STORMWATER QUALITY REPORT
ORTEGA PARK PUBLIC IMPROVEMENTS

ORTEGA PARK, SANTA BARBARA, CA

February 27, 2020

PREPARED FOR:
City of Santa Barbara, Parks and Recreation

PREPARED BY:
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rrm design group

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PURPOSE OF REPORT

The purpose of this report is to assess the project site and identify storm water quality facilities to meet the requirements of the City of Santa Barbara's Storm Water BMP Guidance Manual. The proposed right-of-way improvements include removal and replacement of existing hardscapes, and construction of new parking stalls and sidewalk.

LOCATION

This project consists of approximately 1,500 lineal feet of public improvements along the Ortega Park frontages of East Ortega Street, North Salsipuedes Street and East Cota Street. See the project vicinity map in Figure 1 below.

Figure 1. Project Vicinity Map

BACKGROUND

The proposed improvements will occur in the public right-of-way on Ortega Street, Salsipuedes Street and Cota Street. Each street currently has a 60-foot right-of-way and a 36-foot curb-to-curb distance. The proposed Cota Street improvements consist of removal and replacement of existing sidewalk, curb and gutter to remediate accessibility and drainage issues due to uplifting from tree roots. The subgrade beneath these improvements will remain undisturbed. Therefore, this portion of the project is exempt from stormwater quality requirements under the maintenance provision of Appendix J of the City's BMP Guidance Manual.

The proposed improvements include the addition of back-in angled parking and new sidewalk on Ortega Street, 90° head-in parking and new sidewalk on Salsipuedes Street, and bulb-outs at the intersection of Salsipuedes and Cota Streets.

Slopes on the majority of the site are approximately 2-4% percent. Ortega Street has a mid-block high point with the northern half draining to an inlet on Quarantina Street and the southern half draining to the south. Runoff from the southern portion of Ortega, along with runoff from Salsipuedes Street, drains to an inlet on Cota Street at the intersection with Salsipuedes Street. The drainage boundary for this analysis will be from the street centerlines on Ortega and Salsipuedes Streets to the back of the proposed right-of-way improvements along the Ortega Park frontage. The drainage boundary is depicted on the Existing Hydrology Map, Exhibit A.

METHOD OF ANALYSIS

The approach to analyze the runoff from the project site follows the City of Santa Barbara's Storm Water BMP Guidance Manual. The analysis is a comparison of the pre-project condition to the post-project condition for both hydrologic analysis and storm water quality.

The proposed project will increase the impervious area at the site from 53.9% to approximately 64.0%. See the Proposed Hydrology Map, Exhibit B and the Drainage Area Summary, Attachment 2. Table 1 provides a summary of the proposed changes in impervious area. This increase in impervious area will cause an increase in the amount of storm water peak runoff from the site, requiring BMP's to be designed to both retain and detain storm water as outlined in the City's BMP Guidance Manual.

Table 1. Changes in Impervious Area

Proposed Area	Definition	Area (SF)
New Impervious	Area where new impervious area (hardscape, roof, etc.) is proposed where there is existing pervious area (landscaping, etc.)	18,949
Replaced Impervious	Area where new impervious area (hardscape, roof, etc.) is proposed where there is currently existing impervious area (hardscape, roof, etc.)	7,971
Removed Impervious	Area where new pervious area (landscaping, etc.) is proposed where there is currently existing pervious area (landscaping, etc.)	4,368

Proposed Drainage Management Areas

The proposed project site has been divided into five drainage management areas (DMAs):

- Runoff from DMA 'A' will flow to permeable pavement for infiltration and treatment. Runoff from proposed sidewalk will flow overland onto permeable pavement while runoff from the existing asphalt will flow into an inlet which will direct runoff to gravel storage beneath the proposed permeable pavements. Overflow will continue to flow along the gutter to the existing curb inlet on Quarantina Street.
- Runoff from DMA 'B' will flow to permeable pavement for infiltration and treatment. Runoff from proposed sidewalk will flow overland onto permeable pavement while runoff from the existing asphalt will flow into an inlet which will direct runoff to gravel storage beneath the proposed permeable pavements. Overflow will continue to flow along the gutter to the existing inlet on Cota Street.
- Runoff from DMA 'C will flow from the proposed curb and gutter into bioretention areas for treatment. Overflow from the bioretention areas will continue to flow into proposed curb inlets.
- Runoff from DMA 'D' will flow from the proposed curb and gutter into bioretention areas for treatment. Overflow from the bioretention areas will continue to flow into proposed curb inlets.
- Runoff from DMA 'E' will flow in the curb and gutter on Cota into the curb inlet at the north corner of the Cota and Salsipuedes Streets intersection without treatment. This DMA totals 66 SF, or 0.1% of the total project area.

Infiltration Testing

Infiltration testing for the site was performed in February of 2019 by Earth Systems Pacific. Four infiltration borings were hand-excavated throughout the site to depths varying from 2.5 to 3.5 feet. Two of the four test borings were not tested for infiltration rates due to encountered shallow groundwater. The remaining two borings yielded infiltration rates of 0.6 and 1.4 inches per hour. See Infiltration Testing Report, Attachment 3.

PEAK RUNOFF DISCHARGE RATE

The post-project peak flow of runoff is reduced to below that of the pre-project for the 2-year through 25-year storm events through the use of permeable pavement. The program HydroCAD was used to determine the volume of runoff and the peak flow of runoff from the project site for various storm events for both pre- and post-project conditions, see HydroCAD output in Attachment 1. The results are summarized in Table 2.

Table 2. Peak Flow Summary

Storm Event	Peak Flows (CFS)	
	Existing	Proposed
2-year	1.09	1.09
5-year	1.74	1.71
10-year	2.18	2.14
25-year	2.73	2.68

VOLUME REDUCTION

Per the City's BMP Guidance Manual, the project is required to retain on-site the volume difference between pre- and post-development conditions for the 25-year storm or the one-inch storm, whichever is larger. For this project the one-inch storm event volume difference of 1,612 ft^3 is larger as seen in Table 3 below. Retention is provided by the proposed permeable pavement, see Table 4. Calculations are provided in Attachment 2. Exhibit 3 provides BMP Cross-Section Details.

Table 3. Runoff Volume Summary

Storm Event	Runoff Volume (CF) *(Before Retention)*	
	Existing	Proposed
1-inch	1,443	1,612
2-year	6,881	6,942
5-year	10,823	10,770
10-year	13,531	13,405
25-year	16,917	16,716

Table 4. Volume Retention Summary

Retention BMP	Depth of Gravel Storage (in)	Area of Storage (SF)	Provided Retention Volume (CF)
Permeable Pavement	12	11,002	3,961
Total			**3,961**

STORM WATER QUALITY

The City of Santa Barbara Storm Water BMP Guidance Manual was used to design storm water quality features throughout the site to treat the one-inch 24-hour storm. See calculations in Attachment 2 and a summary in Table 1. Bioretention areas are proposed in the landscape planters for treatment. See Exhibit 3 for BMP Cross-Section Details.

Table 1. Storm Water Quality Summary

DMA	Treatment BMP	Water Quality Design Volume (CF)	Required Treatment Area (SF)	Provided Treatment Area (SF)	Provided Treatment Volume (CF)
A	Permeable Pavement	396	1,100	3,377	1,216
B	Permeable Pavement	1,138	3,161	7,625	2,745
C	Bioretention	33	31	31	33
D	Bioretention	41	38	38	41
E	Untreated	4	-	-	-

CONCLUSIONS

Based on the findings of this report, the proposed drainage design for this project meets the applicable standards and requirements for the City of Santa Barbara. The proposed drainage plan is consistent with the City's Storm Water Management Program (SWMP) design criteria for development. In summary, the proposed design:

- Reduces the post-development peak flow of runoff to below the pre-development rate for the 2- through 25-year storm events
- Reduces the post-development volume of runoff to below the pre-development rate for the 2- through 25-year storm events
- Treats the runoff from the site for the 1-inch 24-hour storm event.

EXHIBITS

EXHIBIT 1

EXISTING CONDITION HYDROLOGY MAP

QUARANTINA STREET

EXISTING CURB INLET

ORTEGA STREET

COTA STREET

SALSIPUEDES STREET

STOP

A

B

C

D

EXISTING CURB INLET

LEGEND

DRAINAGE AREA BOUNDARY

SURFACE FLOW DIRECTION

DRAINAGE AREA NAME

HATCH LEGEND

DESIGNATION	FACILITY	AREA (SF)
	EXISTING IMPERVIOUS	22,663 (53.9%)
	LANDSCAPE	19,368
	TOTAL AREA	42,031

N:\1000\114402.RC1&2\Ortega Park-Dwight Murphy Field\Civil Docs\Engineering\CivilDocs\Hyatt\Exhibits\Existing.dwg, Existing, Feb 26, 2020 11:40am, ADWest

ORTEGA PARK
PUBLIC IMPROVEMENTS

EXISTING DRAINAGE AREA MAP

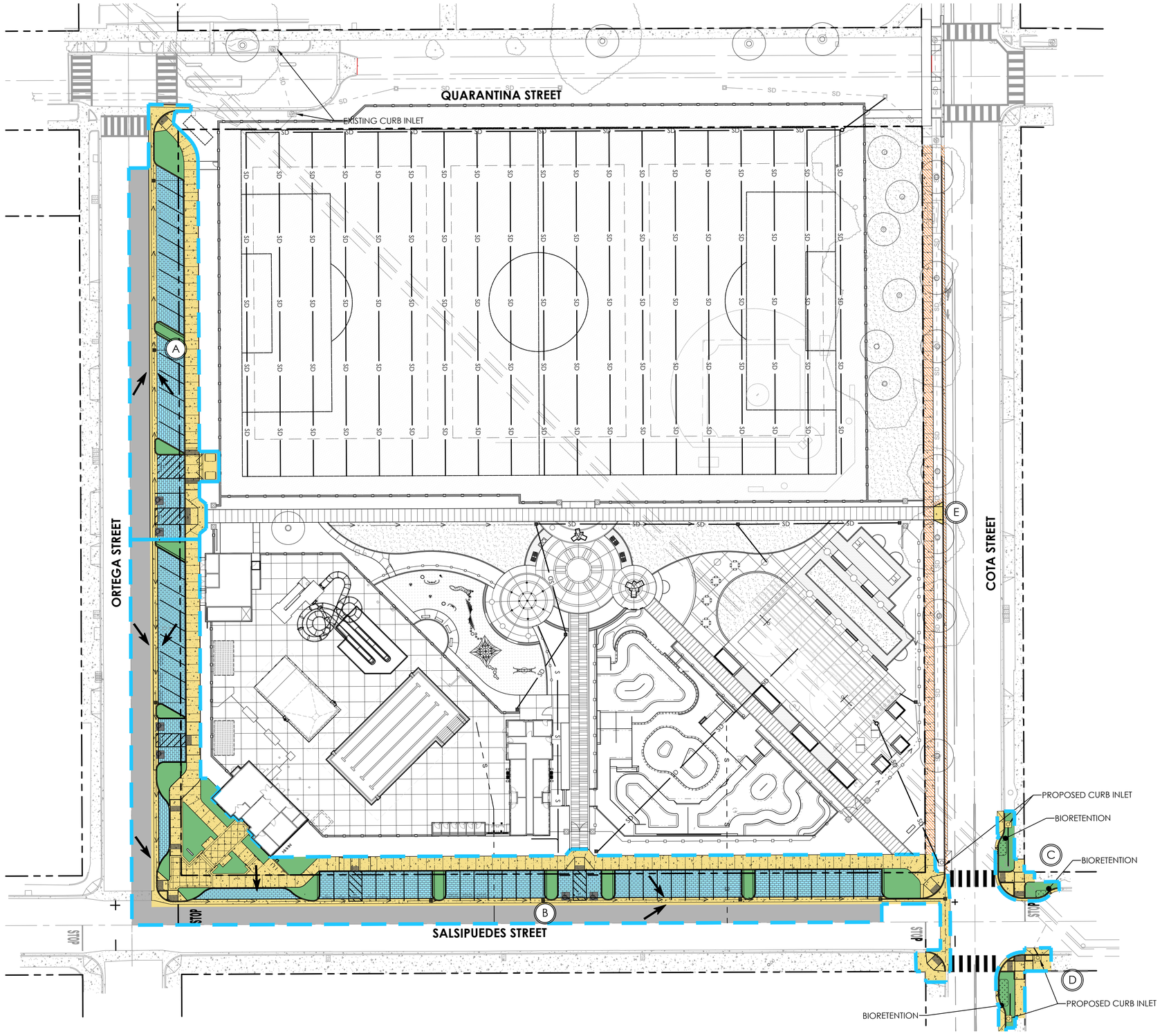
FEBRUARY 25, 2020

SCALE: 1"=30'

rrm design group

EXHIBIT 2

PROPOSED CONDITION HYDROLOGY MAP



LEGEND

- DRAINAGE AREA BOUNDARY
- SURFACE FLOW DIRECTION
- (A) DRAINAGE AREA NAME

HATCH LEGEND

DESIGNATION	FACILITY	AREA (SF)
	NEW/REPLACED IMPERVIOUS AREA	16,544
	EXISTING IMPERVIOUS	10,376
	LANDSCAPE	4,109
	PERMEABLE PAVEMENT	11,002
	BIORETENTION	
	PAVEMENT MAINTENANCE AREA	
	TOTAL IMPERVIOUS	**26,920 (64.0%)**

