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STORMWATER MANAGEMENT REPORT

For

BEV JEAN ESTATES

PRELIMINARY & FINAL MAJOR SITE PLAN
3122 – 3128 WEST BANGS AVENUE
(TAX BLOCK 2601, LOTS 5,6,7,8, 9)
TOWNSHIP OF NEPTUNE
MONMOUTH COUNTY, NEW JERSEY

Dated: September 17, 2020
Project #: 150.142

Prepared By:

Brian Grant, P.E.
Principal

SITE DESCRIPTION

This report is prepared in support of a Land Development Application to develop Block 2601, Los 5, 6, 7, 8 and 9 in the Township of Neptune, Monmouth County, New Jersey. The site is located on West Bangs Avenue and begins approximately 387 feet east of the intersection of West Bangs Avenue and Green Grove Road. The property contains 6.12 acres.

The site was surveyed in July 2016 when Lots 5, 6, 7, and 8 were occupied by single family structures, and Lot 9 was occupied by a garage structure. These structures have since been demolished. The soil conditions are summarized below and are explained in more detail in Geotechnical Report prepared by Mellick-Tully and Associates, P.C., dated September 28, 2016. A copy of this report is included as Appendix 3.

Table 1. Soil Profile Summary

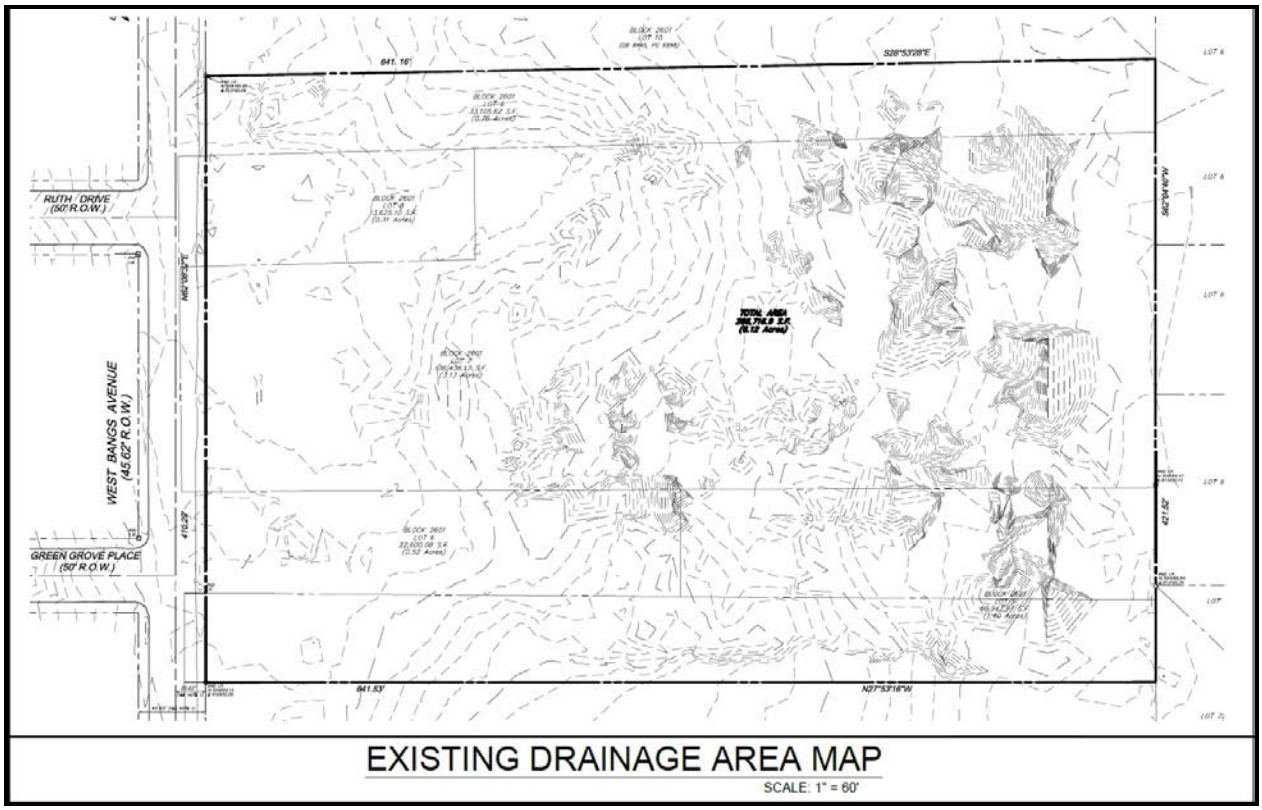
Soil Description	Depth (inches)
Topsoil	4 - 12
Silty Sands or Sandy Silts	1.5 - 12
Sands and Gravel	4 – 10 (average 5.5 ft thickness)
Silty Sands and Clays	Below the clean sands and gravel

The proposed development involves the disturbance of more than 1 acre and the addition of more than ¼ acre of impervious. Therefore, the development will be classified as a major development and will be subject to compliance with the New Jersey Stormwater Management Rules per N.J.A.C. 7:8.

PRE-DEVELOPMENT HYDROLOGY

The site currently drains away from West Bangs Avenue (Elevation 108 to 106) towards the rear of the site (Elevations 90 to 88) as shown in the attached Figure.

Figure 1. Site Topography (Existing Drainage Area Map)



The Owner has received permission from the NJDEP[1] to develop within the isolated wetlands area at the back of the site. A copy of this approval is included as Appendix #2 in this report. Pre-development lot coverages are shown in Table 2 below. These lot coverages were utilized as the basis for pre-development flows which were determined by the Rational method using Hydrology Studio analysis software (v3.0.0.16). The results are summarized in Table 3 below.

Table 2. Pre-Development Lot Coverages

LOT	AREA (AC)	AREA (SF)	BLDG IMPERVIOUS (SF)	LOT IMPERVIOUS (SF)	TOTAL IMPERVIOUS (SF)	TOTAL PERVIOUS (SF)	TOTAL PERVIOUS (AC)
5	1.40	60,947.97	2,297.00	834.00	3,131.00	57,816.97	1.33
6	0.52	22,600.08	885.00	951.00	1,836.00	20,764.08	0.48
7	3.13	136,438.13	2,184.00	3,327.00	5,511.00	130,927.13	3.01
8	0.31	13,625.10	1,524.00	977.00	2,501.00	11,124.10	0.26
9	0.76	33,105.62	407.00	0.00	407.00	32,698.62	0.75
TOTAL	**6.12**	**266,716.90**	**7,297.00**	**6,089.00**	**13,386.00**	**253,330.90**	**5.82**

[1] New Jersey Department of Environmental Protection

Table 3. Pre-Development Peak Outflow (by Return Period)

Return Period (YR)	Peak Outflow (cfs)
2	8.08
10	10.85
100	17.90

POST-DEVELOPMENT HYDROLOGY

Proposed site improvements include the construction of seventeen (17) detached single family residences with attached 2-car garage. Each of the residential lots will have a driveway leading to the attached garage. Primary site access will be provided by a new road currently named Scarlet Fliers Way. Runoff from the entire site will be routed into an underground detention basin and then will outflow via a 24" HDPE line to an existing inlet on Green Grove Road along several residential properties and a publicly owned detention system along the rear property line.

Post Development Drainage Map is shown in the Figure below and post development drainage areas are tabulated below.

Figure 2. Post Development Drainage Area Map

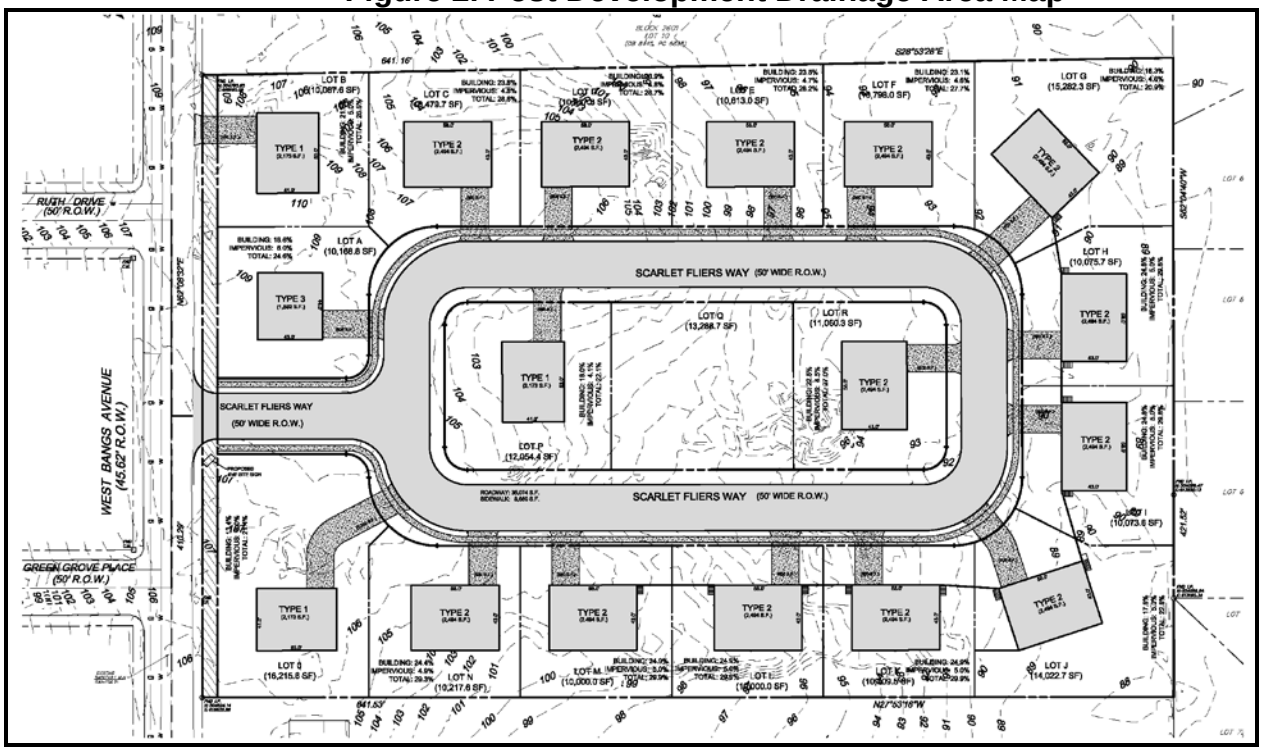


Table 4. Post Development Drainage Areas

WEST BANGS AVENUE
LOT COVERAGE DRAINAGE SHEET
PROPOSED SITE

LOT	AREA (SF)	BLDG IMPERVIOUS (SF)	DRIVEWAY IMPERVIOUS (SF)	TOTAL IMPERVIOUS (SF)	TOTAL PERVIOUS (SF)	CHECK	R.O.W. IMPERVIOUS AT EACH LOT (SF)	BUILDING COVERAGE %	TOTAL COVERAGE%
A	10,168.80	1,892.00	600.00	2,492.00	7,676.80	10,168.80	104.00	18.6	24.6
B	10,087.60	2,173.00	500.00	2,673.00	7,414.60	10,087.60	210.00	21.5	26.5
C	10,479.70	2,494.00	500.00	2,994.00	7,485.70	10,479.70	104.00	23.8	28.6
D	10,437.80	2,494.00	500.00	2,994.00	7,443.80	10,437.80	104.00	23.9	28.7
E	10,613.00	2,494.00	500.00	2,994.00	7,619.00	10,613.00	104.00	23.5	28.2
F	10,798.00	2,494.00	500.00	2,994.00	7,804.00	10,798.00	104.00	23.1	27.7
G	15,282.30	2,494.00	700.00	3,194.00	12,088.30	15,282.30	252.00	16.3	20.9
H	10,075.70	2,494.00	500.00	2,994.00	7,081.70	10,075.70	104.00	24.8	29.8
I	10,073.60	2,494.00	500.00	2,994.00	7,079.60	10,073.60	104.00	24.8	29.8
J	14,022.70	2,494.00	700.00	3,194.00	10,828.70	14,022.70	246.00	17.8	22.8
K	10,009.50	2,494.00	500.00	2,994.00	7,015.50	10,009.50	104.00	24.9	29.9
L	10,000.00	2,494.00	500.00	2,994.00	7,006.00	10,000.00	104.00	24.9	29.9
M	10,000.00	2,494.00	500.00	2,994.00	7,006.00	10,000.00	104.00	24.9	29.9
N	10,217.60	2,494.00	500.00	2,994.00	7,223.60	10,217.60	104.00	24.9	29.9
O	16,215.60	2,173.00	1,300.00	3,473.00	12,742.60	16,215.60	240.00	13.4	21.4
P	12,054.40	2,173.00	500.00	2,673.00	9,381.40	12,054.40	176.00	18.0	22.1
Q (DETENTION)	13,288.70	-	-	-	13,999.30	13,999.30	-	-	-
R	11,060.30	2,494.00	500.00	2,994.00	7,955.80	10,949.80	176.00	22.5	27.0
TOTAL (SF)	204,885.30	40,833.00	9,800.00	50,633.00	154,252.30	204,885.30	2,444.00	15.54	19.28

[RIGHT OF WAY SUMMARY]

IMPERV. DRIVE & SIDEWALK (SF)	7,638.90
IMPERVIOUS ROAD (SF)	35,073.70
PERVIOUS R.O.W. (SF)	15,015.20
PROPOSED R.O.W. DEDICATION	4,103.70
TOTAL R.O.W (SF)	61,831.50

[ON-SITE SUMMARY]

SITE PERVIOUS (SF)	154,252.30
SITE IMPERVIOUS (SF)	50,633.00
TOTAL ON-SITE AREA (SF)	204,885.30
TOTAL ON-SITE AREA (AC)	4.70

TOTAL DEVELOPMENT (SF)	266,716.90
TOTAL DEVELOPMENT (AC)	6.12

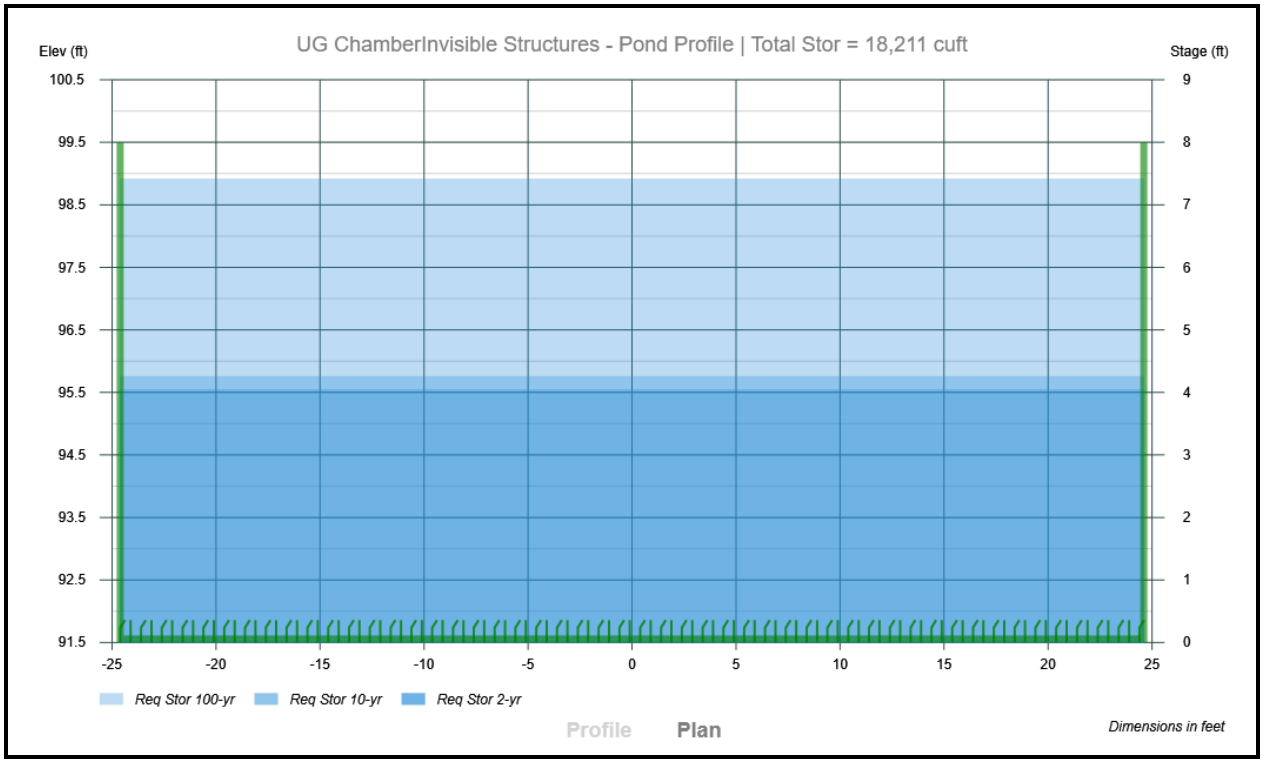
Post Development Flows were calculated using the Modified Rational Method with Hydrology Studio. A copy of the Stormwater Routing Analysis is attached in Appendix 1 of this report. These flows are summarized in the Table below. The calculated flows versus allowable flows are also outlined in the table.

Table 5. Post Development Flow Summary

Return Period	Pre-Development Peak Outflow (cfs)	Allowable Reduction (%)	Allowable Post Development Peak Outflow (cfs)	Calculated Outflow (cfs)
2	8.08	50%	4.04	4.00
10	10.85	75%	8.14	7.94
100	17.90	80%	14.32	14.32

Runoff from the site is stored in an Underground Detention Basin. The system chosen for this basin is a Rainstore3™ system by Invisible Structures. Information about the Rainstore3™ system is provided in Appendix 5 of this report. This system has a 94% void ratio and will be located entirely on Lot Q. The size of the system is 49.21'W x 49.21'W x 8.00'D.

Figure 3. Cross Section of Detention System (above Water Quality Storm Elevation)



The system will be located 0.25’ (3”) below the inflow from the Kraken Manufactured Treatment Device. The 8.00’ foot depth is designed to minimize cover on the system to 3.0 feet maximum per manufacturer instructions. The bottom of the system will be located at elevation 91.50 which is 3.5 feet above the mottling discovered in Test Pit #19 which is shown in the figures below.

Figure 4. Test Pit Location Plan

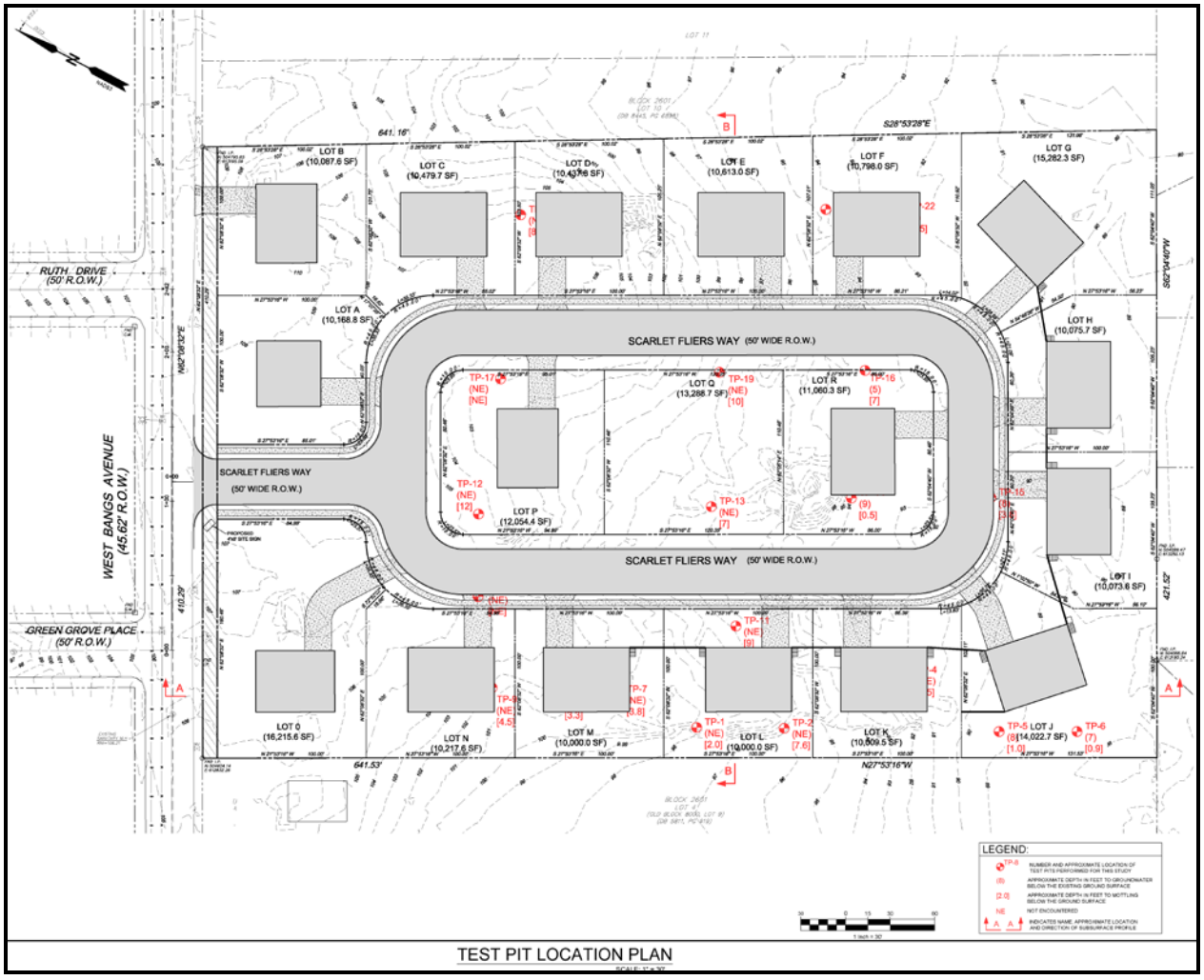
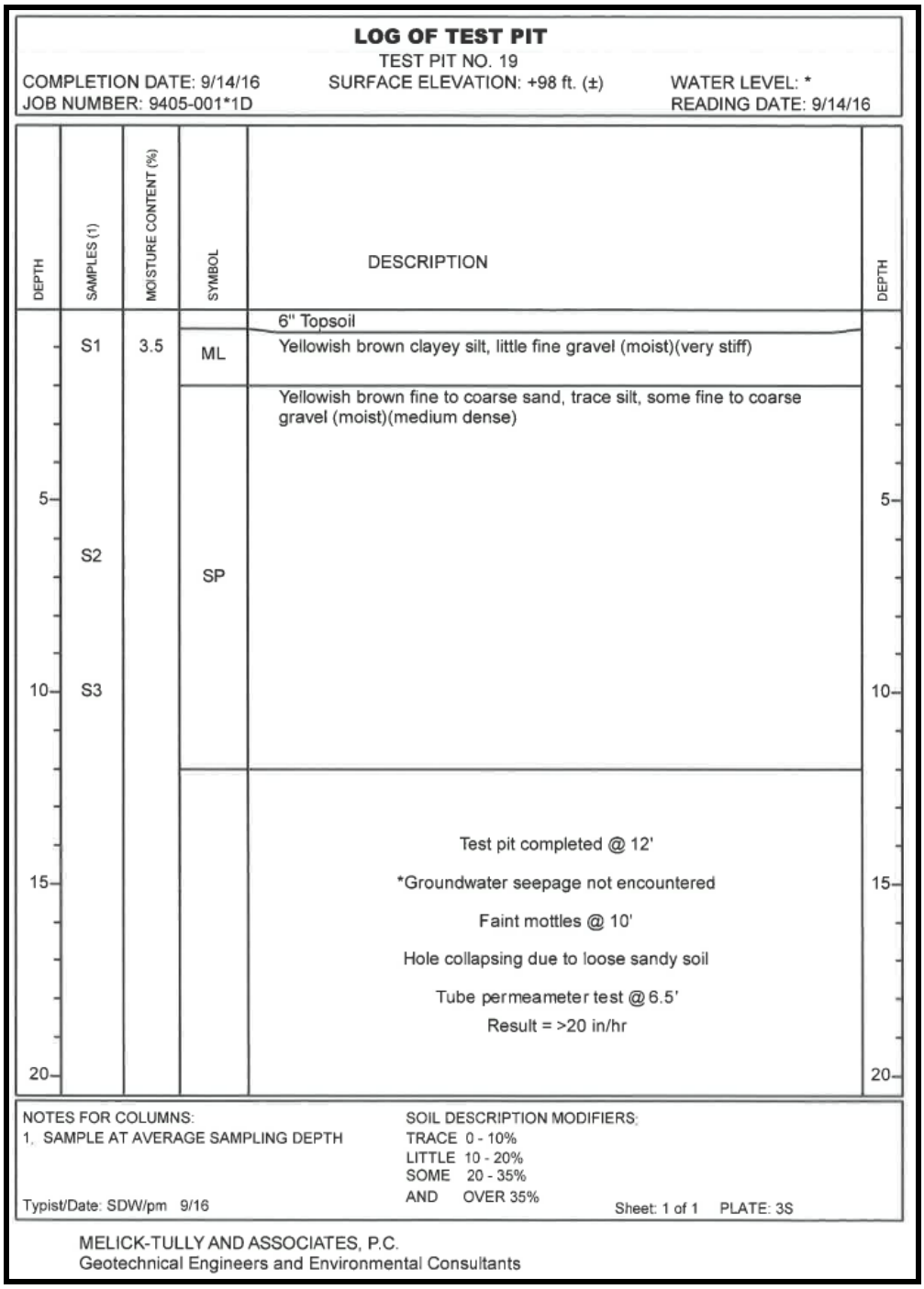


Figure 5. Test Pit #19 Soil Profile



LOG OF TEST PIT

TEST PIT NO. 19

COMPLETION DATE: 9/14/16 SURFACE ELEVATION: +98 ft. (±) WATER LEVEL: *

JOB NUMBER: 9405-001*1D READING DATE: 9/14/16

DEPTH	SAMPLES (1)	MOISTURE CONTENT (%)	SYMBOL	DESCRIPTION	DEPTH
				6" Topsoil	
	S1	3.5	ML	Yellowish brown clayey silt, little fine gravel (moist)(very stiff)	
5	S2		SP	Yellowish brown fine to coarse sand, trace silt, some fine to coarse gravel (moist)(medium dense)	5
10	S3				10
15				Test pit completed @ 12' *Groundwater seepage not encountered Faint mottles @ 10' Hole collapsing due to loose sandy soil Tube permeameter test @ 6.5' Result = >20 in/hr	15
20					20

NOTES FOR COLUMNS:
1. SAMPLE AT AVERAGE SAMPLING DEPTH

SOIL DESCRIPTION MODIFIERS:
TRACE 0 - 10%
LITTLE 10 - 20%
SOME 20 - 35%
AND OVER 35%

Typist/Date: SDW/pm 9/16

Sheet: 1 of 1 PLATE: 3S

MELICK-TULLY AND ASSOCIATES, P.C.
Geotechnical Engineers and Environmental Consultants

The underground detention basin will be routed to achieve the allowable post development flows via an Outlet Control Structure (OCS) site with an 8” diameter orifice at 91.50’, a pair of 10” diameter orifices at 95.14’, and a rectangular weir with a 3.00’ weir at elevation 98.33’. Figures of the routing thru the OCS at 2, 10, and 100-year return periods are shown below.

