = 492 sq ft

D) Actual Flat Surface Area: A_{Actual} = 660 sq ft

E) Area at Design Depth (Top Surface Area): A_{Top} = 660 sq ft

F) Rain Garden Total Volume ($V_T = ((A_{Top} + A_{Actual}) / 2) * Depth$): V_T = 660 cu ft

3. Growing Media

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

Soil Specification to comply with Mile High Flood District (MHFD) Manual Volume 3, latest addition

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 = 0.5 ft

ii) Volume to Drain in 12 Hours: Vol_{12} = 543 cu ft

iii) Orifice Diameter, 3/8" Minimum: D_O = 11/16 in

Design Procedure Form: Rain Garden (RG)

Designer: David Clemmer EIT & Walter Magill PE
Company: Four Points Surveying and Engineering
Date: August 25, 2023
Project: 1448-005 - Lot 1 Indian Meadows
Location: Bioretention Facility BF4

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 **PROVIDE A 30 MIL (MIN) PVC LINER WITH CDOT CLASS B GEOTEXTILE ABOVE IT. USE THE SAME GEOTEXTILE BELOW THE LINER IF THE SUBGRADE IS ANGULAR**
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 No irrigation system currently proposed

Notes:

Design Procedure Form: Rain Garden (RG)

UD-BMP (Version 3.07, March 2018)

Designer: David Clemmer EIT & Walter Magill PE
Company: Four Points Surveying and Engineering
Date: September 1, 2023
Project: 1448-005 - Lot 1 Indian Meadows
Location: Bioretention Facility BF5

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 = 75.0 %

B) Tributary Area's Imperviousness Ratio ($i = I_a/100$): i = 0.750

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 = 0.24 watershed inches

D) Contributing Watershed Area (including rain garden area): Area = 15,246 sq ft

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

F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm: d_6 = 0.34 in

G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume: $V_{WQCV\ OTHER}$ = 241 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} = 229 sq ft

D) Actual Flat Surface Area: A_{Actual} = 790 sq ft

E) Area at Design Depth (Top Surface Area): A_{Top} = 790 sq ft

F) Rain Garden Total Volume ($V_T = ((A_{Top} + A_{Actual}) / 2) * Depth$): V_T = 790 cu ft

3. Growing Media

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

Soil Specification to comply with Mile High Flood District (MHFD) Manual Volume 3, latest addition

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 = 0.5 ft

ii) Volume to Drain in 12 Hours: Vol_{12} = 241 cu ft

iii) Orifice Diameter, 3/8" Minimum: D_O = 1/2 in

Design Procedure Form: Rain Garden (RG)

Designer: David Clemmer EIT & Walter Magill PE
Company: Four Points Surveying and Engineering
Date: September 1, 2023
Project: 1448-005 - Lot 1 Indian Meadows
Location: Bioretention Facility BF5

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 **PROVIDE A 30 MIL (MIN) PVC LINER WITH CDOT CLASS B GEOTEXTILE ABOVE IT. USE THE SAME GEOTEXTILE BELOW THE LINER IF THE SUBGRADE IS ANGULAR**
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:

Design Procedure Form: Rain Garden (RG)

UD-BMP (Version 3.07, March 2018)

Designer: David Clemmer EIT & Walter Magill PE
Company: Four Points Surveying and Engineering
Date: September 1, 2023
Project: 1448-005 - Lot 1 Indian Meadows
Location: Bioretention Facility BF6

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 = 79.0 %

B) Tributary Area's Imperviousness Ratio ($i = I_a/100$): i = 0.790

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 = 0.26 watershed inches

D) Contributing Watershed Area (including rain garden area): Area = 19,166 sq ft

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

F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm: d_6 = 0.34 in

G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume: $V_{WQCV\ OTHER}$ = 326 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} = 303 sq ft

D) Actual Flat Surface Area: A_{Actual} = 900 sq ft

E) Area at Design Depth (Top Surface Area): A_{Top} = 900 sq ft

F) Rain Garden Total Volume ($V_T = ((A_{Top} + A_{Actual}) / 2) * Depth$): V_T = 900 cu ft

3. Growing Media

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

Soil Specification to comply with Mile High Flood District (MHFD) Manual Volume 3, latest addition

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 = 0.5 ft

ii) Volume to Drain in 12 Hours: Vol_{12} = 326 cu ft

iii) Orifice Diameter, 3/8" Minimum: D_O = 9/16 in

Design Procedure Form: Rain Garden (RG)

Designer: David Clemmer EIT & Walter Magill PE
Company: Four Points Surveying and Engineering
Date: September 1, 2023
Project: 1448-005 - Lot 1 Indian Meadows
Location: Bioretention Facility BF6

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 **PROVIDE A 30 MIL (MIN) PVC LINER WITH CDOT CLASS B GEOTEXTILE ABOVE IT. USE THE SAME GEOTEXTILE BELOW THE LINER IF THE SUBGRADE IS ANGULAR**
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:

Appendix H: BMP Design Spreadsheet Calculations for TSS

TSS Removal

BMP Designation Bioretention Facility 1 (BF1)

Event Mean TSS Per Table 5.12.3

140 mg/L

Variable	Value	Unit	
n	4	-	(Turbulance Factor: 1=bad, 5=good)
V_s	0.0059	ft/sec	(Settling Velocity of Particles)
Q	0.47	ft^3/sec	(Applied Flow Rate, 1.25 Yr Peak Flow)
A	475	ft^2	(Area of Treatment)
R	0.97	-	(Fraction of solids removed)

TSS Concentration After Treatment

3.64 mg/L Min 80% Removal of Event Mean TSS

TSS Removal

BMP Designation Bioretention Facility 2 (BF2)

Event Mean TSS Per Table 5.12.3

140 mg/L

Variable	Value	Unit	
n	4	-	(Turbulance Factor: 1=bad, 5=good)
V_s	0.0059	ft/sec	(Settling Velocity of Particles)
Q	0.33	ft^3/sec	(Applied Flow Rate, 1.25 Yr Peak Flow)
A	325	ft^2	(Area of Treatment)
R	0.97	-	(Fraction of solids removed)

TSS Concentration After Treatment

3.87 mg/L Min 80% Removal of Event Mean TSS

TSS Removal

BMP Designation Bioretention Facility 3 (BF3)

Event Mean TSS Per Table 5.12.3

140 mg/L

Variable	Value	Unit	
n	4	-	(Turbulance Factor: 1=bad, 5=good)
V_s	0.0059	ft/sec	(Settling Velocity of Particles)
Q	0.6	ft^3/sec	(Applied Flow Rate, 1.25 Yr Peak Flow)
A	550	ft^2	(Area of Treatment)
R	0.97	-	(Fraction of solids removed)

TSS Concentration After Treatment

4.57 mg/L Min 80% Removal of Event Mean TSS

TSS Removal

BMP Designation Bioretention Facility 4 (BF4)

Event Mean TSS Per Table 5.12.3

140 mg/L

Variable	Value	Unit	
n	4	-	(Turbulance Factor: 1=bad, 5=good)
V_s	0.0059	ft/sec	(Settling Velocity of Particles)
Q	0.56	ft^3/sec	(Applied Flow Rate, 1.25 Yr Peak Flow)
A	660	ft^2	(Area of Treatment)
R	0.98	-	(Fraction of solids removed)

