September 22, 2021

City of Lone Tree
9220 Kimmer Drive, Suite 100
Lone Tree, CO 80124

Re: 9155 Park Meadows Drive – Lone Tree, CO
Living Water Car Wash
Preliminary Drainage Letter

To Whom it may concern:

This letter has been prepared to identify how the developed drainage patterns associated with the proposed Living Water Car Wash will affect the existing stormwater infrastructure around the development site and downstream of the development site. This letter is preliminary in nature and has been prepared to supplement the current Site Improvement Plan submittal. Additional detailed analysis, including hydrologic and hydraulic calculations will be required for the final design of the proposed development.

The subject property is located on the eastern corner of the intersection of South Yosemite Street and Park Meadows Drive. The existing 1.2-acre site consists of a vacant restaurant building and associated drive lanes, parking stalls and landscaping. Proposed site improvements consist of the demolition of the existing building and the construction of a new tunnel car wash with stacking lanes located along the southern portion of the site and the addition of several vacuum stalls located generally to the east of the building.

The site is located within the Park Meadows Filing No. 2 development which is part of the area known as the Entertainment District and consists of several existing commercial uses to the east of South Yosemite Street and South of E-470. A previous drainage study known as the *Westbrook Development – 130 L.L.C. Phase 1 Development – Phase III Drainage Study* by Martin/Martin, Inc. dated June 1998 (Master Drainage Report) provided a regional level design of approximately 41 acres which includes the subject site. The Master Drainage Report includes the drainage design for the subject property within Basin J1, which drains to the existing Detention Pond 1, and a portion of the site that is identified as 0.47 acres that drains into the adjacent ROW as undetained runoff. Detention Pond 1 has been designed and constructed to provide 10-year and 100-year detention volumes and controls for the tributary basins.

The Master Drainage Report anticipated the following conditions for basin J1:

A = 2.82 acres
Imperviousness = 95%
C10 = 0.88
C100 = 0.89
Q10 = 11.91 cfs
Q100 = 19.07 cfs

The proposed development shown in the SIP submittal has a total composite site imperviousness of 68%, which is substantially less than the 95% that was anticipated in the master drainage report. The Master Drainage Report anticipated approximately 0.87 acres of the proposed site to be included in Basin J1, which would equate to an impervious area of 0.95 x 0.87 = 0.83 impervious acres. The proposed development would increase the area that drains to the existing pond to approximately 1.0 acre, but decrease the imperviousness of that basin to approximately 80%, which equates to an impervious area of 0.80 x 1.0 = 0.80 impervious acres. Due to the decrease in impervious area going to Pond 1 with the proposed development, the proposed development will not have a negative impact on the functioning of the existing pond. Additionally, the area of the site that drains offsite to the adjacent ROW will be reduced with the proposed development, further improving the function of the downstream stormwater conveyance infrastructure.

Although it is not anticipated that the proposed development will trigger the need for improvements to downstream stormwater infrastructure, and that the existing detention pond will be sufficient for the proposed development, it is our understanding that the City of Lone Tree will require this project to provide water quality enhancements for the new development. Based on the preliminary grading design, approximately half of the developed site will be tributary to a grass swale that will run between the proposed building and South Yosemite Street. The proposed swale will provide filtration and infiltration for the stormwater that flows through it and the length of the swale is anticipated to provide adequate water quality for the upstream basin prior to discharging into Pond 1. According to the Mile High Flood District, the grass swale is a very effective BMP in achieving a Low Impact Development (LID) and at runoff volume reduction through minimizing directly connected impervious areas (DCIA). Additional information from the Mile High Flood District regarding the proposed water quality swale has been attached to this letter.

The remainder of the developed site will be tributary to a sump inlet in the parking area to the southeast of the proposed building. It is anticipated that a hydrodynamic separator will be used to provide water quality for this basin prior to discharging into the swale to the north of the proposed building. Hydrodynamic separators, such as the Contech Stormceptor, provide water quality for the upstream basin by removing and trapping sediment and oils from the runoff prior to discharging runoff downstream. These systems have the ability to remove upwards of 80% of total suspended solids from the incoming runoff.