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ORTEGA PARK PUBLIC IMPROVEMENTS

PROPOSED DRAINAGE AREA MAP

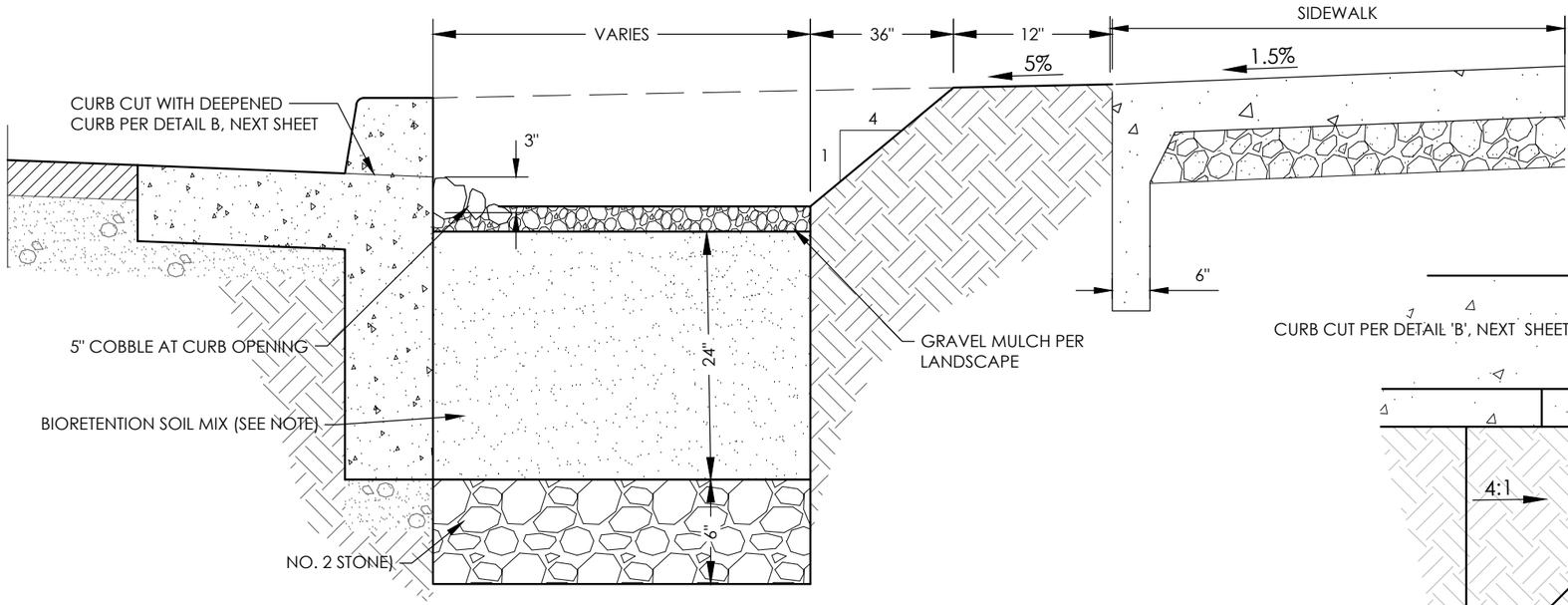
FEBRUARY 26, 2020
SCALE: 1"=30'

rrm design group

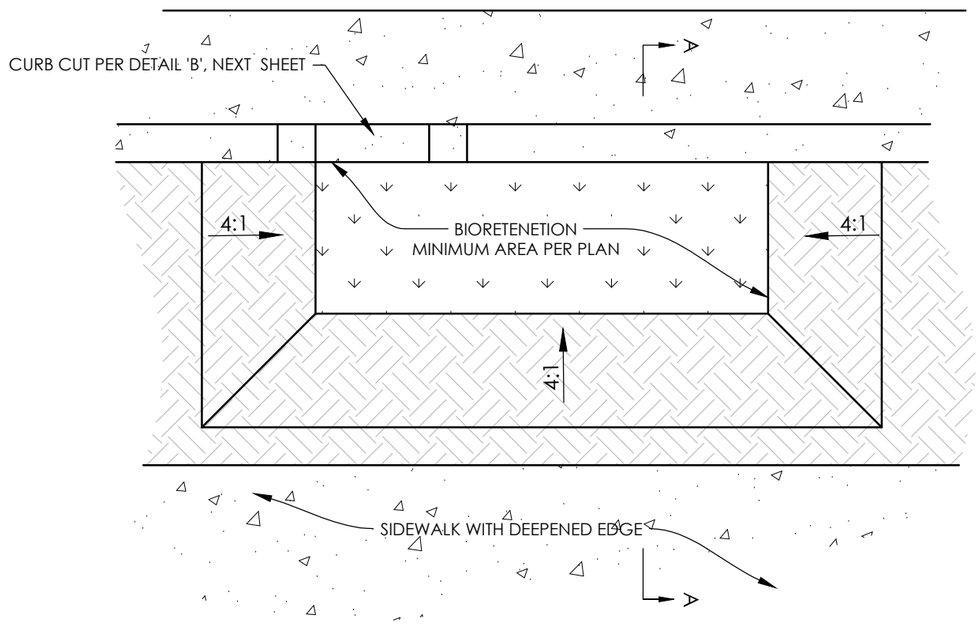
EXHIBIT 3

BMP CROSS-SECTION DETAILS

ATTACHMENTS



SECTION A-A

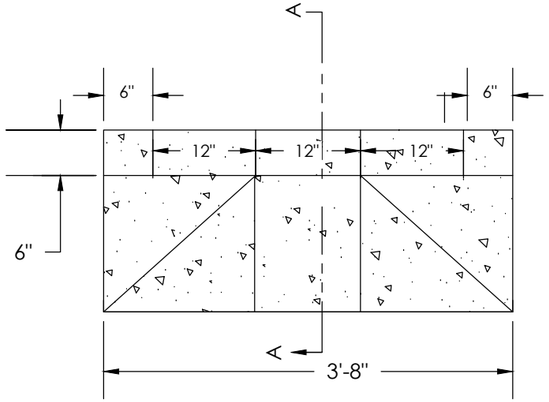


PLAN

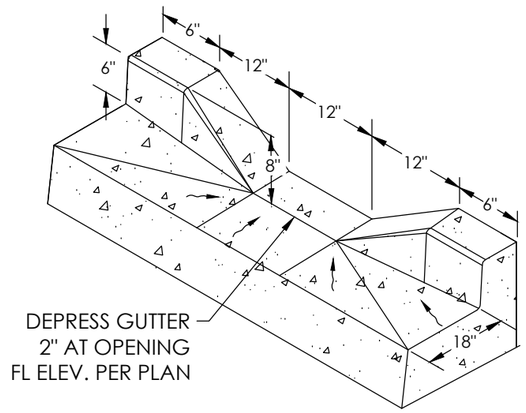
NOTES:

1. OVER-EXCAVATE 1.0' BELOW INFILTRATION BOTTOM AND REPLACED UNIFORMLY WITHOUT COMPACTION.
2. ALL STONE MATERIAL SHALL BE WASHED, OPEN-GRADED (NO SAND), CRUSHED (ANGULAR) AGGREGATE.
3. BIORETENTION SOIL MIX SHALL BE 60 TO 70% SAND, 15 TO 25% COMPOST, AND 10 TO 20% CLEAN TOPSOIL. THE ORGANIC CONTENT SHALL BE 8 TO12% AND PH RANGE SHALL BE 5.5 TO 7.5.
4. EXTEND DEEPENED CURB AND SIDEWALK EDGE 5' BEYOND BOTH SIDES OF BIORETENTION AREA.

B PARKWAY BIORETENTION
SCALE: N.T.S.



PLAN



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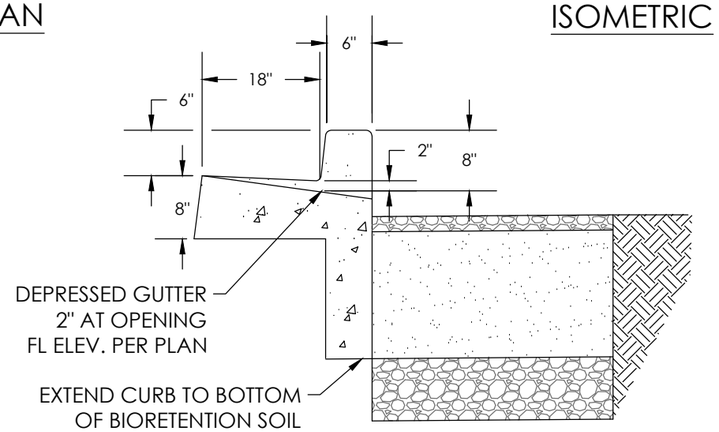
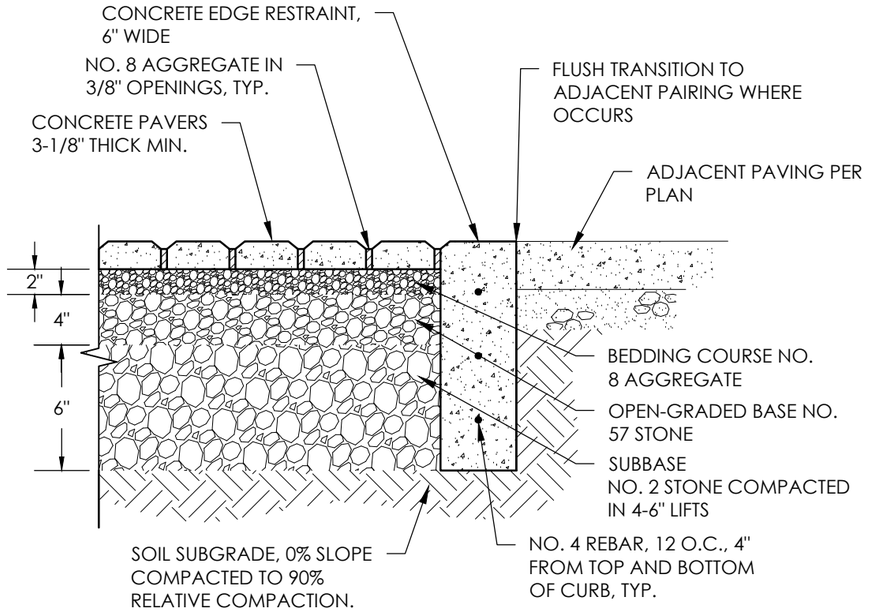


SECTION A-A

ADJACENT TO BIORETENTION

B CURB CUT

SCALE: N.T.S.