TSS Concentration After Treatment

2.49 mg/L Min 80% Removal of Event Mean TSS

TSS Removal

BMP Designation Bioretention Facility 5 (BF5)

Event Mean TSS Per Table 5.12.3

140 mg/L

Variable	Value	Unit	
n	4	-	(Turbulance Factor: 1=bad, 5=good)
V_s	0.0059	ft/sec	(Settling Velocity of Particles)
Q	0.32	ft^3/sec	(Applied Flow Rate, 1.25 Yr Peak Flow)
A	790	ft^2	(Area of Treatment)
R	1.00	-	(Fraction of solids removed)

TSS Concentration After Treatment

0.30 mg/L Min 80% Removal of Event Mean TSS

TSS Removal

BMP Designation Bioretention Facility 6 (BF6)

Event Mean TSS Per Table 5.12.3

140 mg/L

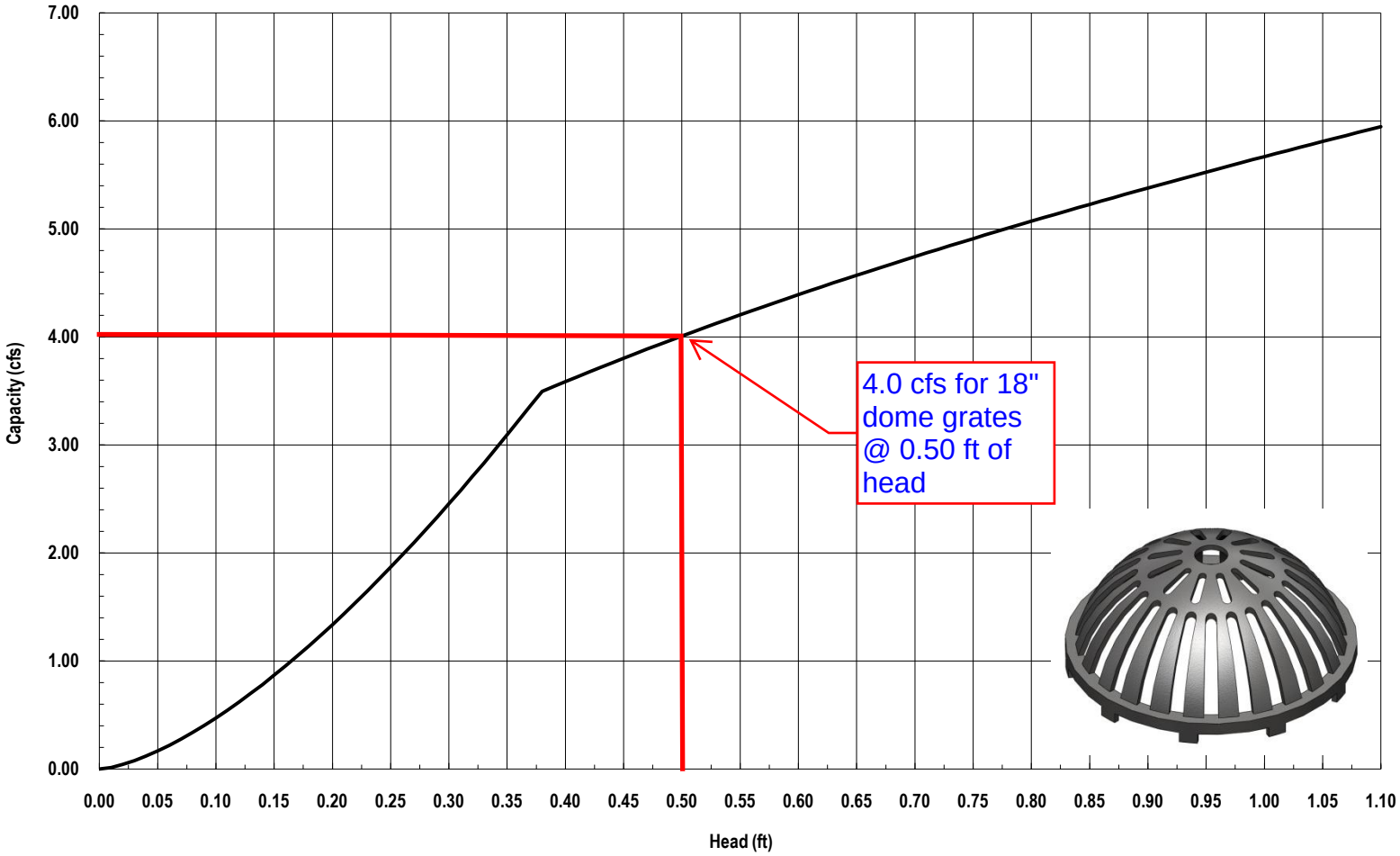
Variable	Value	Unit	
n	4	-	(Turbulance Factor: 1=bad, 5=good)
V_s	0.0059	ft/sec	(Settling Velocity of Particles)
Q	0.43	ft^3/sec	(Applied Flow Rate, 1.25 Yr Peak Flow)
A	900	ft^2	(Area of Treatment)
R	1.00	-	(Fraction of solids removed)