Due to the relatively small size of the development and the upstream basins, we believe that the water quality swale and a hydrodynamic swale will be appropriate and effective methods for providing water quality for the proposed development prior to discharging developed runoff to the existing downstream detention pond. The design for both of these elements will be provided with the final drainage report for the proposed development.

Additional drainage analysis will be required with the final design of the proposed development, however, the key metrics of the development including basin sizes and overall development imperviousness will be within the parameters that were anticipated in the Master Drainage Report and are not anticipated to have a negative impact on the existing downstream stormwater infrastructure, including Pond 1 as discussed in this letter. Water quality will be provided for the new development in accordance with the City of Lone Tree requirements.

Should you have any questions regarding this letter, please feel free to contact me at 303.325.5709.

Sincerely,

PROOF CIVIL CO.

Todd Lyon, P.E.
Principal

Attachments:

- MHFD Grass Swale Design Information
- Master Drainage Report Drainage Map
- Preliminary Grading Plan

Description

Grass swales are densely vegetated trapezoidal or triangular channels with low-pitched side slopes designed to convey runoff slowly. Grass swales have low longitudinal slopes and broad cross-sections that convey flow in a slow and shallow manner, thereby facilitating sedimentation and filtering (straining) while limiting erosion. Berms or check dams may be incorporated into grass swales to reduce velocities and encourage settling and infiltration. When using berms, an underdrain system should be provided. Grass swales are an integral part of the Low Impact Development (LID) concept and may be used as an alternative to a curb and gutter system.

Photograph GS-1. This grass swale provides treatment of roadway runoff in a residential area. Photo courtesy of Bill Ruzzo.

Site Selection

Grass swales are well suited for sites with low to moderate slopes. Drop structures or other features designed to provide the same function as a drop structures (e.g., a driveway with a stabilized grade differential at the downstream end) can be integrated into the design to enable use of this BMP at a broader range of site conditions. Grass swales provide conveyance so they can also be used to replace curb and gutter systems making them well suited for roadway projects.

Grass Swale	
Functions	
LID/Volume Red.	Yes
WQCV Capture	No
WQCV+Flood Control	No
Fact Sheet Includes EURV Guidance	No
Typical Effectiveness for Targeted Pollutants[3]	
Sediment/Solids	Good
Nutrients	Moderate
Total Metals	Good
Bacteria	Poor
Other Considerations	
Life-cycle Costs	Low

[3] Based primarily on data from the International Stormwater BMP Database (www.bmpdatabase.org).

Designing for Maintenance

Recommended ongoing maintenance practices for all BMPs are provided in Chapter 6 of this manual. During design, the following should be considered to ensure ease of maintenance over the long-term:

- Consider the use and function of other site features so that the swale fits into the landscape in a natural way. This can encourage upkeep of the area, which is particularly important in residential areas where a loss of aesthetics and/or function can lead to homeowners filling in and/or piping reaches of this BMP.

- Provide access to the swale for mowing equipment and design sideslopes flat enough for the safe operation of equipment.
- Design and adjust the irrigation system (temporary or permanent) to provide appropriate water for the selected vegetation.
- An underdrain system will reduce excessively wet areas, which can cause rutting and damage to the vegetation during mowing operations.
- When using an underdrain, do not put a filter sock on the pipe. This is unnecessary and can cause the slots or perforations in the pipe to clog.

Benefits

- Removal of sediment and associated constituents through filtering (straining)
- Reduces length of storm sewer systems in the upper portions of a watershed
- Provides a less expensive and more attractive conveyance element
- Reduces directly connected impervious area and can help reduce runoff volumes.

Limitations

- Requires more area than traditional storm sewers.
- Underdrains are recommended for slopes under 2%.
- Erosion problems may occur if not designed and constructed properly.

Design Procedure and Criteria

The following steps outline the design procedure and criteria for stormwater treatment in a grass swale. Figure GS-1 shows trapezoidal and triangular swale configurations.