NOTES:

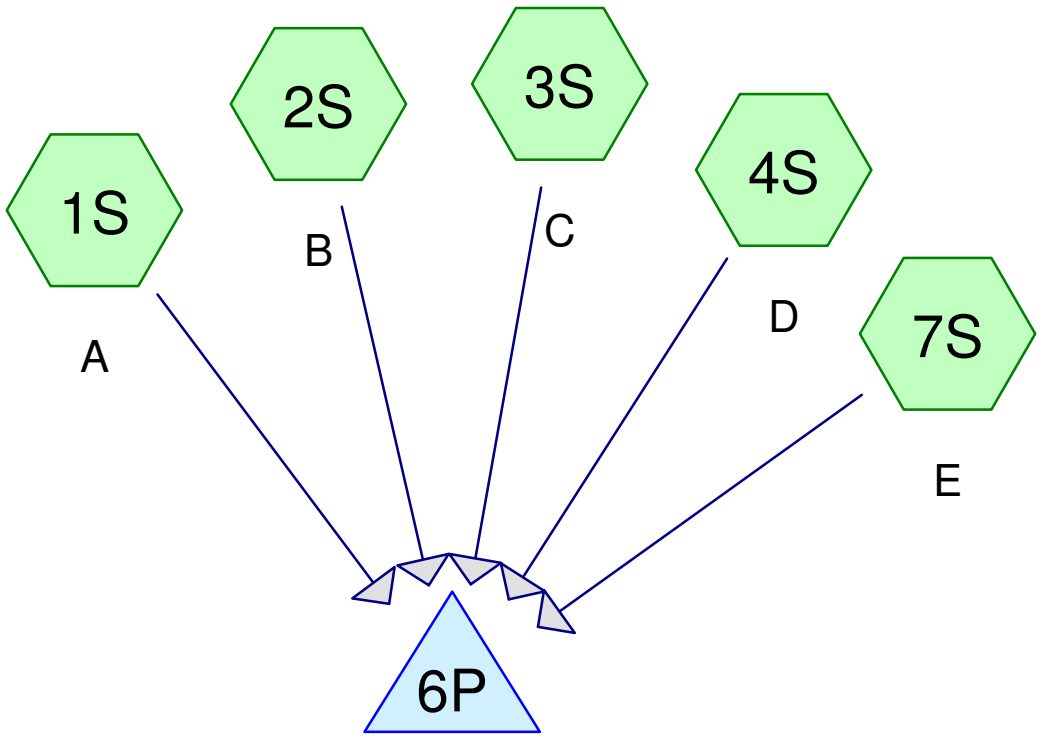
1. ALL AGGREGATE BASE MATERIAL SHALL BE WASHED, OPEN-GRADED (NO SAND), CRUSHED (ANGULAR) AGGREGATE.

C PERMEABLE PAVEMENT

SCALE: N.T.S.

ATTACHMENT 1

HYDROCAD OUTPUT



Total

Subcat Reach Pond Link

Routing Diagram for Existing
Prepared by RRM Design Group, Printed 2/27/2020

Summary for Subcatchment 1S: A

Runoff = 0.05 cfs @ 10.02 hrs, Volume= 324 cf, Depth> 0.36"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 1-inch Rainfall=1.00"

	Area (sf)	CN	Description
	4,964	98	Paved parking, HSG D
*	5,700	80	>75% Grass cover, Good, HSG D
	10,664	88	Weighted Average
	5,700	80	53.45% Pervious Area
	4,964	98	46.55% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 2S: B

Runoff = 0.16 cfs @ 10.02 hrs, Volume= 1,022 cf, Depth> 0.42"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 1-inch Rainfall=1.00"

Area (sf)	CN	Description
16,093	98	Paved parking, HSG D
13,348	80	>75% Grass cover, Good, HSG D
29,441	90	Weighted Average
13,348	80	45.34% Pervious Area
16,093	98	54.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 3S: C

Runoff = 0.01 cfs @ 10.02 hrs, Volume= 44 cf, Depth> 0.56"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 1-inch Rainfall=1.00"

Area (sf)	CN	Description
723	98	Paved parking, HSG D
216	80	>75% Grass cover, Good, HSG D
939	94	Weighted Average
216	80	23.00% Pervious Area
723	98	77.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 4S: D

Runoff = 0.01 cfs @ 10.02 hrs, Volume= 53 cf, Depth> 0.69"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 1-inch Rainfall=1.00"

Area (sf)	CN	Description
888	98	Paved parking, HSG D
33	80	>75% Grass cover, Good, HSG D
921	97	Weighted Average
33	80	3.58% Pervious Area
888	98	96.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 7S: E

Runoff = 0.00 cfs @ 12.69 hrs, Volume= 0 cf, Depth> 0.06"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 1-inch Rainfall=1.00"

Area (sf)	CN	Description
66	80	>75% Grass cover, Good, HSG D
66	80	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Pond 6P: Total

Inflow Area = 42,031 sf, 53.93% Impervious, Inflow Depth > 0.41" for 1-inch event
Inflow = 0.22 cfs @ 10.02 hrs, Volume= 1,443 cf
Primary = 0.22 cfs @ 10.02 hrs, Volume= 1,443 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs

Summary for Subcatchment 1S: A

Runoff = 0.26 cfs @ 10.02 hrs, Volume= 1,656 cf, Depth> 1.86"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 2-year Rainfall=3.20"

	Area (sf)	CN	Description
	4,964	98	Paved parking, HSG D
*	5,700	80	>75% Grass cover, Good, HSG D
	10,664	88	Weighted Average
	5,700	80	53.45% Pervious Area
	4,964	98	46.55% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 2S: B

Runoff = 0.77 cfs @ 10.02 hrs, Volume= 4,844 cf, Depth> 1.97"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 2-year Rainfall=3.20"

Area (sf)	CN	Description
16,093	98	Paved parking, HSG D
13,348	80	>75% Grass cover, Good, HSG D
29,441	90	Weighted Average
13,348	80	45.34% Pervious Area
16,093	98	54.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 3S: C

Runoff = 0.03 cfs @ 10.02 hrs, Volume= 178 cf, Depth> 2.28"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 2-year Rainfall=3.20"

Area (sf)	CN	Description
723	98	Paved parking, HSG D
216	80	>75% Grass cover, Good, HSG D
939	94	Weighted Average
216	80	23.00% Pervious Area
723	98	77.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 4S: D

Runoff = 0.03 cfs @ 10.02 hrs, Volume= 195 cf, Depth> 2.55"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 2-year Rainfall=3.20"

Area (sf)	CN	Description
888	98	Paved parking, HSG D
33	80	>75% Grass cover, Good, HSG D
921	97	Weighted Average
33	80	3.58% Pervious Area
888	98	96.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 7S: E

Runoff = 0.00 cfs @ 10.03 hrs, Volume= 7 cf, Depth> 1.23"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 2-year Rainfall=3.20"

Area (sf)	CN	Description
66	80	>75% Grass cover, Good, HSG D
66	80	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Pond 6P: Total

Inflow Area = 42,031 sf, 53.93% Impervious, Inflow Depth > 1.96" for 2-year event
Inflow = 1.09 cfs @ 10.02 hrs, Volume= 6,881 cf
Primary = 1.09 cfs @ 10.02 hrs, Volume= 6,881 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs

Summary for Subcatchment 1S: A

Runoff = 0.43 cfs @ 10.02 hrs, Volume= 2,647 cf, Depth> 2.98"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 5-Year Rainfall=4.61"

	Area (sf)	CN	Description
	4,964	98	Paved parking, HSG D
*	5,700	80	>75% Grass cover, Good, HSG D
	10,664	88	Weighted Average
	5,700	80	53.45% Pervious Area
	4,964	98	46.55% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 2S: B

Runoff = 1.22 cfs @ 10.02 hrs, Volume= 7,608 cf, Depth> 3.10"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 5-Year Rainfall=4.61"

Area (sf)	CN	Description
16,093	98	Paved parking, HSG D
13,348	80	>75% Grass cover, Good, HSG D
29,441	90	Weighted Average
13,348	80	45.34% Pervious Area
16,093	98	54.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 3S: C

Runoff = 0.04 cfs @ 10.02 hrs, Volume= 269 cf, Depth> 3.44"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 5-Year Rainfall=4.61"

Area (sf)	CN	Description
723	98	Paved parking, HSG D
216	80	>75% Grass cover, Good, HSG D
939	94	Weighted Average
216	80	23.00% Pervious Area
723	98	77.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 4S: D

Runoff = 0.05 cfs @ 10.02 hrs, Volume= 287 cf, Depth> 3.73"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 5-Year Rainfall=4.61"

Area (sf)	CN	Description
888	98	Paved parking, HSG D
33	80	>75% Grass cover, Good, HSG D
921	97	Weighted Average
33	80	3.58% Pervious Area
888	98	96.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 7S: E

Runoff = 0.00 cfs @ 10.03 hrs, Volume= 12 cf, Depth> 2.27"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 5-Year Rainfall=4.61"

Area (sf)	CN	Description
66	80	>75% Grass cover, Good, HSG D
66	80	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Pond 6P: Total

Inflow Area = 42,031 sf, 53.93% Impervious, Inflow Depth > 3.09" for 5-Year event
Inflow = 1.74 cfs @ 10.02 hrs, Volume= 10,823 cf
Primary = 1.74 cfs @ 10.02 hrs, Volume= 10,823 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs

Summary for Subcatchment 1S: A

Runoff = 0.54 cfs @ 10.02 hrs, Volume= 3,331 cf, Depth> 3.75"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 10-Year Rainfall=5.55"

	Area (sf)	CN	Description
	4,964	98	Paved parking, HSG D
*	5,700	80	>75% Grass cover, Good, HSG D
	10,664	88	Weighted Average
	5,700	80	53.45% Pervious Area
	4,964	98	46.55% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 2S: B

Runoff = 1.53 cfs @ 10.02 hrs, Volume= 9,506 cf, Depth> 3.87"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 10-Year Rainfall=5.55"

Area (sf)	CN	Description
16,093	98	Paved parking, HSG D
13,348	80	>75% Grass cover, Good, HSG D
29,441	90	Weighted Average
13,348	80	45.34% Pervious Area
16,093	98	54.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 3S: C

Runoff = 0.05 cfs @ 10.02 hrs, Volume= 330 cf, Depth> 4.22"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 10-Year Rainfall=5.55"

Area (sf)	CN	Description
723	98	Paved parking, HSG D
216	80	>75% Grass cover, Good, HSG D
939	94	Weighted Average
216	80	23.00% Pervious Area
723	98	77.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 4S: D

Runoff = 0.06 cfs @ 10.02 hrs, Volume= 347 cf, Depth> 4.52"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 10-Year Rainfall=5.55"

Area (sf)	CN	Description
888	98	Paved parking, HSG D
33	80	>75% Grass cover, Good, HSG D
921	97	Weighted Average
33	80	3.58% Pervious Area
888	98	96.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 7S: E

Runoff = 0.00 cfs @ 10.03 hrs, Volume= 17 cf, Depth> 3.02"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 10-Year Rainfall=5.55"

Area (sf)	CN	Description
66	80	>75% Grass cover, Good, HSG D
66	80	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Pond 6P: Total

Inflow Area = 42,031 sf, 53.93% Impervious, Inflow Depth > 3.86" for 10-Year event
Inflow = 2.18 cfs @ 10.02 hrs, Volume= 13,531 cf
Primary = 2.18 cfs @ 10.02 hrs, Volume= 13,531 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs

Summary for Subcatchment 1S: A

Runoff = 0.68 cfs @ 10.02 hrs, Volume= 4,189 cf, Depth> 4.71"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 25-Year Rainfall=6.71"

	Area (sf)	CN	Description
	4,964	98	Paved parking, HSG D
*	5,700	80	>75% Grass cover, Good, HSG D
	10,664	88	Weighted Average
	5,700	80	53.45% Pervious Area
	4,964	98	46.55% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 2S: B

Runoff = 1.92 cfs @ 10.02 hrs, Volume= 11,878 cf, Depth> 4.84"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 25-Year Rainfall=6.71"