TSS Concentration After Treatment

0.50 mg/L Min 80% Removal of Event Mean TSS

Appendix I: Inlet Capacity Curve

Nyloplast 18" Dome Grate Inlet Capacity Chart

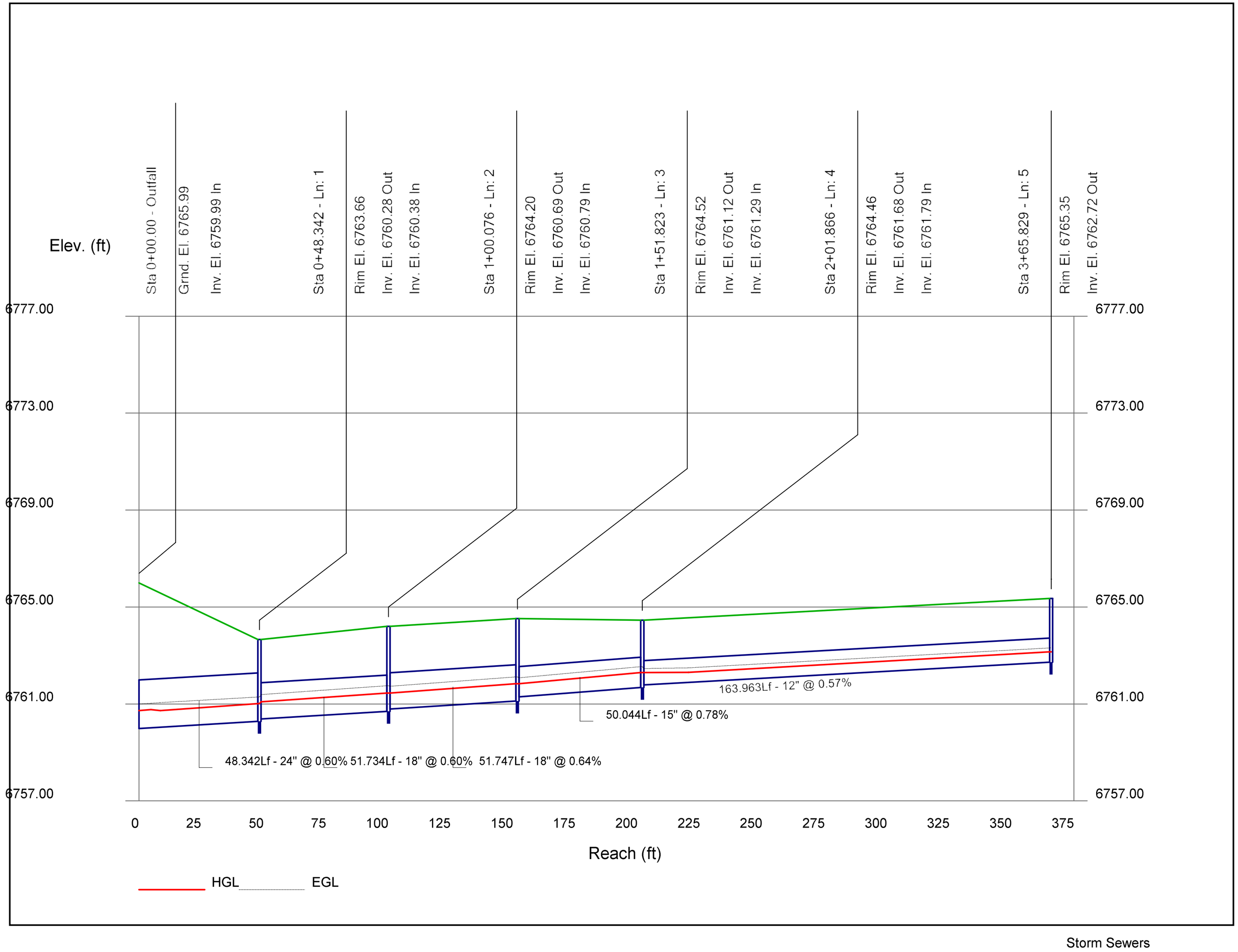


Nyloplast®
3130 Verona Avenue • Buford, GA 30518
(866) 888-8479 / (770) 932-2443 • Fax: (770) 932-2490

Appendix J: Storm Sewer Capacity Calculations and EGL/HGL Profiles

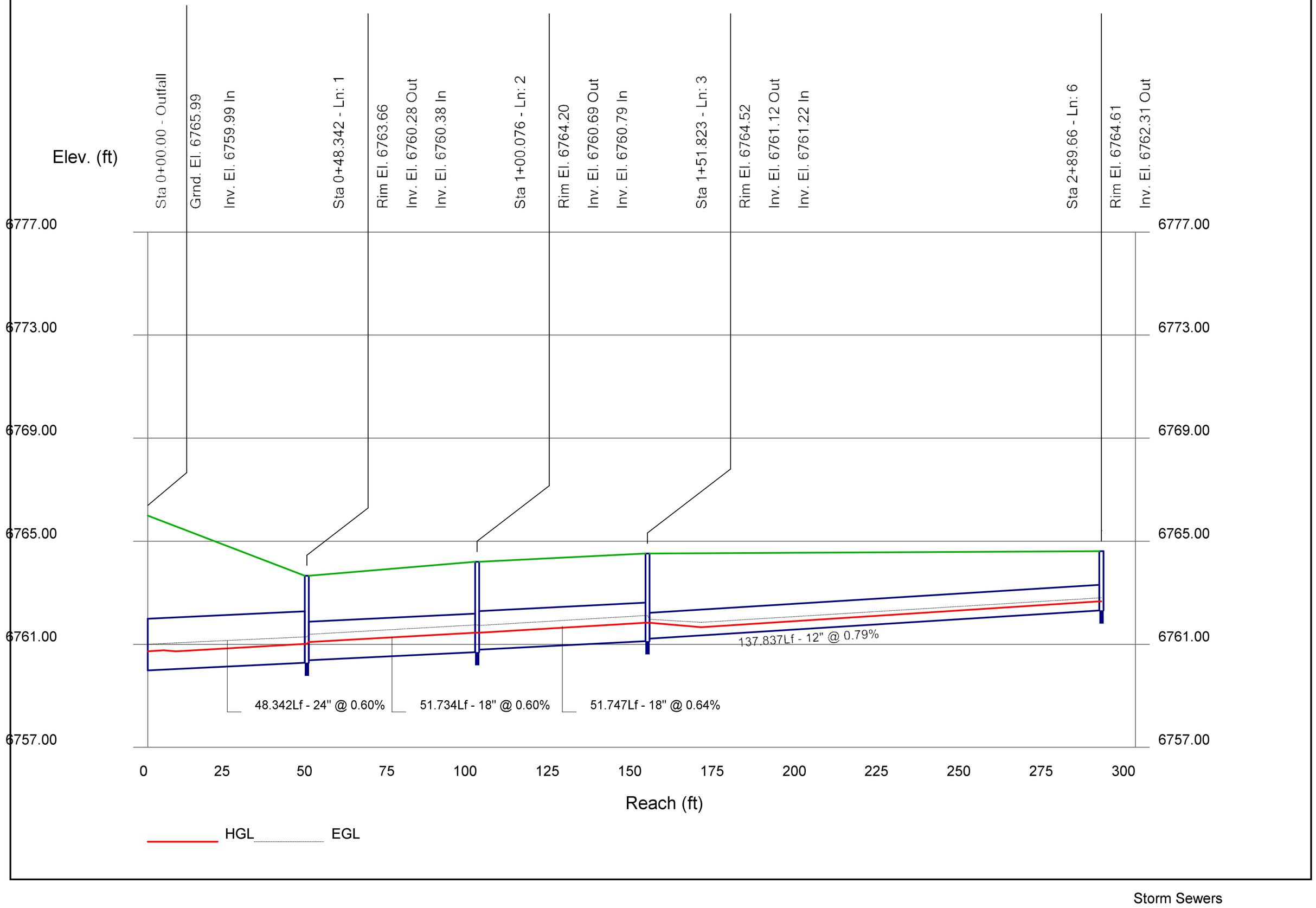
Storm Sewer Profile

Profile 1 - Minor Storm Event (5yr)