1. **Design Discharge**: Determine the 2-year flow rate to be conveyed in the grass swale under fully developed conditions. Use the hydrologic procedures described in the *Runoff* Chapter in Volume 1.

2. **Hydraulic Residence Time**: Increased hydraulic residence time in a grass swale improves water quality treatment. Maximize the length of the swale when possible. If the length of the swale is limited due to site constraints, the slope can also be decreased or the cross-sectional area increased to increase hydraulic residence time.

3. **Longitudinal Slope**: Establish a longitudinal slope that will meet Froude number, velocity, and depth criteria while ensuring that the grass swale maintains positive drainage. Positive drainage can be achieved with a minimum 2% longitudinal slope or by including an underdrain system (see step 8). Use drop structures as needed to accommodate site constraints. Provide for energy dissipation downstream of each drop when using drop structures.

4. **Swale Geometry**: Select geometry for the grass swale. The cross section should be either trapezoidal or triangular with side slopes not exceeding 4:1 (horizontal: vertical), preferably flatter. Increase the wetted area of the swale to reduce velocity. Lower velocities result in improved pollutant removal efficiency and greater volume reduction. If one or both sides of the grass swale are also to be used as a grass buffer, follow grass buffer criteria.

5. **Vegetation**: Select durable, dense, and drought tolerant grasses. Turf grasses, such as Kentucky bluegrass, are often selected due to these qualities[1]. Native turf grasses may also be selected where a more natural look is desirable. This will also provide the benefit of lower irrigation requirements, once established. Turf grass is a general term for any grasses that will form a turf or mat as opposed to bunch grass, which will grow in clumplike fashion. Grass selection should consider both short-term (for establishment) and long-term maintenance requirements, given that some varieties have higher maintenance requirements than others. Follow criteria in the *Revegetation* Chapter of Volume 2, with regard to seed mix selection, planting, and ground preparation.

Native grasses provide a more natural aesthetic and require less water once established.

6. **Design Velocity**: Maximum flow velocity in the swale should not exceed one foot per second. Use the Soil Conservation Service (now the NRCS) vegetal retardance curves for the Manning coefficient (Chow 1959). Determining the retardance coefficient is an iterative process that the UD-BMP workbook automates. When starting the swale vegetation from sod, curve "D" (low retardance) should be used. When starting vegetation from seed, use the "E" curve (very low vegetal retardance).

7. **Design Flow Depth**: Maximum flow depth should not exceed one foot at the 2-year peak flow rate. Check the conditions for the 100-year flow to ensure that drainage is being handled without flooding critical areas, structures, or adjacent streets.

Table GS-1. Grass Swale Design Summary for Water Quality

Design Flow	Maximum Froude Number	Maximum Velocity	Maximum Flow Depth
2-year event	0.5	1 ft/s	1 ft

Use of Grass Swales

Vegetated conveyance elements provide some benefit in pollutant removal and volume reduction even when the geometry of the BMP does not meet the criteria provided in this Fact Sheet. These criteria provide a design procedure that should be used when possible; however, when site constraints are limiting, vegetated conveyance elements designed for stability are still encouraged.

[1] Although Kentucky bluegrass has relatively high irrigation requirements to maintain a lush, green aesthetic, it also withstands drought conditions by going dormant. Over-irrigation of Kentucky bluegrass is a common problem along the Colorado Front Range. It can be healthy, although less lush, with much less irrigation than is typically applied.

8. **Underdrain:** An underdrain is necessary for swales with longitudinal slopes less than 2.0%. The underdrain can drain directly into an inlet box at the downstream end of the swale, daylight through the face of a grade control structure or continue below grade through several grade control structures as shown in Figure GS-1.

   The underdrain system should be placed within an aggregate layer. If no underdrain is required, this layer is not required. The aggregate layer should consist of an 8-inch thick layer of CDOT Class C filter material meeting the gradation in Table GS-2. Use of CDOT Class C Filter material with a slotted pipe that meets the slot dimensions provided in Table GS-3 will eliminate the need for geotextile fabrics. Previous versions of this manual detailed an underdrain system that consisted of a 3- to 4-inch perforated HDPE pipe in a one-foot trench section of AASHTO #67 coarse aggregate surrounded by geotextile fabric. If desired, this system continues to provide an acceptable alternative for use in grass swales. Selection of the pipe size may be a function of capacity or of maintenance equipment. Provide cleanouts at approximately 150 feet on center.