Figure 6. Front View of Routing thru OCS at 2-Year Return Period

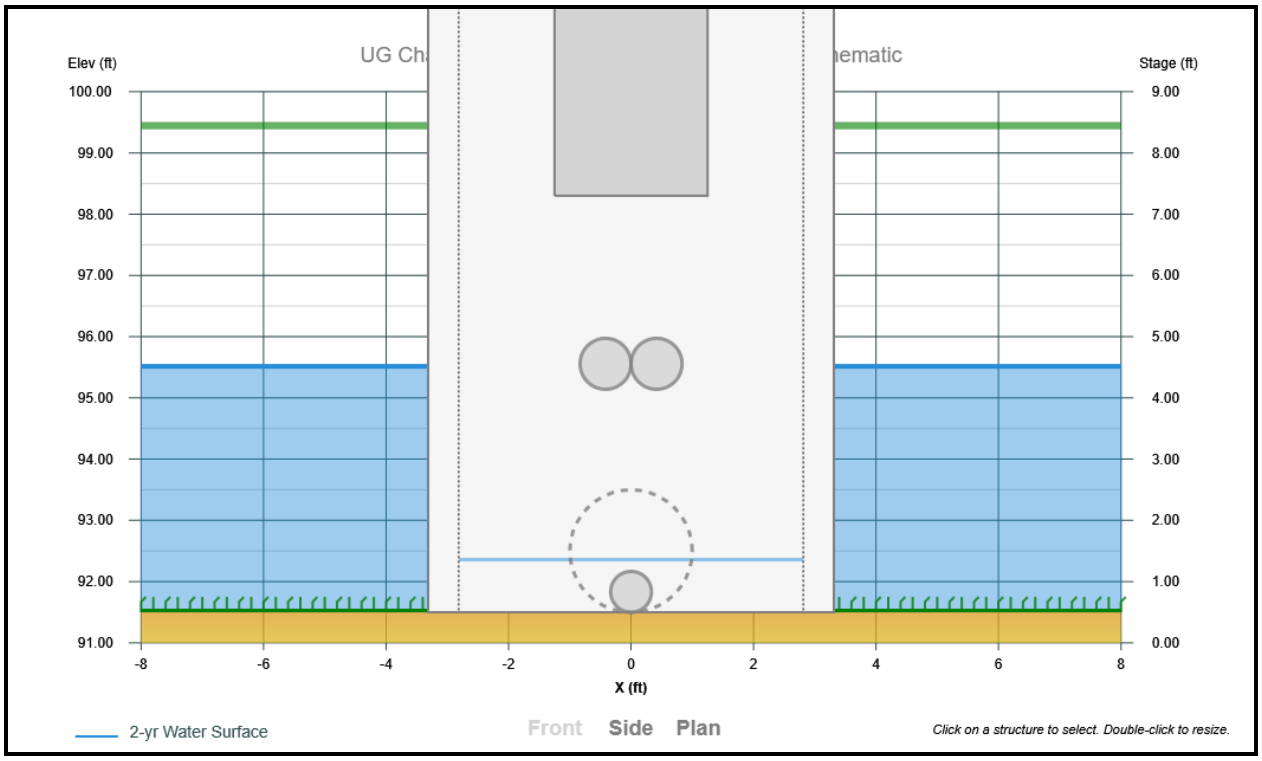


Figure 7. Profile of Routing thru OCS at 2-Year Return Period

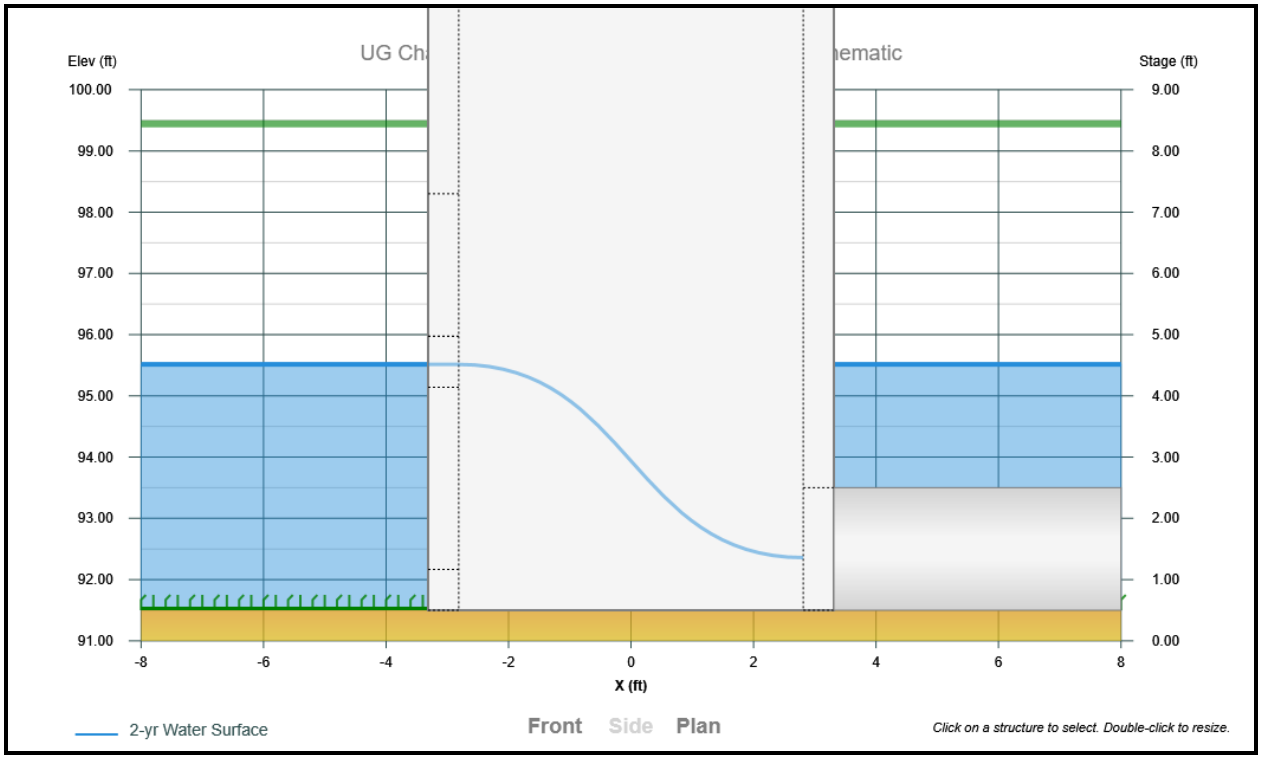


Figure 8. Front View of Routing thru OCS at 10-Year Return Period

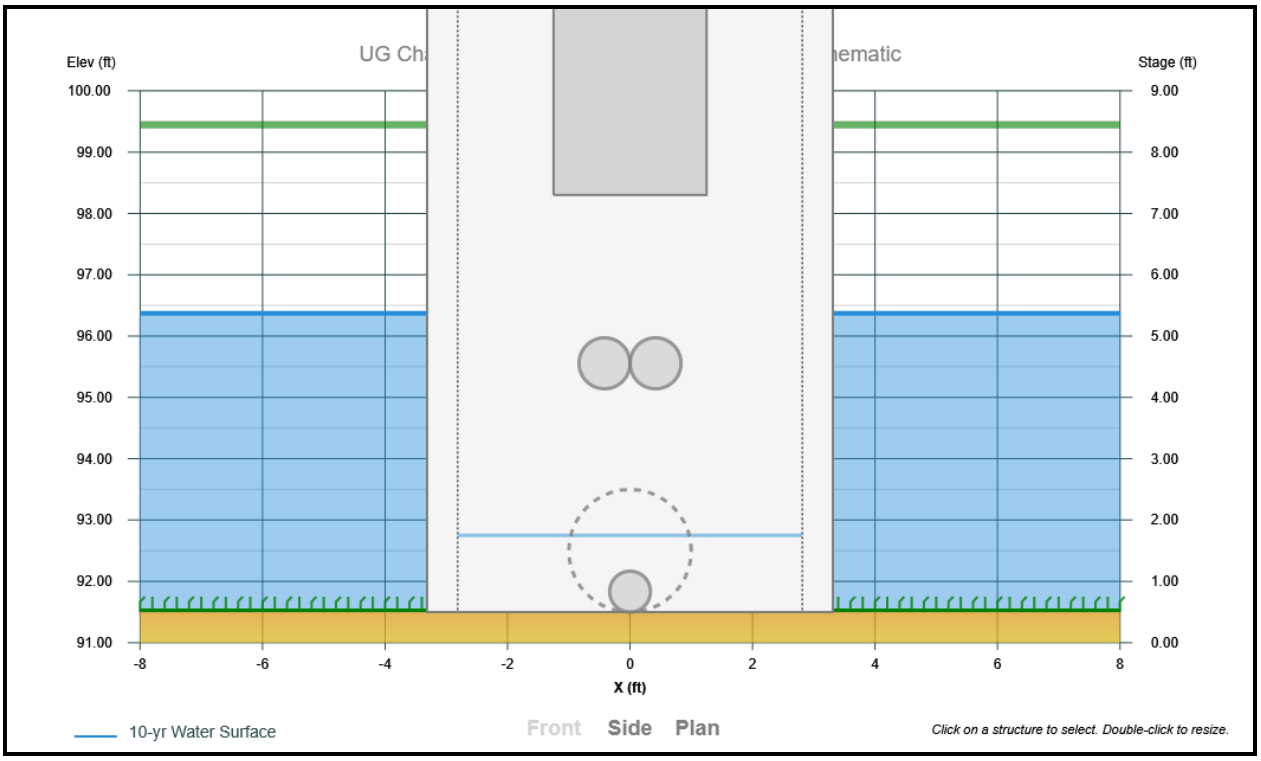


Figure 9. Profile of Routing thru OCS at 10-Year Return Period

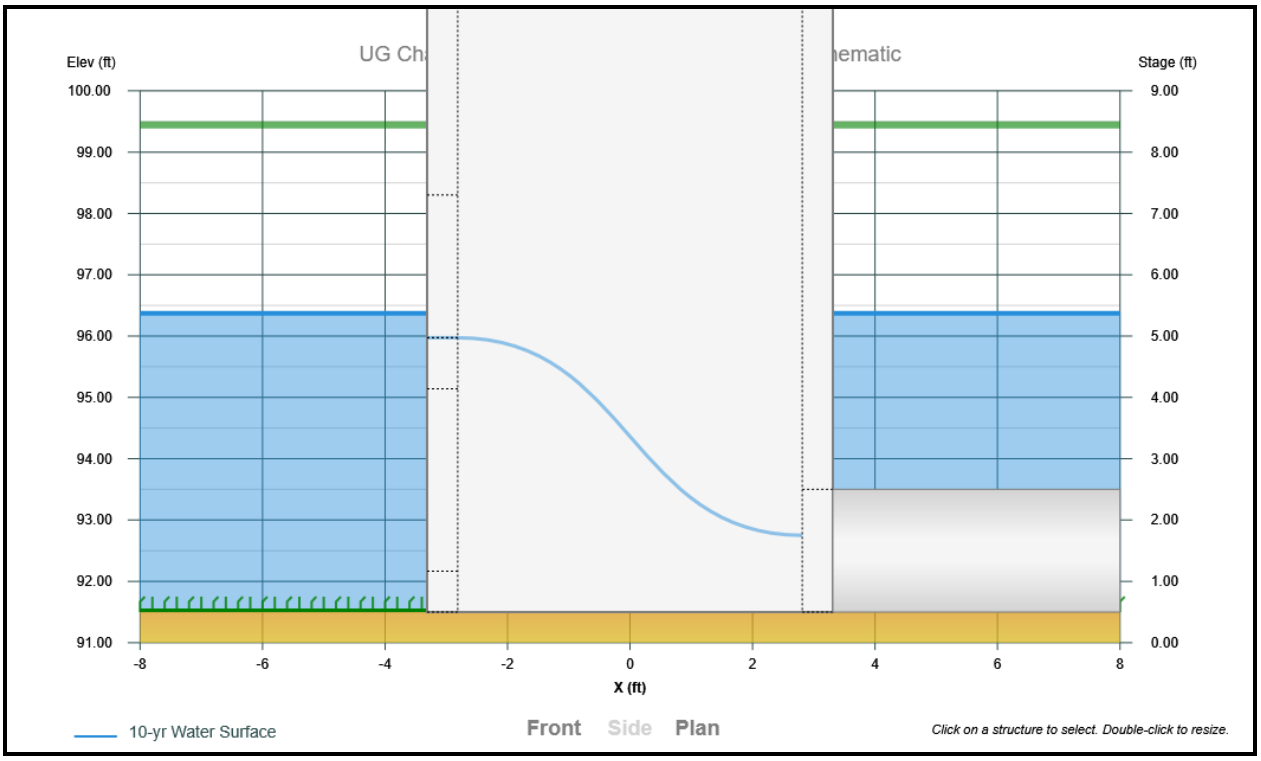


Figure 10. Front View of Routing thru OCS at 100-Year Return Period

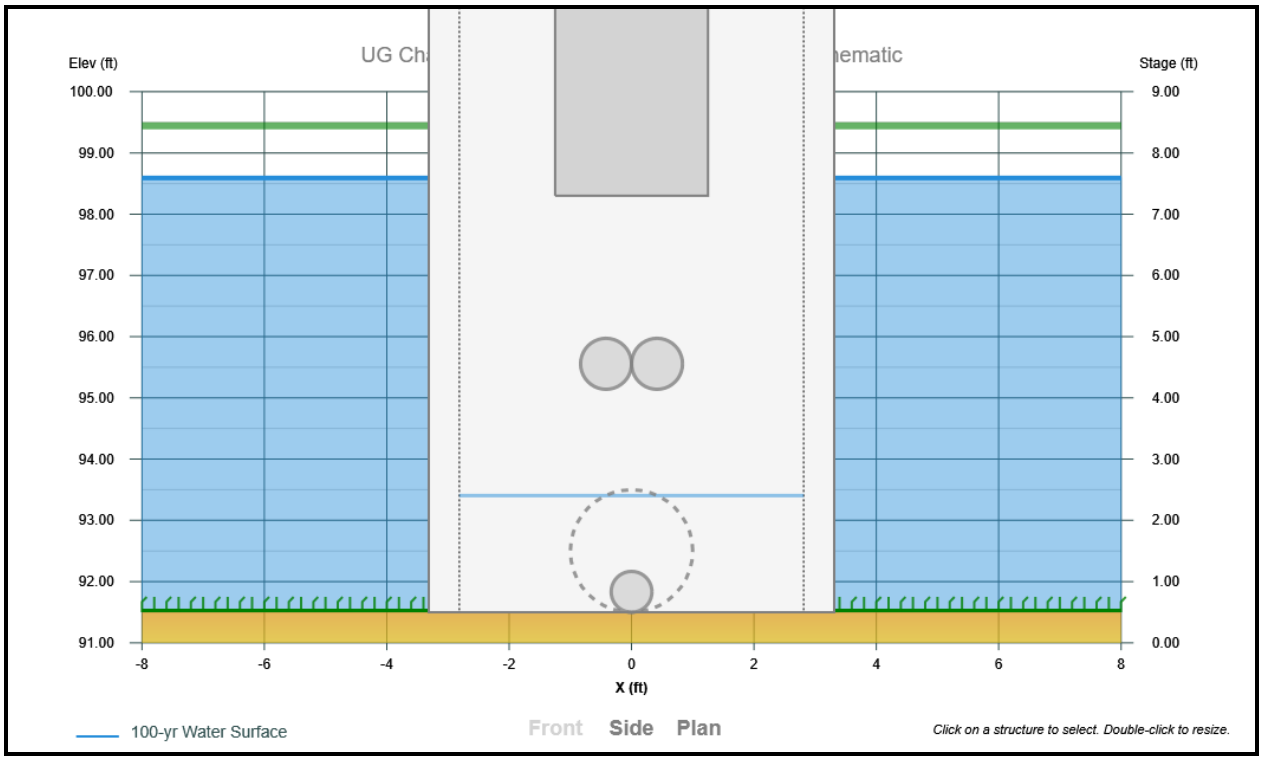
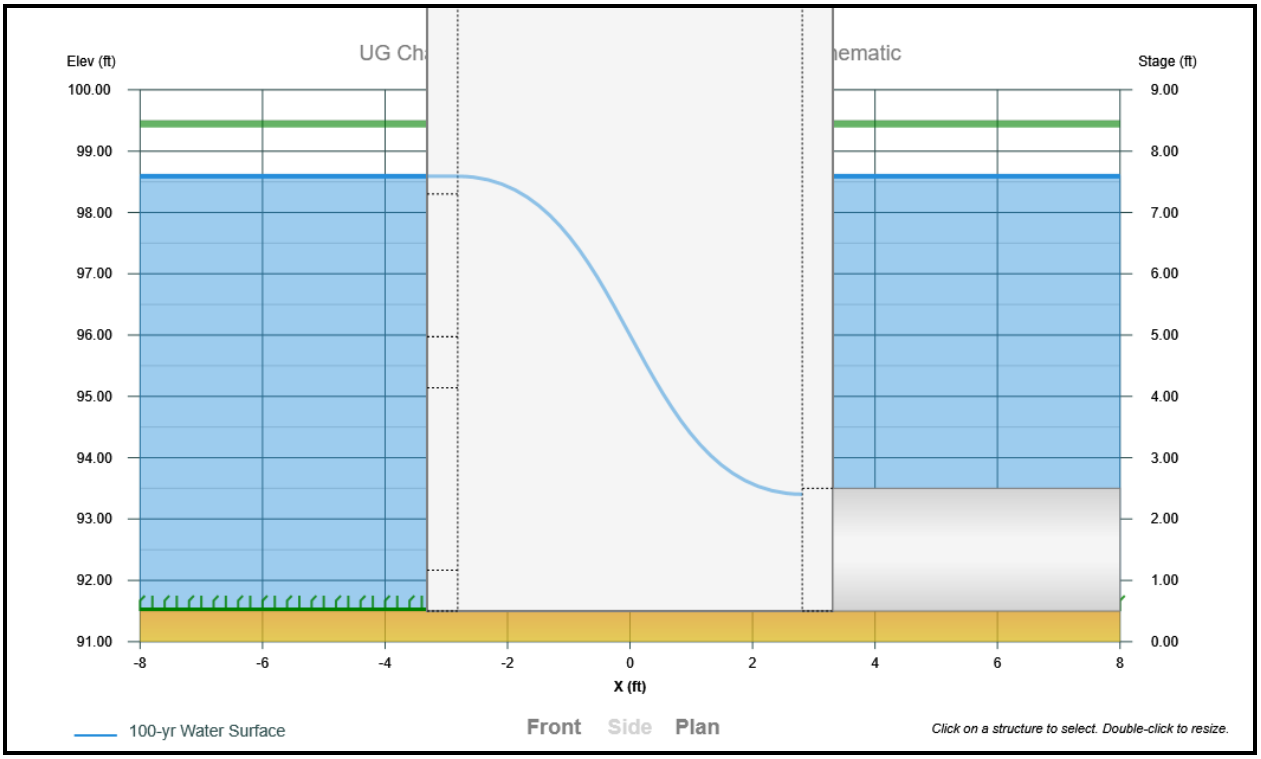


Figure 11. Profile of Routing thru OCS at 100-Year Return Period

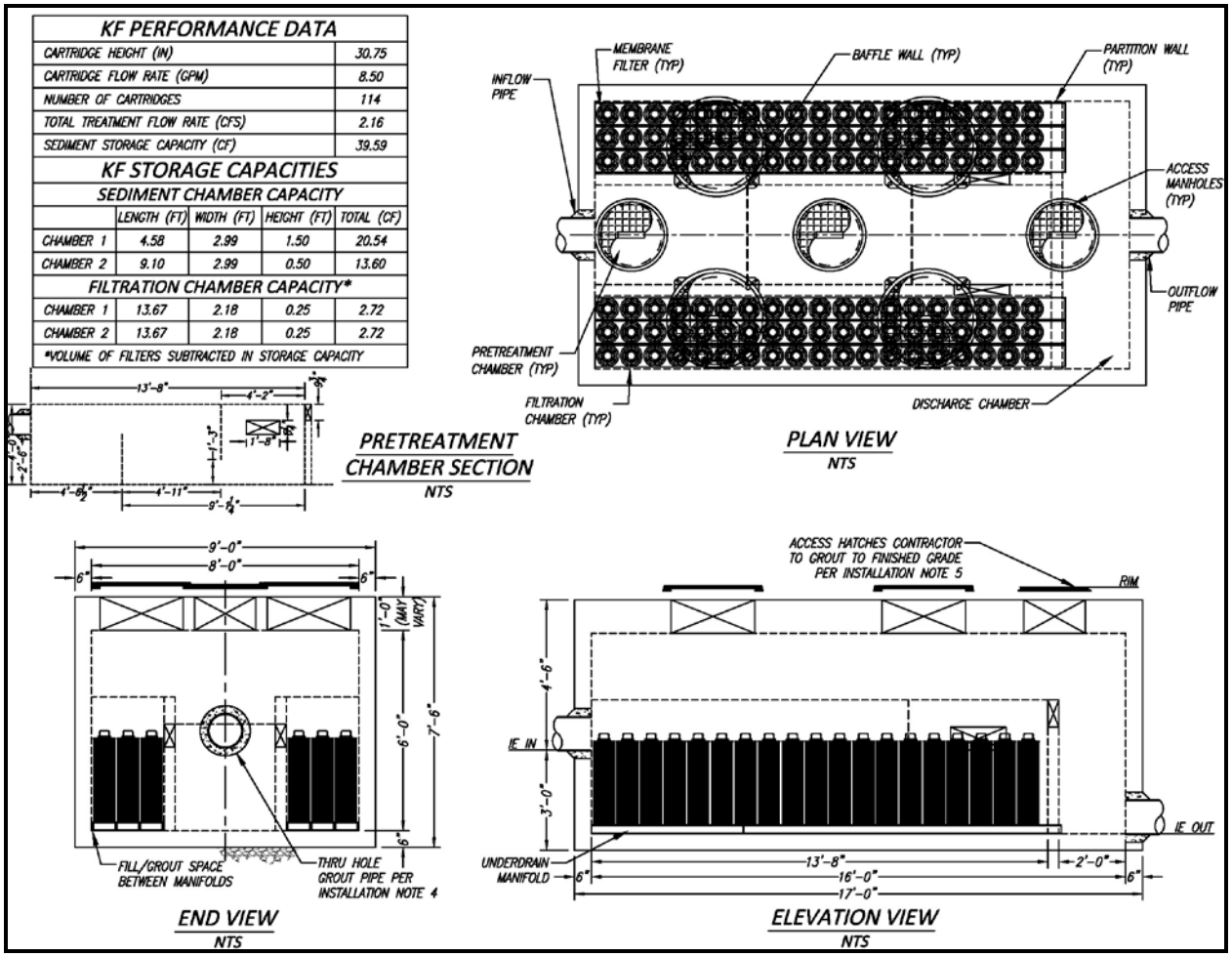


WATER QUALITY MEASURES

REMOVAL OF TOTAL SUSPENDED SOLIDS (TSS)

In accordance with Chapter 4 of the New Jersey Storm Water Best Management Practices Manual (BMPM), the proposed stormwater management facility is required to meet the Stormwater Pollutant Removal Criteria of 80% removal of total suspended solids (TSS). The TSS removal requirement for the Water Quality Storm (WQS) will be provided by two (2) Kraken Model KF8-16 (see Figure 12) with a total treatment flow rate of 4.32 cfs. This is above the peak outflow WQS of 3.82 cfs[2] as shown in the Figure 13 below.

Figure 12. Kraken Model KF8-16 Membrane Filtration System with Pre-Treatment



[2] Calculated using Water Quality Storm method outlined in the New Jersey BMP Manual (Section 9.6 – Manufactured Treatment Devices)

Figure 13. Water Quality Storm Analysis

Water Quality Drainage Areas

ROW Driveway & Sidewalk	=	7,638.9	sf
Road	=	35,073.7	sf
Onsite Driveways	=	9,800.0	sf
Total	=	52,512.6	sf
		1.206	ac

Water Quality Flow (for MTDs) (based on peak flow)

$Q_{(WQS)}$	=	CiA where I = 3.20 in/hr (for Tc=10 min for MTDs)	
C	=	0.99	
$I_{(MTD\text{-}PEAK\ RUNOFF\ RATE)}$	=	3.20	in/hr
A	=	1.206	acres
$Q_{(WQS)}$	=	3.82	cfs

GROUNDWATER RECHARGE

In accordance with Chapter 6 of the BMP manual, compliance with one of the following two groundwater recharge standards is required:

1. "That 100% of the site's average annual pre-developed groundwater recharge volume be maintained after development;" or
2. "That 100% of the difference between the site's pre- and post-development 2-year runoff volumes be infiltrated."

No groundwater recharges are required in Planning Area 1 (PA1).

OFF-SITE DRAINAGE

The site has been developed in accordance with the New Jersey BMP Manual which reduces offsite development flows as shown in Table 5 above (which is also shown below as Table 6).

Table 6. Post Development Flow Summary

Return Period	Pre-Development Peak Outflow (cfs)	Allowable Reduction (%)	Allowable Post Development Peak Outflow (cfs)	Calculated Outflow (cfs)
2	8.08	50%	4.04	4.00
10	10.85	75%	8.14	7.94
100	17.90	80%	14.32	14.32

The point of discharge will be connected to an existing drainage inlet on Green Grove Road (Q_1 in the Figure below). This inlet receives runoff from an area identified as A_{TOT} in Figure 14 below. The inlet also receives runoff via an existing Outlet Control structure for the existing development to the rear of the proposed development (Q_3 and Q_4 in the Figure below). The sum of the inflow rates is denoted by Q_5 in the Figure below.

Figure 14. Receiving Drainage Pipe Stormwater Inflow Calculation

Q_1	**=**	**14.32**	**=**	**(cfs) max inflow from Development (see Page 30 of Stormwater Analysis)**
A_R	=	0.49	=	(ac) Road Drainage Area on Green Grove Road (from 30' south of West Bangs Avenue to 20' north of Squirrel Road)_see pictures below
C_R	=	0.99	=	Coefficient (Roadway)
A_R	=	0.49	=	(ac) Road Drainage Area on Green Grove Road (from 30' south of West Bangs Avenue to 20' north of Squirrel Road)_see pictures below
C_R	=	0.99	=	Coefficient (Roadway)
A_P	=	2.81	=	(ac) 670 ft from HP south of West Bangs Avenue to Drainage Inlet. Lot depth = 182.49 ft (from Tax Map on East side of Green Grove Road
C_P	=	0.55	=	Coefficient (1/4 ac lot w/ HSG B per RSIS Table 7.1)
C_{WA}	=	0.62	=	Weighted Coefficient
A_{TOT}	=	3.29	=	(ac) Total Offsite area draining to inlet = $A_R + A_P$
i	=	6.30	=	(in/hr) 25 year design storm use to size drainage
Q_2	**=**	**12.76**	**=**	**(cfs) Flow from Green Grove Road** = C_{WA} x A_{TOT} x i
Orifice El	=	82.52	=	(ft) Elev of Orifice per survey
Co	=	0.61	=	Orifice Coefficient
D	=	9.50	=	(in) = Orifice Diameter (see picture below)
A	=	0.49	=	(sf) Orifice Area
g	=	32.20	=	(ft/s^2)gravitational constant
h	=	2.06	=	(ft) max height of water above center of orifice before weir (see picture below)
k	=	1	=	constant
Nb	=	1	=	number of orifice(s)
Q_3	**=**	**3.46**	**=**	**[C_oA x sqrt (2gh/k)] x Nb = Max flow thru orifice**
C_w	=	3.33	=	Weir Coefficient
H	=	0.96	=	(ft) Max height of water surface above weir (see picture below)
L		1.00	=	(ft) Length of Weir (see picture below)
Q_4		**3.19**	**=**	**(cfs) Max weir discharge = $C_wLH^{1.5}$**
Q_5	**=**	**33.73**	**=**	**(cfs) = max flow into pipe at upstream end = $Q_1 + Q_2 + Q_3 + Q_4$**

Figure 15. Green Grove Road showing typical property coverage upstream of receiving Drainage Inlet

Figure 16. Outlet Control Structure for Development at rear/south of Project Area

Figure 17. Weir Height (H)

Figure 18. Weir Length (L)

The capacity of the receiving pipe is shown in Figure 19 below. The pipe flowrate capacity of 38.82 cfs exceeds the calculated stormwater inflow flowrate of 33.73 cfs. The capacity of the existing offsite drainage infrastructure is sufficient to accommodate the proposed outfall connection from the detention system for the proposed project with a 5.09 cfs (13.11%) reserve capacity.

Figure 19. Receiving Drainage Pipe Capacity

Pipe ID	Upstream Inv. (ft)	Downstream Inv. (ft)	Pipe Dia (in.)	Pipe Length (ft)	Mannings Coeff (n)	A - Area (sf)	P - Perimeter (ft)	R = A/P	Slope (ft/ft)	Q (cfs)
1-2	82.45	81.39	24	36	0.013	3.14	6.28	0.5	0.0294	**38.82**

OPERATIONS AND MAINTENANCE

The Kraken KF8-16 Maintenance Manual and is attached in Appendix 4 of this report. The system will be maintained per this manual. Maintenance of the Rainstore3™ basin will be performed pursuant to the Manufacturer's recommendations per Appendix 5 of this report.

CONCLUSIONS

The proposed stormwater management system has been designed to meet the BMP water quantity control, and water quality standards per the New Jersey Stormwater Management rules for major development. The existing offsite drainage system is sufficient to accommodate the new outfall from the proposed development.