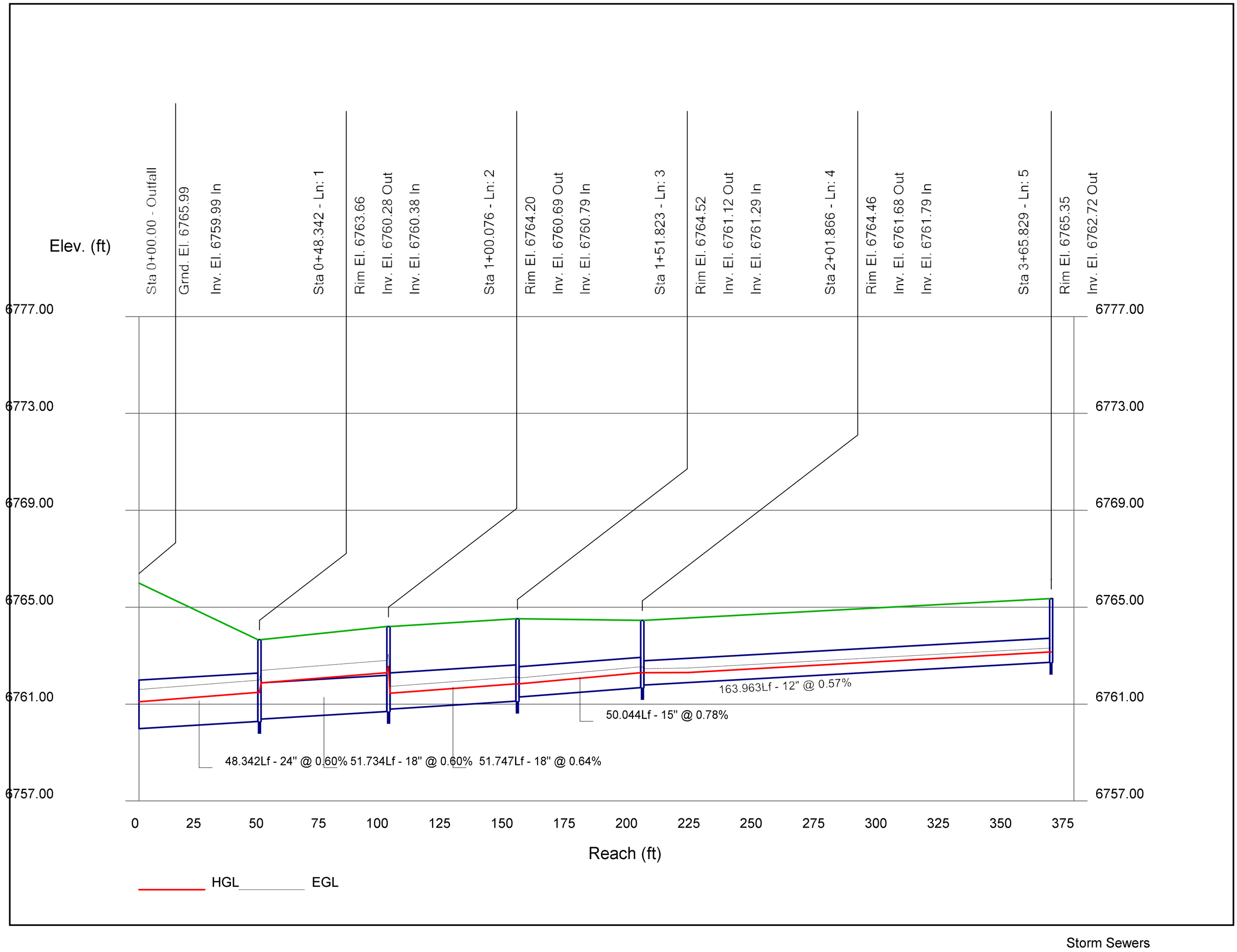
Storm Sewer Profile

Profile 2 - Minor Storm Event (5yr)



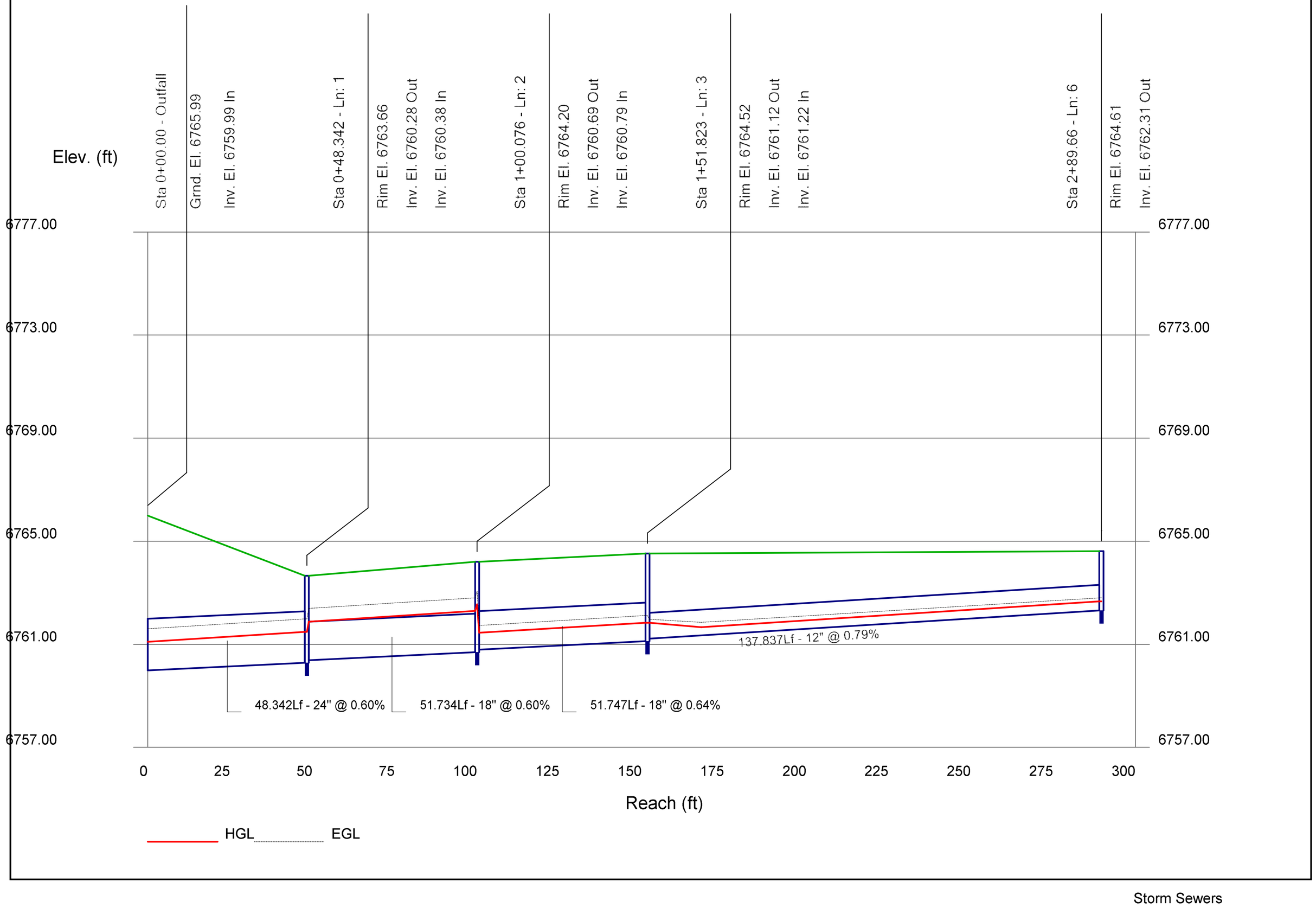
Storm Sewer Profile

Profile 1 - Major Storm Event (100yr)



Storm Sewer Profile

Profile 2 - Major Storm Event (100yr)