Table GS-2. Gradation Specifications for Class C Filter Material
(Source: CDOT Table 703-7)

Sieve Size	Mass Percent Passing Square Mesh Sieves
19.0 mm (3/4")	100
4.75 mm (No. 4)	60 – 100
300 µm (No. 50)	10 – 30
150 µm (No. 100)	0 – 10
75 µm (No. 200)	0 - 3

Table GS-3. Dimensions for Slotted Pipe

Pipe Diameter	Slot Length[1]	Maximum Slot Width	Slot Centers[1]	Open Area[1] (per foot)
4”	1-1/16”	0.032”	0.413”	1.90 in^2
6”	1-3/8”	0.032”	0.516”	1.98 in^2

[1] Some variation in these values is acceptable and is expected from various pipe manufacturers. Be aware that both increased slot length and decreased slot centers will be beneficial to hydraulics but detrimental to the structure of the pipe.

9. **Soil preparation:** Poor soil conditions often exist following site grading. When the section includes an underdrain, provide 4 inches of sandy loam at the invert of the swale extending up to the 2-year water surface elevation. This will improve infiltration and reduce ponding. For all sections, encourage establishment and long-term health of the bottom and side slope vegetation by properly preparing the soil. If the existing site provides a good layer of topsoil, this should be striped, stockpiled, and then replaced just prior to seeding or placing sod. If not available at the site, topsoil can be imported or the existing soil may be amended. Inexpensive soil tests can be performed following rough grading, to determine required soil amendments. Typically, 3 to 5 cubic yards of soil amendment per 1,000 square feet, tilled 4 to 6 inches into the soil is required in order for vegetation to thrive, as well as to enable infiltration of runoff.

10. **Irrigation:** Grass swales should be equipped with irrigation systems to promote establishment and survival in Colorado's semi-arid environment. Systems may be temporary or permanent, depending on the type of grass selected. Irrigation practices have a significant effect on the function of the grass swale. Overwatering decreases the permeability of the soil, reducing the infiltration capacity of the soil and contributing to nuisance baseflows. Conversely, under watering may result in delays in establishment of the vegetation in the short term and unhealthy vegetation that provides less filtering (straining) and increased susceptibility to erosion and riling over the long term.

Construction Considerations

Success of grass swales depends not only on a good design and maintenance, but also on construction practices that enable the BMP to function as designed. Construction considerations include:

- Perform fine grading, soil amendment, and seeding only after upgradient surfaces have been stabilized and utility work crossing the swale has been completed.
- Avoid compaction of soils to preserve infiltration capacities.
- Provide irrigation appropriate to the grass type.
- Weed the area during the establishment of vegetation by hand or mowing. Mechanical weed control is preferred over chemical weed killer.
- Protect the swale from other construction activities.
- When using an underdrain, ensure no filter sock is placed on the pipe. This is unnecessary and can cause the slots or perforations in the pipe to clog.

Photograph GS-2. This community used signage to mitigate compaction of soils post-construction. Photo courtesy of Nancy Styles.