APPENDIX 1
STORMWATER ANALYSIS REPORT

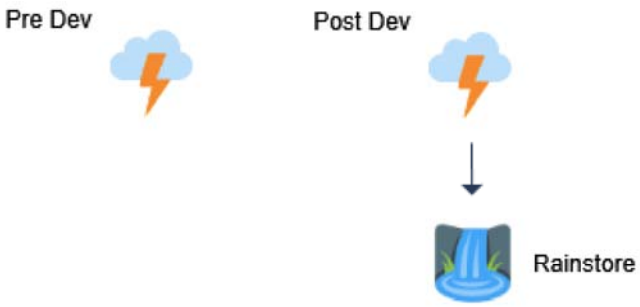
Table of Contents

Basin Model

Hydrology Studio v 3.0.0.16

Project Name: 3128 West Bangs Avenue

09-17-2020



Hydrograph by Return Period

Project Name: 3128 West Bangs Avenue

09-17-2020

Hydrology Studio v 3.0.0.16

Hyd. No.	Hydrograph Type	Hydrograph Name	Peak Outflow (cfs)							
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
1	Mod Rational	Post Dev		6.213			9.901			15.40
2	Rational	Pre Dev		8.079			10.85			17.90
3	Pond Route	Rainstore		3.998			7.939			14.32

Hydrograph 2-yr Summary

Project Name: 3128 West Bangs Avenue

09-17-2020

Hydrology Studio v 3.0.0.16

Hyd. No.	Hydrograph Type	Hydrograph Name	Peak Flow (cfs)	Time to Peak (hrs)	Hydrograph Volume (cuft)	Inflow Hyd(s)	Maximum Elevation (ft)	Maximum Storage (cuft)
1	Mod Rational	Post Dev	6.213	0.17	15,283	----		
2	Rational	Pre Dev	8.079	0.17	4,847	----		
3	Pond Route	Rainstore	3.998	0.73	14,891	1	95.52	9,138

Hydrograph Report

Project Name: 3128 West Bangs Avenue

Hydrology Studio v 3.0.0.16

09-17-2020

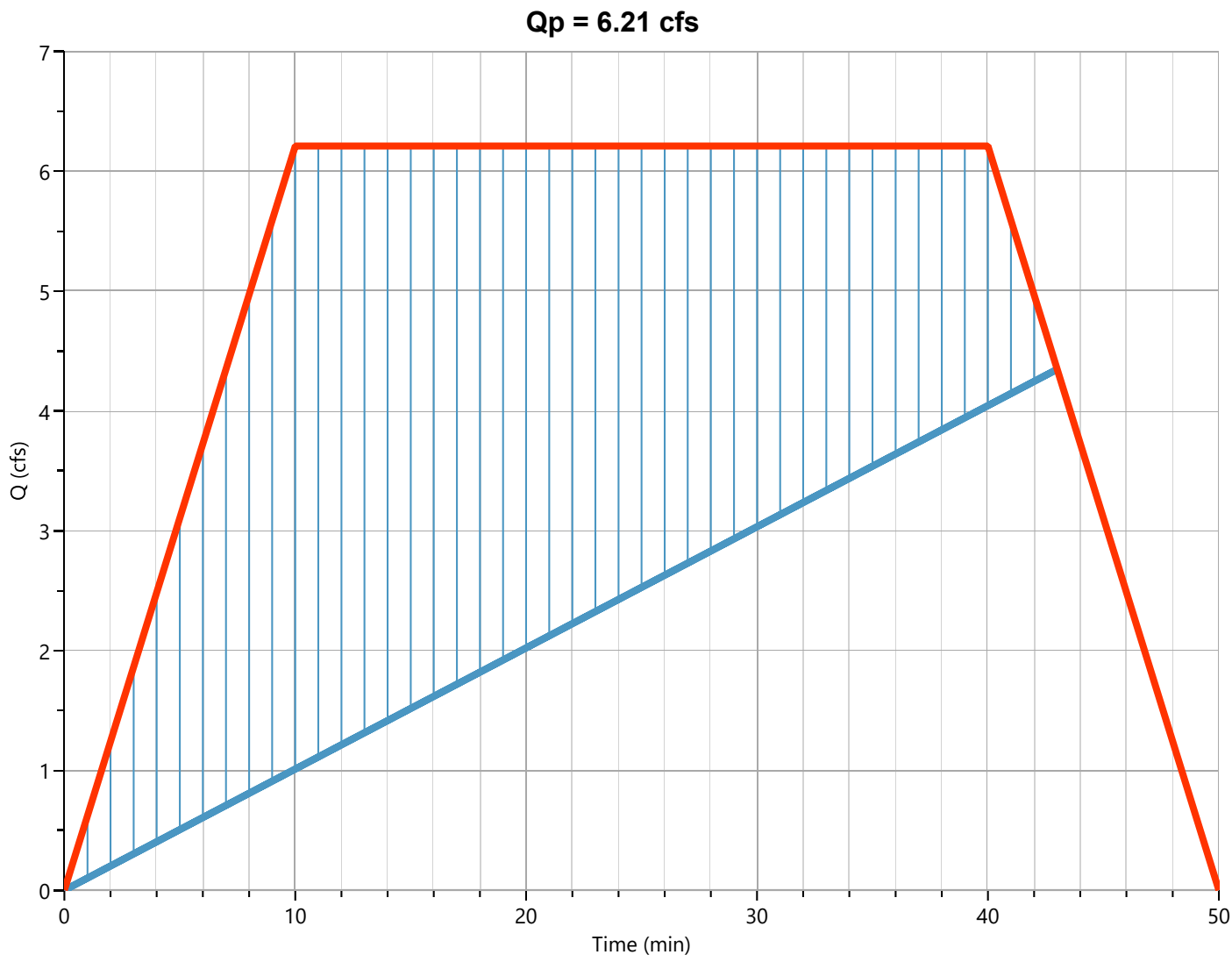
Post Dev

Hyd. No. 1

Hydrograph Type	= Mod Rational	Peak Flow	= 6.213 cfs
Storm Frequency	= 2-yr	Time to Peak	= 0.17 hrs
Time Interval	= 1 min	Runoff Volume	= 15,283 cuft
Drainage Area	= 6.12 ac	Runoff Coeff.	= 0.54*
Tc Method	= User	Time of Conc. (Tc)	= 10.0 min
IDF Curve	= West Bangs AvenueNeptune.idf	Intensity	= 1.88 in/hr
Freq. Corr. Factor	= 1.00	Storm Duration	= 4.1 x Tc
Target Q	= 4.040 cfs	Required Storage	= 9,224 cuft

*** Composite C Worksheet**

AREA (ac)	C	DESCRIPTION
2.14	0.99	Impervious (ROW + Site)
3.98	0.30	Pervious (ROW + Site)
6.12	**0.54**	



Hydrograph Discharge Table

Time (min)	Outflow (cfs)	Time (min)	Outflow (cfs)	Time (min)	Outflow (cfs)	Time (min)	Outflow (cfs)	Time (min)	Outflow (cfs)
1	0.621	37	6.213						
2	1.243	38	6.213						
3	1.864	39	6.213						
4	2.485	40	6.213						
5	3.106	41	5.591						
6	3.728	42	4.970						
7	4.349	43	4.349						
8	4.970	44	3.728						
9	5.591	45	3.106						
10	**6.213**	46	2.485						
11	6.213	47	1.864						
12	6.213	48	1.243						
13	6.213	49	0.621						
14	6.213	50	0.000						
15	6.213	*...end*	*...end*						
16	6.213								
17	6.213								
18	6.213								
19	6.213								
20	6.213								
21	6.213								
22	6.213								
23	6.213								
24	6.213								
25	6.213								
26	6.213								
27	6.213								
28	6.213								
29	6.213								
30	6.213								
31	6.213								
32	6.213								
33	6.213								
34	6.213								
35	6.213								
36	6.213								

Printed values > 1% of Qpeak. nth-point print interval = 1

Hydrograph Report

Project Name: 3128 West Bangs Avenue

Hydrology Studio v 3.0.0.16

09-17-2020

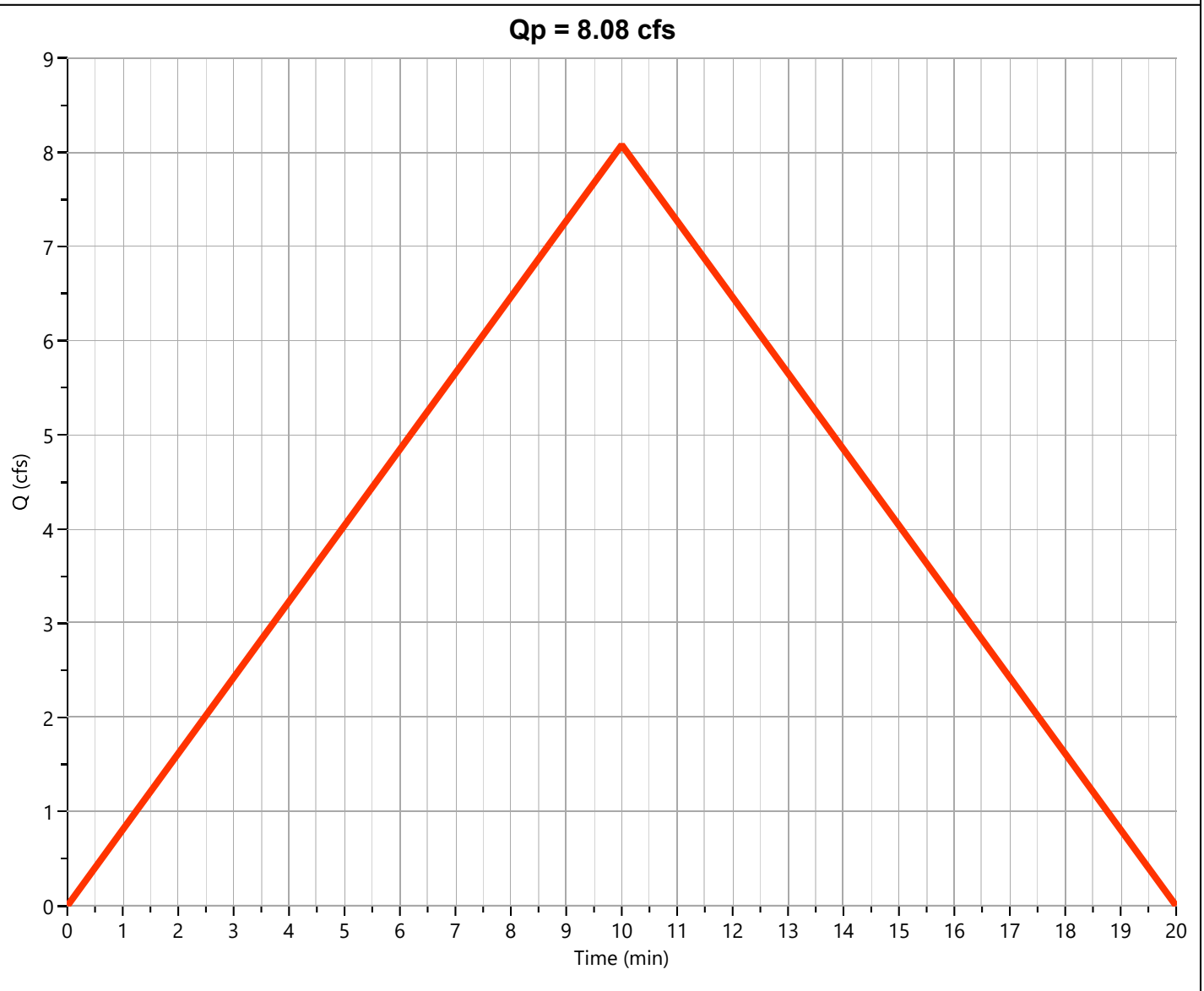
Pre Dev

Hyd. No. 2

Hydrograph Type	= Rational	Peak Flow	= 8.079 cfs
Storm Frequency	= 2-yr	Time to Peak	= 0.17 hrs
Time Interval	= 1 min	Runoff Volume	= 4,847 cuft
Drainage Area	= 6.12 ac	Runoff Coeff.	= 0.33*
Tc Method	= User	Time of Conc. (Tc)	= 10.0 min
IDF Curve	= West Bangs AvenueNeptune.idf	Intensity	= 4.00 in/hr
Freq. Corr. Factor	= 1.00	Asc/Rec Limb Factors	= 1/1

*** Composite C Worksheet**

AREA (ac)	C	DESCRIPTION
0.168	0.99	Buildings
0.14	0.99	Site Impervious
5.813	0.30	Site Pervious
6.12	**0.33**	



Hydrograph Discharge Table

Dev

Time (min)	Outflow (cfs)	Time (min)	Outflow (cfs)	Time (min)	Outflow (cfs)	Time (min)	Outflow (cfs)	Time (min)	Outflow (cfs)
1	0.808								
2	1.616								
3	2.424								
4	3.232								
5	4.040								
6	4.847								
7	5.655								
8	6.463								
9	7.271								
10	**8.079**								
11	7.271								
12	6.463								
13	5.655								
14	4.847								
15	4.040								
16	3.232								
17	2.424								
18	1.616								
19	0.808								
20	0.000								
...end	*...end*								

Printed values > 1% of Qpeak. nth-point print interval = 1

Hydrograph Report

Hydrology Studio v 3.0.0.16

09-17-2020

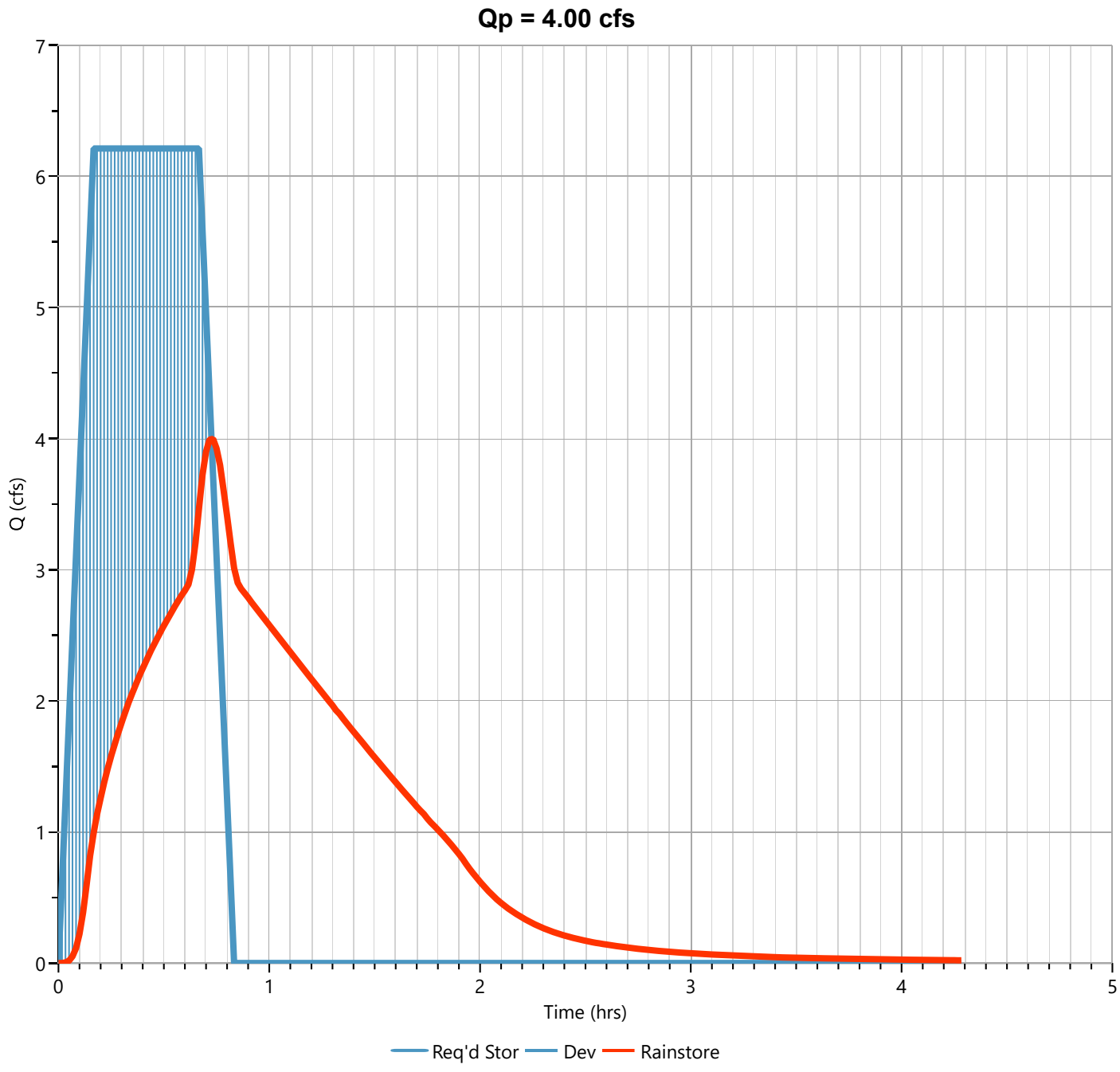
Rainstore

Hyd. No. 3

Hydrograph Type	= Pond Route	Peak Flow	= 3.998 cfs
Storm Frequency	= 2-yr	Time to Peak	= 0.73 hrs
Time Interval	= 1 min	Hydrograph Volume	= 14,891 cuft
Inflow Hydrograph	= 1 - Dev	Max. Elevation	= 95.52 ft
Pond Name	= UG ChamberInvisible Structures	Max. Storage	= 9,138 cuft

Pond Routing by Storage Indication Method

Center of mass detention time = 37 min



Hydrograph Discharge Table

Time (hrs)	Outflow (cfs)	Time (hrs)	Outflow (cfs)	Time (hrs)	Outflow (cfs)	Time (hrs)	Outflow (cfs)	Time (hrs)	Outflow (cfs)
0.07	0.050	0.67	3.463	1.27	2.029	1.87	0.897	2.47	0.182
0.08	0.113	0.68	3.723	1.28	1.998	1.88	0.865	2.48	0.176
0.10	0.222	0.70	3.900	1.30	1.965	1.90	0.831	2.50	0.170
0.12	0.384	0.72	3.992	1.32	1.928	1.92	0.796	2.52	0.164
0.13	0.589	**0.73**	**3.998**	1.33	1.900	1.93	0.757	2.53	0.158
0.15	0.816	0.75	3.926	1.35	1.863	1.95	0.719	2.55	0.154
0.17	0.992	0.77	3.798	1.37	1.830	1.97	0.684	2.57	0.149
0.18	1.135	0.78	3.610	1.38	1.799	1.98	0.651	2.58	0.144
0.20	1.258	0.80	3.409	1.40	1.763	2.00	0.620	2.60	0.140
0.22	1.374	0.82	3.199	1.42	1.733	2.02	0.589	2.62	0.136
0.23	1.482	0.83	3.012	1.43	1.699	2.03	0.560	2.63	0.132
0.25	1.576	0.85	2.901	1.45	1.665	2.05	0.531	2.65	0.128
0.27	1.668	0.87	2.854	1.47	1.636	2.07	0.505	2.67	0.124
0.28	1.754	0.88	2.821	1.48	1.600	2.08	0.479	2.68	0.120
0.30	1.835	0.90	2.787	1.50	1.569	2.10	0.457	2.70	0.116
0.32	1.914	0.92	2.750	1.52	1.537	2.12	0.436	2.72	0.113
0.33	1.989	0.93	2.715	1.53	1.505	2.13	0.416	2.73	0.110
0.35	2.058	0.95	2.683	1.55	1.474	2.15	0.397	2.75	0.107
0.37	2.122	0.97	2.646	1.57	1.441	2.17	0.379	2.77	0.105
0.38	2.188	0.98	2.611	1.58	1.409	2.18	0.362	2.78	0.102
0.40	2.249	1.00	2.579	1.60	1.378	2.20	0.346	2.80	0.100
0.42	2.305	1.02	2.542	1.62	1.345	2.22	0.331	2.82	0.097
0.43	2.366	1.03	2.507	1.63	1.317	2.23	0.316	2.83	0.095
0.45	2.417	1.05	2.476	1.65	1.283	2.25	0.302	2.85	0.092
0.47	2.474	1.07	2.439	1.67	1.254	2.27	0.289	2.87	0.090
0.48	2.522	1.08	2.404	1.68	1.224	2.28	0.276	2.88	0.088
0.50	2.575	1.10	2.373	1.70	1.193	2.30	0.265	2.90	0.086
0.52	2.620	1.12	2.336	1.72	1.163	2.32	0.255	2.92	0.084
0.53	2.669	1.13	2.301	1.73	1.136	2.33	0.245	2.93	0.082
0.55	2.713	1.15	2.270	1.75	1.102	2.35	0.235	2.95	0.080
0.57	2.757	1.17	2.233	1.77	1.071	2.37	0.226	2.97	0.078
0.58	2.803	1.18	2.199	1.78	1.046	2.38	0.217	2.98	0.076
0.60	2.840	1.20	2.168	1.80	1.019	2.40	0.209	3.00	0.074
0.62	2.888	1.22	2.131	1.82	0.988	2.42	0.202	3.02	0.072
0.63	2.999	1.23	2.098	1.83	0.956	2.43	0.195	3.03	0.071
0.65	3.204	1.25	2.066	1.85	0.927	2.45	0.188	3.05	0.069

Printed values > 1% of Qpeak. nth-point print interval = 1

Time (hrs)	Outflow (cfs)	Time (hrs)	Outflow (cfs)	Time (hrs)	Outflow (cfs)	Time (hrs)	Outflow (cfs)	Time (hrs)	Outflow (cfs)
3.07	0.068								
3.08	0.066								
3.10	0.065								
3.12	0.064								
3.13	0.062								
3.15	0.061								
3.17	0.060								
3.18	0.059								
3.20	0.057								
3.22	0.056								
3.23	0.055								
3.25	0.054								
3.27	0.053								
3.28	0.052								
3.30	0.051								
3.32	0.049								
3.33	0.048								
3.35	0.047								
3.37	0.046								
3.38	0.045								
3.40	0.045								
3.42	0.044								
3.43	0.043								
3.45	0.042								
3.47	0.041								
3.48	0.041								
3.50	0.040								
3.52	0.039								
...end	*...end*								

Printed values > 1% of Qpeak. nth-point print interval = 1

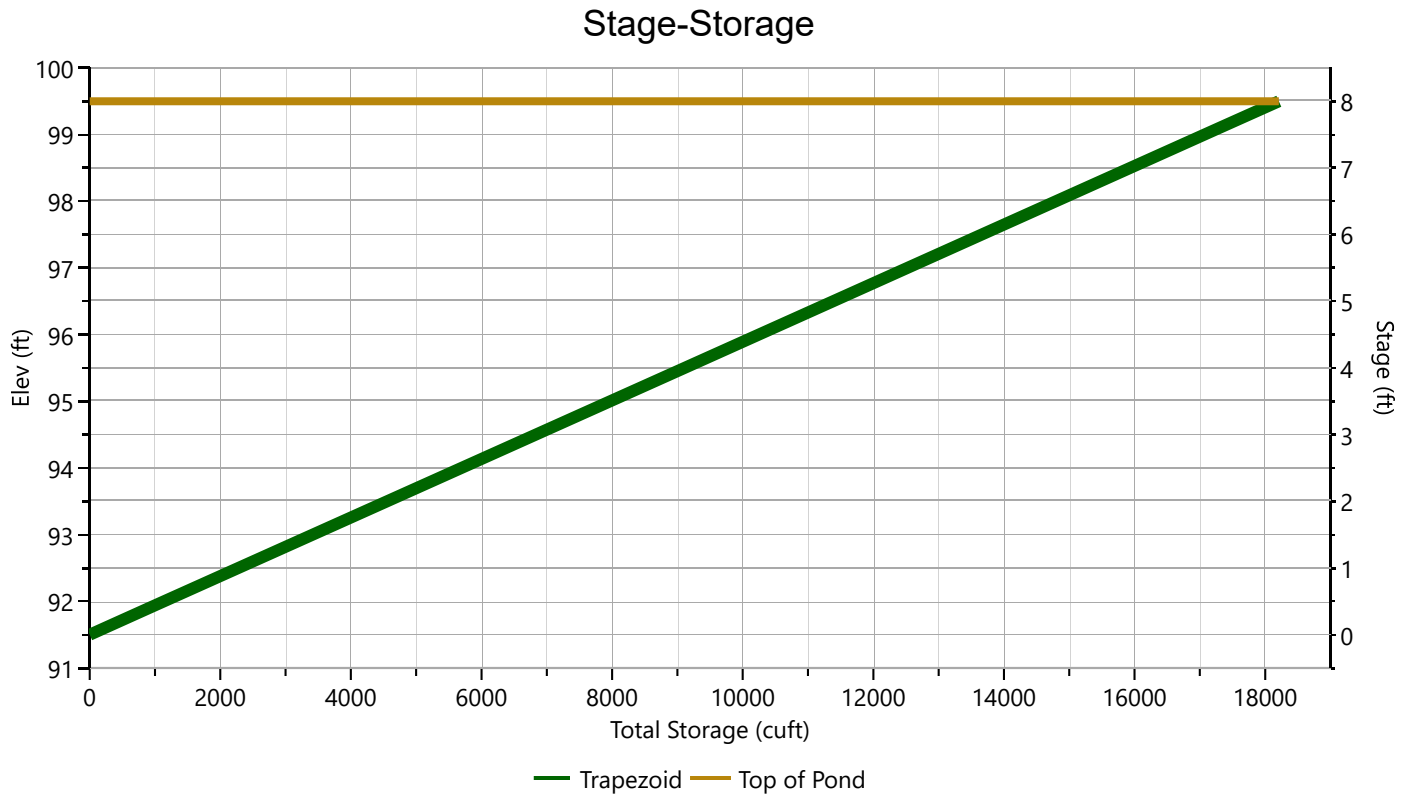
UG ChamberInvisible Structures

Stage-Storage

Trapezoid	
Description	**Input**
Bottom Elevation, ft	91.50
Bottom Length, ft	49.21
Bottom Width, ft	49.21
Side Slope, H:1	0.00
Total Depth, ft	8.00
Voids (%)	94.00

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour Area (sqft)	Incr. Storage (cuft)	Total Storage (cuft)
0.00	91.50	2,422	0.000	0.000
0.40	91.90	2,422	911	911
0.80	92.30	2,422	911	1,821
1.20	92.70	2,422	911	2,732
1.60	93.10	2,422	911	3,642
2.00	93.50	2,422	911	4,553
2.40	93.90	2,422	911	5,463
2.80	94.30	2,422	911	6,374
3.20	94.70	2,422	911	7,284
3.60	95.10	2,422	911	8,195
4.00	95.50	2,422	911	9,105
4.40	95.90	2,422	911	10,016
4.80	96.30	2,422	911	10,926
5.20	96.70	2,422	911	11,837
5.60	97.10	2,422	911	12,747
6.00	97.50	2,422	911	13,658
6.40	97.90	2,422	911	14,568
6.80	98.30	2,422	911	15,479
7.20	98.70	2,422	911	16,390
7.60	99.10	2,422	911	17,300
8.00	99.50	2,422	911	18,211

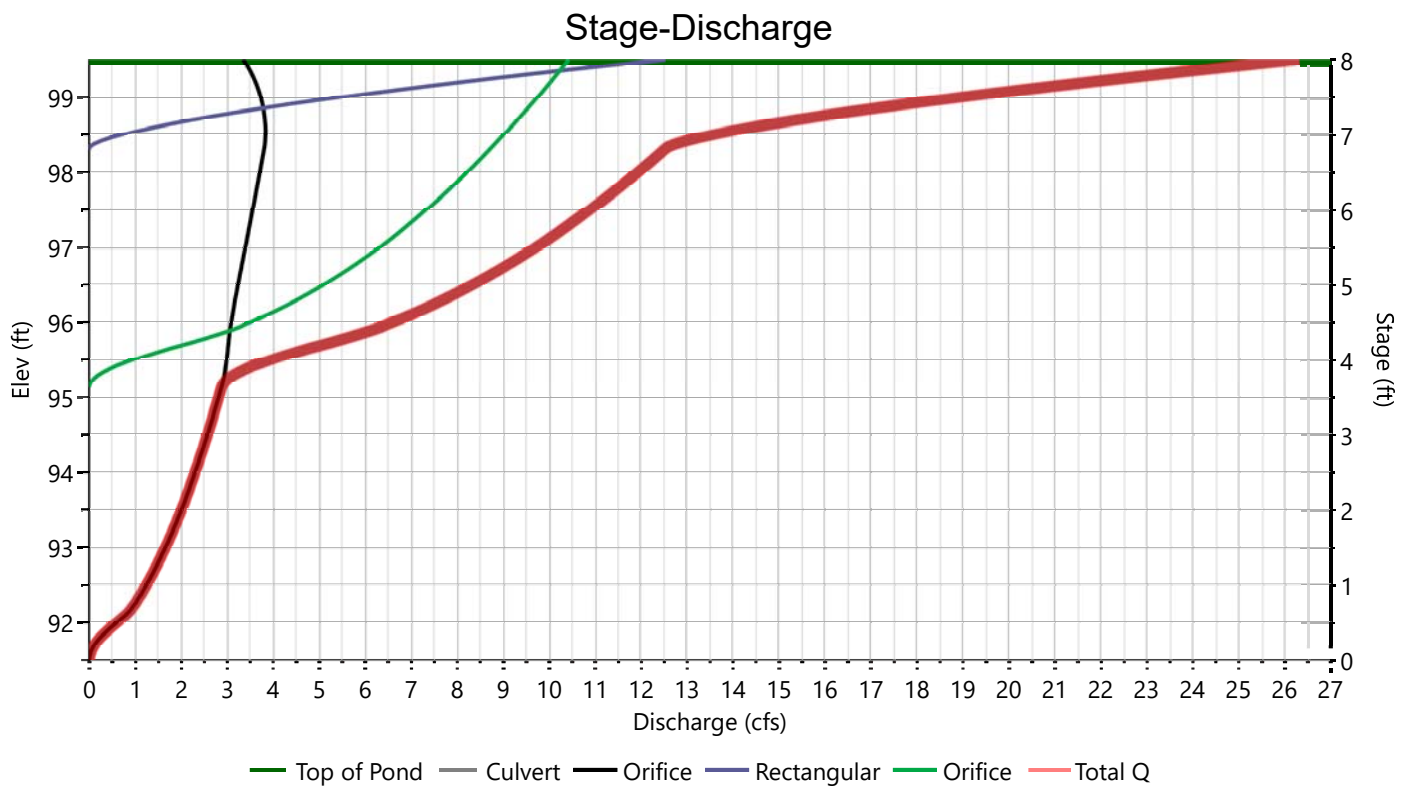


UG ChamberInvisible Structures

Stage-Discharge

Culvert / Orifices	Culvert	Orifices			Orifice Plate	
		1*	2*	3		
Rise, in	24	8	10		Orifice Dia, in	
Span, in	24	8	10		No. Orifices	
No. Barrels	1	1	2	1	Invert Elevation, ft	
Invert Elevation, ft	91.50	91.50	95.14	89.01	Height, ft	
Orifice Coefficient, Co	0.60	0.60	0.60	0.60	Orifice Coefficient, Co	
Length, ft	900					
Barrel Slope, %	1.61					
N-Value, n	0.013					
Weirs	**Riser***	**Weirs**			**Ancillary**	
		1*	2	3		
Shape / Type	Box	Rectangular			Exfiltration, in/hr	
Crest Elevation, ft	101.5	98.33				
Crest Length, ft	20	3				
Angle, deg						
Weir Coefficient, Cw	3.3	3.3				

*Routes through Culvert.