Area (sf)	CN	Description
16,093	98	Paved parking, HSG D
13,348	80	>75% Grass cover, Good, HSG D
29,441	90	Weighted Average
13,348	80	45.34% Pervious Area
16,093	98	54.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 3S: C

Runoff = 0.07 cfs @ 10.02 hrs, Volume= 406 cf, Depth> 5.19"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 25-Year Rainfall=6.71"

Area (sf)	CN	Description
723	98	Paved parking, HSG D
216	80	>75% Grass cover, Good, HSG D
939	94	Weighted Average
216	80	23.00% Pervious Area
723	98	77.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 4S: D

Runoff = 0.07 cfs @ 10.02 hrs, Volume= 422 cf, Depth> 5.50"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 25-Year Rainfall=6.71"

Area (sf)	CN	Description
888	98	Paved parking, HSG D
33	80	>75% Grass cover, Good, HSG D
921	97	Weighted Average
33	80	3.58% Pervious Area
888	98	96.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 7S: E

Runoff = 0.00 cfs @ 10.02 hrs, Volume= 22 cf, Depth> 3.98"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 25-Year Rainfall=6.71"

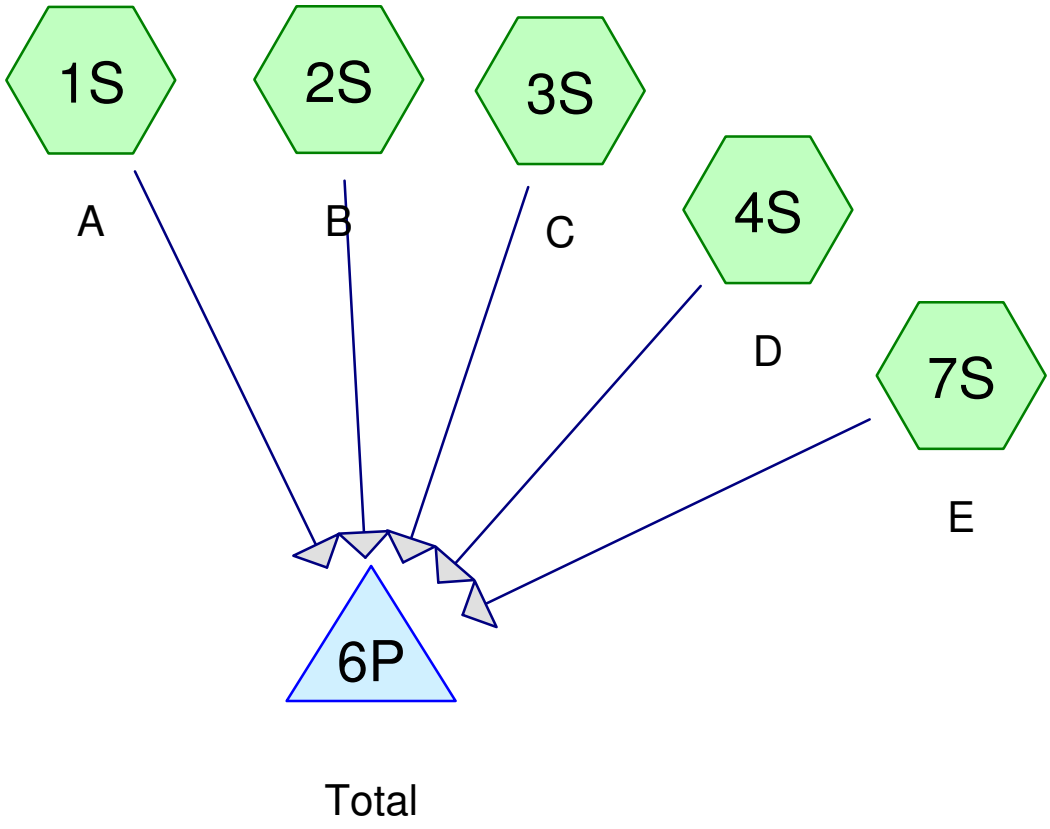
Area (sf)	CN	Description
66	80	>75% Grass cover, Good, HSG D
66	80	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Pond 6P: Total

Inflow Area = 42,031 sf, 53.93% Impervious, Inflow Depth > 4.83" for 25-Year event
Inflow = 2.73 cfs @ 10.02 hrs, Volume= 16,917 cf
Primary = 2.73 cfs @ 10.02 hrs, Volume= 16,917 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs



Subcat Reach Pond Link

Routing Diagram for Proposed
Prepared by RRM Design Group, Printed 2/27/2020

Summary for Subcatchment 1S: A

Runoff = 0.06 cfs @ 10.02 hrs, Volume= 396 cf, Depth> 0.45"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 1-inch Rainfall=1.00"

	Area (sf)	CN	Description
	6,639	98	Paved parking, HSG D
	648	80	>75% Grass cover, Good, HSG D
*	3,377	72	Permeable Pavement
	10,664	89	Weighted Average
	4,025	73	37.74% Pervious Area
	6,639	98	62.26% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 2S: B

Runoff = 0.19 cfs @ 10.02 hrs, Volume= 1,138 cf, Depth> 0.46"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 1-inch Rainfall=1.00"

	Area (sf)	CN	Description
	19,028	98	Paved parking, HSG D
	2,788	80	>75% Grass cover, Good, HSG D
*	7,625	72	Permeable Pavement
	29,441	90	Weighted Average
	10,413	74	35.37% Pervious Area
	19,028	98	64.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 3S: C

Runoff = 0.01 cfs @ 10.02 hrs, Volume= 33 cf, Depth> 0.42"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 1-inch Rainfall=1.00"

Area (sf)	CN	Description
517	98	Paved parking, HSG D
422	80	>75% Grass cover, Good, HSG D
939	90	Weighted Average
422	80	44.94% Pervious Area
517	98	55.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 4S: D

Runoff = 0.01 cfs @ 10.02 hrs, Volume= 41 cf, Depth> 0.53"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 1-inch Rainfall=1.00"

Area (sf)	CN	Description
670	98	Paved parking, HSG D
251	80	>75% Grass cover, Good, HSG D
921	93	Weighted Average
251	80	27.25% Pervious Area
670	98	72.75% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 7S: E

Runoff = 0.00 cfs @ 10.02 hrs, Volume= 4 cf, Depth> 0.71"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 1-inch Rainfall=1.00"

Area (sf)	CN	Description
66	98	Paved parking, HSG D
66	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 1S: A

Runoff = 0.27 cfs @ 10.02 hrs, Volume= 1,717 cf, Depth> 1.93"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 2-year Rainfall=3.20"

	Area (sf)	CN	Description
	6,639	98	Paved parking, HSG D
	648	80	>75% Grass cover, Good, HSG D
*	3,377	72	Permeable Pavement
	10,664	89	Weighted Average
	4,025	73	37.74% Pervious Area
	6,639	98	62.26% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 2S: B

Runoff = 0.77 cfs @ 10.02 hrs, Volume= 4,885 cf, Depth> 1.99"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 2-year Rainfall=3.20"

	Area (sf)	CN	Description
	19,028	98	Paved parking, HSG D
	2,788	80	>75% Grass cover, Good, HSG D
*	7,625	72	Permeable Pavement
	29,441	90	Weighted Average
	10,413	74	35.37% Pervious Area
	19,028	98	64.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 3S: C

Runoff = 0.02 cfs @ 10.02 hrs, Volume= 155 cf, Depth> 1.98"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 2-year Rainfall=3.20"

Area (sf)	CN	Description
517	98	Paved parking, HSG D
422	80	>75% Grass cover, Good, HSG D
939	90	Weighted Average
422	80	44.94% Pervious Area
517	98	55.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 4S: D

Runoff = 0.03 cfs @ 10.02 hrs, Volume= 171 cf, Depth> 2.22"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 2-year Rainfall=3.20"

Area (sf)	CN	Description
670	98	Paved parking, HSG D
251	80	>75% Grass cover, Good, HSG D
921	93	Weighted Average
251	80	27.25% Pervious Area
670	98	72.75% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 7S: E

Runoff = 0.00 cfs @ 10.02 hrs, Volume= 14 cf, Depth> 2.59"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 2-year Rainfall=3.20"

Area (sf)	CN	Description
66	98	Paved parking, HSG D
66	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Pond 6P: Total

Inflow Area = 42,031 sf, 64.05% Impervious, Inflow Depth > 1.98" for 2-year event
Inflow = 1.09 cfs @ 10.02 hrs, Volume= 6,942 cf
Primary = 1.09 cfs @ 10.02 hrs, Volume= 6,942 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs

Summary for Subcatchment 1S: A

Runoff = 0.42 cfs @ 10.02 hrs, Volume= 2,676 cf, Depth> 3.01"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 5-Year Rainfall=4.61"

	Area (sf)	CN	Description
	6,639	98	Paved parking, HSG D
	648	80	>75% Grass cover, Good, HSG D
*	3,377	72	Permeable Pavement
	10,664	89	Weighted Average
	4,025	73	37.74% Pervious Area
	6,639	98	62.26% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 2S: B

Runoff = 1.21 cfs @ 10.02 hrs, Volume= 7,571 cf, Depth> 3.09"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 5-Year Rainfall=4.61"

	Area (sf)	CN	Description
	19,028	98	Paved parking, HSG D
	2,788	80	>75% Grass cover, Good, HSG D
*	7,625	72	Permeable Pavement
	29,441	90	Weighted Average
	10,413	74	35.37% Pervious Area
	19,028	98	64.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 3S: C

Runoff = 0.04 cfs @ 10.02 hrs, Volume= 243 cf, Depth> 3.11"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 5-Year Rainfall=4.61"

Area (sf)	CN	Description
517	98	Paved parking, HSG D
422	80	>75% Grass cover, Good, HSG D
939	90	Weighted Average
422	80	44.94% Pervious Area
517	98	55.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 4S: D

Runoff = 0.04 cfs @ 10.02 hrs, Volume= 259 cf, Depth> 3.38"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 5-Year Rainfall=4.61"

Area (sf)	CN	Description
670	98	Paved parking, HSG D
251	80	>75% Grass cover, Good, HSG D
921	93	Weighted Average
251	80	27.25% Pervious Area
670	98	72.75% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 7S: E

Runoff = 0.00 cfs @ 10.02 hrs, Volume= 21 cf, Depth> 3.79"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 5-Year Rainfall=4.61"

Area (sf)	CN	Description
66	98	Paved parking, HSG D
66	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Pond 6P: Total

Inflow Area = 42,031 sf, 64.05% Impervious, Inflow Depth > 3.07" for 5-Year event
Inflow = 1.71 cfs @ 10.02 hrs, Volume= 10,770 cf
Primary = 1.71 cfs @ 10.02 hrs, Volume= 10,770 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs

Summary for Subcatchment 1S: A

Runoff = 0.53 cfs @ 10.02 hrs, Volume= 3,339 cf, Depth> 3.76"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 10-Year Rainfall=5.55"

	Area (sf)	CN	Description
	6,639	98	Paved parking, HSG D
	648	80	>75% Grass cover, Good, HSG D
*	3,377	72	Permeable Pavement
	10,664	89	Weighted Average
	4,025	73	37.74% Pervious Area
	6,639	98	62.26% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 2S: B

Runoff = 1.51 cfs @ 10.02 hrs, Volume= 9,419 cf, Depth> 3.84"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 10-Year Rainfall=5.55"

	Area (sf)	CN	Description
	19,028	98	Paved parking, HSG D
	2,788	80	>75% Grass cover, Good, HSG D
*	7,625	72	Permeable Pavement
	29,441	90	Weighted Average
	10,413	74	35.37% Pervious Area
	19,028	98	64.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 3S: C

Runoff = 0.05 cfs @ 10.02 hrs, Volume= 304 cf, Depth> 3.88"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 10-Year Rainfall=5.55"

Area (sf)	CN	Description
517	98	Paved parking, HSG D
422	80	>75% Grass cover, Good, HSG D
939	90	Weighted Average
422	80	44.94% Pervious Area
517	98	55.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 4S: D