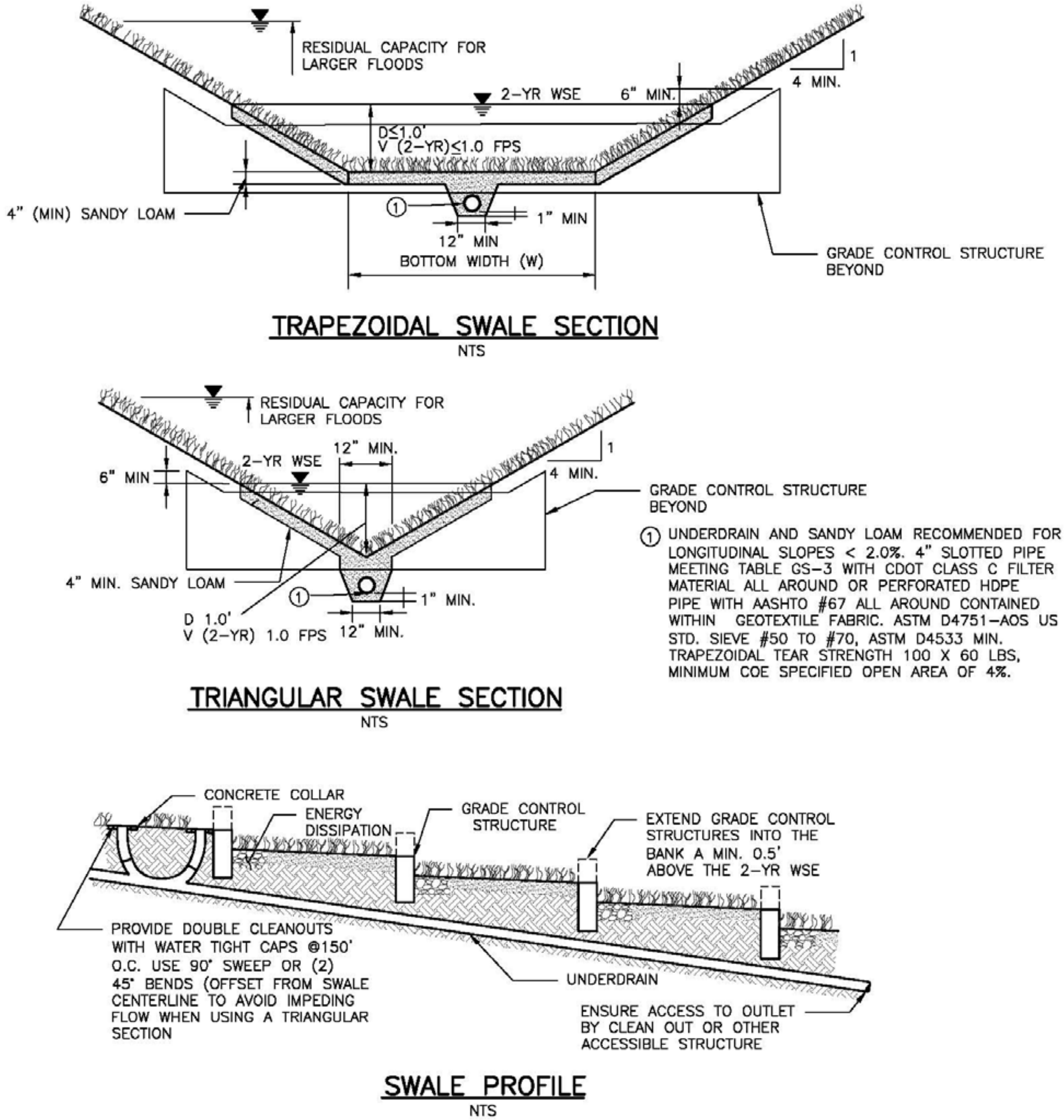


Figure GS-1. Grass Swale Profile and Sections

Design Example

The *UD-BMP* workbook, designed as a tool for both designer and reviewing agency is available at www.udfcd.org. This section provides a completed design form from this workbook as an example.

Design Procedure Form: Grass Swale (GS)

Sheet 1 of 1

Designer:	**M. Levine**
Company:	**BMP Inc.**
Date:	**November 24, 2010**
Project:	**Filing 30**
Location:	**Swale between north property line and 52nd Ave.**