UG ChamberInvisible Structures

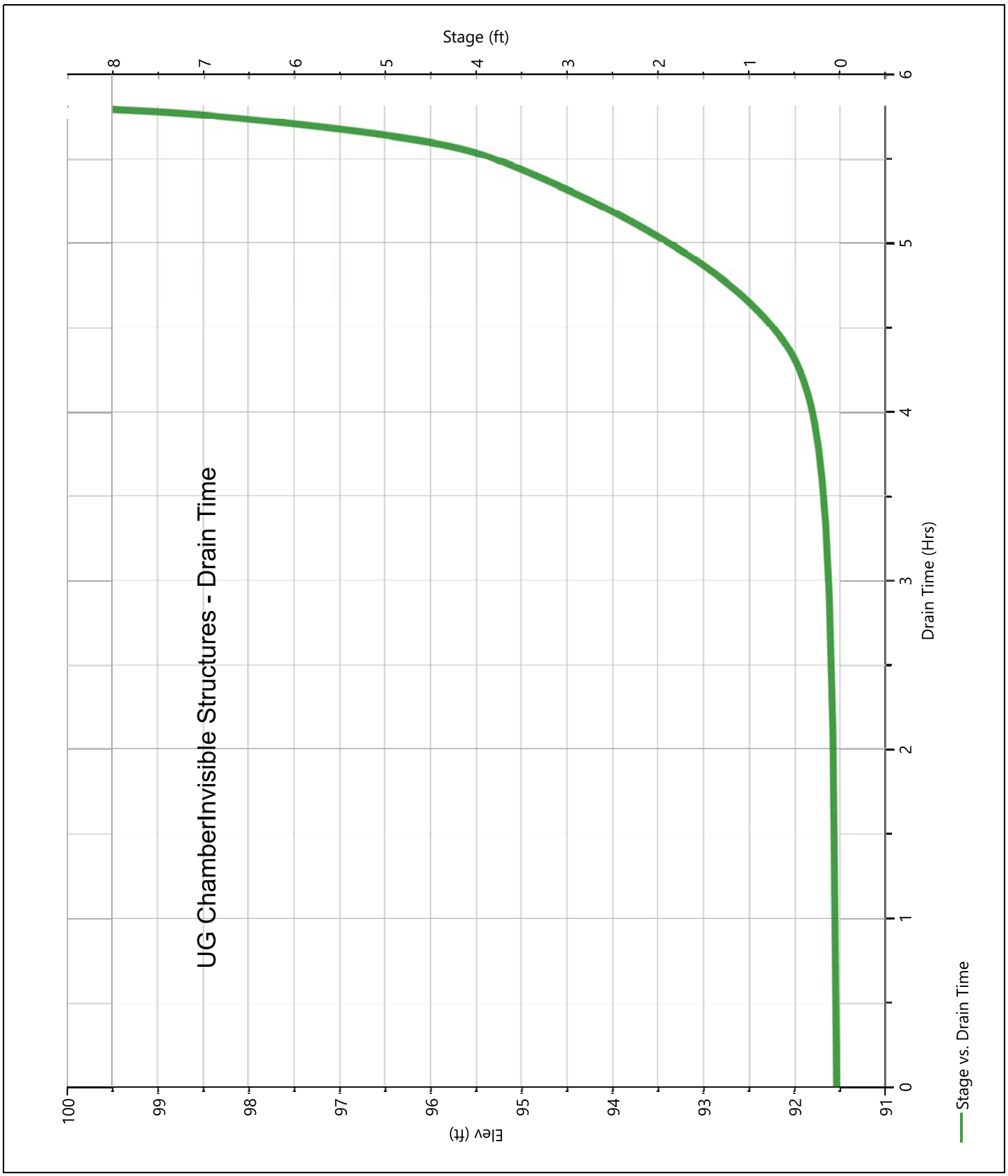
Stage-Storage-Discharge Summary

Stage (ft)	Elev. (ft)	Storage (cuft)	Culvert (cfs)	Orifices, cfs			Riser (cfs)	Weirs, cfs			Pf Riser (cfs)	Exfil (cfs)	User (cfs)	Total (cfs)
				1	2	3		1	2	3				
0.00	91.50	0.000	0.000	0.000	0.000		0.000	0.000						0.000
0.40	91.90	911	0.409 ic	0.409	0.000		0.000	0.000						0.409
0.80	92.30	1,821	1.046 ic	1.046	0.000		0.000	0.000						1.046
1.20	92.70	2,732	1.420 ic	1.420	0.000		0.000	0.000						1.420
1.60	93.10	3,642	1.733 ic	1.733	0.000		0.000	0.000						1.733
2.00	93.50	4,553	2.002 ic	2.002	0.000		0.000	0.000						2.002
2.40	93.90	5,463	2.244 ic	2.244	0.000		0.000	0.000						2.244
2.80	94.30	6,374	2.466 ic	2.466	0.000		0.000	0.000						2.466
3.20	94.70	7,284	2.670 ic	2.670	0.000		0.000	0.000						2.670
3.60	95.10	8,195	2.859 ic	2.859	0.000		0.000	0.000						2.859
4.00	95.50	9,105	3.925 ic	2.988	0.937		0.000	0.000						3.925
4.40	95.90	10,016	6.164 ic	3.063	3.102		0.000	0.000						6.164
4.80	96.30	10,926	7.702 ic	3.174	4.528		0.000	0.000						7.702
5.20	96.70	11,837	8.917 ic	3.302	5.615		0.000	0.000						8.917
5.60	97.10	12,747	9.952 ic	3.428	6.524		0.000	0.000						9.952
6.00	97.50	13,658	10.88 ic	3.556	7.321		0.000	0.000						10.88
6.40	97.90	14,568	11.72 ic	3.679	8.039		0.000	0.000						11.72
6.80	98.30	15,479	12.50 ic	3.801	8.698		0.000	0.000						12.50
7.20	98.70	16,390	15.36 ic	3.821	9.311		0.000	2.230						15.36
7.60	99.10	17,300	20.26 ic	3.684	9.886		0.000	6.691						20.26
8.00	99.50	18,211	26.31 ic	3.350	10.43		0.000	12.53						26.31

Suffix key: ic = inlet control, oc = outlet control, s = submerged weir

UG ChamberInvisible Structures

Pond Drawdown



Design Storm Report

Custom Storm filename: West Bangs AvenueNeptune 2.cds

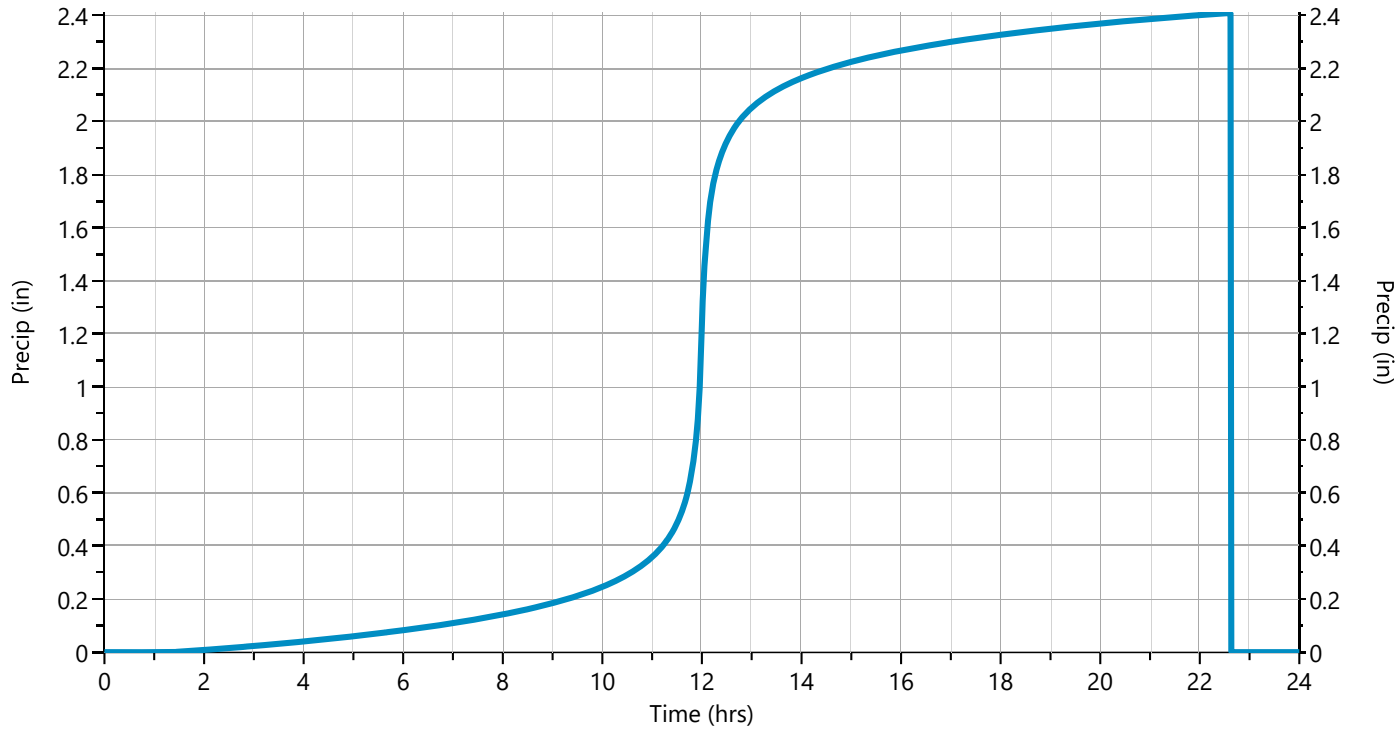
Hydrology Studio v 3.0.0.16

09-17-2020

Storm Distribution: IDF Based - Synthetic

Storm Duration	Total Rainfall Volume (in)								
	1-yr	✔ 2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
24 hrs	2.10	2.45	0	3.67	4.64	6.30	8.08	10.05	

Incremental Rainfall Distribution, 2-yr									
Time (hrs)	Precip (in)	Time (hrs)	Precip (in)	Time (hrs)	Precip (in)	Time (hrs)	Precip (in)	Time (hrs)	Precip (in)
11.50	0.006480	11.68	0.011062	11.87	0.027026	12.05	0.059608	12.23	0.016135
11.52	0.006747	11.70	0.011762	11.88	0.030374	12.07	0.049946	12.25	0.014944
11.53	0.007035	11.72	0.012543	11.90	0.034471	12.08	0.042601	12.27	0.013895
11.55	0.007345	11.73	0.013418	11.92	0.039568	12.10	0.036875	12.28	0.012967
11.57	0.007681	11.75	0.014403	11.93	0.046035	12.12	0.032315	12.30	0.012142
11.58	0.008045	11.77	0.015520	11.95	0.054430	12.13	0.028619	12.32	0.011403
11.60	0.008440	11.78	0.016793	11.97	0.065635	12.15	0.025576	12.33	0.010739
11.62	0.008872	11.80	0.018256	11.98	0.081114	12.17	0.023038	12.35	0.010140
11.63	0.009344	11.82	0.019948	**12.00**	**0.103444**	12.18	0.020896	12.37	0.009596
11.65	0.009861	11.83	0.021923	12.02	0.091192	12.20	0.019070	12.38	0.009102
11.67	0.010432	11.85	0.024252	12.03	0.072715	12.22	0.017498	12.40	0.008651



Hydrograph 10-yr Summary

Project Name: 3128 West Bangs Avenue

09-17-2020

Hydrology Studio v 3.0.0.16

Hyd. No.	Hydrograph Type	Hydrograph Name	Peak Flow (cfs)	Time to Peak (hrs)	Hydrograph Volume (cuft)	Inflow Hyd(s)	Maximum Elevation (ft)	Maximum Storage (cuft)
1	Mod Rational	Post Dev	9.901	0.17	20,198	----		
2	Rational	Pre Dev	10.85	0.17	6,511	----		
3	Pond Route	Rainstore	7.939	0.58	19,585	1	96.37	11,089

Hydrograph Report

Project Name: 3128 West Bangs Avenue

Hydrology Studio v 3.0.0.16

09-17-2020

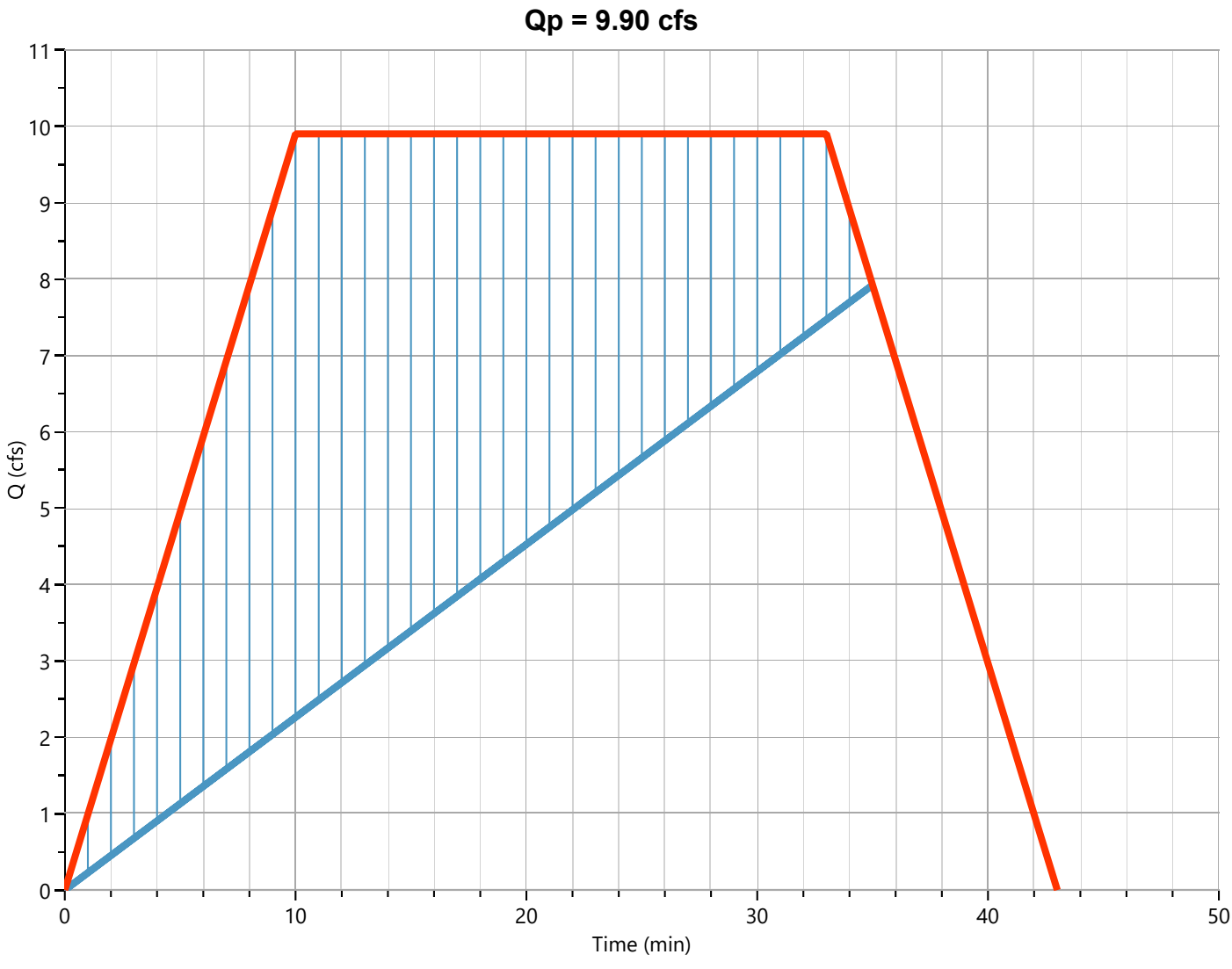
Post Dev

Hyd. No. 1

Hydrograph Type	= Mod Rational	Peak Flow	= 9.901 cfs
Storm Frequency	= 10-yr	Time to Peak	= 0.17 hrs
Time Interval	= 1 min	Runoff Volume	= 20,198 cuft
Drainage Area	= 6.12 ac	Runoff Coeff.	= 0.54*
Tc Method	= User	Time of Conc. (Tc)	= 10.0 min
IDF Curve	= West Bangs AvenueNeptune.idf	Intensity	= 3.00 in/hr
Freq. Corr. Factor	= 1.00	Storm Duration	= 3.4 x Tc
Target Q	= 8.138 cfs	Required Storage	= 9,701 cuft

*** Composite C Worksheet**

AREA (ac)	C	DESCRIPTION
2.14	0.99	Impervious (ROW + Site)
3.98	0.30	Pervious (ROW + Site)
6.12	**0.54**	



Hydrograph Discharge Table

Time (min)	Outflow (cfs)	Time (min)	Outflow (cfs)	Time (min)	Outflow (cfs)	Time (min)	Outflow (cfs)	Time (min)	Outflow (cfs)
1	0.990	37	5.941						
2	1.980	38	4.950						
3	2.970	39	3.960						
4	3.960	40	2.970						
5	4.950	41	1.980						
6	5.941	42	0.990						
7	6.931	43	0.000						
8	7.921	*...end*	*...end*						
9	8.911								
10	**9.901**								
11	9.901								
12	9.901								
13	9.901								
14	9.901								
15	9.901								
16	9.901								
17	9.901								
18	9.901								
19	9.901								
20	9.901								
21	9.901								
22	9.901								
23	9.901								
24	9.901								
25	9.901								
26	9.901								
27	9.901								
28	9.901								
29	9.901								
30	9.901								
31	9.901								
32	9.901								
33	9.901								
34	8.911								
35	7.921								
36	6.931								

Printed values > 1% of Qpeak. nth-point print interval = 1

Hydrograph Report

Project Name: 3128 West Bangs Avenue

Hydrology Studio v 3.0.0.16

09-17-2020

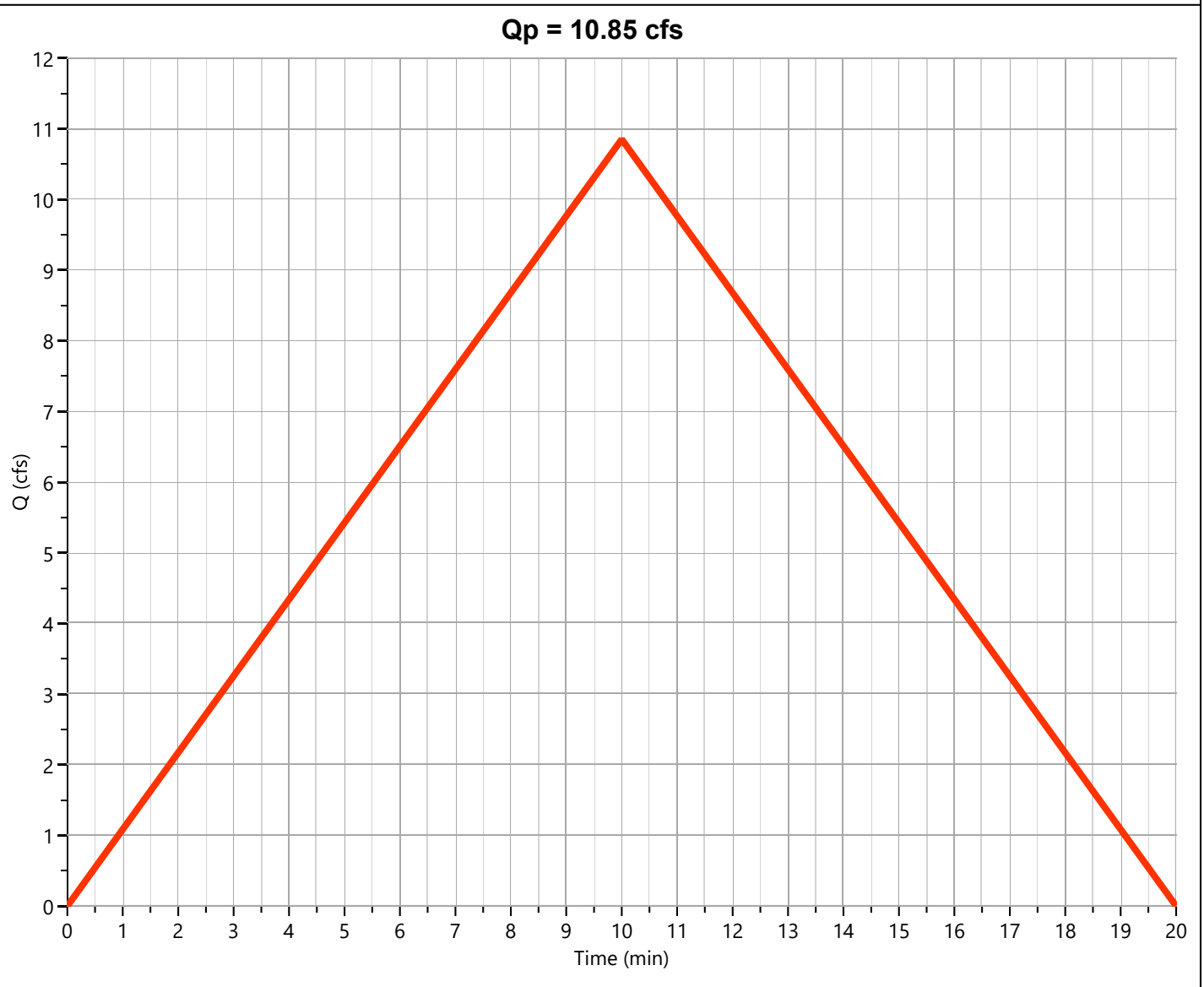
Pre Dev

Hyd. No. 2

Hydrograph Type	= Rational	Peak Flow	= 10.85 cfs
Storm Frequency	= 10-yr	Time to Peak	= 0.17 hrs
Time Interval	= 1 min	Runoff Volume	= 6,511 cuft
Drainage Area	= 6.12 ac	Runoff Coeff.	= 0.33*
Tc Method	= User	Time of Conc. (Tc)	= 10.0 min
IDF Curve	= West Bangs AvenueNeptune.idf	Intensity	= 5.37 in/hr
Freq. Corr. Factor	= 1.00	Asc/Rec Limb Factors	= 1/1

*** Composite C Worksheet**

AREA (ac)	C	DESCRIPTION
0.168	0.99	Buildings
0.14	0.99	Site Impervious
5.813	0.30	Site Pervious
6.12	**0.33**	



Hydrograph Discharge Table

Dev

Time (min)	Outflow (cfs)	Time (min)	Outflow (cfs)	Time (min)	Outflow (cfs)	Time (min)	Outflow (cfs)	Time (min)	Outflow (cfs)
1	1.085								
2	2.170								
3	3.255								
4	4.341								
5	5.426								
6	6.511								
7	7.596								
8	8.681								
9	9.766								
10	**10.85**								
11	9.766								
12	8.681								
13	7.596								
14	6.511								
15	5.426								
16	4.341								
17	3.255								
18	2.170								
19	1.085								
20	0.000								
...end	*...end*								

Printed values > 1% of Qpeak. nth-point print interval = 1

Hydrograph Report

Hydrology Studio v 3.0.0.16

09-17-2020

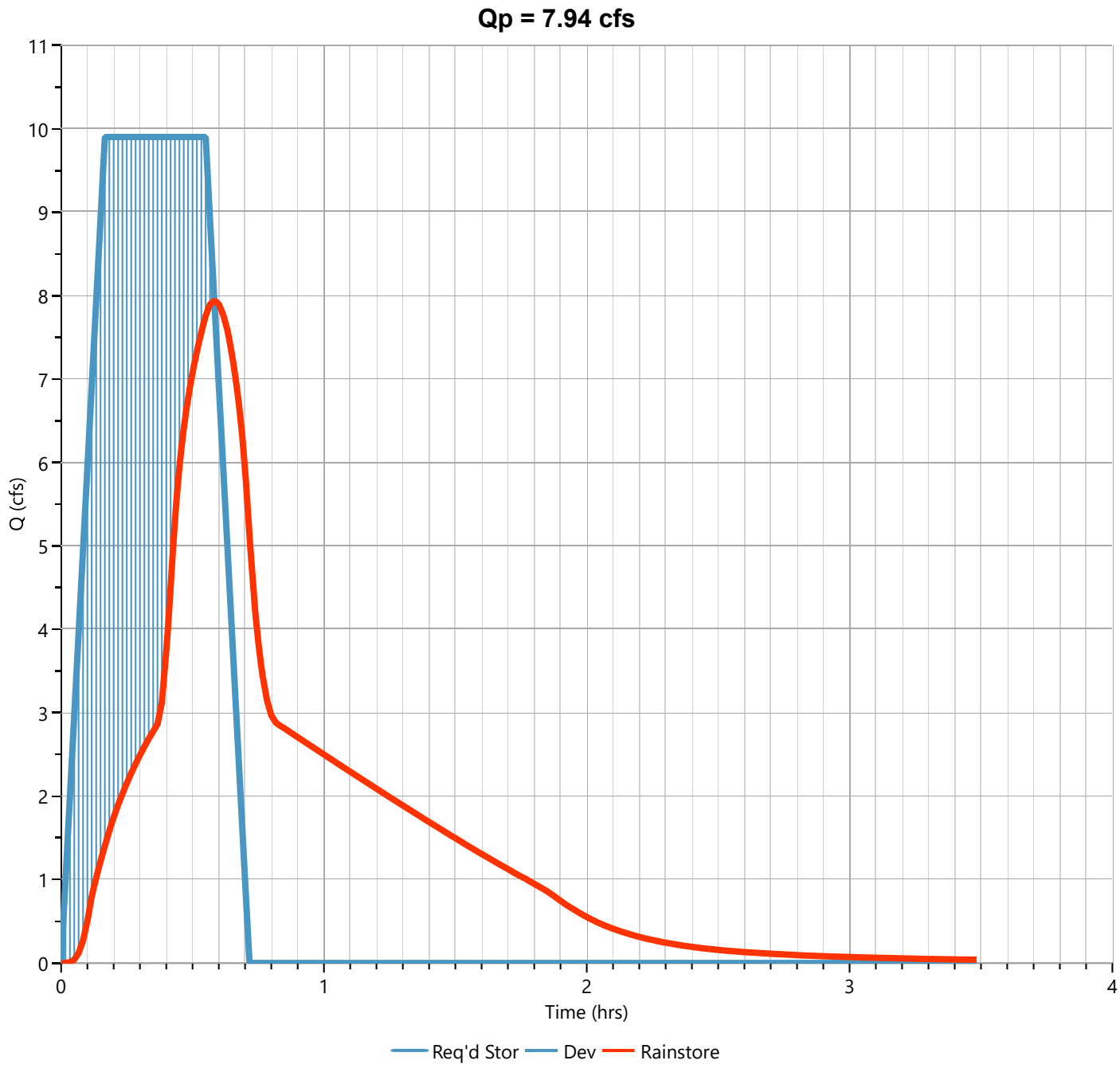
Rainstore

Hyd. No. 3

Hydrograph Type	= Pond Route	Peak Flow	= 7.939 cfs
Storm Frequency	= 10-yr	Time to Peak	= 0.58 hrs
Time Interval	= 1 min	Hydrograph Volume	= 19,585 cuft
Inflow Hydrograph	= 1 - Dev	Max. Elevation	= 96.37 ft
Pond Name	= UG ChamberInvisible Structures	Max. Storage	= 11,089 cuft

Pond Routing by Storage Indication Method

Center of mass detention time = 31 min



Hydrograph Discharge Table

Time (hrs)	Outflow (cfs)	Time (hrs)	Outflow (cfs)	Time (hrs)	Outflow (cfs)	Time (hrs)	Outflow (cfs)	Time (hrs)	Outflow (cfs)
0.07	0.119	0.67	6.942	1.27	1.954	1.87	0.821	2.47	0.168
0.08	0.269	0.68	6.488	1.28	1.919	1.88	0.785	2.48	0.162
0.10	0.504	0.70	5.904	1.30	1.890	1.90	0.746	2.50	0.157
0.12	0.796	0.72	5.146	1.32	1.853	1.92	0.708	2.52	0.152
0.13	1.022	0.73	4.408	1.33	1.822	1.93	0.674	2.53	0.148
0.15	1.214	0.75	3.854	1.35	1.789	1.95	0.642	2.55	0.143
0.17	1.406	0.77	3.439	1.37	1.753	1.97	0.611	2.57	0.139
0.18	1.583	0.78	3.148	1.38	1.724	1.98	0.580	2.58	0.135
0.20	1.746	0.80	2.967	1.40	1.689	2.00	0.551	2.60	0.131
0.22	1.896	0.82	2.882	1.42	1.657	2.02	0.524	2.62	0.127
0.23	2.026	0.83	2.843	1.43	1.625	2.03	0.497	2.63	0.123
0.25	2.156	0.85	2.812	1.45	1.590	2.05	0.473	2.65	0.119
0.27	2.275	0.87	2.776	1.47	1.561	2.07	0.451	2.67	0.115
0.28	2.385	0.88	2.739	1.48	1.527	2.08	0.430	2.68	0.112
0.30	2.490	0.90	2.707	1.50	1.497	2.10	0.410	2.70	0.109
0.32	2.591	0.92	2.672	1.52	1.464	2.12	0.392	2.72	0.106
0.33	2.687	0.93	2.635	1.53	1.431	2.13	0.374	2.73	0.104
0.35	2.777	0.95	2.602	1.55	1.401	2.15	0.358	2.75	0.101
0.37	2.863	0.97	2.569	1.57	1.368	2.17	0.342	2.77	0.099
0.38	3.120	0.98	2.532	1.58	1.337	2.18	0.327	2.78	0.096
0.40	3.746	1.00	2.498	1.60	1.307	2.20	0.312	2.80	0.094
0.42	4.516	1.02	2.465	1.62	1.274	2.22	0.298	2.82	0.092
0.43	5.299	1.03	2.428	1.63	1.246	2.23	0.285	2.83	0.089
0.45	5.935	1.05	2.395	1.65	1.215	2.25	0.273	2.85	0.087
0.47	6.413	1.07	2.362	1.67	1.184	2.27	0.262	2.87	0.085
0.48	6.765	1.08	2.325	1.68	1.155	2.28	0.252	2.88	0.083
0.50	7.071	1.10	2.292	1.70	1.127	2.30	0.242	2.90	0.081
0.52	7.332	1.12	2.260	1.72	1.091	2.32	0.232	2.92	0.079
0.53	7.559	1.13	2.223	1.73	1.063	2.33	0.223	*...end*	*...end*
0.55	7.757	1.15	2.190	1.75	1.038	2.35	0.215		
0.57	7.895	1.17	2.157	1.77	1.011	2.37	0.207		
0.58	**7.939**	1.18	2.121	1.78	0.979	2.38	0.200		
0.60	7.896	1.20	2.090	1.80	0.948	2.40	0.193		
0.62	7.774	1.22	2.055	1.82	0.919	2.42	0.186		
0.63	7.577	1.23	2.019	1.83	0.888	2.43	0.180		
0.65	7.302	1.25	1.989	1.85	0.856	2.45	0.174		