Major Event Storm Sewer Velocity Information

Line	Pipe Size	Q	Inv Elev Dn	HGL Dn	Depth Dn	Area Dn	Veloc Dn	Vel Hd Dn	EGL Dn	Line Length	Inv Elev Up	HGL Up	Depth Up	Area Up	Veloc Up	Vel Hd Up	EGL Up	Sf Dn	Sf Up
	(in)	(cfs)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(%)
1	24	11.22	6759.99	6761.10	1.11	1.78	6.29	0.50	6761.60	48.342	6760.28	6761.48	1.20**	1.97	5.70	0.50	6761.99	0.000	0.000
2	18	10.14	6760.38	6761.88	1.50*	1.77	5.74	0.51	6762.39	51.734	6760.69	6762.29	1.50	1.77	5.74	0.51	6762.80	0.795	0.795
3	18	9.06	6760.79	6761.45	0.66	0.75	4.72	0.28	6761.73	51.747	6761.12	6761.84	0.72**	0.83	4.24	0.28	6762.12	0.000	0.000
4	15	6.12	6761.29	6761.84	0.55	0.52	4.61	0.24	6762.08	50.044	6761.68	6762.30	0.62**	0.60	3.95	0.24	6762.54	0.000	0.000
5	12	2.67	6761.79	6762.30	0.51	0.32	2.60	0.16	6762.46	163.963	6762.72	6763.15 j	0.43**	0.32	3.24	0.16	6763.31	0.000	0.000
6	12	1.86	6761.22	6761.84	0.62	0.25	1.45	0.13	6761.97	137.837	6762.31	6762.67 j	0.36**	0.25	2.92	0.13	6762.80	0.000	0.000
	Notes: * depth assumed ** Critical depth.; j-Line contains hyd. jump; z-Zero Junction Loss																		

Appendix K: Standard forms No. 3, 4, & 5

Standard Form No. 3 Final Drainage Study Checklist

Instructions:

1. The applicant shall identify with a "check mark" if information is provided with letter. If applicant believes information is not required, indicate with "N/A" and attach separate sheet with explanation.
2. The reviewer will determine if information labeled "N/A" is required and whether additional information must be submitted.

I. General

x A. Report typed and legible in 8½" x 11" format.
x B. Report bound (comb, spiral, or staple – no notebook).
x C. Drawings that are 8½ x 11 or 11 x 17 bound within report, larger drawings (up to 24 x 36) included in a pocket attached to the report. Drawings shall be at an appropriate size and scale to be legible and include project area.

II. Cover

x A. Report Type – Final Drainage Study.
x B. Project Name, Subdivision, Original Date, Revision Date.
x C. Preparer's name, firm, address, phone number.
x D. "DRAFT" for 1st submittal and revisions; "FINAL" once approved.

III. Title Sheet

x A. Table of Contents.
x B. Certification, PE Stamp, signature, and date from licensed Colorado PE.
x C. Note: City of Steamboat Springs plan review and approval is only for general conformance with City design criteria and the City code. The City is not responsible for the accuracy and adequacy of the design, dimensions, and elevations that shall be confirmed and correlated at the job site. The City of Steamboat Springs assumes no responsibility for the completeness or accuracy of this document.

IV. Introduction

x A. Description of site location, size in acres, existing and proposed land use, and any pertinent background info.
x B. Reference planning application type and plan set date and preparer.
x C. Identify drainage reports for adjacent development.

V. Drainage Criteria and Methodology Used

x A. Identify design rainfall and storm frequency.
x B. Identify the runoff calculation method used.
x C. Identify culvert and storm sewer design methodology.
n/a D. Identify detention discharge and storage methodology.
n/a E. Discuss HEC-HMS methodologies and parameters, if HEC-HMS is used.

VI. Existing Conditions (Pre-Development/Historic)

x A. Indicate ground cover, imperviousness, topography, and size of site (acres).
x B. Describe existing stormwater system (sizes, materials, etc.).
x C. Describe other notable features (canals, major utilities, etc.).
x D. Note site outfall locations and ultimate outfall location (typically Yampa River).
x E. Note capacity of existing system and identify any constraints.
x F. Identify NRCS soil type.
x G. Discuss any existing easements.
x H. Identify the FEMA Map reviewed, if site is in floodplain/way, and zone designation.

VII. Proposed Conditions

x A. Indicate ground cover, imperviousness, topography, and disturbed area (acres).
x B. Describe proposed stormwater system (sizes, materials, etc.).
x C. Describe proposed outlets and indicate historic and proposed flow for each.
x D. Include calculations for all culverts, ditches, ponds, etc. in appendix.
x E. Include a summary table for the 5- and 100-year events showing historic flow and proposed flow for total site and each basin.
x F. Discuss proposed easements.
x G. Describe off-site flows to be passed thru site.
x H. Summarize any impacts to downstream properties or indicate none. Reference CLOMR/LOMR and impacts.

I. Detention Ponds.
n/a 1. Indicate pond volume and area (size and depth) requirement.
n/a 2. Indicate release rates.
n/a 3. Discuss outfall design, location, and overflow location.
n/a 4. Discuss maintenance requirements.

J. Curb and Gutter
n/a 1. Indicate gutter capacity.
n/a 2. Indicate curb capacity.
n/a 3. Indicate design velocity
n/a 4. Indicate design depth of flow in street.

K. Culverts
x 1. Indicate whether each culvert is under inlet or outlet control.
x 2. Show that headwater is less than the maximum allowable.
x 3. Indicate design velocity.
x 4. Indicate required and provided flow rates.
x 5. Discuss whether outlet protection is required and what will be used.

L. Inlets
x 1. Indicate inlet capacity.
x 2. Indicate the type of inlet(s) used.

M. Channels
n/a 1. Indicate design velocity (and type of dissipation if required).
n/a 2. Indicate required and provided flow capacity.
n/a 3. Show critical cross-section(s) including water surface.

N. Site Discharge
n/a 1. Discuss use and design of detention to ensure discharge is less than or equal to historic flow.
x 2. Provide documentation that downstream facilities are adequate and no adverse impacts to downstream property owners (i.e. no rise certification)

VIII. Post Construction Stormwater Management

x A. Discuss in general terms which permanent BMP practices will be used to control pollutant and sediment discharge after construction is complete. Exhibit A, Storm Water Quality Plan shall be attached that will give details (see separate checklist)

IX. Conclusions

x A. Provide general summary.
x B. Note if site complies with criteria and any variances to criteria.
x C. Indicate if peak proposed flow is less than, equal to, or greater than peak historic flow for each outfall, design point, and for the total site.
x D. List proposed new stormwater system requirements.

X. References

x A. Provide a reference list of all criteria, master plans, drainage reports and technical information used.

XI. Tables

x A. Include a copy of all tables prepared for the study.

XII. Figures

x A. Vicinity Map.
x B. Site Plan (include the horizontal and vertical datum used and all benchmarks).
C. Existing conditions.
x 1. Delineate existing basin boundaries.
x 2. Delineate offsite basins impacting the site.
x 3. Show existing and proposed topography at an interval of at least 2-ft.
x 4. Show existing runoff flow arrows.
x 5. Show existing stormwater features (structures, sizes, materials, etc.).
x 6. Show floodplain limits and information.
x 7. For each basin show bubble with basin number, acreage and % impervious.
x 8. For each outlet show bubble with acreage and historic flow and proposed flow or provide information in summary table on figure.
D. Proposed Conditions
X 1. Delineate proposed basin boundaries.
X 2. Show proposed runoff flow arrows.
X 3. Show existing and proposed topography at an interval of at least 2-ft.
X 4. For each basin show bubble with basin number, acreage and percent impervious or provide a summary table or figure.
X 5. For each outlet show bubble with acreage, historic flow, and proposed flow or provide a summary table or figure.
x 6. Show floodplain limits and information.
X 7. Show proposed building footprints and FFE for commercial and multi-family
X 8. Show property lines and easements (existing and proposed).
x 9. Label public and private facilities. A general note can be placed on the plans in lieu of labeling all facilities, if applicable.