1. Design Discharge for 2-Year Return Period	Q_2 = 4.00 cfs
2. Hydraulic Residence Time	
A) : Length of Grass Swale	L_S = 400.0 ft
B) Calculated Residence Time (based on design velocity below)	T_{HR}= 6.7 minutes
3. Longitudinal Slope (vertical distance per unit horizontal)	
A) Available Slope (based on site constraints)	S_{avail} = 0.020 ft / ft
B) Design Slope	S_D = 0.010 ft / ft
4. Swale Geometry	
A) Channel Side Slopes (Z = 4 min., horiz. distance per unit vertical)	Z = 4.00 ft / ft
B) Bottom Width of Swale (enter 0 for triangular section)	W_B = 4.00 ft
5. Vegetation	Choose One
A) Type of Planting (seed vs. sod, affects vegetal retardance factor)	○ Grass From Seed ◉ Grass From Sod
6. Design Velocity (1 ft / s maximum)	V_2 = 1.00 ft / s
7. Design Flow Depth (1 foot maximum)	D_2 = 0.62 ft
A) Flow Area	A_2 = 4.0 sq ft
B) Top Width of Swale	W_T = 9.0 ft
C) Froude Number (0.50 maximum)	F = 0.26
D) Hydraulic Radius	R_H = 0.44
E) Velocity-Hydraulic Radius Product for Vegetal Retardance	VR = 0.44
F) Manning's n (based on SCS vegetal retardance curve D for sodded grass)	n = 0.088
G) Cumulative Height of Grade Control Structures Required	H_D = 4.00 ft
8. Underdrain (Is an underdrain necessary?)	Choose One ◉ YES ○ NO — AN UNDERDRAIN IS REQUIRED IF THE DESIGN SLOPE < 2.0%
9. Soil Preparation (Describe soil amendment)	Till 5 CY of compost per 1000 SF to a depth of 6 inches.
10. Irrigation	Choose One ◉ Temporary ○ Permanent

Notes:

References

Chow, Ven Te. 1959. *Open Channel Flow*. McGraw Hill: New York, NY.