Printed values > 1% of Qpeak. nth-point print interval = 1

Design Storm Report

Custom Storm filename: West Bangs AvenueNeptune 2.cds

Hydrology Studio v 3.0.0.16

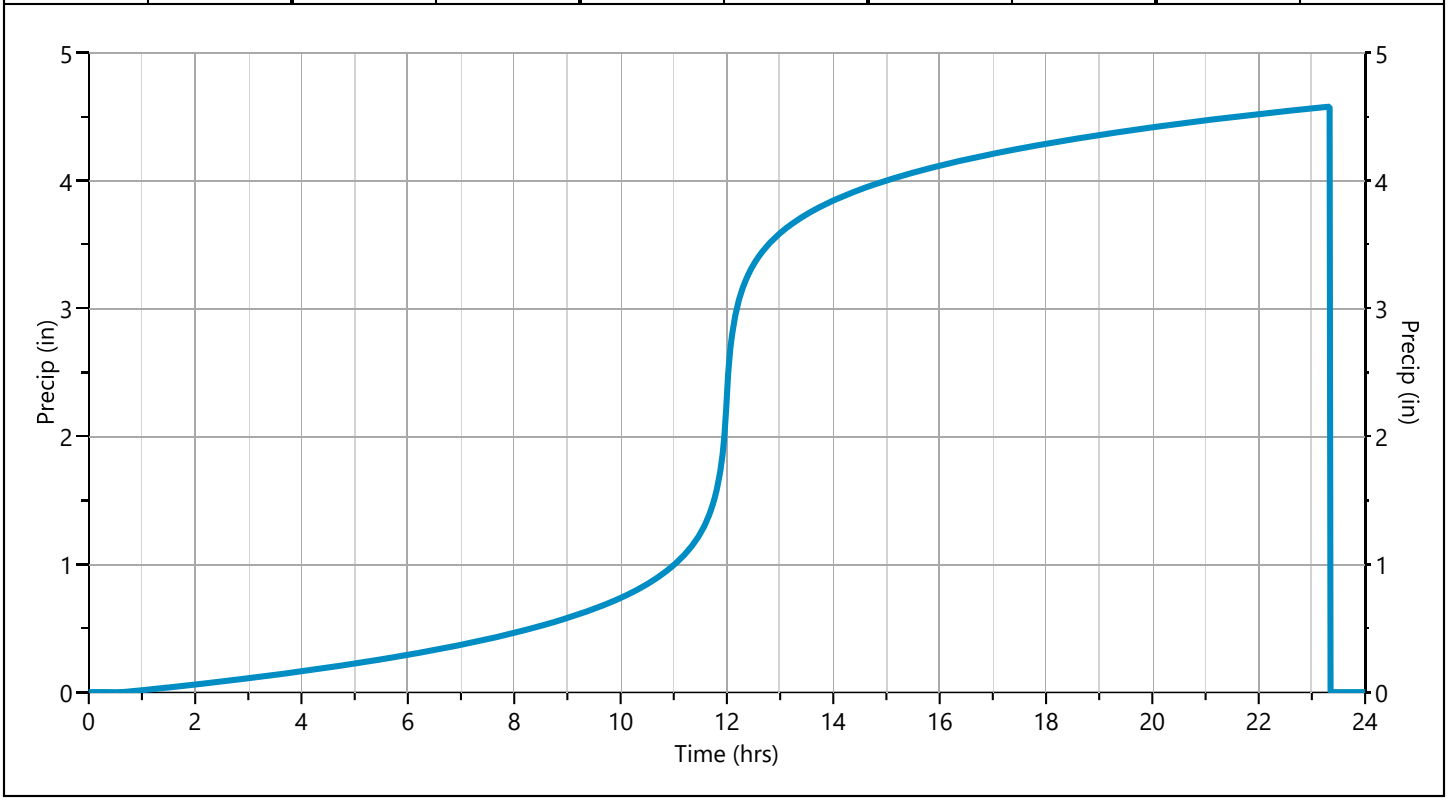
09-17-2020

Storm Distribution: IDF Based - Synthetic

Storm Duration	Total Rainfall Volume (in)								
	1-yr	2-yr	3-yr	5-yr	✔ 10-yr	25-yr	50-yr	100-yr	
24 hrs	2.10	2.45	0	3.67	4.64	6.30	8.08	10.05	

Incremental Rainfall Distribution, 10-yr

Time (hrs)	Precip (in)	Time (hrs)	Precip (in)	Time (hrs)	Precip (in)	Time (hrs)	Precip (in)	Time (hrs)	Precip (in)
11.50	0.011762	11.68	0.018340	11.87	0.039527	12.05	0.080709	12.23	0.025258
11.52	0.012160	11.70	0.019312	11.88	0.043826	12.07	0.068593	12.25	0.023656
11.53	0.012585	11.72	0.020388	11.90	0.049053	12.08	0.059349	12.27	0.022236
11.55	0.013042	11.73	0.021585	11.92	0.055518	12.10	0.052106	12.28	0.020970
11.57	0.013532	11.75	0.022925	11.93	0.063675	12.12	0.046307	12.30	0.019836
11.58	0.014061	11.77	0.024432	11.95	0.074220	12.13	0.041576	12.32	0.018814
11.60	0.014632	11.78	0.026138	11.97	0.088256	12.15	0.037656	12.33	0.017889
11.62	0.015251	11.80	0.028083	11.98	0.107636	12.17	0.034363	12.35	0.017049
11.63	0.015923	11.82	0.030318	**12.00**	**0.135681**	12.18	0.031564	12.37	0.016282
11.65	0.016657	11.83	0.032909	12.02	0.120276	12.20	0.029161	12.38	0.015580
11.67	0.017459	11.85	0.035940	12.03	0.097118	12.22	0.027078	12.40	0.014935



Hydrograph 100-yr Summary

Project Name: 3128 West Bangs Avenue

09-17-2020

Hydrology Studio v 3.0.0.16

Hyd. No.	Hydrograph Type	Hydrograph Name	Peak Flow (cfs)	Time to Peak (hrs)	Hydrograph Volume (cuft)	Inflow Hyd(s)	Maximum Elevation (ft)	Maximum Storage (cuft)
1	Mod Rational	Post Dev	15.40	0.17	38,802	----		
2	Rational	Pre Dev	17.90	0.17	10,743	----		
3	Pond Route	Rainstore	14.32	0.70	37,859	1	98.60	16,144

Hydrograph Report

Project Name: 3128 West Bangs Avenue

Hydrology Studio v 3.0.0.16

09-17-2020

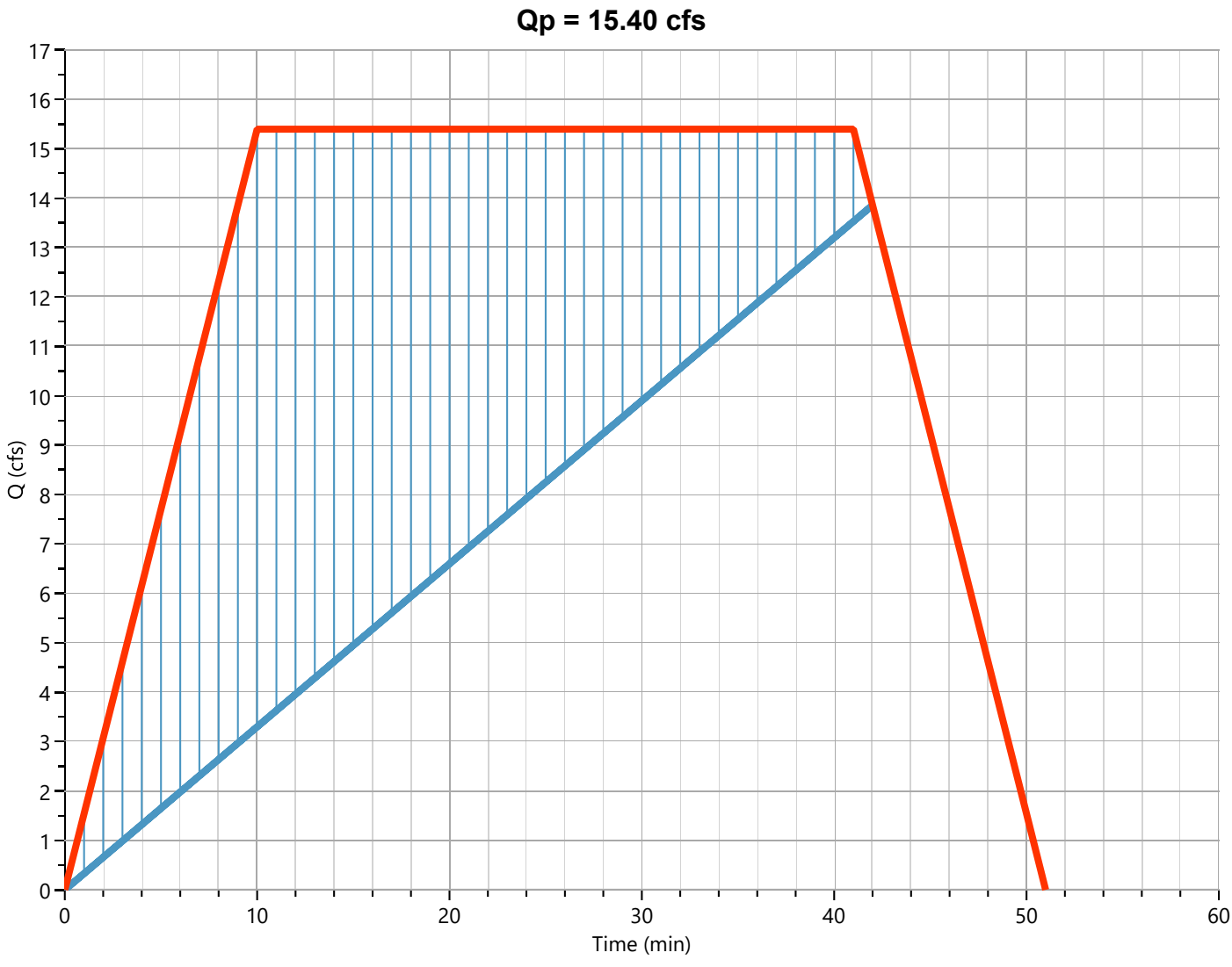
Post Dev

Hyd. No. 1

Hydrograph Type	= Mod Rational	Peak Flow	= 15.40 cfs
Storm Frequency	= 100-yr	Time to Peak	= 0.17 hrs
Time Interval	= 1 min	Runoff Volume	= 38,802 cuft
Drainage Area	= 6.12 ac	Runoff Coeff.	= 0.54*
Tc Method	= User	Time of Conc. (Tc)	= 10.0 min
IDF Curve	= West Bangs AvenueNeptune.idf	Intensity	= 3.73 in/hr
Freq. Corr. Factor	= 1.25	Storm Duration	= 4.2 x Tc
Target Q	= 14.32 cfs	Required Storage	= 16,892 cuft

*** Composite C Worksheet**

AREA (ac)	C	DESCRIPTION
2.14	0.99	Impervious (ROW + Site)
3.98	0.30	Pervious (ROW + Site)
6.12	**0.54**	



Hydrograph Discharge Table

Time (min)	Outflow (cfs)	Time (min)	Outflow (cfs)	Time (min)	Outflow (cfs)	Time (min)	Outflow (cfs)	Time (min)	Outflow (cfs)
1	1.540	37	15.40						
2	3.080	38	15.40						
3	4.619	39	15.40						
4	6.159	40	15.40						
5	7.699	41	15.40						
6	9.239	42	13.86						
7	10.78	43	12.32						
8	12.32	44	10.78						
9	13.86	45	9.239						
10	**15.40**	46	7.699						
11	15.40	47	6.159						
12	15.40	48	4.619						
13	15.40	49	3.080						
14	15.40	50	1.540						
15	15.40	51	0.000						
16	15.40	*...end*	*...end*						
17	15.40								
18	15.40								
19	15.40								
20	15.40								
21	15.40								
22	15.40								
23	15.40								
24	15.40								
25	15.40								
26	15.40								
27	15.40								
28	15.40								
29	15.40								
30	15.40								
31	15.40								
32	15.40								
33	15.40								
34	15.40								
35	15.40								
36	15.40								

Printed values > 1% of Qpeak. nth-point print interval = 1

Hydrograph Report

Project Name: 3128 West Bangs Avenue

Hydrology Studio v 3.0.0.16

09-17-2020

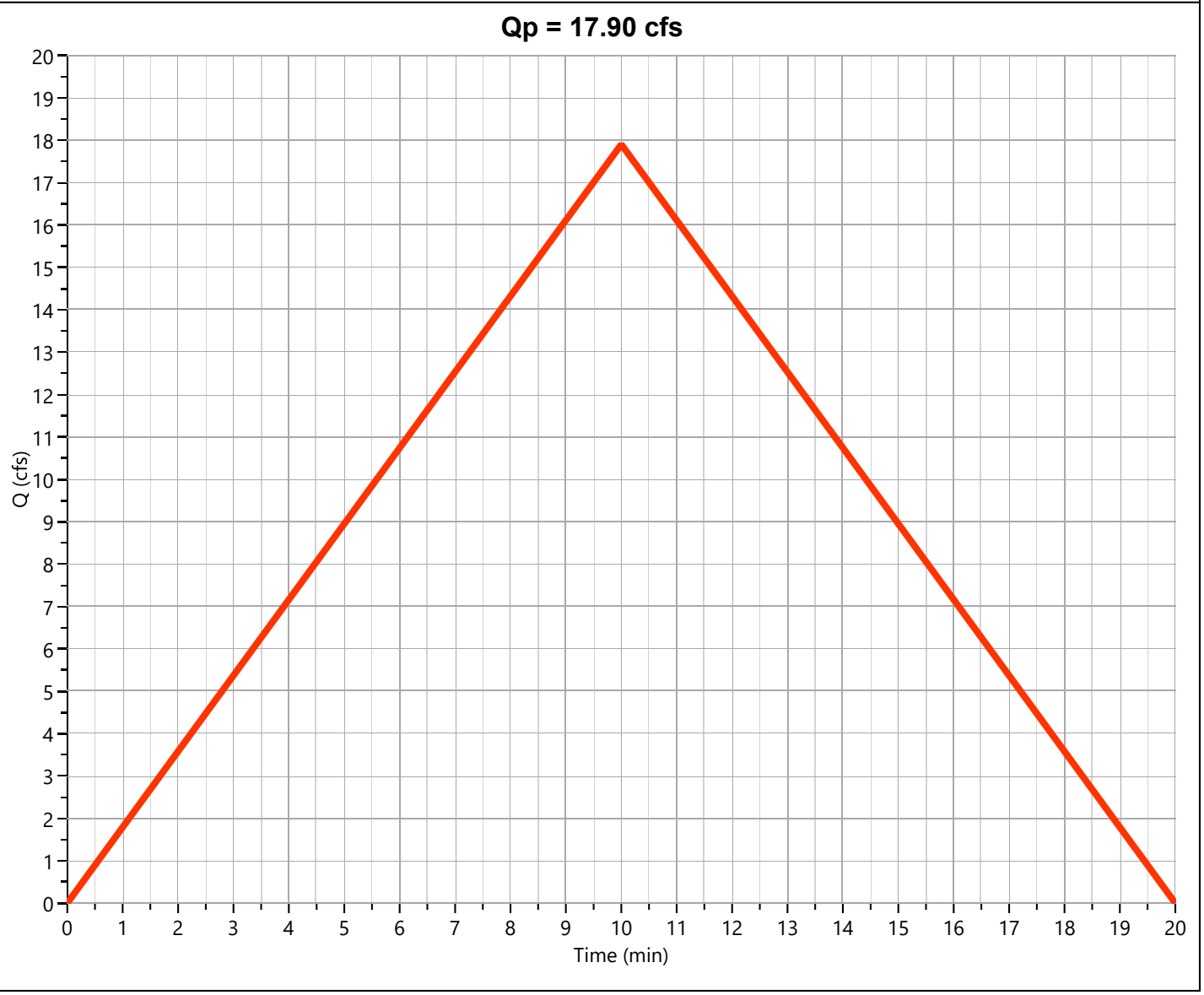
Pre Dev

Hyd. No. 2

Hydrograph Type	= Rational	Peak Flow	= 17.90 cfs
Storm Frequency	= 100-yr	Time to Peak	= 0.17 hrs
Time Interval	= 1 min	Runoff Volume	= 10,743 cuft
Drainage Area	= 6.12 ac	Runoff Coeff.	= 0.33*
Tc Method	= User	Time of Conc. (Tc)	= 10.0 min
IDF Curve	= West Bangs AvenueNeptune.idf	Intensity	= 7.09 in/hr
Freq. Corr. Factor	= 1.25	Asc/Rec Limb Factors	= 1/1

*** Composite C Worksheet**

AREA (ac)	C	DESCRIPTION
0.168	0.99	Buildings
0.14	0.99	Site Impervious
5.813	0.30	Site Pervious
6.12	**0.33**	



Hydrograph Discharge Table

Time (min)	Outflow (cfs)	Time (min)	Outflow (cfs)	Time (min)	Outflow (cfs)	Time (min)	Outflow (cfs)	Time (min)	Outflow (cfs)
1	1.790								
2	3.581								
3	5.371								
4	7.162								
5	8.952								
6	10.74								
7	12.53								
8	14.32								
9	16.11								
10	**17.90**								
11	16.11								
12	14.32								
13	12.53								
14	10.74								
15	8.952								
16	7.162								
17	5.371								
18	3.581								
19	1.790								
20	0.000								
...end	*...end*								

Printed values > 1% of Qpeak. nth-point print interval = 1

Hydrograph Report

Hydrology Studio v 3.0.0.16

09-17-2020

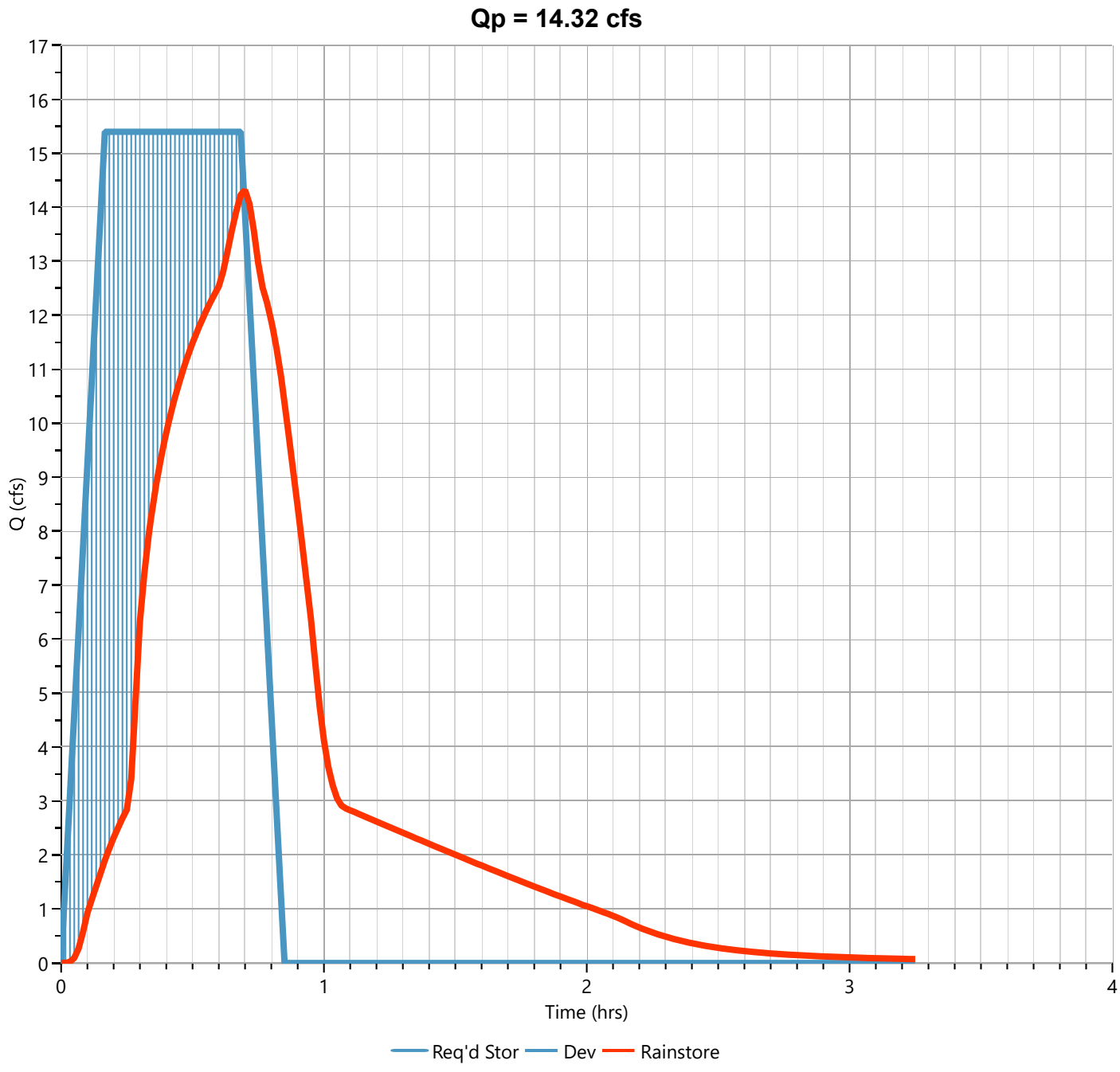
Rainstore

Hyd. No. 3

Hydrograph Type	= Pond Route	Peak Flow	= 14.32 cfs
Storm Frequency	= 100-yr	Time to Peak	= 0.70 hrs
Time Interval	= 1 min	Hydrograph Volume	= 37,859 cuft
Inflow Hydrograph	= 1 - Dev	Max. Elevation	= 98.60 ft
Pond Name	= UG ChamberInvisible Structures	Max. Storage	= 16,144 cuft

Pond Routing by Storage Indication Method

Center of mass detention time = 24 min



Hydrograph Discharge Table

Time (hrs)	Outflow (cfs)	Time (hrs)	Outflow (cfs)	Time (hrs)	Outflow (cfs)	Time (hrs)	Outflow (cfs)	Time (hrs)	Outflow (cfs)
0.07	0.269	0.67	13.93	1.27	2.483	1.87	1.291	2.47	0.306
0.08	0.578	0.68	14.23	1.28	2.448	1.88	1.261	2.48	0.292
0.10	0.925	**0.70**	**14.32**	1.30	2.411	1.90	1.231	2.50	0.279
0.12	1.176	0.72	14.06	1.32	2.381	1.92	1.199	2.52	0.267
0.13	1.420	0.73	13.57	1.33	2.344	1.93	1.169	2.53	0.257
0.15	1.660	0.75	12.97	1.35	2.308	1.95	1.142	2.55	0.247
0.17	1.902	0.77	12.51	1.37	2.277	1.97	1.110	2.57	0.237
0.18	2.121	0.78	12.24	1.38	2.242	1.98	1.077	2.58	0.228
0.20	2.323	0.80	11.89	1.40	2.206	2.00	1.051	2.60	0.219
0.22	2.507	0.82	11.47	1.42	2.177	2.02	1.025	2.62	0.211
0.23	2.681	0.83	10.97	1.43	2.139	2.03	0.996	2.63	0.203
0.25	2.837	0.85	10.39	1.45	2.105	2.05	0.964	2.65	0.197
0.27	3.404	0.87	9.748	1.47	2.075	2.07	0.934	2.67	0.190
0.28	4.874	0.88	9.104	1.48	2.037	2.08	0.904	2.68	0.183
0.30	6.325	0.90	8.451	1.50	2.005	2.10	0.872	2.70	0.177
0.32	7.218	0.92	7.781	1.52	1.973	2.12	0.839	2.72	0.171
0.33	7.925	0.93	7.095	1.53	1.936	2.13	0.804	2.73	0.165
0.35	8.507	0.95	6.392	1.55	1.906	2.15	0.766	2.75	0.160
0.37	9.004	0.97	5.576	1.57	1.872	2.17	0.727	2.77	0.155
0.38	9.435	0.98	4.755	1.58	1.836	2.18	0.692	2.78	0.150
0.40	9.821	1.00	4.121	1.60	1.807	2.20	0.659	2.80	0.145
0.42	10.17	1.02	3.635	1.62	1.771	2.22	0.627	2.82	0.141
0.43	10.48	1.03	3.290	1.63	1.740	2.23	0.596	*...end*	*...end*
0.45	10.76	1.05	3.050	1.65	1.707	2.25	0.566		
0.47	11.02	1.07	2.917	1.67	1.671	2.27	0.538		
0.48	11.26	1.08	2.863	1.68	1.644	2.28	0.511		
0.50	11.48	1.10	2.828	1.70	1.608	2.30	0.485		
0.52	11.69	1.12	2.795	1.72	1.575	2.32	0.462		
0.53	11.88	1.13	2.758	1.73	1.546	2.33	0.441		
0.55	12.06	1.15	2.722	1.75	1.511	2.35	0.420		
0.57	12.23	1.17	2.692	1.77	1.482	2.37	0.401		
0.58	12.38	1.18	2.654	1.78	1.448	2.38	0.383		
0.60	12.53	1.20	2.618	1.80	1.416	2.40	0.366		
0.62	12.81	1.22	2.587	1.82	1.386	2.42	0.350		
0.63	13.19	1.23	2.551	1.83	1.352	2.43	0.334		
0.65	13.58	1.25	2.514	1.85	1.324	2.45	0.320		

Printed values > 1% of Qpeak. nth-point print interval = 1

Design Storm Report

Custom Storm filename: West Bangs AvenueNeptune 2.cds

Hydrology Studio v 3.0.0.16

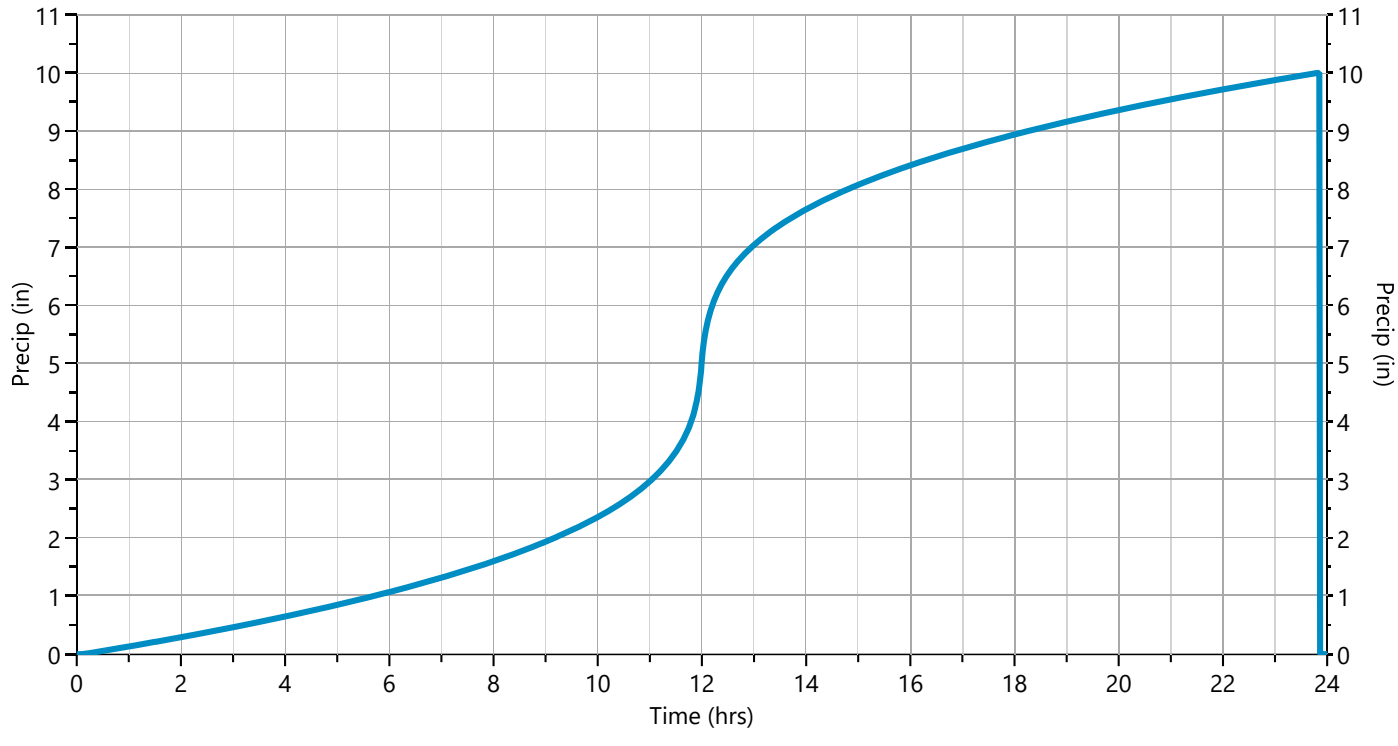
09-17-2020

Storm Distribution: IDF Based - Synthetic

Storm Duration	Total Rainfall Volume (in)								
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	✔ 100-yr	
24 hrs	2.10	2.45	0	3.67	4.64	6.30	8.08	10.05	

Incremental Rainfall Distribution, 100-yr

Time (hrs)	Precip (in)	Time (hrs)	Precip (in)	Time (hrs)	Precip (in)	Time (hrs)	Precip (in)	Time (hrs)	Precip (in)
11.50	0.021917	11.68	0.030668	11.87	0.056490	12.05	0.106261	12.23	0.039319
11.52	0.022470	11.70	0.031907	11.88	0.061605	12.07	0.091330	12.25	0.037346
11.53	0.023057	11.72	0.033269	11.90	0.067825	12.08	0.080141	12.27	0.035584
11.55	0.023682	11.73	0.034772	11.92	0.075544	12.10	0.071466	12.28	0.034002
11.57	0.024349	11.75	0.036441	11.93	0.085359	12.12	0.064556	12.30	0.032572
11.58	0.025062	11.77	0.038303	11.95	0.098223	12.13	0.058928	12.32	0.031273
11.60	0.025826	11.78	0.040397	11.97	0.115741	12.15	0.054260	12.33	0.030088
11.62	0.026649	11.80	0.042766	11.98	0.140822	12.17	0.050328	12.35	0.029003
11.63	0.027535	11.82	0.045470	**12.00**	**0.179274**	12.18	0.046971	12.37	0.028005
11.65	0.028494	11.83	0.048586	12.02	0.157815	12.20	0.044072	12.38	0.027083
11.67	0.029534	11.85	0.052213	12.03	0.127071	12.22	0.041543	12.40	0.026230