XIII. Appendices

x A. Runoff Calculations.
x B. Culvert Calculations.
n/a C. Pond Calculations.
x D. Other Calculations.

Acknowledgements

Standard Form No. 3 was prepared by: Walter Magill, P.E 08-25-2023
Date

Include Attachment A – Scope Approval Form (see Standard Form No. 5)
Include Attachment B – Storm Water Quality Plan (see Standard Form No. 4)

Note: Final Drainage Study and Stormwater Quality Plan compiled as one continuous report

Standard Form No. 4 Stormwater Quality Plan Checklist

This list is not an exhaustive list of every possible item that may be required or requested in a Stormwater Quality Plan but provides a general guideline for preparation of the Stormwater Quality Plan.

Instructions:

1. The applicant shall identify with a "check mark" if information is provided within the Stormwater Quality Plan. If applicant believes information is not required, indicate with "N/A" and attach separate sheet with explanation. If information is included with the associated drainage letter or study, indicated with a "D."
2. The reviewer will determine if information labeled "N/A" is required and whether additional information must be submitted.

I. General

x A. Report typed and legible in 8½" x 11" format.
x B. Report bound (comb, spiral, or staple – no notebook) and in digital PDF format.
x C. Drawings that are 11" x 17" bound within letter, larger drawings (up to 24" x 36") included in a pocket attached to the letter, and a digital PDF copy. Drawings shall be at an appropriate size and scale to be legible and include project area.

II. Cover

x A. Report Type – Stormwater Quality Plan.
x B. Project Name, Subdivision or Development, Original Date, Revision Date.
x C. Preparer's name, firm, address, and phone number.
x D. "DRAFT" for 1st submittal and revisions; "FINAL" once approved.

III. Title Sheet

x A. Table of Contents.
_____ B. Certification, PE Stamp, signature and date from licensed Colorado PE (for Final).
x C. Note: City of Steamboat Springs plan review and approval is only for general conformance with City design criteria and City code. The City is not responsible for the accuracy and adequacy of the design, dimensions, and elevations that shall be confirmed and correlated at the job site. The City of Steamboat Springs assumes no responsibility for the completeness or accuracy of this document.

IV. Introduction and Background

x A. Description of site location, study limits, size in acres, existing and proposed land use, soil data, permeability of the site, drainage patterns, and any pertinent background info.
x B. State purpose and goal of Stormwater Quality Plan and report along with any special requirements of the desired outcome.
x C. List any project stakeholders and/or requestors.
x D. Describe the background of the flooding source and any previous studies.

V. Design Criteria and Methodology Used

X A. Identify design rainfall and storm frequency used to design permanent stormwater treatment facilities.

X B Identify the runoff calculation method used to design permanent stormwater treatment facilities.

X C. Identify the standard the design will meet and the means and methodologies by which it will use to meet the standard.

X D. Provide all details supporting the use of the selected design standard.

VI. Proposed Conditions

X A. Identify total site area, total site imperviousness, area to be treated, and impervious area to be treated. Include justification for treating less than the total site area.

X B. Describe potential site contaminant sources including sediment.

X C. Identify source and quantity of on-site and off-site stormwater flows that need to be managed and how they will be managed.

X D. For each permanent treatment facility, identify the design standard, MDCIA level (if applicable), area treated (& percentage of total), imperviousness of area treated, C values of area treated, soil types, and all pertinent data for design.

n/a E. Volume based facilities: Provide total storage pond volume, WQCV, drain time, release rate, sediment storage, outlet & overflow structures, area and depth of pond, micropool, forebays, etc. (include all calculations in the appendix).

X F. Flow based facilities: Provide design flow rate and all treatment calculations and how flows larger than the water quality design flow rate will be handled. If proprietary facilities are proposed, provide the justification and sizing requirements from manufacturer.

n/a G. If stormwater detention is provided, discuss how water quality is provided within the detention facility. No underground detention is allowed.

VII. Operation and Maintenance Plan Requirements

See template O&M plan and guidance document.

X A. Describe general project information, facility description, ROW and access information, vegetation management, hydraulic design parameters, environmental permitting, snow and ice control, and additional pertinent information in the notes.

X B. Indicate, describe, and detail the permanent stormwater treatment facilities.

x C Include section details where necessary of the permanent treatment facilities.

x D. Provide an inspection and maintenance schedule and procedure of permanent treatment facilities and who is responsible for them.

X E. Identify design specifications for construction.

Acknowledgements

Standard Form No. 4 prepared by: Walter Magill, PE 09-01-2023
Date

Include appropriate Project Sheet(s) and Design Checklist(s) (See Section 5.12)
Include this form as part of the Stormwater Quality Plan.

Standard Form No. 5 Drainage and Stormwater Treatment Scope Approval Form

Prior to starting a development plan and before the first drainage submittal, a Drainage and Stormwater Treatment Scope Approval Form must be submitted for review and signed by the City Engineer. A signed form shall also be included in every drainage submittal as Attachment A. This Scope Approval Form is for City requirements only. Values may be approximate. The City encourages supporting calculations and figures to be attached.

Project Information	
Project name:	Lot 1 Indian Meadows (Name subject to change)
Project location:	Lot 1 Indian Meadows
Developer name/contact info:	GRAY STONE, LLC
Drainage engineer name/contact info:	Joe Wiedemeier, PE FPSE
Application Type:	Development Plan
Proposed Land Use:	Hotel - Commercial

Project Site Parameters	
Total parcel area (acres):	3.87
Disturbed area (acres):	3.00
Existing impervious area (acres, if applicable):	0.25
Proposed new impervious area (acres):	2.5
Proposed total impervious area (acres):	2.5
Proposed number of project outfalls:	3
Number of additional parking spaces:	160+-
Description and site percentage of existing cover/land use(s):	Vacant except for paved access roads Sparse vegetation and bare ground Wetlands located along the east property line
Description and site percentage of proposed cover/land use(s):	Commercial Development (2) new hotels and all associated infrastructure
Expected maximum proposed conveyance gradient (%):	5%
Description of size (acres) and cover/land use(s) of offsite areas draining to the site	Minimal off site areas draining to the site.

Type of Study Required:

☐ Drainage Letter
☐ Conceptual Drainage Study
☒ Final Drainage Study
☒ Stormwater Quality Plan

Hydrologic Evaluation:

☒ Rational Method ☐ CUHP/SWMM ☐ HEC-HMS ☐ Other_____

Project Drainage	
Number of subbasins to be evaluated:	3 main basins, multiple sub basins
Presence of pass through flow (circle):	YES (NO)
Description of proposed stormwater conveyance on site:	See drainage exhibit, DR2. Sheet flow, curb/gutter combo (rollback curbs), inlets, Bioretention
Project includes roadway conveyance as part of design evaluation (circle):	(YES) NO
Description of conveyance of site runoff downstream of site, identify any infrastructure noted in Stormwater Master Plan noted as lacking capacity for minor or major storm event:	Runoff from DB1 basin will outfall along the east property line and in the form of concentrated flow at the NE property corner.
Detention expected onsite (circle):	YES (NO) Per hydraulic study of Walton Creek/Yampa
Presence of Floodway or Floodplain on site (circle):	(YES) NO Floodplains associated with the site
Anticipated modification of Floodway or Floodplain proposed (circle):	(YES) NO Floodplain development proposed
Describe culvert or storm sewer conveyance evaluative method:	Rational Method, Manning's equation