ENTERTAINMENT DISTRICT

MASTER DRAINAGE PLAN

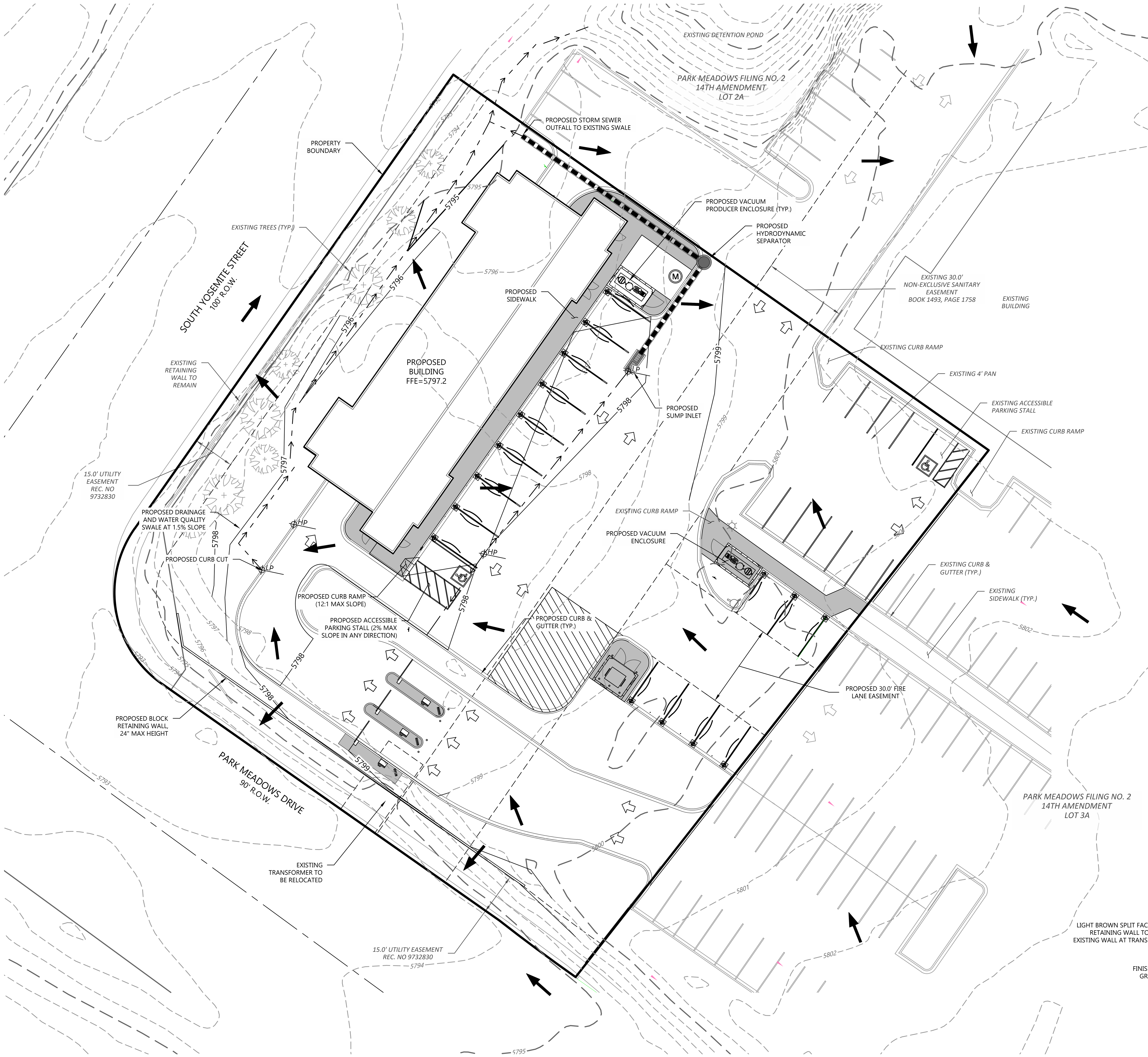
BASIN DATA

BASIN		Tc MIN	C10	C100	Q10 CFS	Q100 CFS
A1	DEVELOPED	12.28	0.88	0.89	46.31	72.79
G1	DEVELOPED	7.41	0.88	0.89	16.34	26.48
G2	DEVELOPED	5.00	0.88	0.89	2.03	3.22
G3	DEVELOPED	5.00	0.90	0.90	1.19	1.87
G4	DEVELOPED	6.73	0.90	0.90	9.73	15.85
G5	DEVELOPED	5.00	0.88	0.89	3.55	5.64
G6	DEVELOPED	5.00	0.90	0.90	2.28	3.58
G7	DEVELOPED	5.00	0.88	0.89	6.54	10.39
H1	DEVELOPED	7.06	0.88	0.89	15.88	25.70
H2	DEVELOPED	5.85	0.88	0.89	9.75	15.94
H3	DEVELOPED	6.08	0.90	0.90	6.25	10.14
H4	DEVELOPED	5.00	0.88	0.89	3.55	5.64
I1	DEVELOPED	5.00	0.90	0.90	0.77	1.22
I2	DEVELOPED	8.73	0.88	0.89	24.44	41.65
I3	DEVELOPED	5.00	0.88	0.89	4.00	6.36
I4	DEVELOPED	5.00	0.90	0.90	2.07	3.26
I5	DEVELOPED	5.00	0.90	0.90	2.33	3.67
I6	DEVELOPED	5.00	0.88	0.89	1.16	1.85
J1	DEVELOPED	7.94	0.88	0.89	11.91	19.07
J2	DEVELOPED	5.00	0.88	0.89	3.04	4.83
J3	DEVELOPED	5.00	0.90	0.90	2.07	3.26
J4	DEVELOPED	7.95	0.88	0.89	7.64	12.51
J5	DEVELOPED	5.00	0.90	0.90	1.19	1.87
J6	DEVELOPED	8.08	0.88	0.89	8.19	13.75
K1	DEVELOPED	5.00	0.88	0.89	11.86	18.85
K2	DEVELOPED	5.00	0.88	0.89	14.85	23.60
K3	DEVELOPED	5.00	0.88	0.89	1.42	2.26
K4	DEVELOPED	5.00	0.88	0.89	1.42	2.26
K5	DEVELOPED	5.00	0.88	0.89	6.27	9.86
M	DEVELOPED	5.00	0.88	0.89	28.59	45.43
O	DEVELOPED	5.00	0.90	0.93	10.94	17.76
P1	DEVELOPED	5.00	0.90	0.93	6.48	10.52
P2	DEVELOPED	5.00	0.90	0.93	6.48	10.52
P3	DEVELOPED	5.64	0.88	0.89	35.78	58.85