Runoff = 0.05 cfs @ 10.02 hrs, Volume= 319 cf, Depth> 4.16"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 10-Year Rainfall=5.55"

Area (sf)	CN	Description
670	98	Paved parking, HSG D
251	80	>75% Grass cover, Good, HSG D
921	93	Weighted Average
251	80	27.25% Pervious Area
670	98	72.75% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 7S: E

Runoff = 0.00 cfs @ 10.02 hrs, Volume= 25 cf, Depth> 4.58"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 10-Year Rainfall=5.55"

Area (sf)	CN	Description
66	98	Paved parking, HSG D
66	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Pond 6P: Total

Inflow Area = 42,031 sf, 64.05% Impervious, Inflow Depth > 3.83" for 10-Year event
Inflow = 2.14 cfs @ 10.02 hrs, Volume= 13,405 cf
Primary = 2.14 cfs @ 10.02 hrs, Volume= 13,405 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs

Summary for Subcatchment 1S: A

Runoff = 0.67 cfs @ 10.02 hrs, Volume= 4,173 cf, Depth> 4.70"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 25-Year Rainfall=6.71"

	Area (sf)	CN	Description
	6,639	98	Paved parking, HSG D
	648	80	>75% Grass cover, Good, HSG D
*	3,377	72	Permeable Pavement
	10,664	89	Weighted Average
	4,025	73	37.74% Pervious Area
	6,639	98	62.26% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 2S: B

Runoff = 1.88 cfs @ 10.02 hrs, Volume= 11,739 cf, Depth> 4.78"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 25-Year Rainfall=6.71"

	Area (sf)	CN	Description
	19,028	98	Paved parking, HSG D
	2,788	80	>75% Grass cover, Good, HSG D
*	7,625	72	Permeable Pavement
	29,441	90	Weighted Average
	10,413	74	35.37% Pervious Area
	19,028	98	64.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 3S: C

Runoff = 0.06 cfs @ 10.02 hrs, Volume= 379 cf, Depth> 4.85"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 25-Year Rainfall=6.71"

Area (sf)	CN	Description
517	98	Paved parking, HSG D
422	80	>75% Grass cover, Good, HSG D
939	90	Weighted Average
422	80	44.94% Pervious Area
517	98	55.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 4S: D

Runoff = 0.06 cfs @ 10.02 hrs, Volume= 393 cf, Depth> 5.13"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 25-Year Rainfall=6.71"

Area (sf)	CN	Description
670	98	Paved parking, HSG D
251	80	>75% Grass cover, Good, HSG D
921	93	Weighted Average
251	80	27.25% Pervious Area
670	98	72.75% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Subcatchment 7S: E

Runoff = 0.00 cfs @ 10.02 hrs, Volume= 31 cf, Depth> 5.56"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type I 24-hr 25-Year Rainfall=6.71"

Area (sf)	CN	Description
66	98	Paved parking, HSG D
66	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	120	0.0120	1.16		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.7	120	Total, Increased to minimum Tc = 12.0 min			

Summary for Pond 6P: Total

Inflow Area = 42,031 sf, 64.05% Impervious, Inflow Depth > 4.77" for 25-Year event
Inflow = 2.68 cfs @ 10.02 hrs, Volume= 16,716 cf
Primary = 2.68 cfs @ 10.02 hrs, Volume= 16,716 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs

ATTACHMENT 2

STORM WATER QUALITY CALCULATIONS

DRAINAGE AREA SUMMARY

ORTEGA PARK PUBLIC IMPROVEMENTS

PROPOSED CONDITION

DMA	Total Area (SF)	Hardscape (SF)	Existing Pavement (SF)	Permeable Pavement (SF)	Landscape (SF)	Total Impervious (SF)	Total Pervious (SF)	Percent Impervious	1" 24-Hour Runoff Volume (CF)	Provided BMP Area (SF)	Required BMP Area (SF)	Provided Treatment Volume (CF)
A	10,664	3,936	2,703	3,377	648	6,639	4,025	62.3%	396	3,377	1,769	1,216
B	29,441	11,355	7,673	7,625	2,788	19,028	10,413	64.6%	1138	7,625	5,492	2,745
C	939	517	0	0	422	517	422	55.1%	33	65	63	70
D	921	670	0	0	251	670	251	72.7%	41	82	81	89
E	66	66	0	0	0	66	0	100.0%	4	-	-	-
Total	**42,031**	**16,544**	**10,376**	**11,002**	**4,109**	**26,920**	**15,111**	**64.0%**	**1,612**	**11,149**	**7,406**	**4,119**

Project Statistics

New Impervious Area	18,949
Replaced Impervious Area	7,971
New Pervious Area	4368

EXISTING CONDITION

DMA	Total Area (SF)	Hardscape (SF)	Landscape (SF)	Percent Impervious
A	10,664	4,964	5,700	46.5%
B	29,441	16,096	13,345	54.7%
C	939	723	216	77.0%
D	921	888	33	96.4%
E	66	0	66	0.0%
Total	**42,031**	**22,671**	**19,360**	**53.9%**

Permeable Pavement Worksheet Area A

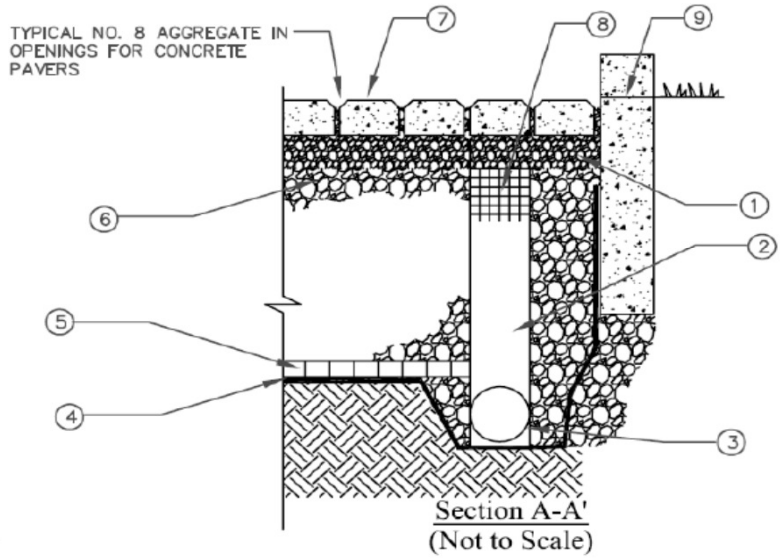


Figure D-6: Permeable Pavement cross-section

Refer to Figures D-6 and Figure 6-16 for a diagrammatic description of the geometric variables.

Step 1: Determine design volume reduction, $V_{reduction}$			
1-1. Enter the volume difference between the pre- and post-development conditions for the 25-yr, 24-hr design storm, V_{25}, calculated using SBUH method, Appendix C	V_{25}=	637	ft^3
1-2. Enter the volume generated from a one-inch, 24-hr storm event, $V_{one\text{-}inch}$, calculated using SBUH method, Appendix C	$V_{one\text{-}inch}$=	396	ft^3
1-3. Determine design volume reduction which is the larger of V_{25} and $V_{one\text{-}inch}$ and is the volume to be retained on-site	$V_{reduction}$=	637	ft^3
Step 2: Determine storm water quality design volume, V_{wq}			
2-1. Determine the water quality design volume, V_{wq}, using SBUH method, Appendix C (Note: V_{wq} is always equal to $V_{one\text{-}inch}$)	V_{wq}=	396	ft^3

Step 3: Determine design volume, V_{design} (for sizing)			
3-1. If no infiltration (i.e., impermeable liner w/ underdrains), $V_{design} = V_{wq}$.	V_{design}=		ft^3
3-2. If partial infiltration (i.e., permeable liner w/underdrains), $V_{design} = V_{wq}+0.2V_{wq}$	V_{design}=		ft^3
3-3. If full infiltration (i.e., permeable liner w/ no underdrains), $V_{design} = V_{reduction}$	V_{design}=	637	ft^3
Step 4: Calculate design infiltration rate (assume full infiltration, $V_{design} = V_{reduction}$)			
4-1. Enter soil infiltration rate (0.5 in/hr min.), $k_{measured}$	$K_{measured}$=	1	in/hr
4-2. Enter correction factor for testing (0.3 small scale, 0.5 large scale), F_t	F_t=	0.3	ft
4-3. Enter correction factor for plugging, (0.7 loams-sandy loams, 0.8 fine-loamy sands, 0.9 medium sands, 1.0 coarse sands-cobbles, F_p	F_p=	0.8	ft
4-4. Enter the depth from the bottom of the facility to the maximum wet-season water table or nearest impervious layer, whichever is less. D	D=	10	ft
4-5. Enter the estimated width of the facility	W=	16	ft
4-6. Calculate the correction factor of geometry (0.25 min, 1.0 max), $F_g = 4•D/W +0.05$	F_g=	1	
4-7. Calculate the design infiltration rate, $k_{design}=k_{measured}F_tF_pF_g$	K_{design}=	0.24	in/hr
Step 5: Determine maximum depth that can be infiltrated			
5-1. Enter drawdown time (72 hrs max.), t	t=	72	hrs
5-2. Calculate max. depth of runoff that can be infiltrated within the t, $d_{max}=k_{design}t/12$	d_{max}=	1.44	ft
Step 6: Determine infiltrating surface area (gravel drainage area)			
6-1. Enter gravel drainage layer porosity, n	n=	0.32	
6-2. Enter depth of gravel drainage layer, l	l=	12	in
6-3. Enter the time to fill the gravel drainage layer with water (Use 2 hours for most designs), T	T=	2	hrs
6-4. Calculate infiltrating surface area for dry wells: $A=V_{design}/(Tk_{design}/12)+n*l/12))$	A=	1,769	ft^3
Step 4: Determine Provided Retention Capacity			
4-1. Enter provided infiltrating surface area, A_p	A_p=	3,377	ft^2
4-2. Calculate provided retention capacity, $V_p=(Tk_{design}/12)+n*l/12)*A_p$	V_p=	1,216	ft^3
4-3. Check $V_p \geq V_{design}$		OK	

NO

Permeable Pavement Worksheet Area B

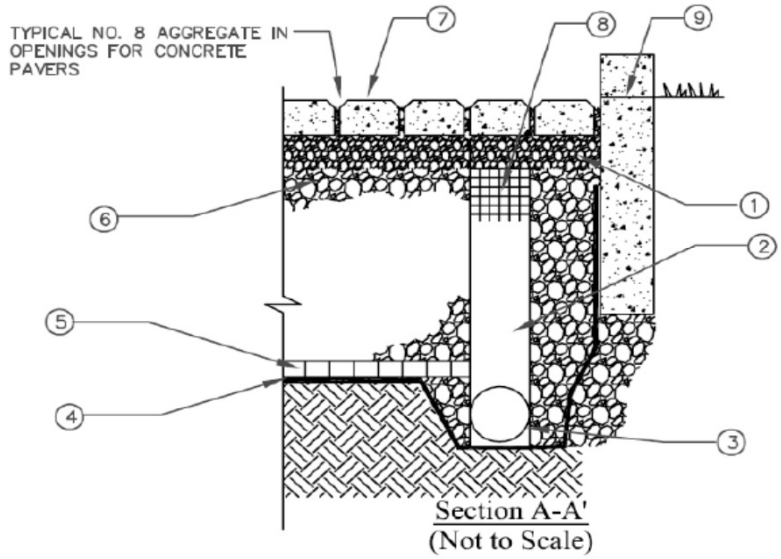


Figure D-6: Permeable Pavement cross-section

Refer to Figures D-6 and Figure 6-16 for a diagrammatic description of the geometric variables.