Permanent Stormwater Treatment Facility Design Standard (check all that apply with only one standard per tributary basin):

☒ WQCV Standard ☒ TSS Standard ☐ Infiltration Standard
☐ Constrained Redevelopment WQCV Standard
☐ Constrained Redevelopment TSS Standard
☐ Constrained Redevelopment Infiltration Standard
☐ Does not Require Permanent Stormwater Treatment (attach Exclusion Tracking Form)

Project Permanent Stormwater Treatment	
Justification of choice of proposed design standard, including how the site meets the constrained redevelopment standard, infiltration test results, etc.:	Both the WQCV and TSS standards for a treatment train configuration.
Concept-level permanent stormwater treatment facility design details (type, location of facilities, proprietary structure selection, treatment train concept, etc.):	Six new bioretention facilities with associated storm-sewer network. Facilities will be combined into the parking lot design and primarily along the east property line and NE property corner. Some WQCV treatment provided to the west to US Highway 40 roadside ditch.
Proposed LID measures to reduce runoff volume:	Storage in the form of bioretention facilities (6 total)
Will treatment evaluation include off-site, pass through flow (circle):	YES (NO)

Approvals

Walter Magill, PE (FPSE)	09-01-2021	970-819-1161
Prepared By: (Insert drainage engineer name & firm)	Date	Phone number

Approved By:

Printed Name: City Engineer	Date

Appendix L: Operation and Maintenance Plan for Stormwater BMPs and Conveyance Network

OPERATION AND MAINTENANCE PLAN
PERMANENT STORM WATER QUALITY BMPs
HOTELS AT LOT 1 INDIAN MEADOWS

1. GENERAL PROJECT INFORMATION

A. (ADDRESS TBD), STEAMBOAT SPRINGS, ROUTT COUNTY, COLORADO.

2. GENERAL FACILITY DESCRIPTION

THE FACILITIES ASSOCIATED WITH THIS DEVELOPMENT ARE BIO-RETENTION SYSTEMS AND GRASS BUFFERS THAT ARE CAPABLE OF TREATING RUNOFF FOR TOTAL SUSPENDED SOLIDS (TSS) AND OTHER POLLUTANTS COMMONLY DERIVED FROM VEHICLES AND OTHER MOTORIZED EQUIPMENT. THESE STORM WATER BEST MANAGEMENTS PRACTICES (BMPs) WERE DESIGNED AND ENGINEERED ACCORDING TO STEAMBOAT SPRINGS STANDARDS AND SPECIFICATIONS.

3. INSPECTION & MAINTENANCE FREQUENCY & PROCEDURE

A. THE FOLLOWING TABLES PROVIDES AN INSPECTION AND MAINTENANCE SCHEDULE FOR THE PROPOSED BMPs:

Rain Garden Inspection and Maintenance Schedule

Activity	Required Frequency
Inspection for uniform mulch cover, plant health, sediment accumulation, rill and gully development, and impacts from foot or vehicle traffic; maintain as necessary. Debris, sediment, and litter removal.	Twice annually. Typcailly performed in the spring and fall periods.
Inspect curb cut inlets and storm inlets. Ensure inlets are functioning properly and free of sediment buildup, debris, trash, etc.	Twice annually. Typcailly performed in the spring and fall periods.
Weeding and Mulching. Pull intrusive weeds. Apply a shredded hardwood much 2"-3" deep AFTER the aformentioned activities are completed.	Once annually. Typically performed in the spring.
Irrigation and watering.	Rain gardens are outfitted with irrigation. Ensure irrigation heads are working properly. Adjust irrigation schedule accordingly based on moisture conditions. Watering frequency is vital for first few years of vegetation establishment. At a minimu, rain gardens should be irrigated for 2 mins for grasses and shrubs and 5 minutes for trees at least two times per week durign the growing season. (Spring/Summer/Early Fall)
Pruning may be performed on well established shrubs and trees by qualified personell.	As needed.

B. INLET INSPECTION AND MAINTENANCE: ALL PRIVATE STORMWATER INLETS ARE OUTFITTED W/ 12" SUMPS. INLETS AND SUMPS SHOULD BE INSPECTED AND MAINTAINED ONCE ANNUALLY FOR BLOCKAGE AND SEDIMENT BUILDUP IN THE SUMP. SEDIMENT SHOULD BE REMOVED FROM SUMPS IF THE DEPTH EXCEEDS 6". DAMAGED INLETS SHOULD BE REPAIRED OR REPLACED IMMEDIATELY.

4. EQUIPMENT, STAFFING AND VEGETATION MANAGEMENT

A. EQUIPMENT:
A.A. VEGETATION MAINTENANCE TOOLS SUCH AS A LAWNMOWER, WEED WHACKER, AND BLOWER.
A.B. SEDIMENT AND DEBRIS REMOVAL TOOLS SUCH AS RAKES, SHOVELS, BUCKETS, BLOWERS, AND/OR LANDSCAPING VACUUM.

B. STAFFING: OWNER'S REPRESENTATIVE (ASSIGNED PRIOR TO CONSTRUCTION)

C. SEEDING: GRASS BUFFERS WILL BE INSTALLED W/ PROPER SEEDING AND FERTILIZER TO ESTABLISH GROWTH. ANY BARE AREAS THAT APPEAR DURING THE GRASS BUFFER LIFE CYCLE SHOULD BE RE-SEEDED AS NECESSARY W/ NATIVE SEED MIX.

D. MOWING: VEGETATION HEALTH SHOULD BE MAINTAINED IN AND AROUND THE GRASS BUFFERS WITH REGULAR MOWING AND WEEDEATING. THE REQUIRED MOW AREA POST-CONSTRUCTION FOR THE ENTIRE SITE WAS ESTIMATED TO BE 0.15 ACRES.

E. UNDESIRABLE VEGETATION AND WEEDS: UNDESIRABLE VEGETATION AND NOXIOUS WEEDS SHOULD BE REMOVED REGULARLY BY THE LANDSCAPING STAFF. WEEDS SHOULD BE MOWED OR REMOVED BY HAND.

5. SNOW AND ICE CONTROL

THE GRASS BUFFERS AND BIORETENTION SYSTEMS WILL SERVE AS A SNOW STORAGE AREAS DURING THE WINTER MONTHS. PLOW OPERATORS SHALL TAKE CARE NOT TO DAMAGE OR DISTURB THE FINISHED GRADE OF THE BMPs OR THE INSTALLED TRM AND UNDERDRAIN FEATURES. PLOW OPERATORS SHALL TAKE CARE NOT TO DAMAGE STORMWATER INLET GRATES.

6. RIGHT-OF-WAY, ADJACENT OWNERSHIP & ACCESS

A. ACCESS INFORMATION AND DETAILS: ACCESS FROM THE SHARED PRIVATE ACCESS RUNNING NORTH-SOUTH OFF STONE LANE.

B. MAINTENANCE OPERATIONS WILL REQUIRE TEMPORARY OBSTRUCTION OF THE PRIVATE SHARED CROSS ACCESS ROAD TO FAIRFIELD INN. A RIGHT-OF-WAY PERMIT SHOULD NOT BE REQUIRED FOR TEMPORARY OBSTRUCTIONS BUT IT SHOULD BE NOTED THAT TRAFFIC WILL LIKELY NEED TO MANAGED FOR A ONE-WAY SCENARIO IF A SERVICE VEHICLE AND EQUIPMENT IS TO PARK ON THE CROSS ACCESS ROAD SHOULDER. MAINTENANCE CREWS SHOULD PLACE MUTCD APPROVED TRAFFIC CONTROL DEVICES (ORANGE CONES AND/OR BARRICADES) AROUND ALL VEHICLES AND EQUIPMENT THAT ARE TEMPORARILY WITHIN THE 30-FOOT ACCESS EASEMENT.