* NOTE: FLOWS BASED ON 0.3 CFS/AC FOR MINOR STORM AND 1.0 CFS/AC FOR MAJOR STORM

PARK MEADOWS, FILING NO 2, LOT 1

WESTBROOK ENTERTAINMENT & SPORTS DISTRICT PD
PLANNING AREA PA2/PA3/PA4
1.198 ACRES
SIP, PROJECT SP21-67

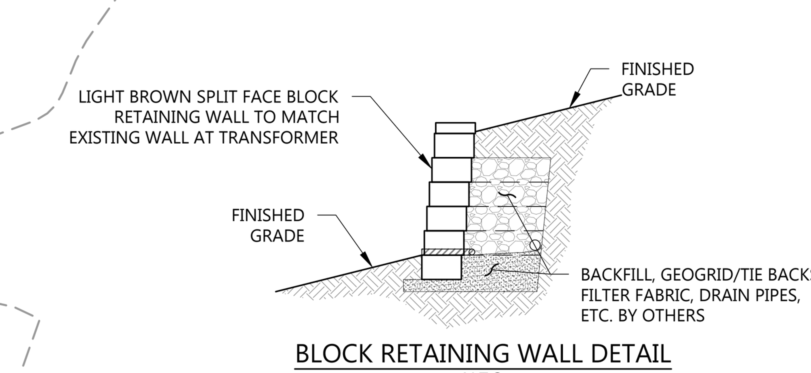


LEGEND:

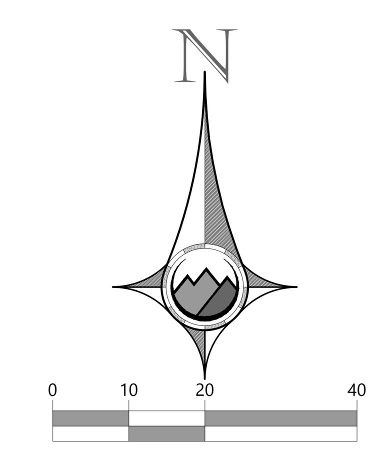
- PROPERTY LINE
- PROPOSED BUILDING
- EXISTING BUILDING
- PROPOSED EASEMENT
- EXISTING EASEMENT
- PROPERTY SETBACK
- 5400 PROPOSED 5' CONTOUR
- 5401 PROPOSED 1' CONTOUR
- 5400 EXISTING 5' CONTOUR
- 5401 EXISTING 1' CONTOUR
- SD PROPOSED STORM LINE
- XSD EXISTING STORM LINE
- PROPOSED SAWCUT
- PROPOSED STORM INLET
- EXISTING STORM INLET
- FLOW DIRECTION
- 25.25 PROPOSED SPOT GRADE
- 25.25 EXISTING SPOT GRADE
- 2.00% SLOPE AND DIRECTION
- HP HIGH POINT
- LP LOW POINT
- GB GRADE BREAK

NOTES:

1. ALL ELEVATION SPOTS ALONG CURB INDICATE FLOWLINE ELEVATION UNLESS OTHERWISE INDICATED.
2. PROPOSED ACCESSIBLE PARKING SPOTS SHALL HAVE 2.0% MAX SLOPE IN ANY DIRECTION.



BLOCK RETAINING WALL DETAIL
N.T.S.



SCALE: 1" = 20'

REVISIONS

08/19/2021	1ST SIP SUBMITTAL
09/22/2021	2ND SIP SUBMITTAL

DATE:	09.22.2021
SCALE:	AS SHOWN
DRAWN BY:	WBP
CHECKED BY:	TAL

HOVER ARCHITECTURE
385 INVERNESS PKWY, STE 190
ENGLEWOOD, CO 80112
(720) 773-2800

PROJECT NUMBER
1202.28

SHEET
8 OF 17

GRADING PLAN