IDF Report

IDF filename: West Bangs AvenueNeptune.idf

Hydrology Studio v 3.0.0.16

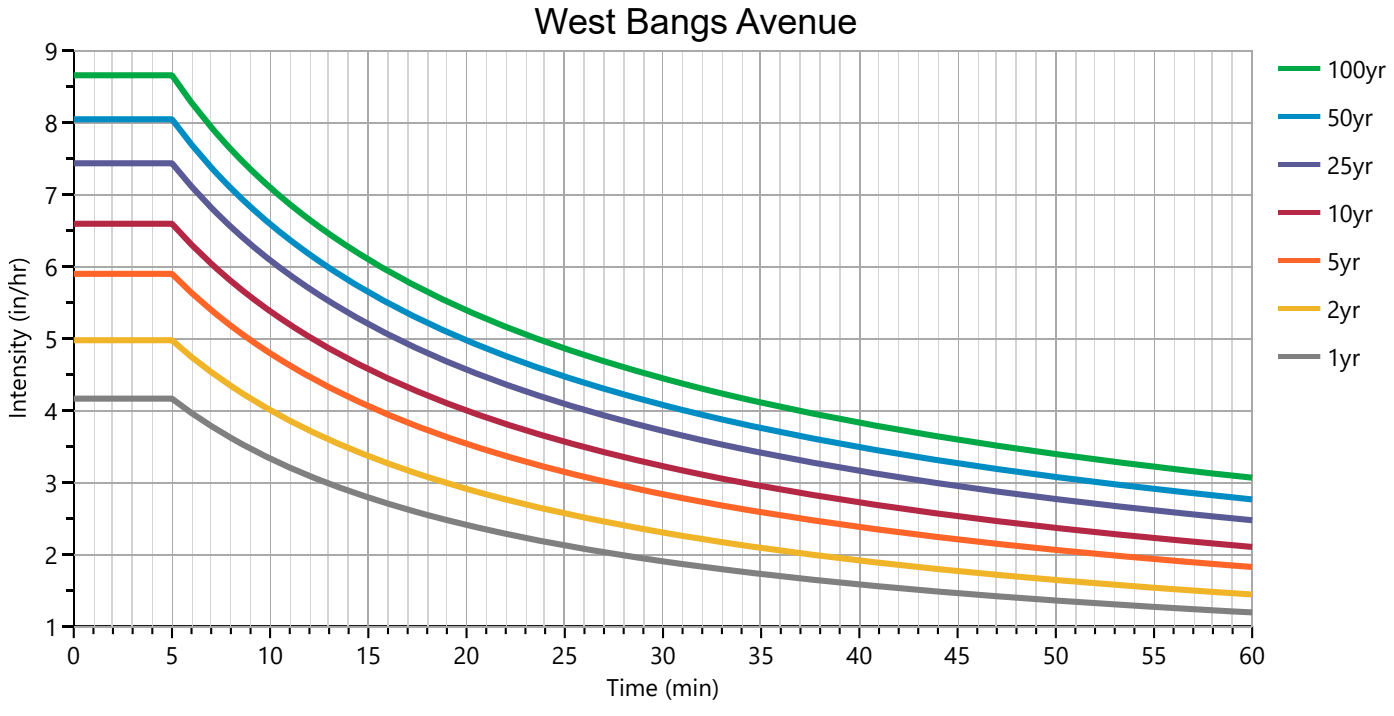
09-17-2020

Equation Coefficients	Intensity = B / (Tc + D)^E (in/hr)								
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
B	49.1339	64.1138	0.0000	62.7646	62.8554	58.9227	52.6667	48.7746	
D	12.1000	13.0000	0.0000	12.5000	12.1000	11.2000	10.0000	9.1000	
E	0.8697	0.8848	0.0000	0.8265	0.7945	0.7436	0.6941	0.6537	

Minimum Tc = 5 minutes

Tc (min)	Intensity Values (in/hr)								
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
Cf	1.00	1.00	1.00	1.00	1.00	1.10	1.20	1.25	
5	4.16	4.97	0	5.89	6.59	7.43	8.04	8.65	
10	3.33	4.00	0	4.79	5.37	6.08	6.58	7.09	
15	2.79	3.36	0	4.06	4.57	5.20	5.64	6.09	
20	2.41	2.91	0	3.53	3.99	4.56	4.97	5.39	
25	2.12	2.57	0	3.14	3.56	4.09	4.46	4.86	
30	1.90	2.30	0	2.83	3.22	3.71	4.07	4.44	
35	1.72	2.09	0	2.58	2.95	3.41	3.75	4.10	
40	1.58	1.91	0	2.38	2.72	3.16	3.49	3.83	
45	1.46	1.76	0	2.20	2.53	2.95	3.26	3.59	
50	1.35	1.64	0	2.06	2.36	2.76	3.07	3.39	
55	1.27	1.53	0	1.93	2.22	2.61	2.91	3.21	
60	1.19	1.44	0	1.82	2.10	2.47	2.76	3.06	

Cf = Correction Factor applied to Rational Method runoff coefficient.



Precipitation Report

Precipitation filename: West Bangs AvenueNeptune2.pcp

Hydrology Studio v 3.0.0.16 (Rainfall totals in Inches)

09-17-2020

	Active	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Active			✔			✔			✔
SCS Storms	**> SCS Dimensionless Storms**								
SCS 6hr		1.20	1.50	0	1.86	2.18	2.64	3.01	3.41
Type I, 24-hr		0	0	0	0	0	0	0	0
Type IA, 24-hr		0	0	0	0	0	0	0	0
Type II, 24-hr		1.82	2.28	0	2.85	3.31	3.94	4.43	4.94
Type II FL, 24-hr		0	0	0	0	0	0	0	0
Type III, 24-hr		0	0	0	0	0	0	0	0
Synthetic Storms	**> IDF-Based Synthetic Storms**								
1-hr		1.19	1.44	0	1.82	2.10	2.47	2.76	3.06
2-hr		1.41	1.69	0	2.21	2.60	3.14	3.59	4.07
3-hr		1.52	1.83	0	2.44	2.89	3.56	4.14	4.75
6-hr		1.71	2.04	0	2.82	3.42	4.34	5.21	6.14
12-hr		1.90	2.24	0	3.23	4.00	5.25	6.51	7.87
24-hr	✔	2.10	2.45	0	3.67	4.64	6.30	8.08	10.05
Huff Distribution	**> 1st Quartile (0 to 6 hrs)**								
1-hr		0.76	0.98	0	1.33	1.61	2.01	2.34	2.69
2-hr		0.89	1.14	0	1.50	1.80	2.24	2.60	2.99
3-hr		0.98	1.24	0	1.59	1.90	2.33	2.68	3.07
6-hr		1.20	1.50	0	1.86	2.18	2.64	3.01	3.41
Huff Distribution	**> 2nd Quartile (>6 to 12 hrs)**								
8-hr		0	0	0	0	0	0	0	0
12-hr		0	0	0	0	0	0	0	0
Huff Distribution	**> 3rd Quartile (>12 to 24 hrs)**								
18-hr		0	0	0	0	0	0	0	0
24-hr		0	0	0	0	0	0	0	0
Custom Storms	**> Custom Storm Distributions**								
NJ Water Quality 2-hr		0	1.25	0	0	0	0	0	0
Austin Tx		0	0	0	0	0	0	0	0
My Custom Storm 3		0	0	0	0	0	0	0	0
My Custom Storm 4		0	0	0	0	0	0	0	0
My Custom Storm 5		0	0	0	0	0	0	0	0
My Custom Storm 6		0	0	0	0	0	0	0	0
My Custom Storm 7		0	0	0	0	0	0	0	0
My Custom Storm 8		0	0	0	0	0	0	0	0
My Custom Storm 9		0	0	0	0	0	0	0	0
My Custom Storm 10		0	0	0	0	0	0	0	0

Precipitation Report Cont'd

Precipitation filename: West Bangs AvenueNeptune2.pcp

Rainfall totals in Inches

09-17-2020

	Active	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Active			✔			✔			✔
Huff Indiana	**> Indianapolis**								
30-min		0.99	1.19	0	1.44	1.63	1.89	2.08	2.28
1-hr		1.21	1.46	0	1.81	2.08	2.45	2.75	3.06
2-hr		1.46	1.77	0	2.22	2.57	3.05	3.44	3.85
3-hr		1.57	1.90	0	2.38	2.76	3.30	3.75	4.21
6-hr		1.92	2.31	0	2.88	3.36	4.01	4.56	5.13
12-hr		0	0	0	0	0	0	0	0
24-hr		0	0	0	0	0	0	0	0
Huff Indiana	**> Evansville**								
30-min		0.99	1.19	0	1.44	1.63	1.89	2.08	2.28
1-hr		1.21	1.46	0	1.81	2.08	2.45	2.75	3.06
2-hr		1.46	1.77	0	2.22	2.57	3.05	3.44	3.85
3-hr		1.57	1.90	0	2.38	2.76	3.30	3.75	4.21
6-hr		1.92	2.31	0	2.88	3.36	4.01	4.56	5.13
12-hr		0	0	0	0	0	0	0	0
24-hr		0	0	0	0	0	0	0	0
Huff Indiana	**> Fort Wayne**								
30-min		0.99	1.19	0	1.44	1.63	1.89	2.08	2.28
1-hr		1.21	1.46	0	1.81	2.08	2.45	2.75	3.06
2-hr		1.46	1.77	0	2.22	2.57	3.05	3.44	3.85
3-hr		1.57	1.90	0	2.38	2.76	3.30	3.75	4.21
6-hr		1.92	2.31	0	2.88	3.36	4.01	4.56	5.13
12-hr		0	0	0	0	0	0	0	0
24-hr		0	0	0	0	0	0	0	0
Huff Indiana	**> South Bend**								
30-min		0.99	1.19	0	1.44	1.63	1.89	2.08	2.28
1-hr		1.21	1.46	0	1.81	2.08	2.45	2.75	3.06
2-hr		1.46	1.77	0	2.22	2.57	3.05	3.44	3.85
3-hr		1.57	1.90	0	2.38	2.76	3.30	3.75	4.21
6-hr		1.92	2.31	0	2.88	3.36	4.01	4.56	5.13
12-hr		0	0	0	0	0	0	0	0
24-hr		0	0	0	0	0	0	0	0

Precipitation Report Cont'd

Precipitation filename: West Bangs AvenueNeptune2.pcp

Rainfall totals in Inches

09-17-2020

	Active	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Active			✔			✔			✔
NRCS Storms	**> NRCS Dimensionless Storms**								
NRCS MSE3, 24-hr		2.72	3.27	0	4.07	4.72	5.63	6.37	7.15
NRCS MSE4, 24-hr		2.72	3.27	0	4.07	4.72	5.63	6.37	7.15
NRCS MSE3, 24-hr		3.28	3.72	0	4.47	5.12	6.07	6.85	7.65
NRCS MSE4, 24-hr		3.28	3.72	0	4.47	5.12	6.07	6.85	7.65
NRCS MSE5, 24-hr		3.28	3.72	0	4.47	5.12	6.07	6.85	7.65
NRCS MSE6, 24-hr		3.28	3.72	0	4.47	5.12	6.07	6.85	7.65
NOAA-A, 24-hr		3.28	3.72	0	4.47	5.12	6.07	6.85	7.65
NOAA-B, 24-hr		3.28	3.72	0	4.47	5.12	6.07	6.85	7.65
NOAA-C, 24-hr		3.28	3.72	0	4.47	5.12	6.07	6.85	7.65
NOAA-D, 24-hr		3.28	3.72	0	4.47	5.12	6.07	6.85	7.65
NRCC-A, 24-hr		3.28	3.72	0	4.47	5.12	6.07	6.85	7.65
NRCC-B, 24-hr		3.28	3.72	0	4.47	5.12	6.07	6.85	7.65
NRCC-C, 24-hr		3.28	3.72	0	4.47	5.12	6.07	6.85	7.65
NRCC-D, 24-hr		3.28	3.72	0	4.47	5.12	6.07	6.85	7.65
CA-1, 24-hr		3.28	3.72	0	4.47	5.12	6.07	6.85	7.65
CA-2, 24-hr		3.28	3.72	0	4.47	5.12	6.07	6.85	7.65
CA-3, 24-hr		3.28	3.72	0	4.47	5.12	6.07	6.85	7.65
CA-4, 24-hr		3.28	3.72	0	4.47	5.12	6.07	6.85	7.65
CA-5, 24-hr		3.28	3.72	0	4.47	5.12	6.07	6.85	7.65
CA-6, 24-hr		3.28	3.72	0	4.47	5.12	6.07	6.85	7.65

APPENDIX 2
NJDEP WETLANDS DEVELOPMENT APPROVAL

State of New Jersey
DEPARTMENT OF ENVIRONMENTAL PROTECTION
Division of Land Use Regulation
Mail Code 501-02A, P. O. Box 420
Trenton, New Jersey 08625-0420
www.state.nj.us/dep/landuse

CHRIS CHRISTIE
Governor

KIM GUADAGNO
Lt. Governor

BOB MARTIN
Commissioner

April 28, 2017

Scarlet Fliers Venture, LLC
c/o Mr. Derrick Griggs
444 Neptune Blvd.
Neptune, NJ 07753

RE: Freshwater Wetlands Letter of Interpretation: Line Verification
DLUR File No.: 1334-16-0009.1
Activity Number: FWW 160002
Applicant: Scarlet Fliers Venture LLC
Block: 2601 Lots: 5-7 & 9
Township of Neptune, Monmouth County

Dear Mr. Griggs,

This letter is in response to your request for a Letter of Interpretation to have Division of Land Use Regulation (Division) staff verify the boundary of the freshwater wetlands and/or State open waters on the referenced property.

In accordance with agreements between the State of New Jersey Department of Environmental Protection (NJDEP), the U.S. Army Corps of Engineers (USACOE) Philadelphia and New York Districts, and the U.S. Environmental Protection Agency (USEPA), the Division is the lead agency for establishing the extent of State and Federally regulated wetlands and waters. The USEPA and/or USACOE retain the right to reevaluate and modify the jurisdictional determination at any time should the information prove to be incomplete or inaccurate.

Based upon the information submitted, and upon a site inspection conducted by Division staff on February 2, 2017, the Division has determined that the wetlands boundary line as shown on the plan map entitled: "WETLANDS DELINEATION MAP, 3122-3138 WEST BANGS AVENUE, TOWNSHIP OF NEPTUNE, COUNTY OF MONMOUTH, NEW JERSEY", consisting of 1 sheet, dated 9/07/16, unrevised, and prepared by Grant Engineering & Construction Group, LLC, is accurate as shown.

Wetlands Resource Value Classification ("RVC")

The Division has determined that the resource value and the standard transition area or buffer required adjacent to the delineated wetlands are as follows:

Intermediate: Flags L1 to L13 (50-foot wetland buffer)

Please be advised that the above wetland is classified as isolated. RVC may affect requirements for wetland and/or transition area permitting. This classification may affect the requirements for an Individual Wetlands Permit (see N.J.A.C. 7:7A-7), the types of Statewide General Permits available for the property (see N.J.A.C. 7:7A-4) and any modification available through a transition area waiver (see N.J.A.C. 7:7A-6). Please refer to the Freshwater Wetlands Protection Act (N.J.S.A. 13:9B-1 et seq.) and implementing rules for additional information.

Wetlands resource value classification is based on the best information available to the Department. The classification is subject to reevaluation at any time if additional or updated information is made available, including, but not limited to, information supplied by the applicant.

Under N.J.S.A. 13:9B-7a(2), if the Division has classified a wetland as exceptional resource value, based on a finding that the wetland is documented habitat for threatened and endangered species that remains suitable for use for breeding, resting or feeding by such species, an applicant may request a change in this classification. Such requests for a classification change must demonstrate that the habitat is no longer suitable for the documented species because there has been a change in the suitability of this habitat. Requests for resource value classification changes and associated documentation should be submitted to the Division at the address at the top of this letter.

General Information

Pursuant to the Freshwater Wetlands Protection Act Rules, you are entitled to rely upon this jurisdictional determination for a period of five years from the date of this letter unless it is determined that the letter is based on inaccurate or incomplete information. Should additional information be disclosed or discovered, the Division reserves the right to void the original letter of interpretation and issue a revised letter of interpretation.

Regulated activities proposed within a wetland, wetland transition area or water area, as defined by N.J.A.C. 7:7A-2.2 and 2.6 of the Freshwater Wetlands Protection Act rules, require a permit from this office unless specifically exempted at N.J.A.C. 7:7A-2.8. The approved plan and supporting jurisdictional limit information are now part of the Division's public records.

This letter in no way legalizes any fill which may have been placed, or other regulated activities which may have occurred on-site. This determination of jurisdiction extent or presence does not make a finding that wetlands or water areas are "isolated" or part of a surface water tributary system unless specifically called out in this letter as such. Furthermore, obtaining this

determination does not affect your responsibility to obtain any local, State, or Federal permits which may be required.

Appeal Process

In accordance with N.J.A.C. 7:7A-1.7, any person who is aggrieved by this decision may request a hearing within 30 days of the date the decision is published in the DEP Bulletin by writing to: New Jersey Department of Environmental Protection, Office of Legal Affairs, Attention: Adjudicatory Hearing Requests, P.O. Box 402, Trenton, NJ 08625-0402. This request must include a completed copy of the Administrative Hearing Request Checklist found at www.state.nj.us/dep/landuse/forms. Hearing requests received after 30 days of publication notice may be denied. The DEP Bulletin is available on the Department's website at www.state.nj.us/dep/bulletin. In addition to your hearing request, you may file a request with the Office of Dispute Resolution to engage in alternative dispute resolution. Please see the website www.nj.gov/dep/odr for more information on this process.

Please contact Tejal Kuray of our staff by e-mail at Tejal.Kuray@dep.nj.gov or (609) 633-9259 should you have any questions regarding this letter. Be sure to indicate the Department's file number in all communication.

Sincerely,

Joslin C. Tamagno
Environmental Supervisor, ES4
Bureau of Urban Growth and Redevelopment
Division of Land Use Regulation

c: Mr. Z. Lewis, Lewis Consulting Group, Agent (original)

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF LAND USE REGULATION

Mail Code 501-02A, P.O. Box 420, Trenton, New Jersey 08625-0420
Telephone: (609) 777-0454 or Fax: (609) 777-3656
www.nj.gov/dep/landuse

PERMIT

In accordance with the laws and regulations of the State of New Jersey, the Department of Environmental Protection hereby grants this permit to perform the activities described below. This permit is revocable with due cause and is subject to the limitations, terms and conditions listed below and on the attached pages. For the purpose of this document, "permit" means "approval, certification, registration, authorization, waiver, etc." Violation of any term, condition or limitation of this permit is a violation of the implementing rules and may subject the permittee to enforcement action.

Approval Date
APR 28 2017

Expiration Date
APR 27 2022

Permit Number(s):	Type of Approval(s):	Enabling Statute(s):
1334-16-0009.1 FWW160001	Freshwater Wetlands General Permit 6; Water Quality Certificate	N.J.S.A. 13:9B-1 et seq. N.J.S.A. 58:10A-1 et seq.

Permittee:

Scarlet Fliers Venture LLC
c/o Derrick Griggs
444 Neptune Blvd
Neptune, NJ 07753

Site Location:

Block: 2601
Lots: 5, 6, 7, 9
Municipality: Neptune
County: Monmouth

Description of Authorized Activities:

This permit authorizes the permanent disturbance of 0.865 acres (37,682 square feet) of freshwater wetlands and 0.594 acres (25,896 square feet) of freshwater wetlands transition area for the construction of a housing development under a Freshwater Wetlands General Permit 6 – Non-tributary wetlands, as shown on the plans referenced on the last page of this permit.

The Division of Land Use Regulation has reviewed the referenced application for a General Permit authorization pursuant to the requirements of the Freshwater Wetlands Protection Act Rules at N.J.A.C. 7:7A-5. The activities allowed by this authorization shall comply with applicable conditions noted at N.J.A.C. 7:7-4.3, 5, and 13.1. Failure to comply with these conditions shall constitute a violation of the Freshwater Wetland Protection Act (N.J.S.A. 13:9B-1 et. seq.).

This authorization to conduct activities in freshwater wetlands includes the issuance of a Water Quality Certificate.

Prepared by:

Tejal Kuray

If the permittee undertakes any regulated activity authorized under a permit, such action shall constitute the permittee's acceptance of the permit in its entirety as well as the permittee's agreement to abide by the permit and all conditions therein.

Received and/or Recorded by County Clerk:

This permit is not valid unless authorizing signature appears on the last page.

FRESHWATER WETLAND SPECIAL CONDITIONS:

1. The total amount of disturbance associated with this authorization shall not exceed 0.865 acres (37,682 square feet) of wetland and 0.594 acres (25,896 square feet) of freshwater wetlands transition area for the construction of single family residential units under a Freshwater Wetlands General Permit No. 6.

2. The wetlands affected by this permit authorization are of Intermediate resource value and the standard transition area or buffer required adjacent to these wetlands is 50 feet. This general permit includes a transition area waiver, which allows encroachment only in that portion of the transition area, which has been determined by the Department to be necessary to accomplish the regulated activities. Any additional regulated activities conducted within the standard transition area on-site shall require a separate transition area waiver from the Division. Regulated activities within a transition area are defined at N.J.A.C. 7:7A-2.6. Please refer to the Freshwater Wetlands Protection Act (N.J.S.A. 13:9B-1 et seq.) and implementing rules (N.J.A.C. 7:7A-1.1 et seq.) for additional information. (delete is TA only)

3. This authorization for a General Permit is valid for a term not to exceed five years from the date of this permit. If the permittee wishes to continue an activity covered by the permit after the expiration date of the permit, the permittee must apply for and obtain a permit extension or a new permit, prior to the permit's expiration. If the term of the authorization exceeds the expiration date of the general permit issued by rule, and the permit upon which the authorization is based is modified by rule to include more stringent standards or conditions, or is not reissued, the applicant must comply with the requirements of the new regulations by applying for a new General Permit authorization or an Individual permit.

STANDARD CONDITIONS:

1. The issuance of a permit shall in no way expose the State of New Jersey or the Department to liability for the sufficiency or correctness of the design of any construction or structure(s). Neither the State nor the Department shall, in any way, be liable for any loss of life or property that may occur by virtue of the activity or project conducted as authorized under a permit.

2. The issuance of a permit does not convey any property rights or any exclusive privilege.

3. The permittee shall obtain all applicable Federal, State, and local approvals prior to commencement of regulated activities authorized under a permit.

4. The permittee will be responsible for the installation of a sediment barrier around all disturbed soils, which is sufficient to prevent the sedimentation of the remaining wetlands and transition area. In addition, a permittee conducting an activity involving soil disturbance, the creation of drainage structures, or changes in natural contours shall obtain

time the permittee becomes aware of the noncompliance, and in writing within five working days of the time the permittee becomes aware of the noncompliance. Such notice shall not, however, serve as a defense to enforcement action if the project is found to be in violation of this chapter. The written notice shall include:

a. A description of the noncompliance and its cause;
b. The period of noncompliance, including exact dates and times;
c. If the noncompliance has not been corrected, the anticipated length of time it is expected to continue; and
d. The steps taken or planned to reduce, eliminate, and prevent recurrence of the noncompliance.

7. It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the authorized activity in order to maintain compliance with the conditions of the permit.

8. The permittee shall allow an authorized representative of the Department, upon the presentation of credentials, to:
   a. Enter upon the permittee's premises where a regulated activity is located or conducted, or where records must be kept under the conditions of the permit;
   b. Have access to and copy, at reasonable times, any records that must be kept under the conditions of the permit; and
   c. Inspect at reasonable times any facilities, equipment, practices, or operations regulated or required under the permit. Failure to allow reasonable access under this paragraph shall be considered a violation of this chapter and subject the permittee to enforcement action under.

9. The permittee and its contractors and subcontractors shall comply with all conditions, site plans, and supporting documents approved by the permit. Any noncompliance with a permit constitutes a violation of this chapter and is grounds for enforcement action under, as well as, in the appropriate case, suspension and/or termination of the permit.

10. All conditions, site plans, and supporting documents approved by a permit shall remain in full force and effect so long as the regulated activity or project, or any portion thereof, is in existence, unless the permit is modified.

11. If any condition or permit is determined to be legally unenforceable, modifications and additional conditions may be imposed by the Department as necessary to protect public health, safety, and welfare, or the environment.

12. A copy of the permit and all approved site plans and supporting documents shall be maintained at the site at all times and made available to Department representatives or their designated agents immediately upon request.

13. A permit shall be transferred to another person only in accordance with the regulations N.J.A.C. 7:7A-14.2.

14. A permit can be suspended or terminated by the Department for cause as specified at N.J.A.C. 7:7A 14.4 and 14.5.

15. The submittal of a request to modify a permit by the permittee, or a notification of planned changes or anticipated noncompliance, does not stay any condition of a permit.

16. Where the permittee becomes aware that it failed to submit any relevant facts in an application, or submitted incorrect information in an application or in any report to the Department, it shall promptly submit such facts or information.

17. The permittee shall submit written notification to the Bureau of Coastal and Land Use Compliance and Enforcement, 401 East State Street, 4th Floor, P.O. Box 420, Mail Code 401-04C, Trenton, NJ 08625, seven days prior to the commencement of site preparation or of regulated activities, whichever comes first. The notification shall contain proof of recording of a conservation restriction or easement, if one was required as part of the permit.

18. Best management practices shall be followed whenever applicable. (N.J.A.C. 7:7A-1.4)

19. If the permittee, before or during the work authorizes, encounters a possible historic property, as described at N.J.A.C. 7:7A-12.2(l), that is or may be eligible for listing in the New Jersey or National Register, the permittee shall preserve the resource and immediately notify the Department and proceed as directed.

APPROVED PLAN:

The drawing hereby approved is one (1) sheet prepared by Grant Engineering & Construction Group, LLC entitled: "NJDEP GENERAL PERMIT #6 MAP, 3122-3138 WEST BANGS AVENUE, TOWNSHIP OF NEPTUNE, COUNTY OF MONMOUTH, NEW JERSEY" dated 09/07/16, unrevised.

If you need clarification on any section of this permit or conditions, please contact the Division of Land Use Regulation's Technical Support Call Center at (609) 777-0454.

Approved By:

Joslin C. Tamagno
Environmental Supervisor, ES4
Bureau of Urban Growth and Redevelopment
Division of Land Use Regulation

4-28-17
Date

Original sent to Agent to record

c: Permittee
Mr. Z. Lewis, Lewis Consulting Group, Agent

APPENDIX 3
MELICK-TULLY GEOTECH REPORT
(dated September 28, 2016)

REPORT
SOILS AND FOUNDATION INVESTIGATION

PROPOSED "WEST BANGS AVENUE ESTATES" RESIDENTIAL DEVELOPMENT
TOWNSHIP OF NEPTUNE, MONMOUTH COUNTY, NEW JERSEY
SCARLET FLIER VENTURE, LLC

September 28, 2016

Prepared By:
Melick-Tully and Associates, P.C.
117 Canal Road
South Bound Brook, NJ 08880
Tel: 732-356-3400 Fax: 732-356-9054

MTA Project No. 9405-001*1D

MELICK-TULLY AND ASSOCIATES, P.C.
GEOTECHNICAL ENGINEERS AND ENVIRONMENTAL CONSULTANTS

Principals:
EUGENE M. GALLAGHER JR., P.E.
ROBERT E. SCHWANKERT, P.E.
TODD E. HOROWITZ, P.E.
MARK R. DENNO, P.E.
CHRISTOPHER P. TANSEY, P.E.

Senior Associates:
RICHARD D. LEV, CPG, LSRP
JAMES H. BEATTIE, P.E.

Consultant:
RAYMOND J. TULLY, P.E.

September 28, 2016

Grant Engineering & Construction Group, LLC
2517 Highway 35, Building. P, Suite 202
Manasquan, New Jersey 08736

Attention: Mr. Brian Grant, P.E.
Principal

Report
Soils and Foundation Investigation
Proposed Residential Development – West Bangs Avenue Estates
Township of Neptune, Monmouth County, New Jersey
Scarlet Flier Venture, LLC

Introduction

This report presents the results of a subsurface investigation performed by Melick-Tully and Associates, P.C. (MTA) for a proposed residential development currently referred to as "West Bangs Avenue Estates" that may be constructed in the Township of Neptune, Monmouth County, New Jersey. The site is located adjacent to and south of West Bangs Avenue, opposite its intersections with Green Grove Place and Ruth Drive. The approximate location of the site is shown on the Site Location Map, Plate 1. Our services were provided in general accordance with our revised proposal dated August 3, 2016.

Proposed Construction

Concept Plan 6 prepared by Grant Engineering and Construction Group, LLC, (Drawing S-1 dated 8/5/16) was provided to us which indicates that the development would include 20 single family homes on lots ranging from about 7,500 to 13,400 square feet in plan area. The proposed development will include paved roadways and utilities including water, sanitary sewer and stormwater. It is our understanding that the stormwater facilities are proposed to be incorporated into the site design in the form of underground structures located under the roadway and adjacent open areas. Four locations for stormwater facilities are shown on the current site plans, all located in the southwest portion of the site. Specific design details, including size, configuration and depth, are not available at this time.

Detailed structural loading information and site grading have not been provided. It is expected that the buildings would impose relatively light floor and foundation loads, and that minor cuts and fills would be required to achieve the final site grades. No information has been provided regarding the possibility of basements.