Step 1: Determine design volume reduction, $V_{reduction}$		
1-1. Enter the volume difference between the pre- and post-development conditions for the 25-yr, 24-hr design storm, V_{25}, calculated using SBUH method, Appendix C	V_{25}= 1977	ft^3
1-2. Enter the volume generated from a one-inch, 24-hr storm event, $V_{one\text{-}inch}$, calculated using SBUH method, Appendix C	$V_{one\text{-}inch}$= 1138	ft^3
1-3. Determine design volume reduction which is the larger of V_{25} and $V_{one\text{-}inch}$ and is the volume to be retained on-site	$V_{reduction}$= 1977	ft^3
Step 2: Determine storm water quality design volume, V_{wq}		
2-1. Determine the water quality design volume, V_{wq}, using SBUH method, Appendix C (Note: V_{wq} is always equal to $V_{one\text{-}inch}$)	V_{wq}= 1138	ft^3

Step 3: Determine design volume, V_{design} (for sizing)			
3-1. If no infiltration (i.e., impermeable liner w/ underdrains), $V_{design} = V_{wq}$.	V_{design}=		ft^3
3-2. If partial infiltration (i.e., permeable liner w/underdrains), $V_{design} = V_{wq}+0.2V_{wq}$	V_{design}=		ft^3
3-3. If full infiltration (i.e., permeable liner w/ no underdrains), $V_{design} = V_{reduction}$	V_{design}=	1977	ft^3
Step 4: Calculate design infiltration rate (assume full infiltration, $V_{design} = V_{reduction}$)			
4-1. Enter soil infiltration rate (0.5 in/hr min.), $k_{measured}$	$K_{measured}$=	1	in/hr
4-2. Enter correction factor for testing (0.3 small scale, 0.5 large scale), F_t	F_t=	0.3	ft
4-3. Enter correction factor for plugging, (0.7 loams-sandy loams, 0.8 fine-loamy sands, 0.9 medium sands, 1.0 coarse sands-cobbles, F_p	F_p=	0.8	ft
4-4. Enter the depth from the bottom of the facility to the maximum wet-season water table or nearest impervious layer, whichever is less. D	D=	10	ft
4-5. Enter the estimated width of the facility	W=	16	ft
4-6. Calculate the correction factor of geometry (0.25 min, 1.0 max), $F_g = 4•D/W +0.05$	F_g=	1	
4-7. Calculate the design infiltration rate, $k_{design}=k_{measured}F_tF_pF_g$	K_{design}=	0.24	in/hr
Step 5: Determine maximum depth that can be infiltrated			
5-1. Enter drawdown time (72 hrs max.), t	t=	72	hrs
5-2. Calculate max. depth of runoff that can be infiltrated within the t, $d_{max}=k_{design}t/12$	d_{max}=	1.44	ft
Step 6: Determine infiltrating surface area (gravel drainage area)			
6-1. Enter gravel drainage layer porosity, n	n=	0.32	
6-2. Enter depth of gravel drainage layer, l	l=	12	in
6-3. Enter the time to fill the gravel drainage layer with water (Use 2 hours for most designs), T	T=	2	hrs
6-4. Calculate infiltrating surface area for dry wells: $A=V_{design}/(Tk_{design}/12)+n*l/12))$	A=	5,492	ft^3
Step 4: Determine Provided Retention Capacity			
4-1. Enter provided infiltrating surface area, A_p	A_p=	7,625	ft^2
4-2. Calculate provided retention capacity, $V_p=(Tk_{design}/12)+n*l/12)*A_p$	V_p=	2,745	ft^3
4-3. Check $V_p \geq V_{design}$		OK	

NO

Bioretention Worksheet Area C

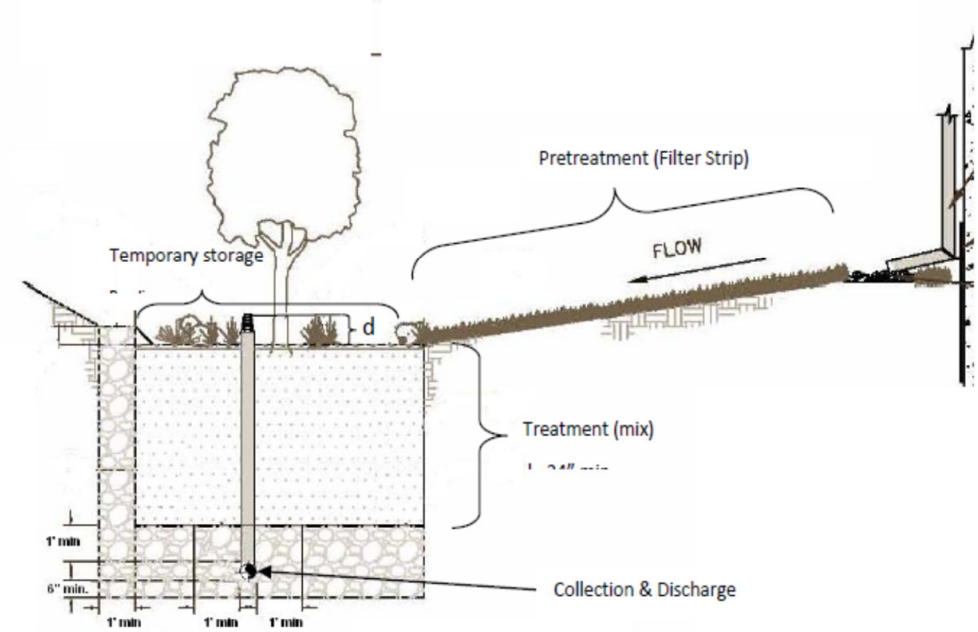


Figure D-1: Bioretention Area Cross-Section

Refer to Figure D-1 and Figure 6-2 for the description of the geometric variables.

Step 1: Determine design volume reduction, $V_{reduction}$			
1-1. Enter the volume difference between the pre- and post-development conditions for the 25-yr, 24-hr design storm, V_{25}, calculated using SBUH method, Appendix C	V_{25}=	68	ft^3
1-2. Enter the volume generated from a one-inch, 24-hr storm event, $V_{one\text{-}inch}$, calculated using SBUH method, Appendix C	$V_{one\text{-}inch}$=	33	ft^3
1-3. Determine design volume reduction which is the larger of V_{25} and $V_{one\text{-}inch}$ and is the volume to be retained on-site	$V_{reduction}$=	68	ft^3
Step 2: Determine storm water quality design volume, V_{wq}			
2-1. Determine the water quality design volume, V_{wq}, using SBUH method, Appendix C (Note: V_{wq} is always equal to $V_{one\text{-}inch}$)	V_{wq}=	33	ft^3

Step 3: Determine design volume, V_{design} (for sizing)			
3-1. If underdrain system is used, $V_{design} = V_{wq}$ If there is no underdrain system, the larger of $V_{reduction}$ and V_{wq}	V_{design}=	68	ft^3
Step 4: Pretreatment			
4-1. If pretreatment is required please go to the vegetated filter strip worksheet, Appendix C			
Step 5: Calculate Bioretention Area			
5-1. Enter thickness of planting mix (min.24"), l	l=	24	in
5-2. Enter Storage depth (12" max.) above the filter, d	d=	3	in
5-3. Enter infiltration rate, k_{design} (Note: infiltration rate of planting soil. If no underdrain, infiltration rate of native subsoil or fill. If no underdrains, see step 4 of the infiltration BMP Worksheet, Appendix D to calculate k_{design}).	k_{design}=	0.24	in/hr
5-4. Enter drawdown time, t	t=	48	hr
5-5. Calculate bioretention area, $A_{sf}=(V_{design}*l)/[(t*k_{design}/12)*(l+d)]$	A_{sf}=	63	ft2
Step 6: Calculate underdrain system flow rate (if an underdrain is provided)			
6-1. Calculate filtered flow rate to be conveyed by the longitudinal drain pipe, $Q_f=k_{design}*A_{sf}/43200$ (Note: for this example, step 6-1 is equivalent to step 5-1 of the Sand Filter Worksheet, Appendix D).	Q_f=	N/A	cfs
6-2. Calculate underdrain system capacity (steps 5-2 throuhg 5-7 of Sand Filter Worksheet)			
6-3. Enter minimum slope for energy gradient, S_e	S_e=		
6-4. Enter Hazen-Williams coeffiient for plastic, C	C=		
6-5. Enter pipe diameter, D	D=		in
6-6. Calculate pipe hydraulic radius, $R_h=D/48$	R_h=		
6-7. Calculate velocity at the outlet of the pipe, $V_p=1.318CR_h^{0.63}S_e^{0.54}$	V_p=		ft/s
6-8. Calculate pipe capacity, $Q_{cap}=0.25\pi(D/12)^2V_p$	Q_{cap}=		cfs
Step 7: Provide Conveyance Capacity for Flows Higher than Q_{wq}			
7-1. An emergency overflow must be provided if the bioretention area is placed online or in the event the surface area becomes clogged.			
Step 8: Calculate Provided Treatment Volume			
8-1. Enter provided bioretention area	A_p=	65	ft^2
8-2. Calculate provided treatment volume, Vpt=[Ap*(t*kdesign/12)*(l+d)]/l	V_{pt}=	70	ft^3
8-3. Check $V_{pt} > V_{wq}$		OK	

Bioretention Worksheet Area D

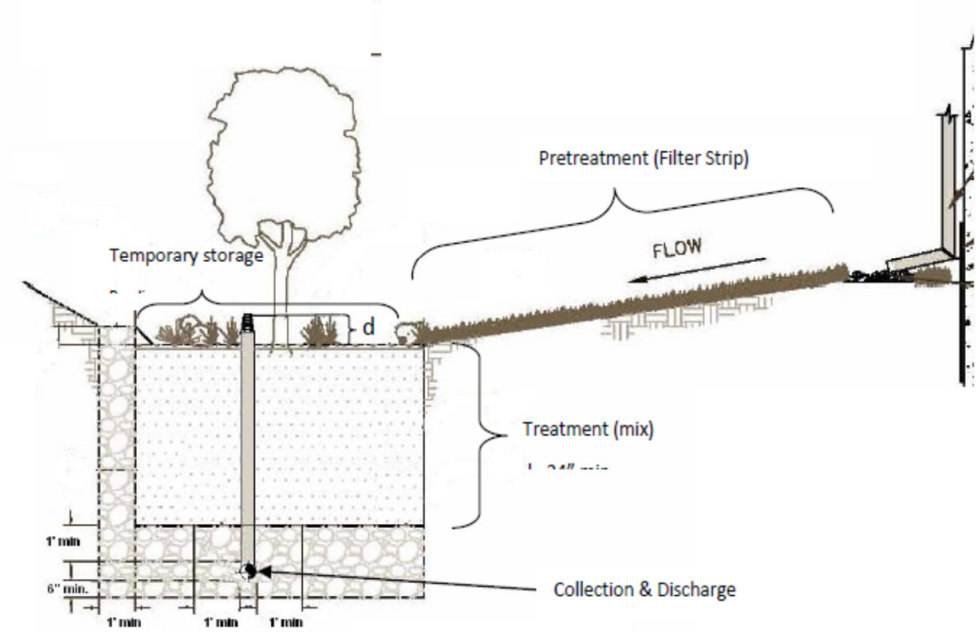


Figure D-1: Bioretention Area Cross-Section

Refer to Figure D-1 and Figure 6-2 for the description of the geometric variables.