7. HYDRAULIC DESIGN OF GRASS BUFFERS AND BIORETENTION SYSTEMS

(SEE THE APPROVED FINAL DRAINAGE REPORT FOR HOTELS AT LOT 1 INDIAN MEADOWS WITH HYDRAULIC CALCULATIONS AND RESULTS IN THE APPENDICES)

8. SENSITIVE AREA, WETLANDS & PERMITS

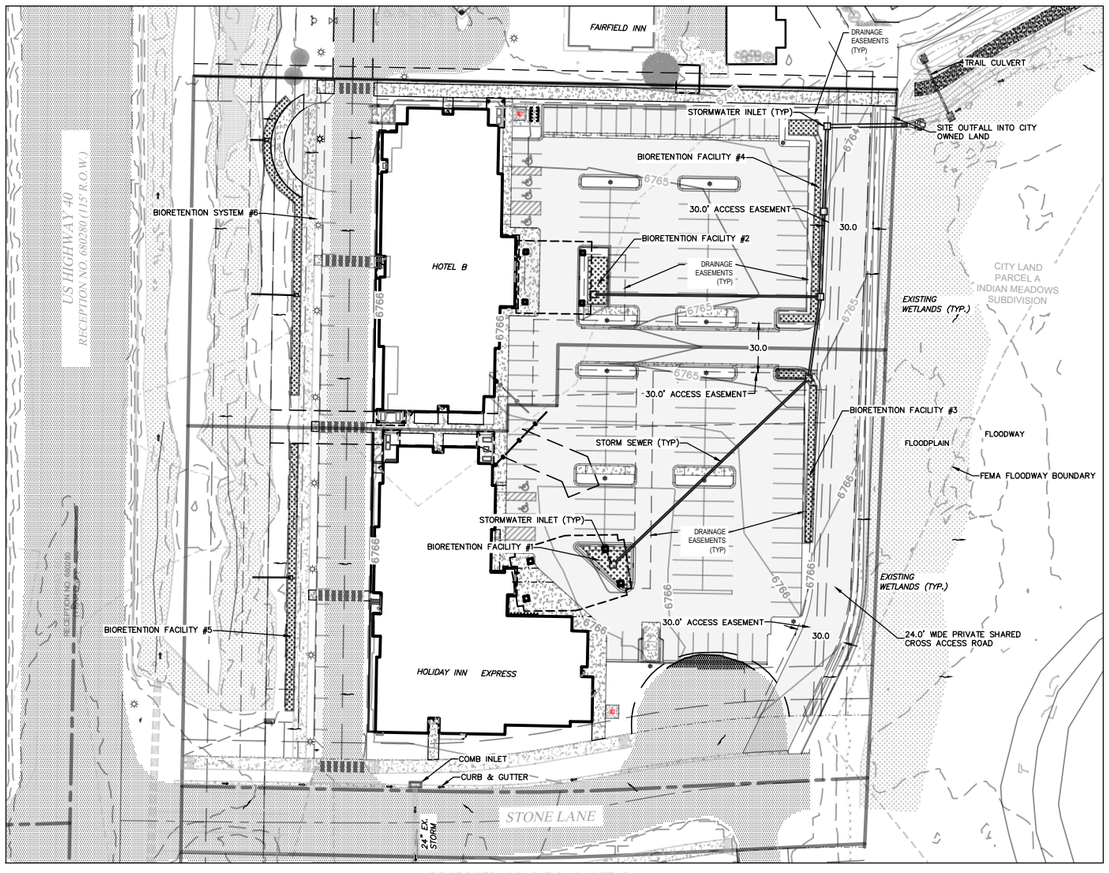
WETLANDS ARE PRESENT ON CITY OWNED LAND JUST ALONG THE EASTERLY PROPERTY LINE AND WHERE DRAINAGE FROM THE HOTEL PARKING LOTS ULTIMATELY OUTFALLS. WETLANDS SHOULD NOT BE DISTURBED AND SEDIMENT AND DEBRIS FROM MAINTENANCE OPERATIONS SHALL NOT BE DISCARDED INTO WETLANDS.

9. MISCELLANEOUS INFORMATION

PROJECT SURVEY: EXISTING CONDITIONS AND TOPOGRAPHIC SURVEY WAS PREPARED BY FOUR POINTS SURVEYING & ENGINEERING. ANY QUESTIONS COMMENTS OR CONCERNS REGARDING THIS OPERATION AND MAINTENANCE PLAN SHOULD BE CONVEYED TO FOUR POINTS SURVEYING AND ENGINEERING AND THE ENGINEER OF RECORD.

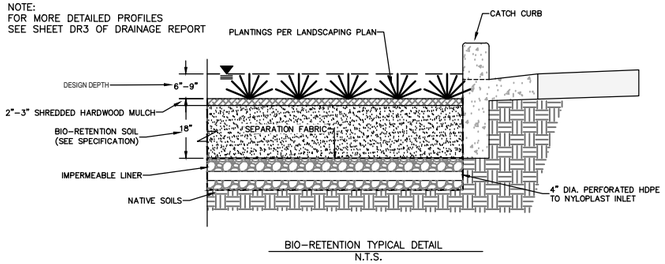
10. BMP DETAILS (SEE BELOW)

11. RESOURCE INFORMATION FOR BMP MAINTENANCE (SEE FOLLOWING PAGE)



PROPOSED CONDITIONS SITE PLAN

NOTE: SEE DR2 AND DR3 FOR UNDERDRAIN LAYOUT



BIO-RETENTION TYPICAL DETAIL
N.T.S.

COLORADO REGISTERED PROFESSIONAL ENGINEER
WALTER N. MAGILL
33243

FOUR POINTS SURVEYING ENGINEERING

No.	DATE	REVISIONS	INT

HOLIDAY INN EXPRESS & HOTEL B
CONSTRUCTION PLANS

INDIAN MEADOWS FIL. NO. 4
LOTS 1 AND 2
STEAMBOAT SPRINGS, CO 80487

HORIZONTAL SCALE
0 40' 80'
SCALE: 1" = 40'

DATE: 9/1/2023
JOB #: 1448-005
DRAWN BY: AP/DSC/AAC
DESIGN BY: AP/DSC/AAC/WNM
REVIEW BY: FPSE

IF THIS DRAWING IS PRESENTED IN A FORMAT OTHER THAN 24" X 36", THE GRAPHIC SCALE SHOULD BE UTILIZED.

DRAWING:
OPERATION AND MAINTENANCE PLAN

SHEET NO.
OM1

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.

FOUR POINTS SURVEYING | ENGINEERING

No	DATE	REVISIONS	INT

HOLIDAY INN EXPRESS & HOTEL B
CONSTRUCTION PLANS

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REVIEW BY: FPSE
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DRAWING:
UDFCD ADDITIONAL OPERATION AND MAINTENANCE REFERENCES

SHEET NO.
OM2