Purpose and Scope of Work

The purpose of our services was to:

1) explore on a preliminary basis the subsurface soil and groundwater conditions within or adjacent to the proposed buildings, paved and stormwater facility areas;

2) estimate the relevant geotechnical engineering properties of the encountered materials;

3) initiate field percolation tests and/or obtain tube samples for laboratory permeability testing at or near the locations and depths identified to us;

4) evaluate the site foundation requirements considering the anticipated structural loads and encountered subsurface conditions;

5) recommend an appropriate type of foundation for support of the proposed structures, and provide preliminary geotechnical-related foundation design and installation criteria, including an estimate of the Site Class as defined by the International Building Code 2015, New Jersey Edition, for seismic design purposes;

6) provide recommendations for the support and the need for subdrainage of the lowest level floor slabs;

7) provide preliminary geotechnical related parameters for use in pavement design; and

8) discuss appropriate earthwork considerations consistent with the proposed construction and encountered subsurface conditions.

To accomplish these purposes, a subsurface exploration program consisting of 22 supervised test pits was performed at the site. The test pits were excavated using a small track mounted excavator on the first day and a larger excavator on the second day. The test pits extended to depths ranging from approximately 9 feet to 13 feet below the existing surface grades. Upon completion, all test pits were backfilled using the excavated materials which were nominally compacted. The approximate location of the test pits are shown on the Plot Plan, Plate 2.

All field work was performed under the direct technical observation of a representative of MTA. Our representative located the explorations in the field relative to existing surface features shown on the plans provided to us, maintained continuous logs of the explorations as the work proceeded, and collected representative samples of the encountered materials. Relatively undisturbed tube samples were obtained from the explorations for laboratory tube permeameter permeability testing. Field percolation tests were also conducted at three of the 22 test pit locations (TP-1, 3 & 7) in accordance with Appendix E, of the New Jersey State Stormwater BMP Manual.

Descriptions of the subsurface conditions encountered in the test pits are presented on the Logs of Test Pits, Plates 3A through 3V. The soils encountered in the test pits conducted within the proposed below grade stormwater facilities (TP-1 through TP-8) were visually classified in general accordance with the United States Department of Agriculture (USDA) soil classification system shown on Plate 4. The soils encountered in the remaining test pits were visually classified in general accordance with the Unified Soil Classification System (USCS) shown on Plate 5. Graphical depictions of the generalized subsurface profile through the proposed stormwater management areas are presented on Plate 6, Subsurface Sections.

All soil samples were returned to our office where they were visually examined in our soil mechanics laboratory. Selected samples were subjected to geotechnical laboratory testing consisting of natural moisture content determinations and mechanical grain-size analyses to aid in their identification and for geotechnical evaluation purposes. The results of the grain-size tests are presented on Plates 7A and 7B, Gradation Curves, while the results of the moisture content testing are presented on the appropriate exploration logs.

Percolation tests were conducted in three test pits performed for the proposed stormwater management areas to assist Grant Engineering & Construction Group, LLC with their evaluation and design of the stormwater facilities. In addition, relatively undisturbed tube samples were obtained from several locations throughout the development and were subjected to laboratory tube permeameter permeability testing to provide data for the design of dry wells which might be used to control runoff. The findings of the field infiltration and tube permeameter tests are presented on the appropriate test pit logs and summarized in a subsequent section of this report.

The results of our field exploration and laboratory testing programs and visual evaluation of the soil samples have provided the basis for our engineering analyses and geotechnical design recommendations. The following discussions of our findings and recommendations are subject to the limitations attached as an Appendix to this report.

Site Conditions

Surface Features: The site is a rectangular property with approximate dimensions of 410 to 420 by 640 feet. There are four single-family residences which front West Bangs Avenue that are slated to be demolished. One dwelling is still occupied (3124 West Bangs Avenue). The site is partially wooded in the eastern portions and the south, in an area designated as wetlands on the plans provided to us. The site is surrounded by developed land (single family homes) on all sides. The plans indicate wetlands are present along the southern portion of the property.

Surface elevations shown on the plans provided to us indicate the site slopes down from the northeast corner to the west and south ranging from a high of about Elevation +109 feet to lows of about Elevation +106 feet in the west to +89 feet in the south, along the rear of the property. Surface elevation in the wetlands range from +88 feet to +92 feet.

Subsurface Conditions: The subsurface conditions encountered in the explorations performed for this study consisted of the following generalized strata listed in order of increasing depth:

1) Surface Materials: All of the explorations encountered a layer of topsoil varying from four to twelve inches in thickness. The mathematical average thickness was about seven inches, but the method of removal and replacement can greatly impact the actual quantity excavated and handled during construction.

2) Silty Sands or Sandy Silts: A layer of silty sand or clayey or sandy silt was encountered below the surface materials in 20 of the 22 explorations. These materials extended to depths ranging from 1.5 to 12 feet below the surface grades, however, they extended to depths less than five feet in 18 of the 22 explorations. The silty sands were generally medium dense in relative density and the silts and clayey silts were generally stiff to very stiff in consistency.

3) Sands and Gravel: The majority of the explorations encountered loose to medium dense sands or gravel with minor percentages of silt below the upper silty sands and clays and silts. The sands extended to depths of four to greater than ten feet below the ground surface with eleven of the test pits terminating in the stratum. The sand varied in thickness from three to greater than ten feet with an average thickness of about five and one-half feet.

4) Silty Sands and Clays: Silty and clayey sands or clay were encountered below the clean sands in 8 of the 22 explorations, and more frequently in the southern half of the property. The silty sands were medium dense in relative density, and the clayey soils were stiff.

Groundwater seepage was observed in 7 of the 22 test pits at depths ranging from approximately 5 to 11 feet below the ground surface. Mottling, generally indicative of seasonally saturated conditions in the subsoils was observed in 20 of the 22 test pits, at depths ranging from approximately 0.5 to 10 feet below the existing ground surface.

Findings and Recommendations

General: Based on the results of our study, it is our opinion that:

1) Following our recommended site preparation procedures, the proposed structures may be supported on shallow foundations which derive their support from the undisturbed native soils or controlled compacted fill. Foundation elements may be sized for an allowable bearing pressure of 3,000 pounds per square foot. The floor slabs may be supported on undisturbed native soils or controlled compacted fill placed on the native soils to achieve floor subgrade elevation.

2) The existing silty sand and sandy silt located in the upper portions of the soil profile may be suitable for reuse as controlled compacted fill but will be very moisture sensitive. The ability to reuse these materials will be dependent on sufficient moisture conditioning, which could require significant drying and suitable staging and drying areas. This material would be better suited for general fill in lawn or landscaped areas.

3) Groundwater seepage was observed in approximately one third of the test pits at depths of about five to eleven feet below grade. It is therefore unlikely that groundwater will have a significant impact on shallow construction such as slab-on-grade construction, but groundwater control may be required for deeper excavations such as utilities or basements particularly in the lower portions of the site. Seasonal and climatic variations in groundwater levels should be expected, as we have experienced drought-like conditions in recent months. Mottling, likely indicative of seasonally saturated conditions or seasonal water was observed in 20 of the 22 test pits at depths of 0.5 to 10 feet below grade.

4) Due to the presence of generally lower permeability soils at and near the ground surface, undercuts and replacement with more permeable sand or gravel will be required for below grade stormwater facilities, including potential drywells for individual home roof runoff. The undercuts are expected to be generally less than five feet in depth, but variations in the depth of the underlying permeable material may result in undercuts as deep as ten feet in areas.

The following sections of this report present further discussions of these geotechnical-related items.

Site Preparation and Earthwork: The vegetation should be cleared and grubbed and the existing topsoil should be removed for its full depth from within and at least five feet beyond the limits of the proposed improvement areas. The topsoil would not be suitable for reuse as controlled compacted fill. Also, all structural elements of the residential structures slated for demolition should be removed for their full depth and the resultant excavations backfilled with controlled compacted fill. Explorations were not conducted adjacent to the existing structures and variations in subsurface conditions, including the presence of fill and subsurface structures

should be expected. Any fill encountered should be removed for its full depth and replaced with controlled compacted fill.

Following removal of any fill or buried remnants of structures, slabs, and demolition debris, the exposed natural subgrade soils should be proofrolled and compacted to a dense and stable condition under the observation of a representative of MTA using a heavy vibrating drum compactor with a minimum static drum weight of at least 12,000 pounds prior to fill placement. Proofrolling should not be performed in areas where below grade stormwater infiltration is proposed. Any areas which cannot be compacted to a dense and stable condition should be selectively overexcavated and the excavation filled with predominantly granular material.

The exposed natural soils will consist of very silty and clayey soils that are moisture sensitive and subject to disturbance if wet. Care should be exercised during the earthwork activities to minimize disturbance of the subgrade soils. Depending on when work is performed, overexcavation or drying of soils could be required to achieve a stable subgrade.

Following proofrolling, controlled compacted fill should be placed as required to reach the proposed final grades. The excavated upper silty and clayey soils would be poorly suited for reuse as fill due to their sensitivity to moisture related compaction and stability problems and susceptibility to softening and instability if left exposed to weather and construction traffic effects. The results of the laboratory moisture content testing indicate that the upper silty and clayey soils were at moisture contents estimated to permit compaction but there has been an extended dry period and the seasonal and climactic conditions at the time of construction will significantly impact the level of effort needed to maintain the soils at moisture contents suitable

to achieve the required level of compaction. These materials become extremely difficult, if not impossible, to compact when wet.

Any imported fill required for site grading should consist of uncontaminated, relatively well-graded granular materials containing less than fifteen percent by weight of material passing a U.S. Standard No. 200 sieve and having a maximum particle size of three inches. The contractor should provide written certification from the fill supplier stating that the material is uncontaminated soil from a commercial or non-commercial source.

All controlled compacted fill required to attain site grades in the building or pavement areas should be spread in horizontal layers on the order of twelve inches or less in loose thickness and uniformly compacted to at least 95 percent of its maximum dry density as determined by the ASTM D-1557 modified Proctor test procedure using a vibratory roller with a minimum 12,000 pound static drum weight. Backfill placed in confined areas such as foundation or utility trench excavations should be spread in layers on the order of six inches and uniformly compacted to the same degree of compaction using manually operated vibratory compaction equipment.

We recommend that all site excavations be performed in accordance with the current OSHA Excavation Regulations, as well as in accordance with any other locally applicable guidelines. All excavated material should be disposed of in accordance with any environmental regulations or other requirements. Based on the results of the explorations performed for our study, it is our opinion that the on-site silty sands and sands would generally be classified as Type “C” soils as defined by the OSHA Excavation Regulations. Sloughing of excavations should be anticipated and excavation sidewalls should be flattened as necessary to maintain safe conditions. If sufficient space is not available to safely slope the excavations in accordance with

the applicable guidelines, temporary excavation support must be provided. The contractor should be required to provide monitoring of his excavations and provide all necessary support to protect people and property.

Groundwater was encountered at depths ranging from approximately five to eleven feet below the ground surface. We estimate water flow into excavations below the groundwater would be moderate in intensity and could generally be controlled by pumping from sumps located in the excavations. Deeper excavations in the sandy soils extending several feet below the groundwater levels could require well points. We recommend the contract documents require the contractor to provide all dewatering necessary to maintain the excavations in a relatively dry condition until construction is complete. Positive surface drainage including berms or surface drainage swales should be provided at all times during construction to minimize surface runoff from collecting atop the exposed subgrades. Exposure of the soil subgrades to runoff could result in softening or disturbance of the exposed soils.

Foundation Design Criteria: The proposed structures may be supported by conventional shallow foundations established on the undisturbed natural soils, or controlled compacted fill. Foundations established on the undisturbed natural soils or controlled compacted fill could be designed to impose maximum allowable net bearing pressures of up to 3,000 pounds per square foot. All foundations should be at least 18 inches of width regardless of bearing pressures.

Exterior foundations should be established at least three feet below the lowest adjacent exterior grades, or deeper if required by the local building code to provide protection from frost penetration. Interior foundations in permanently heated portions of the structures could be

established at convenient depths below the floor slabs, provided they reach the intended bearing stratum.

We estimate that total settlements of the anticipated lightly loaded foundations designed and constructed in accordance with our recommendations would be on the order of one-half of one inch or less. All foundation subgrades should be observed by a representative of MTA prior to concrete placement to confirm adequate bearing materials are present.

Seismic Design Criteria: Based on the conditions encountered in the test pits and the geologic setting of the site, we estimate that the proposed structures could be designed assuming Site Class "D" as defined by the International Building Code 2015, New Jersey Edition.

Floor Slab Design Criteria: It is our opinion that at-grade floor slabs of the structures could derive their support from undisturbed native soils or properly placed controlled compacted fill. Controlled compacted fill should conform to the gradation and installation criteria previously discussed. Prior to construction of the floor slab, we recommend the exposed soils be thoroughly proofrolled and recompacted to a firm and unyielding consistency with a heavy vibrating drum compactor to densify any materials that become disturbed by the construction operations. Any unstable areas should be removed and replaced with controlled compacted fill or crushed stone. It is our recommendation that a minimum four inch thick layer of clean, three-quarter inch crushed stone or washed gravel be provided under the at grade slab to act as a capillary break. All building floor slab subgrades should be observed by a representative of MTA prior to concrete placement to confirm adequate bearing materials are present.

Basement Considerations: Information concerning potential basements was not provided to us. However, based on the conditions encountered, installation of basements may be feasible from a geotechnical construction viewpoint, but the design would have to consider the encountered groundwater seepage and mottling levels, which are variable across the site. Any local ordinance requirements and available drainage outlets should also be considered in the design. Any basement should be established at least two feet above seasonal high groundwater levels. Subject to the conditions present on specific lots, it is our opinion that exterior basement foundation and subslab drainage systems may be required. If it is desired to develop additional information on the seasonal water conditions, piezometers could be installed and water levels monitored through the spring of next year, typically the high groundwater period. To also reduce basement water concerns, the areas around the basement should also be graded away from the building and roof drainage discharged outside the backfill envelope as necessary to limit surface water from entering the ground immediately outside the basement walls.

If basement foundation and subslab drainage is required, it is preliminarily expected to at least include a minimum four-inch diameter porous wall or perforated, smooth interior wall pipes with inverts near the foundation subgrade level and at least 18 inches below the inside floor slab level (and six inches below nearby interior subslab drainage pipe inverts). The foundation drains should extend around the outside perimeter of the basement and below grade walls. The pipe should be bedded atop and surrounded by at least six inches of three-quarter inch crushed stone or washed gravel encased and separated from the adjacent backfill by a layer of filter fabric. An artificial vertical drainage member (Miradrain, or equivalent) should be attached directly to the basement walls (or a vertical layer of clean stone separated from the backfill soil with filter

fabric), and extended up to within about two to three feet of the final exterior grades. The vertical wall drains should be hydraulically connected to the foundation drain in accordance with the manufacturer's requirements. The drains should discharge by gravity into the site stormwater system or to an appropriate discharge point. Infiltration facilities should be separated from the basement area to the degree practical to reduce the potential for water entering the basement drainage system.

The basement floor slabs should be underlain by a minimum eight inch thick layer of three-quarter inch clean crushed stone or washed gravel. The drainage should also include four inch diameter, smooth interior wall perforated collector pipes bedded on and surrounded by at least four inches of clean stone with pipe inverts below the base of the drainage layer installed as the subslab stone layer and sloped to allow flow to a sump pit(s) or alternate discharge point. If possible, exterior foundation drains should not be connected to an interior sump(s) so as not to rely on a sump pump(s) within the basement area(s) to remove the water. If sump pits are utilized, backup pumping and power supply equipment should be provided. If the foundation drains are connected to the interior sump(s), it is possible that substantial pumping of the sump(s) could occur during wet periods. The seepage and dewatering conditions should be reviewed during construction to confirm the adequacy of the basement drainage systems.

Lateral Earth Pressures: Below-grade building walls, or excavation support systems should be designed to resist lateral earth pressures imposed by the adjacent soils, as well as surcharge loads due to adjacent traffic, floor slab or foundation loads, etc. All below-grade walls should be provided drainage to prevent the build-up of hydrostatic pressures. Below-grade walls which are not fixed and thus free to rotate slightly during backfilling should be designed to resist

earth pressures assuming an active earth pressure condition, while fixed walls should accommodate an at rest condition. Excavated granular soils or imported sand and gravel soils would be preferred backfill materials. Earth pressures from compacted granular materials could be estimated assuming a total drained unit weight of 120 pounds per cubic foot and an angle of internal friction of 30 degrees. Silty and clayey soils would not be desirable for use as backfill as they are poor draining and impose higher lateral pressures.

Below Grade Stormwater Area: The test pits in the proposed stormwater areas, located in the south-southwest portion of the site, encountered approximately 42 to 58 inches of sandy loam or silt loam. Underlying these low permeability soils, sand was encountered to the termination depths of 5 of the 8 stormwater test pits, approximately 7.8 feet below surface grades in one test pit and was not encountered in 2 of the 8 test pits. Where the sand was not encountered (Test Pits TP-4 and TP-5), generally low permeability soils were encountered for the full depth of the test pits.

Any stormwater infiltration facilities will need to be hydraulically connected with the lower, more permeable sands encountered. Undercuts of the upper less permeable soils and replacement with more permeable soil will be critical for these facilities to function properly. In addition, the design of any infiltration facilities will need to consider the soil and groundwater conditions encountered, including the depth to mottling.

Groundwater was observed at depths of about seven to eight feet below grade in Test Pits 5 and 6, conducted in lowest ground surface area of the proposed stormwater facility area. Mottling, potentially indicative of seasonally saturated conditions was observed in the

stormwater test pits, at depths ranging from less than one foot to almost eight feet below the existing ground surface in the stormwater areas.

Percolation tests were performed in accordance with the test procedure outlined on Appendix E of the New Jersey Stormwater Best Management Practices Manual at depths of about five to six and one-half feet below the ground surface within Test Pits 1, 3 and 7. In addition, laboratory tube permeameter tests were also conducted on selected samples obtained from the stormwater test pits and on various building lots where dry wells might be considered. The test results are shown on the individual test pit logs and are summarized below.

Summary of Field Infiltration Test Results – Stormwater Basin Areas

Exploration No.	Depth of Test (ft)	Infiltration Rate (in/hr)	Test Method	USDA Description of Soil Tested
TP-1	5.0	22	Field Percolation	Sand
TP-2	4.5	>20	Tube Permeameter	Sand
TP-2	9.0	4.1	Tube Permeameter	Loamy Sand
TP-3	5.0	22	Field Percolation	Sand
TP-4	9.0	>20	Tube Permeameter	Loamy Sand
TP-7	6.5	22	Field Percolation	Loamy Sand
TP-8	6.0	8.0	Tube Permeameter	Sand
TP-9	7.0	>20	Tube Permeameter	Sand
TP-10	5.0	>20	Tube Permeameter	Sand
TP-11	5.0	>20	Tube Permeameter	Sand
TP-12	5.5	4.3	Tube Permeameter	Loamy Sand
TP-12	10.0	>20	Tube Permeameter	Sand
TP-16	5.0	>20	Tube Permeameter	Sand
TP-18	7.0	>20	Tube Permeameter	Sand
TP-18	12.0	>20	Tube Permeameter	Sand
TP-19	6.5	>20	Tube Permeameter	Sand
TP-21	5.5	>20	Tube Permeameter	Sand

Note: The tube permeameter results above reflect the lowest of three replicates tested.

Please contact us if you have any questions regarding this report.

The following Plates and Appendix are attached and complete this report:

Plate 1 – Site Location Map
Plate 2 – Plot Plan
Plates 3A through 3V – Logs of Test Pits
Plate 4 – United States Department of Agriculture Soil Classification System
Plate 5 – Unified Soil Classification System
Plate 6 – Subsurface Sections
Plates 7A and 7B – Gradation Curves
Appendix – Limitations

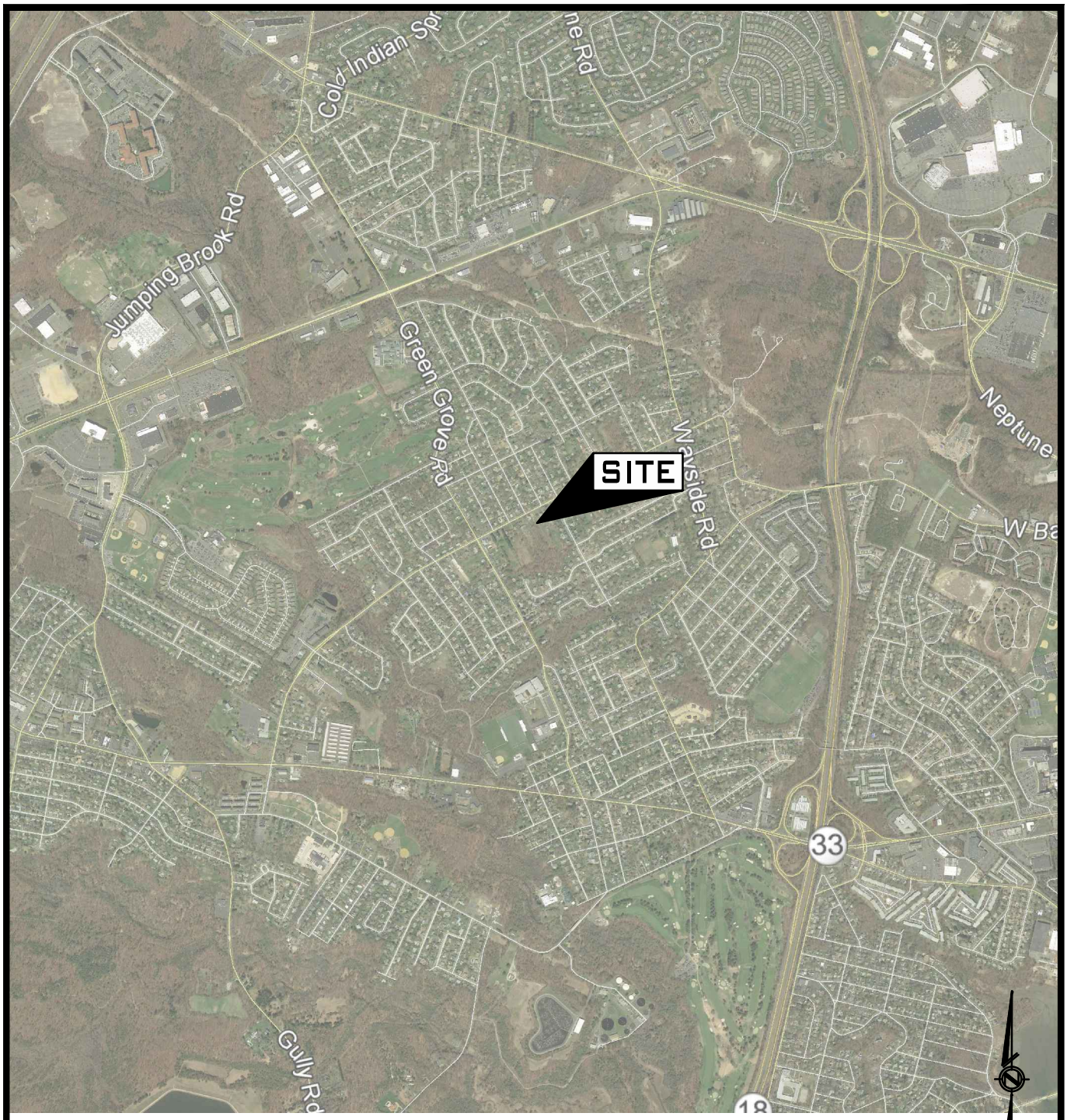
Very truly yours,

MELICK-TULLY and ASSOCIATES, P.C.

Scott D. Watkins, P.E.
Project Manager

Christopher P. Tansey, P.E.
Vice President

SDW:CPT/sdw
9405-001*1D
(3 copies submitted)



Aerial Photo courtesy of Google Earth Pro

MELICK–TULLY AND ASSOCIATES, P.C.
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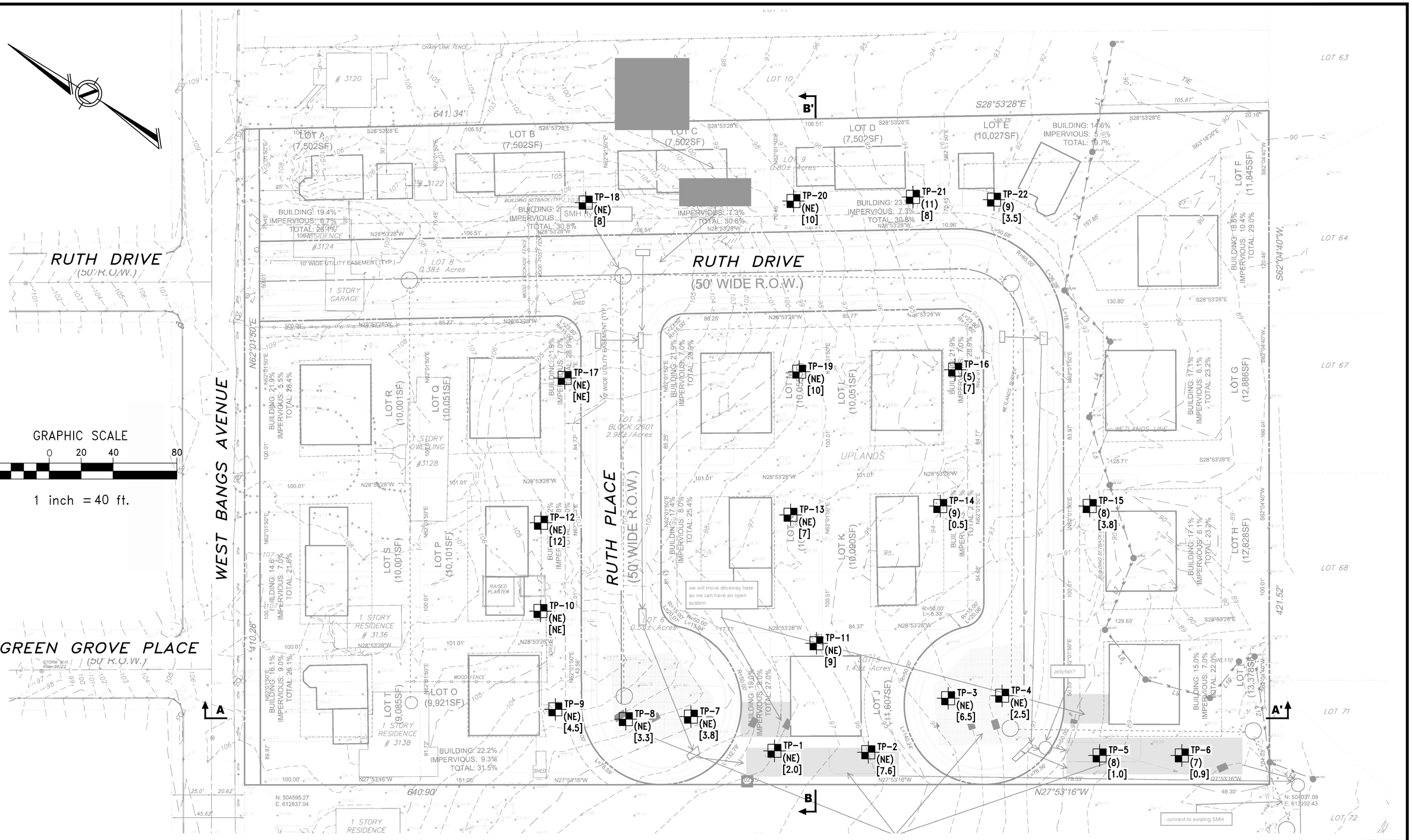
117 Canal Road
South Bound Brook, New Jersey 08880
(732) 356–3400

SITE LOCATION MAP

PROPOSED WEST BANGS AVENUE ESTATES
NEPTUNE, NEW JERSEY
SCARLET FLIER VENTURE, LLC

JOB NO.	FILE NO.	DR. BY	CHK. BY	DATE	SCALE	PLATE
9405–001*1D	27250	VJD	SDW	9/16/16	1"=2,000'	1



GRAPHIC SCALE

40 0 20 40 80

1 inch = 40 ft.

KEY:

TP-1	NUMBER AND APPROXIMATE LOCATION OF TEST PITS PERFORMED FOR THIS STUDY
A A'	INDICATES NAME, APPROXIMATE LOCATION AND DIRECTION OF SUBSURFACE PROFILE
(8)	APPROXIMATE DEPTH IN FEET TO GROUNDWATER BELOW THE EXISTING GROUND SURFACE
[2.0]	APPROXIMATE DEPTH IN FEET TO MOTTLING BELOW THE GROUND SURFACE
NE	NOT ENCOUNTERED

NOTES:

1. This drawing is part of Melick–Tully and Associates, P.C. Report No. 9405–001*1D and should be read together with the report for complete evaluation.
2. General layout was obtained from a drawing prepared by Grant Eng., entitled "Concept Plan 6", dated 8/5/16, scale 1"= 30'.