Step 1: Determine design volume reduction, $V_{reduction}$			
1-1. Enter the volume difference between the pre- and post-development conditions for the 25-yr, 24-hr design storm, V_{25}, calculated using SBUH method, Appendix C	V_{25}=	88	ft^3
1-2. Enter the volume generated from a one-inch, 24-hr storm event, $V_{one\text{-}inch}$, calculated using SBUH method, Appendix C	$V_{one\text{-}inch}$=	41	ft^3
1-3. Determine design volume reduction which is the larger of V_{25} and $V_{one\text{-}inch}$ and is the volume to be retained on-site	$V_{reduction}$=	88	ft^3
Step 2: Determine storm water quality design volume, V_{wq}			
2-1. Determine the water quality design volume, V_{wq}, using SBUH method, Appendix C (Note: V_{wq} is always equal to $V_{one\text{-}inch}$)	V_{wq}=	41	ft^3

Step 3: Determine design volume, V_{design} (for sizing)			
3-1. If underdrain system is used, $V_{design} = V_{wq}$ If there is no underdrain system, the larger of $V_{reduction}$ and V_{wq}	V_{design}=	88	ft^3
Step 4: Pretreatment			
4-1. If pretreatment is required please go to the vegetated filter strip worksheet, Appendix C			
Step 5: Calculate Bioretention Area			
5-1. Enter thickness of planting mix (min.24"), l	l=	24	in
5-2. Enter Storage depth (12" max.) above the filter, d	d=	3	in
5-3. Enter infiltration rate, k_{design} (Note: infiltration rate of planting soil. If no underdrain, infiltration rate of native subsoil or fill. If no underdrains, see step 4 of the infiltration BMP Worksheet, Appendix D to calculate k_{design}).	k_{design}=	0.24	in/hr
5-4. Enter drawdown time, t	t=	48	hr
5-5. Calculate bioretention area, $A_{sf}=(V_{design}*l)/[(t*k_{design}/12)*(l+d)]$	A_{sf}=	81	ft2
Step 6: Calculate underdrain system flow rate (if an underdrain is provided)			
6-1. Calculate filtered flow rate to be conveyed by the longitudinal drain pipe, $Q_f=k_{design}*A_{sf}/43200$ (Note: for this example, step 6-1 is equivalent to step 5-1 of the Sand Filter Worksheet, Appendix D).	Q_f=	N/A	cfs
6-2. Calculate underdrain system capacity (steps 5-2 throuhg 5-7 of Sand Filter Worksheet)			
6-3. Enter minimum slope for energy gradient, S_e	S_e=		
6-4. Enter Hazen-Williams coeffiient for plastic, C	C=		
6-5. Enter pipe diameter, D	D=		in
6-6. Calculate pipe hydraulic radius, $R_h=D/48$	R_h=		
6-7. Calculate velocity at the outlet of the pipe, $V_p=1.318CR_h^{0.63}S_e^{0.54}$	V_p=		ft/s
6-8. Calculate pipe capacity, $Q_{cap}=0.25\pi(D/12)^2V_p$	Q_{cap}=		cfs
Step 7: Provide Conveyance Capacity for Flows Higher than Q_{wq}			
7-1. An emergency overflow must be provided if the bioretention area is placed online or in the event the surface area becomes clogged.			
Step 8: Calculate Provided Treatment Volume			
8-1. Enter provided bioretention area	A_p=	82	ft^2
8-2. Calculate provided treatment volume, Vpt=[Ap*(t*kdesign/12)*(l+d)]/l	V_{pt}=	89	ft^3
8-3. Check $V_{pt} > V_{wq}$		OK	

ATTACHMENT 3

INFILTRATION TESTING REPORT

INFILTRATION TESTING AND PAVEMENT SECTION REPORT

FOR PROPOSED STORMWATER INFILTRATION BMP

AT ORTEGA PARK

SANTA BARBARA, CALIFORNIA

PROJECT NO.: 302880-001

MAY 31, 2019

PREPARED FOR

RRM DESIGN GROUP

ATTENTION: MICHAEL HAMILTON

BY

EARTH SYSTEMS PACIFIC

1731-A WALTER STREET

VENTURA, CALIFORNIA 93003

Earth Systems
1731 Walter Street, Suite A | Ventura, CA 93003 | Ph: 805.642.6727 | www.earthsystems.com

May 31, 2019

Project No.: 302880-001
Report No.: 19-5-104

RRM Design Group
Attention: Michael Hamilton
10 East Figueroa Street, Suite 200
Santa Barbara, CA 93101

Project: Ortega Park (Proposed Adjacent Parking Areas)
Santa Barbara, California
Subject: Infiltration Testing and Pavement Section Report

Introduction

As authorized, Earth Systems Pacific has performed a geotechnical study for storm water infiltration BMPs and parking improvements to be constructed at the proposed parking areas adjacent to Ortega Park in Santa Barbara, California.

Site Setting

The proposed parking areas are currently covered with landscaping and hardscaping. The project site is relatively flat and is bounded by East Ortega Street to the northwest, North Quarantina Street to the northeast, East Cota Street to the south east, and North Salsipuedes Street to the southwest. The geographic coordinates of the project site are 34.4251˚ North Latitude and 119.6901° West Longitude.

Infiltration Testing

On February 7, 2019, four approximately 4-inch diameter infiltration borings (IT-1, IT-2, IT-5, and IT-6) were hand-excavated to depths of about 2.5, 6, 2.5, and 3.5 feet, respectively, below the ground surface to determine the soil profile and allow installation of plastic casing for infiltration testing (see attached Site Plan for boring locations).

After drilling was completed, 2-inch diameter slotted PVC casings were lowered into Borings IT-1 and IT-5. Earth Systems did not perform an infiltration test in Borings IT-2 and IT-6 because of the shallow groundwater. The annuli between the casings and boring walls were then filled with pea gravel.

It should be noted that the rate the water surface drops in a borehole is a percolation rate, which is related to, but is not an infiltration rate. Percolation rate ignores the wetted soil surface area into which the water is infiltrating and does not account for the volume of water infiltrate. An infiltration rate considers both factors. Hence, percolation rates (in unit length

per unit time) are an overestimation of infiltration rates (also in unit length per unit time). Earth Systems uses the Porchet equation to account for the wetted surface area and volume of water infiltrated to estimate an infiltration rate. Forms of the equation can be found in the Riverside County - Low Impact Development BMP Design Handbook (2001), the South Orange County Version, Technical Guidance Documents Appendices (2017), or in a paper by J.W. Van Hoorn, "Determining Hydraulic Conductivity with the Inversed Auger Hole and Infiltrometer Methods." The Porchet equation in its most simple form is the volume of water infiltrated divided by the product of the change in time and the wetted surface area. By substitution, the equation can be shown to be equal to:

$$\text{Infiltration Rate (inches /hr.)} = \frac{\Delta H * r * 60}{\Delta t * (r + 2H_{avg})}$$

where: ΔH = Change in water level (inches)
Δt = Change in time (minutes)
r = Radius of test hole (inches)
H_{avg} = Average height of water in test hole (inches)

The above equation does not account for the gravel pack in the annulus between the borehole wall and the slotted pipe fitted in the test hole. Ignoring the gravel pack inflates the amount of water infiltrated and, hence, yields an unconservative infiltration rate. A method to account for the volume occupied by the gravel (and the slotted pile) and adjust he infiltration rate accordingly is presented in Caltrans Test 750. Earth Systems makes this additional adjustment to our test data. The equation is:

$$\text{Correction Factor} = n * [1 - (O/D)^2] + (I/D)^2$$

Where: n = Pea gravel porosity
O = Outside diameter of slotted pipe (inches)
D = Test hole diameter (inches)
I = Inside diameter of slotted pipe (inches)

Earth Systems has determined an average porosity for the pea gravel used in our testing. The other values are simple measurements.

Based on the testing, the recommended test infiltration rates for the depths tested and boring locations are summarized in the following table:

Boring	Boring Depth (feet)	Infiltration Rate (inch/hour)	Infiltration Rate (cm/s)
IT-1	2.5	1.4	0.0010
IT-5	2.5	0.6	0.0004

There are many factors that influence the infiltration rate. Clear water was used in our tests, whereas deleterious material will likely be contained in the storm water. Variations in soil conditions within the limits of the proposed infiltration system will likely affect infiltration characteristics. The designer who utilizes the infiltration results should consider these factors, as well as apply a factor-of-safety to the infiltration rate to account for future disposal bed siltation.

The designer of the proposed infiltration system beneath the pavement should also consider that compacted soil will be present below the proposed parking areas. The infiltration rates provided above are for the onsite soils at the depths tested. Compaction of the soils will reduce the infiltration rate of the soils underlying the Class II Permeable Base. The designer of the proposed infiltration system should consider the use of gravel-filled drains that extend below the compacted native soils to allow the storm water to infiltrate into the underlying native soils.

Paving Design

A Resistance ("R") Value test was conducted on a bulk sample secured on March 14, 2019. The test was performed in accordance with California Method 301. Three specimens at different moisture contents were tested, and the R-Value at 300 psi exudation pressure was determined from the plotted results. An R-Value of 16 was measured (see attached R-Value Testing Sheet).

The following preliminary paving sections table summarizes thicknesses of asphalt and Class II base required for different traffic indices (ranging from 4.0 to 8.0, with 0.5 intervals) using an "R"-Value of 16. Asphalt and Class II base should be compacted to a minimum of 95 percent of maximum dry density on subgrade soils compacted to a minimum of 90 percent of maximum dry density.

Traffic Index	Asphalt Thickness (inches)	Min. Aggregate Base Thickness (inches)
4.0	3.0	5.0
4.5	3.0	6.5
5.0	3.0	8.0
5.5	3.0	9.5
6.0	3.0	11.5
6.5	3.0	13.0
7.0	3.0	14.5
7.5	3.5	16.0
8.0	5.0	14.5

The preliminary paving sections table provided above has been designed for the type of traffic indicated. If the pavement is placed before construction on the project is complete, construction loads, which could increase the traffic indices above those assumed above, should be taken into account. Also, subgrade "R"-Values should be reevaluated at or near the end of rough grading so that final pavement designs can be made.

Please call if you have any questions, or if we can be of further service.

Respectfully submitted,

EARTH SYSTEMS PACIFIC

mlu

May 31, 2019

Meng Wei Lu
Civil Engineer

REGISTERED PROFESSIONAL ENGINEER
MENG WEI LU
C 89106
Exp 9/30/20
CIVIL
STATE OF CALIFORNIA

Reviewed and Approved

Todd J. Tranby
Engineering Geologist

PROFESSIONAL GEOLOGIST
TODD J. TRANBY
No. 2078
CERTIFIED
ENGINEERING
GEOLOGIST
STATE OF CALIFORNIA

Attachment:
- Vicinity Map
- Site Plan
- Logs of Borings
- Infiltration Test Results
- R-Value Testing Sheet

Copies:
- 4 - Client (3 mail, 1 email)
- 1 - Project File

*Taken from USGS Topo Map, Santa Barbara Quadrangle, California, 2015.

Approximate Scale: 1" = 2,000'

0 2,000' 4,000'

N

VICINITY MAP

Ortega Park
Santa Barbara, California

Earth Systems

May 2019	302880-001

SANTA BARBARA JUNIOR HIGH

{N'ELY. R/W LINE}

N QUARANTINA ST

N 41°30'00" W

451.04

{ORIGINAL S'WLY. R/W LINE}

(ABANDONED)

(ABANDONED)

6"-RCW

8"-SD

15"-SD

(E) 36'

60'

RIGHT-OF-WAY

12'

8'

25'

18'

E ORTEGA STREET

E COTA STREET

N SALSIPUEDES STREET

B-3

IT-1

IT-2

IT-6

IT-5

17.5'

24'

8'

2'

B-3 : Approximate boring location.

IT-6 : Approximate infiltration testing locations.

N

Approximate Scale: 1" = 60'

0 60' 120'

SITE PLAN

Ortega Park
Santa Barbara, California

Earth Systems

May 2019 | 302880-001

Earth Systems

1731-A Walter Street, Ventura, California 93003
PHONE: (805) 642-6727 FAX: (805) 642-1325

BORING NO: IT-1
PROJECT NAME: Ortega Park
PROJECT NUMBER: 302880-001
BORING LOCATION: Per Plan

DRILLING DATE: February 7, 2019
DRILLING METHOD: Hand Auger
DRILL:
LOGGED BY: SC

Vertical Depth	Sample Type: Bulk	Sample Type: SPT	Sample Type: Mod. Calif.	PENETRATION RESISTANCE (BLOWS/6")	SYMBOL	USCS CLASS	UNIT DRY WT. (pcf)	MOISTURE CONTENT (%)	DESCRIPTION OF UNITS
0						SM			**SOIL:** Dark brown silty sand; soft; moist. **ARTIFICIAL FILL:** Yellowish brown silty sand with sandstone gravel; medium dense; damp to moist.
5									Total Depth: 2.5 feet. No Groundwater Encountered. Installed 2.5 feet of 2.0 inch slotted PVC pipe and gravel pack.
10									
15									
20									

Note: The stratification lines shown represent the approximate boundaries between soil and/or rock types and the transitions may be gradual.

Earth Systems

1731-A Walter Street, Ventura, California 93003
PHONE: (805) 642-6727 FAX: (805) 642-1325

BORING NO: IT-2
PROJECT NAME: Ortega Park
PROJECT NUMBER: 302880-001
BORING LOCATION: Per Plan

DRILLING DATE: February 7, 2019
DRILLING METHOD: Hand Auger
DRILL:
LOGGED BY: SC

Vertical Depth	Sample Type: Bulk	Sample Type: SPT	Sample Type: Mod. Calif.	PENETRATION RESISTANCE (BLOWS/6")	SYMBOL	USCS CLASS	UNIT DRY WT. (pcf)	MOISTURE CONTENT (%)	DESCRIPTION OF UNITS
0						SM			**SOIL:** Dark brown silty sand; soft; moist.
									ARTIFICIAL FILL: Yellowish brown silty sand with sandstone gravel; medium dense; damp to moist.
									Becomes very moist.
5									**ARTIFICIAL FILL:** Yellowish brown silty sand to sandy silt; loose; moist.
									Total Depth: 6.0 feet.
									Groundwater Depth: 4.30 feet.
									Hole abandoned for testing due to high groundwater.
10									
15									
20									

Note: The stratification lines shown represent the approximate boundaries between soil and/or rock types and the transitions may be gradual.

Earth Systems

1731-A Walter Street, Ventura, California 93003
PHONE: (805) 642-6727 FAX: (805) 642-1325

BORING NO: IT-5
PROJECT NAME: Ortega Park
PROJECT NUMBER: 302880-002
BORING LOCATION: Per Plan

DRILLING DATE: February 7, 2019
DRILLING METHOD: Hand Auger
DRILL:
LOGGED BY: SC

Vertical Depth	Sample Type: Bulk	Sample Type: SPT	Sample Type: Mod. Calif.	PENETRATION RESISTANCE (BLOWS/6")	SYMBOL	USCS CLASS	UNIT DRY WT. (pcf)	MOISTURE CONTENT (%)	DESCRIPTION OF UNITS
0						SM			**ARTIFICIAL FILL:** Yellowish brown silty sand: some gravel; medium dense; moist.
									Total Depth: 2.5 feet. No Groundwater Encountered. Installed 2.5 feet of 2.0 inch slotted PVC pipe and gravel pack.
5									
10									
15									
20									

Note: The stratification lines shown represent the approximate boundaries between soil and/or rock types and the transitions may be gradual.

Earth Systems

1731-A Walter Street, Ventura, California 93003
PHONE: (805) 642-6727 FAX: (805) 642-1325

BORING NO: IT-6
PROJECT NAME: Ortega Park
PROJECT NUMBER: 302880-002
BORING LOCATION: Per Plan

DRILLING DATE: February 7, 2019
DRILLING METHOD: Hand Auger
DRILL:
LOGGED BY: SC

Vertical Depth	Sample Type: Bulk	Sample Type: SPT	Sample Type: Mod. Calif.	PENETRATION RESISTANCE (BLOWS/6")	SYMBOL	USCS CLASS	UNIT DRY WT. (pcf)	MOISTURE CONTENT (%)	DESCRIPTION OF UNITS
0						SM			**ARTIFICIAL FILL:** Yellowish brown silty sand: some gravel; medium dense; moist.
									Brick fragments, some discoloration, coarse gravel.
									Refusal at 3.5 feet due to coarse gravel, two attempts made.
									Total Depth: 3.5 feet.
5									No Groundwater Encountered.
10									
15									
20									

Note: The stratification lines shown represent the approximate boundaries between soil and/or rock types and the transitions may be gradual.

INFILTRATION RATE BY THE BOREHOLE PERCOLATION TEST METHOD

This workbook calculates an adjusted infiltration rate from a borehole percolation test. The percolation rate is adjusted for sidewall area according to the Porchet method, and then re-adjusted for the effect of the gravel placed in annulus between the borehole wall and a pipe placed in the borehole by a method presented in Caltrans Test 750.

Project Name	Ortega Park
Project Number	302880-001
Test Hole No.	IT-1
Tester	SC
Pre-Soak Date	February 7, 2019
Test Date	February 7, 2019

Test Hole Radius, r (inches)	2
Total Depth of Test Hole, D_T (feet)	2.5
Inside Diameter of Pipe, I (inches)	2.00
Outside Diameter of Pipe, O (inches)	2.38
Pipe Stick-Up (feet)	0.5
Porosity of Gravel, n	0.41
Porosity Correction Factor, C	0.51
Factor of Safety (FOS), F	N/A

Interval No.	Delta Time, Δt (min.)	Initial Depth to Water from TOP, D_o (ft.)	Final Depth to Water from TOP, D_f (ft.)	Initial Water Height, H_o (in.)	Final Water Height, H_f (in.)	Change in Water Height, ΔH (in.)	Perc Rate, (in/hr)	Infiltration Rate (in./hr.)	Corrected Infiltration Rate (in/hr)
1	3.00	2.00	2.20	12.00	9.60	2.40	48.00	4.07	2.09
2	3.00	2.00	2.16	12.00	10.08	1.92	38.40	3.19	1.64
3	3.00	2.00	2.15	12.00	10.20	1.80	36.00	2.98	1.53
4	3.00	1.97	2.13	12.36	10.44	1.92	38.40	3.10	1.59
5	3.00	1.97	2.13	12.36	10.44	1.92	38.40	3.10	1.59
6	3.00	2.00	2.13	12.00	10.44	1.56	31.20	2.55	1.31
7	3.00	1.98	2.12	12.24	10.56	1.68	33.60	2.71	1.40
8	3.00	1.97	2.11	12.36	10.68	1.68	33.60	2.68	1.38
9	3.00	1.98	2.12	12.24	10.56	1.68	33.60	2.71	1.40
10	3.00	1.97	2.11	12.36	10.68	1.68	33.60	2.68	1.38
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									

INFILTRATION RATE BY THE BOREHOLE PERCOLATION TEST METHOD

This workbook calculates an adjusted infiltration rate from a borehole percolation test. The percolation rate is adjusted for sidewall area according to the Porchet method, and then re-adjusted for the effect of the gravel placed in annulus between the borehole wall and a pipe placed in the borehole by a method presented in Caltrans Test 750.

Project Name	Ortega Park
Project Number	302880-001
Test Hole No.	IT-5
Tester	JW
Pre-Soak Date	February 7, 2019
Test Date	February 7, 2019

Test Hole Radius, r (inches)	2
Total Depth of Test Hole, D_T (feet)	2.5
Inside Diameter of Pipe, I (inches)	2.00
Outside Diameter of Pipe, O (inches)	2.38
Pipe Stick-Up (feet)	0.5
Porosity of Gravel, n	0.41
Porosity Correction Factor, C	0.51
Factor of Safety (FOS), F	N/A

Interval No.	Delta Time, Δt (min.)	Initial Depth to Water from TOP, D_o (ft.)	Final Depth to Water from TOP, D_f (ft.)	Initial Water Height, H_o (in.)	Final Water Height, H_f (in.)	Change in Water Height, ΔH (in.)	Perc Rate, (in/hr)	Infiltration Rate (in./hr.)	Corrected Infiltration Rate (in/hr)
1	5.00	1.30	1.50	20.40	18.00	2.40	28.80	1.43	0.73
2	5.00	1.50	1.70	18.00	15.60	2.40	28.80	1.62	0.83
3	5.00	1.40	1.60	19.20	16.80	2.40	28.80	1.52	0.78
4	5.00	1.50	1.65	18.00	16.20	1.80	21.60	1.19	0.61
5	5.00	1.50	1.65	18.00	16.20	1.80	21.60	1.19	0.61
6	5.00	1.45	1.60	18.60	16.80	1.80	21.60	1.16	0.59
7	5.00	1.50	1.65	18.00	16.20	1.80	21.60	1.19	0.61
8	5.00	1.50	1.65	18.00	16.20	1.80	21.60	1.19	0.61
9									
10									
11									
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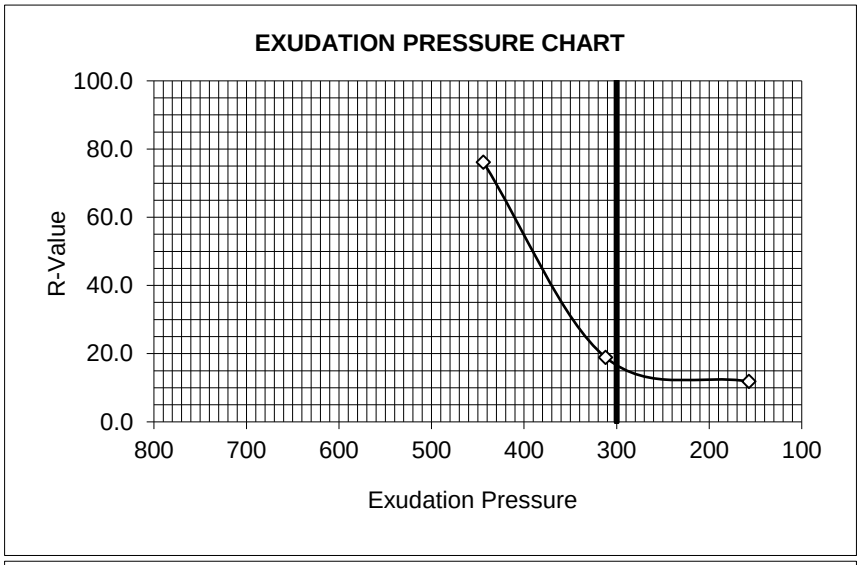
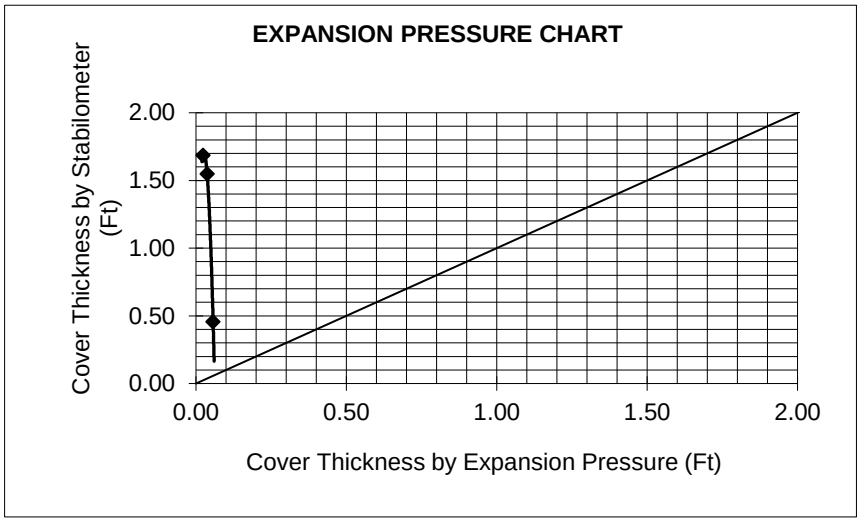
May 21, 2019 **File No.: 302880-001**





JOB NAME: Ortega Park
SAMPLE I. D.: B-3@0-4'
SOIL DESCRIPTION: Brown/ML-Silty Clay

SPECIMEN NUMBER	A	B	C
EXUDATION PRESSURE	444	312	157
RESISTANCE VALUE	76.1	18.9	11.8
EXPANSION DIAL(0.0001")	17	11	7
EXPANSION PRESSURE (PSF)	73.6	47.6	30.3
% MOISTURE AT TEST	13.9	14.7	15.4
DRY DENSITY AT TEST	114.2	112.2	112.6

R-VALUE @ 300 PSI EXUDATION	**16**
R-VALUE by Expansion Pressure*	**N/A**

**Based on Traffic Index = 8.00 & Gravel Factor = 1.34*