PLOT PLAN

PROPOSED WEST BANGS AVENUE ESTATES
NEPTUNE, NEW JERSEY
SCARLET FLIER VENTURE, LLC

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& Environmental Consultants
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JOB NO.	FILE NO.			
9405–001*1D	27250			
DR. BY	CHK. BY	DATE	SCALE	PLATE
VJD	SDW	9/16/16	1"=40'	2

LOG OF TEST PIT

TEST PIT NO. 1

COMPLETION DATE: 9/12/16 | SURFACE ELEVATION: +98 ft. (±) | WATER LEVEL: *

JOB NUMBER: 9405-001*1D | READING DATE: 9/12/16

DEPTH	SAMPLES (1)	MOISTURE CONTENT (%)	DEPTH (INCHES)	DESCRIPTION	DEPTH
			0-6	Topsoil: Brown (10YR, 5/4) sandy loam, weak fine subangular blocky, moist, friable, abrupt smooth boundary, few fine roots	
	S1, T1		6-42	Yellow (2.5Y, 8/8) sandy loam, 10% gravel, moderate medium subangular blocky, moist, friable, clear wavy boundary, few fine faint gray mottles (10YR, 6/1) encountered @ 24 inches to 28 inches	
	S2, T2	2.0	42-120	Yellowish brown (10YR, 5/6) sand, 30% gravel, single grain, moist, loose	
5					5
	S3, T3				
10				Test pit completed @ 10'	10
				*Groundwater seepage not encountered	
				Percolation test at 5', Result = 22.0 in/hr	
15					15

NOTES FOR COLUMNS:
1. SAMPLE AT AVERAGE SAMPLING DEPTH

SOIL DESCRIPTION MODIFIERS:
TRACE 0 - 10%
LITTLE 10 - 20%
SOME 20 - 35%
AND OVER 35%

Typist/Date: SDW/pm 9/16

Sheet: 1 of 1 PLATE: 3A

MELICK-TULLY AND ASSOCIATES, P.C.
Geotechnical Engineers and Environmental Consultants

LOG OF TEST PIT

TEST PIT NO. 2

COMPLETION DATE: 9/12/16 | SURFACE ELEVATION: +96 ft. (±) | WATER LEVEL: *

JOB NUMBER: 9405-001*1D | READING DATE: 9/12/16

DEPTH	SAMPLES (1)	MOISTURE CONTENT (%)	DEPTH (INCHES)	DESCRIPTION	DEPTH
			0-5	Topsoil: Brown (10YR, 5/3) silt loam, weak fine angular blocky, moist, friable, abrupt smooth boundary, few fine roots	
	S1, T1	5.4	5-45	Yellow (2.5Y, 7/8) silt loam, 5% gravel, moderate medium angular blocky, moist, friable, clear wavy boundary, few fine roots	
	S2, T2	1.0	45-91	Yellowish brown (10YR, 5/6) sand, 50% gravel, single grain, moist, loose, clear wavy boundary	
5					5
	S3, T3	8.2	91-120	Yellow (10YR, 7/8) sandy loam, moderate medium subangular blocky, common medium distinct gray (10YR, 6/1) mottles encountered @ 91 inches to 120 inches	
10				Test pit completed @ 10'	10
				*Groundwater seepage not encountered	
				Tube Permeameter Test @ 4'5, Result = >20 in/hr	
				Tube Permeameter Test @ 9', Result = 4.1 in/hr	
15					15

NOTES FOR COLUMNS:

1. SAMPLE AT AVERAGE SAMPLING DEPTH

SOIL DESCRIPTION MODIFIERS:

TRACE 0 - 10%
LITTLE 10 - 20%
SOME 20 - 35%
AND OVER 35%

Typist/Date: SDW/pm 9/16

Sheet: 1 of 1 PLATE: 3B

MELICK-TULLY AND ASSOCIATES, P.C.
Geotechnical Engineers and Environmental Consultants

LOG OF TEST PIT

TEST PIT NO. 3

COMPLETION DATE: 9/12/16 | SURFACE ELEVATION: +93.5 ft. (±) | WATER LEVEL: *

JOB NUMBER: 9405-001*1D | READING DATE: 9/12/16

DEPTH	SAMPLES (1)	MOISTURE CONTENT (%)	DEPTH (INCHES)	DESCRIPTION	DEPTH
	S1, T1	8.7	0-8	Topsoil: Yellowish brown (10YR, 5/4) silt loam, moderate medium subangular blocky, moist, friable, clear wavy boundary, few fine roots	
			8-48	Yellowish brown (10YR, 5/2) sandy loam to silt loam, moderate medium subangular blocky, moist, friable, clear wavy boundary, few fine roots	
5	S2, T2	1.7	48-78	Yellowish brown (10YR, 5/6) sand, 50% gravel, single grain, moist, loose, clear wavy boundary	5
	S3, T3	2.3	78-120	Yellowish brown (10YR, 5/6) sand, 50% gravel, single grain, moist, loose, common medium distinct gray (10YR, 6/1) mottles encountered @ 78 inches to 120 inches	
10				Test pit completed @ 10'	10
				*Groundwater seepage not encountered	
				Percolation test @ 5', Result = 22.0 in/hr	
15					15

NOTES FOR COLUMNS:
1. SAMPLE AT AVERAGE SAMPLING DEPTH

SOIL DESCRIPTION MODIFIERS:
TRACE 0 - 10%
LITTLE 10 - 20%
SOME 20 - 35%
AND OVER 35%

Typist/Date: SDW/pm 9/16

Sheet: 1 of 1 PLATE: 3C

MELICK-TULLY AND ASSOCIATES, P.C.
Geotechnical Engineers and Environmental Consultants

LOG OF TEST PIT

TEST PIT NO. 4

COMPLETION DATE: 9/12/16 | SURFACE ELEVATION: +92 ft. (±) | WATER LEVEL: *

JOB NUMBER: 9405-001*1D | READING DATE: 9/12/16

DEPTH	SAMPLES (1)	MOISTURE CONTENT (%)	DEPTH (INCHES)	DESCRIPTION	DEPTH
	S1, T1	11.2	0-8	Topsoil: Brown (10YR, 4/3) silt loam, moderate medium angular blocky, moist, friable, abrupt smooth boundary, few fine roots	
			8-52	Yellowish brown (10YR, 5/4) silt loam, 10% gravel, moderate medium subangular blocky, moist, firm, clear wavy boundary, common medium distinct gray (10YR, 6/1) mottles encountered @ 30 inches to 52 inches	
5	S2	7.8	52-84	Yellow (10YR, 7/8) sandy loam, moderate medium subangular blocky, moist, friable, clear wavy boundary, many coarse prominent gray (10YR, 6/1) mottles encountered @ 52 inches to 84 inches	5
	S3, T2	1.7	84-120	Yellow (10YR, 7/8) loamy sand, 35% gravel, single grain, moist, loose, common medium distinct gray (10YR, 6/1) mottles encountered @ 84 inches to 120 inches	
10				Test pit completed @ 10' *Groundwater seepage not encountered Tube Permeameter Test @ 9', Result = >20 in/hr	10
15					15

NOTES FOR COLUMNS:

1. SAMPLE AT AVERAGE SAMPLING DEPTH

SOIL DESCRIPTION MODIFIERS:

TRACE 0 - 10%
LITTLE 10 - 20%
SOME 20 - 35%
AND OVER 35%

Typist/Date: SDW/pm 9/16

Sheet: 1 of 1 PLATE: 3D

MELICK-TULLY AND ASSOCIATES, P.C.
Geotechnical Engineers and Environmental Consultants

LOG OF TEST PIT

TEST PIT NO. 5

COMPLETION DATE: 9/12/16 | SURFACE ELEVATION: +89 ft. (±) | WATER LEVEL: 8'

JOB NUMBER: 9405-001*1D | READING DATE: 9/12/16

DEPTH	SAMPLES (1)	MOISTURE CONTENT (%)	DEPTH (INCHES)	DESCRIPTION	DEPTH
			0-10	Topsoil: Brown (10YR, 5/3) silt loam, moderate medium angular blocky, moist, friable, abrupt smooth boundary, few fine roots	
	S1, T1	11.2	10-44	Light brown-gray (10YR, 6/2) silt loam, moderate medium subangular blocky, moist, friable, clear wavy boundary, common medium distinct gray (10YR, 6/1) mottles encountered @ 12 inches to 44 inches	
			44-66	Brownish yellow (10YR, 6/8) loamy sand, 10% gravel, single grain, moist, loose, clear wavy boundary, common medium distinct gray (10YR, 6/1) mottles encountered @ 44 inches to 66 inches	
5	S2, T2				5
			66-120	Brownish yellow (10YR, 6/8) sandy clay loam, 10% gravel, moderate medium subangular blocky, wet, friable, many coarse prominent gray (10YR, 6/1) mottles encountered @ 66 inches to 120 inches	
	S3, T2				
10					10
				Test pit completed @ 10'	
				Groundwater seepage encountered @ 8'	
15					15

NOTES FOR COLUMNS:

1. SAMPLE AT AVERAGE SAMPLING DEPTH

SOIL DESCRIPTION MODIFIERS:

TRACE 0 - 10%
LITTLE 10 - 20%
SOME 20 - 35%
AND OVER 35%

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MELICK-TULLY AND ASSOCIATES, P.C.
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LOG OF TEST PIT

TEST PIT NO. 6

COMPLETION DATE: 9/12/16 | SURFACE ELEVATION: +89 ft. (±) | WATER LEVEL: 7'

JOB NUMBER: 9405-001*1D | READING DATE: 9/12/16

DEPTH	SAMPLES (1)	MOISTURE CONTENT (%)	DEPTH (INCHES)	DESCRIPTION	DEPTH
			0-11	Topsoil: Light brownish gray (10YR, 6/2) silt loam, weak fine angular blocky, moist, friable, abrupt smooth boundary, few fine roots	
	S1, T1	12.9	11-52	Brown (10YR, 5/3) silt loam, 2% gravel, moderate medium subangular blocky, moist, firm, clear wavy boundary, common medium distinct gray (10YR, 6/1) mottles encountered @ 11 inches to 52 inches	
5	S2, T2		52-84	Yellow (10YR, 7/8) sandy loam, 15% gravel, moderate medium subangular blocky, moist, friable, clear wavy boundary, many coarse prominent gray (10YR, 6/1) mottles encountered @ 52 inches to 84 inches	5
	S3, T2		84-120	Brownish yellow (10YR, 6/8) sand, 15% gravel, single grain, wet, loose, few fine faint gray (10YR, 6/1) mottles encountered @ 84 inches to 120 inches	
10				Test pit completed @ 10' Groundwater seepage encountered @ 7'	10
15					15

NOTES FOR COLUMNS:
1. SAMPLE AT AVERAGE SAMPLING DEPTH

SOIL DESCRIPTION MODIFIERS:
TRACE 0 - 10%
LITTLE 10 - 20%
SOME 20 - 35%
AND OVER 35%

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MELICK-TULLY AND ASSOCIATES, P.C.
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LOG OF TEST PIT

TEST PIT NO. 7

COMPLETION DATE: 9/12/16 | SURFACE ELEVATION: +100 ft. (±) | WATER LEVEL: *

JOB NUMBER: 9405-001*1D | READING DATE: 9/12/16

DEPTH	SAMPLES (1)	MOISTURE CONTENT (%)	DEPTH (INCHES)	DESCRIPTION	DEPTH
			0-6	Topsoil: Brown (10YR, 5/3) silt loam, moderate medium angular blocky, moist, friable, abrupt smooth boundary, few fine roots	
	S1, T1	1.9	6-24	Yellowish brown (10YR, 5/6) sandy loam, 10% gravel, moderate medium subangular blocky, moist, friable, clear wavy boundary	
	S2, T2		24-52	Yellowish brown (10YR, 5/6) sandy clay loam, 10% gravel, moderate medium subangular blocky, moist, firm, clear wavy boundary, few fine faint gray (10YR, 6/1) mottles encountered @ 46 inches to 52 inches	
5	S3, T2		52-84	Brownish yellow (10YR, 6/8) loamy sand, 20% gravel, single grain, moist, loose, few fine faint gray (10YR, 6/1) mottles encountered @ 52 inches to 58 inches	5
	S4, T4		84-120	Yellow (10YR, 7/8) sand, 10% gravel, single grain, moist, loose, few fine faint gray (10YR, 6/1) mottles encountered @ 98 inches to 120 inches	
10				Test pit completed @ 10' *Groundwater seepage not encountered Percolation test @ 6.5', Result = 22.0 in/hr	10
15					15

NOTES FOR COLUMNS:

1. SAMPLE AT AVERAGE SAMPLING DEPTH

SOIL DESCRIPTION MODIFIERS:

TRACE 0 - 10%
LITTLE 10 - 20%
SOME 20 - 35%
AND OVER 35%

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LOG OF TEST PIT

TEST PIT NO. 8

COMPLETION DATE: 9/13/16 | SURFACE ELEVATION: +102 ft. (±) | WATER LEVEL: *

JOB NUMBER: 9405-001*1D | READING DATE: 9/13/16

DEPTH	SAMPLES (1)	MOISTURE CONTENT (%)	DEPTH (INCHES)	DESCRIPTION	DEPTH
			0-4	Topsoil: Brown (10YR, 5/3) silt loam, weak fine angular blocky, slightly moist, friable, abrupt smooth boundary, few fine roots	
	S1, T1	3.2	4-39	Yellowish brown (10YR, 5/4) silt loam, 5% gravel, moderate medium angular blocky, moist, firm, clear wavy boundary	
	S2, T2		39-58	Yellow (10YR, 7/8) silt, 15% gravel, moderate medium subangular blocky, moist, firm, clear wavy boundary, common medium distinct gray (10YR, 6/1) mottles encountered @ 39 inches to 58 inches	
5	S3, T3		58-120	Yellow (10YR, 7/8) sand, 30% gravel, single grain, moist, loose, few fine faint (10YR, 6/1) mottles encountered @ 104 inches to 120 inches	5
10				Test pit completed @ 10' *Groundwater seepage not encountered Tube Permeameter Test @ 6', Result = 8.0 in/hr	10
15					15

NOTES FOR COLUMNS:
1. SAMPLE AT AVERAGE SAMPLING DEPTH

SOIL DESCRIPTION MODIFIERS:
TRACE 0 - 10%
LITTLE 10 - 20%
SOME 20 - 35%
AND OVER 35%

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LOG OF TEST PIT

TEST PIT NO. 9

COMPLETION DATE: 9/13/16 | SURFACE ELEVATION: +103 ft. (±) | WATER LEVEL: *

JOB NUMBER: 9405-001*1D | READING DATE: 9/13/16

DEPTH	SAMPLES (1)	MOISTURE CONTENT (%)	SYMBOL	DESCRIPTION	DEPTH
				4" Topsoil	
			ML	Yellowish brown clayey silt, little fine to coarse sand (moist)(medium dense)	
	S1		SM	Reddish yellow fine to medium sand, little silt, trace fine gravel (moist)(medium dense)	
			SP	Yellowish brown fine to medium sand, trace silt (moist)(loose)	
5	S2		ML	Gray clayey silt, little fine sand (moist)(very stiff)	5
	S3, T1		SP	Yellowish brown fine to coarse sand, trace silt, trace to little fine to coarse gravel (moist)(medium dense)	
10				Test pit completed @ 10'	10
				*Groundwater seepage not encountered	
				Prominent gray mottling @ 4.5' - 6'	
				Tube Permeameter Test @ 7.0'	
15				Result = >20 in/hr	15
20					20

NOTES FOR COLUMNS:

1. SAMPLE AT AVERAGE SAMPLING DEPTH

SOIL DESCRIPTION MODIFIERS:

TRACE 0 - 10%
LITTLE 10 - 20%
SOME 20 - 35%
AND OVER 35%

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LOG OF TEST PIT

TEST PIT NO. 10

COMPLETION DATE: 9/13/16 | SURFACE ELEVATION: +105.5 ft. (±) | WATER LEVEL: *

JOB NUMBER: 9405-001*1D | READING DATE: 9/13/16

DEPTH	SAMPLES (1)	MOISTURE CONTENT (%)	SYMBOL	DESCRIPTION	DEPTH
				10" Topsoil	
	S1		SP/SM	Yellowish brown fine to coarse sand, trace to little silt, some fine to coarse gravel (moist)(medium dense)	
5	S2, T1		SP	Yellowish brown fine to coarse sand, trace silt, little fine to coarse gravel (moist)(medium dense)	5
	S3				
10				Test pit completed @ 9' *Groundwater seepage not encountered Tube permeameter test @ 5.0' Result = >20 in/hr	10
15					15
20					20

NOTES FOR COLUMNS:
1. SAMPLE AT AVERAGE SAMPLING DEPTH

SOIL DESCRIPTION MODIFIERS:
TRACE 0 - 10%
LITTLE 10 - 20%
SOME 20 - 35%
AND OVER 35%

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MELICK-TULLY AND ASSOCIATES, P.C.
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LOG OF TEST PIT

TEST PIT NO. 11

COMPLETION DATE: 9/13/16 | SURFACE ELEVATION: +96 ft. (±) | WATER LEVEL: *

JOB NUMBER: 9405-001*1D | READING DATE: 9/13/16

DEPTH	SAMPLES (1)	MOISTURE CONTENT (%)	SYMBOL	DESCRIPTION	DEPTH
				4" Topsoil	
	S1	4.6	ML	Yellowish brown clayey silt, little fine to coarse gravel (moist)(very stiff)	
5	S2, T1	1.7	GP	Yellowish brown fine gravel, and fine to coarse sand, trace silt (moist)(medium dense)	5
10	S3		SM	Gray fine sand, some clayey silt (moist)(medium dense)	10
				Test pit completed @ 12'	
				*Groundwater seepage not encountered	
15				Faint gray mottles @ 9'	15
				Prominent mottles @ 11'	
				Tube permeameter test @ 5.0'	
				Result = >20 in/hr	
20					20

NOTES FOR COLUMNS:

1. SAMPLE AT AVERAGE SAMPLING DEPTH

SOIL DESCRIPTION MODIFIERS:

TRACE 0 - 10%
LITTLE 10 - 20%
SOME 20 - 35%
AND OVER 35%

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LOG OF TEST PIT

TEST PIT NO. 12

COMPLETION DATE: 9/13/16 | SURFACE ELEVATION: +104 ft. (±) | WATER LEVEL: *

JOB NUMBER: 9405-001*1D | READING DATE: 9/13/16

DEPTH	SAMPLES (1)	MOISTURE CONTENT (%)	SYMBOL	DESCRIPTION	DEPTH
				1' Topsoil/Fill, brick	
	S1			Reddish yellow fine to medium sand, little silt, trace fine gravel (moist)(medium dense)	
5	S2, T1	3.3	SM		5
				- grading with some fine to coarse gravel	
10	S3, T2				10
				Test pit completed @ 12'	
				*Groundwater seepage not encountered	
15				Faint mottles @ 8'	15
				Tube permeameter test @ 5.5'	
				Result = 4.3 in/hr	
				Tube permeameter test @ 10.0'	
				Result = >20 in/hr	
20					20

NOTES FOR COLUMNS:

1. SAMPLE AT AVERAGE SAMPLING DEPTH

SOIL DESCRIPTION MODIFIERS:

TRACE 0 - 10%
LITTLE 10 - 20%
SOME 20 - 35%
AND OVER 35%

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LOG OF TEST PIT

TEST PIT NO. 13

COMPLETION DATE: 9/13/16 | SURFACE ELEVATION: +96 ft. (±) | WATER LEVEL: *

JOB NUMBER: 9405-001*1D | READING DATE: 9/13/16

DEPTH	SAMPLES (1)	MOISTURE CONTENT (%)	SYMBOL	DESCRIPTION	DEPTH
				9" Topsoil	
	S1	5.6	ML	Yellowish brown silt, little fine sand, little fine to coarse gravel (moist)(stiff)	
5	S2		SM	Yellowish brown fine sand, some silt, trace fine gravel (moist)(medium dense)	5
10	S3		SM	Gray fine sand, some silt (moist)(medium dense)	10
15				Test pit completed @ 13' *Groundwater seepage not encountered Prominent gray mottling @ 7' to 13'	15
20					20

NOTES FOR COLUMNS:
1. SAMPLE AT AVERAGE SAMPLING DEPTH

SOIL DESCRIPTION MODIFIERS:
TRACE 0 - 10%
LITTLE 10 - 20%
SOME 20 - 35%
AND OVER 35%

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LOG OF TEST PIT

TEST PIT NO. 14

COMPLETION DATE: 9/13/16 | SURFACE ELEVATION: +94 ft. (±) | WATER LEVEL: 9'

JOB NUMBER: 9405-001*1D | READING DATE: 9/13/16

DEPTH	SAMPLES (1)	MOISTURE CONTENT (%)	SYMBOL	DESCRIPTION	DEPTH
				6" Topsoil	
			ML	Yellowish brown clayey silt, trace fine sand, trace gravel (moist)(stiff)	
	S1, T1		SP	Yellowish brown fine to coarse sand, trace silt, some to and fine to coarse gravel (moist)(medium dense)	
5					5
			SM	Yellowish brown fine sand, some silt (moist to wet)(medium dense)	
10	S2				10
				Test pit completed @ 11' Slight groundwater seepage encountered @ 9' Mottling @ 5.5' to 11'	
15					15
20					20

NOTES FOR COLUMNS:

1. SAMPLE AT AVERAGE SAMPLING DEPTH

SOIL DESCRIPTION MODIFIERS:

TRACE 0 - 10%
LITTLE 10 - 20%
SOME 20 - 35%
AND OVER 35%

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LOG OF TEST PIT

TEST PIT NO. 15

COMPLETION DATE: 9/13/16 | SURFACE ELEVATION: +91 ft. (±) | WATER LEVEL: 8'

JOB NUMBER: 9405-001*1D | READING DATE: 9/13/16

DEPTH	SAMPLES (1)	MOISTURE CONTENT (%)	SYMBOL	DESCRIPTION	DEPTH
				4" Topsoil	
	S1	6.6	ML	Brown silt, trace fine sand (moist)(stiff)	
			SP	Yellowish brown fine to coarse sand, trace silt, some fine to coarse gravel (moist)(medium dense)	
5			SM	Yellowish brown fine sand, little to some silt (moist)(medium dense)	5
10				Test pit completed @ 11' Slight groundwater seepage encountered @ 8' Mottling @ 3.8' to 11'	10
15					15
20					20

NOTES FOR COLUMNS:
1. SAMPLE AT AVERAGE SAMPLING DEPTH

SOIL DESCRIPTION MODIFIERS:
TRACE 0 - 10%
LITTLE 10 - 20%
SOME 20 - 35%
AND OVER 35%

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LOG OF TEST PIT

TEST PIT NO. 16

COMPLETION DATE: 9/13/16 | SURFACE ELEVATION: +94.5 ft. (±) | WATER LEVEL: 10'

JOB NUMBER: 9405-001*1D | READING DATE: 9/13/16

DEPTH	SAMPLES (1)	MOISTURE CONTENT (%)	SYMBOL	DESCRIPTION	DEPTH
				4" Topsoil	
			ML	Yellowish brown clayey silt, little fine to coarse gravel (moist)(stiff)	
5	S1		SP	Yellowish brown fine to medium sand, trace silt, little fine to coarse gravel (moist)(medium dense)	5
10	S2		CL	Brown silty clay, little fine sand (moist to wet)(stiff)	10
			SM	Yellowish brown fine to medium sand, some silt (wet)(medium dense)	
15				Test pit completed @ 11.5' Slight groundwater seepage encountered @ 5' Groundwater seepage encountered @ 10' Gray mottling @ 7' to 11' Tube permeameter test @ 5.0' Result = >20 in/hr	15
20					20

NOTES FOR COLUMNS:
1. SAMPLE AT AVERAGE SAMPLING DEPTH

SOIL DESCRIPTION MODIFIERS:
TRACE 0 - 10%
LITTLE 10 - 20%
SOME 20 - 35%
AND OVER 35%

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LOG OF TEST PIT

TEST PIT NO. 17

COMPLETION DATE: 9/14/16 | SURFACE ELEVATION: +103 ft. (±) | WATER LEVEL: *

JOB NUMBER: 9405-001*1D | READING DATE: 9/14/16

DEPTH	SAMPLES (1)	MOISTURE CONTENT (%)	SYMBOL	DESCRIPTION	DEPTH
				4" Topsoil	
	S1	4.5	ML	Yellowish brown clayey silt, little fine to coarse sand, little fine to coarse gravel (moist)(very stiff)	
5	S2, T1		SP	Yellowish brown fine to coarse sand, trace silt, some fine to coarse gravel (moist)(medium dense)	5
10	S3				10
15				Test pit completed @ 13' *Groundwater seepage not encountered	15
20					20

NOTES FOR COLUMNS:
1. SAMPLE AT AVERAGE SAMPLING DEPTH

SOIL DESCRIPTION MODIFIERS:
TRACE 0 - 10%
LITTLE 10 - 20%
SOME 20 - 35%
AND OVER 35%

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LOG OF TEST PIT

TEST PIT NO. 18

COMPLETION DATE: 9/14/16 | SURFACE ELEVATION: +105 ft. (±) | WATER LEVEL: *

JOB NUMBER: 9405-001*1D | READING DATE: 9/14/16

DEPTH	SAMPLES (1)	MOISTURE CONTENT (%)	SYMBOL	DESCRIPTION	DEPTH
				9" Topsoil	
	S1	4.6	SM	Brown fine to coarse sand, some silt, some fine to coarse gravel (moist)(medium dense)	
5	S2, T1		SP	Yellowish brown fine to coarse sand, trace silt, little fine to coarse gravel (moist)(medium dense)	5
	S3		SM	Light brown fine to coarse sand, some silt (moist)(dense)	
10	S4		SP	Yellowish brown fine to coarse sand, trace silt, trace fine gravel (moist)(medium dense)	10
15				Test pit completed @ 12' *Groundwater seepage not encountered Faint mottles @ 8' perched on silty sand Tube permeameter test @ 7.0' Result = >20 in/hr Tube permeameter test @ 12.0' Result = >20 in/hr	15
20					20

NOTES FOR COLUMNS:

1. SAMPLE AT AVERAGE SAMPLING DEPTH

SOIL DESCRIPTION MODIFIERS:

TRACE 0 - 10%
LITTLE 10 - 20%
SOME 20 - 35%
AND OVER 35%

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LOG OF TEST PIT

TEST PIT NO. 19

COMPLETION DATE: 9/14/16 | SURFACE ELEVATION: +98 ft. (±) | WATER LEVEL: *

JOB NUMBER: 9405-001*1D | READING DATE: 9/14/16

DEPTH	SAMPLES (1)	MOISTURE CONTENT (%)	SYMBOL	DESCRIPTION	DEPTH
				6" Topsoil	
	S1	3.5	ML	Yellowish brown clayey silt, little fine gravel (moist)(very stiff)	
			SP	Yellowish brown fine to coarse sand, trace silt, some fine to coarse gravel (moist)(medium dense)	
5	S2				5
10	S3				10
15				Test pit completed @ 12' *Groundwater seepage not encountered Faint mottles @ 10' Hole collapsing due to loose sandy soil Tube permeameter test @ 6.5' Result = >20 in/hr	15
20					20

NOTES FOR COLUMNS:

1. SAMPLE AT AVERAGE SAMPLING DEPTH

SOIL DESCRIPTION MODIFIERS:

TRACE 0 - 10%
LITTLE 10 - 20%
SOME 20 - 35%
AND OVER 35%

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LOG OF TEST PIT

TEST PIT NO. 20

COMPLETION DATE: 9/14/16 | SURFACE ELEVATION: +98 ft. (±) | WATER LEVEL: *

JOB NUMBER: 9405-001*1D | READING DATE: 9/14/16

DEPTH	SAMPLES (1)	MOISTURE CONTENT (%)	SYMBOL	DESCRIPTION	DEPTH
				5" Topsoil	
			ML	Brown clayey silt, little fine sand, little fine to coarse gravel (moist)(stiff)	
	S1		SM	Yellowish brown fine sand, little silt, trace fine gravel (moist)(medium dense)	
5	S2. T1				5
			SP	Yellowish brown fine to coarse sand, trace silt, some fine to coarse gravel (moist)(medium dense)	
10					10
				Test pit completed @ 12'	
				*Groundwater seepage not encountered	
15				Faint mottles @ 10'	15
20					20

NOTES FOR COLUMNS:
1. SAMPLE AT AVERAGE SAMPLING DEPTH

SOIL DESCRIPTION MODIFIERS:
TRACE 0 - 10%
LITTLE 10 - 20%
SOME 20 - 35%
AND OVER 35%

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LOG OF TEST PIT

TEST PIT NO. 21

COMPLETION DATE: 9/14/16 | SURFACE ELEVATION: +95 ft. (±) | WATER LEVEL: 11'

JOB NUMBER: 9405-001*1D | READING DATE: 9/14/16

DEPTH	SAMPLES (1)	MOISTURE CONTENT (%)	SYMBOL	DESCRIPTION	DEPTH
				7" Topsoil	
			ML	Brown clayey silt, trace fine sand, trace fine to coarse gravel (moist)(very stiff)	
5	S1,T1		SP	Yellowish brown fine to coarse sand, trace silt, some fine to coarse gravel (moist)(medium dense)	5
	S2				
10			SM	Yellowish brown fine sand, little to some silt (moist)(medium dense)	10
				Test pit completed @ 12' Slight groundwater seepage encountered @ 11' Gray mottling @ 8' to 12' Tube permeameter test @ 5.5' Result = >20 in/hr	
15					15
20					20

NOTES FOR COLUMNS:
1. SAMPLE AT AVERAGE SAMPLING DEPTH

SOIL DESCRIPTION MODIFIERS:
TRACE 0 - 10%
LITTLE 10 - 20%
SOME 20 - 35%
AND OVER 35%

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LOG OF TEST PIT

TEST PIT NO. 22

COMPLETION DATE: 9/14/16 | SURFACE ELEVATION: +92 ft. (±) | WATER LEVEL: 9'

JOB NUMBER: 9405-001*1D | READING DATE: 9/14/16

DEPTH	SAMPLES (1)	MOISTURE CONTENT (%)	SYMBOL	DESCRIPTION	DEPTH
				10" Topsoil	
			ML	Yellowish brown clayey silt, little fine to coarse sand, little fine to coarse gravel (moist)(very stiff)	
5			SM	Brown fine to coarse sand, little silt, some fine to coarse gravel (moist)(medium dense)	5
			SM	Yellowish brown fine to medium sand, some silt, some fine to coarse gravel (moist)(medium dense)	
10			SM	Yellowish brown fine sand, and clayey silt, little fine to coarse gravel (wet)(medium dense)	10
15				Test pit completed @ 11' Slight groundwater seepage encountered @ 9' Mottling @ 3.5' to 11'	15
20					20

NOTES FOR COLUMNS:
1. SAMPLE AT AVERAGE SAMPLING DEPTH

SOIL DESCRIPTION MODIFIERS:
TRACE 0 - 10%
LITTLE 10 - 20%
SOME 20 - 35%
AND OVER 35%

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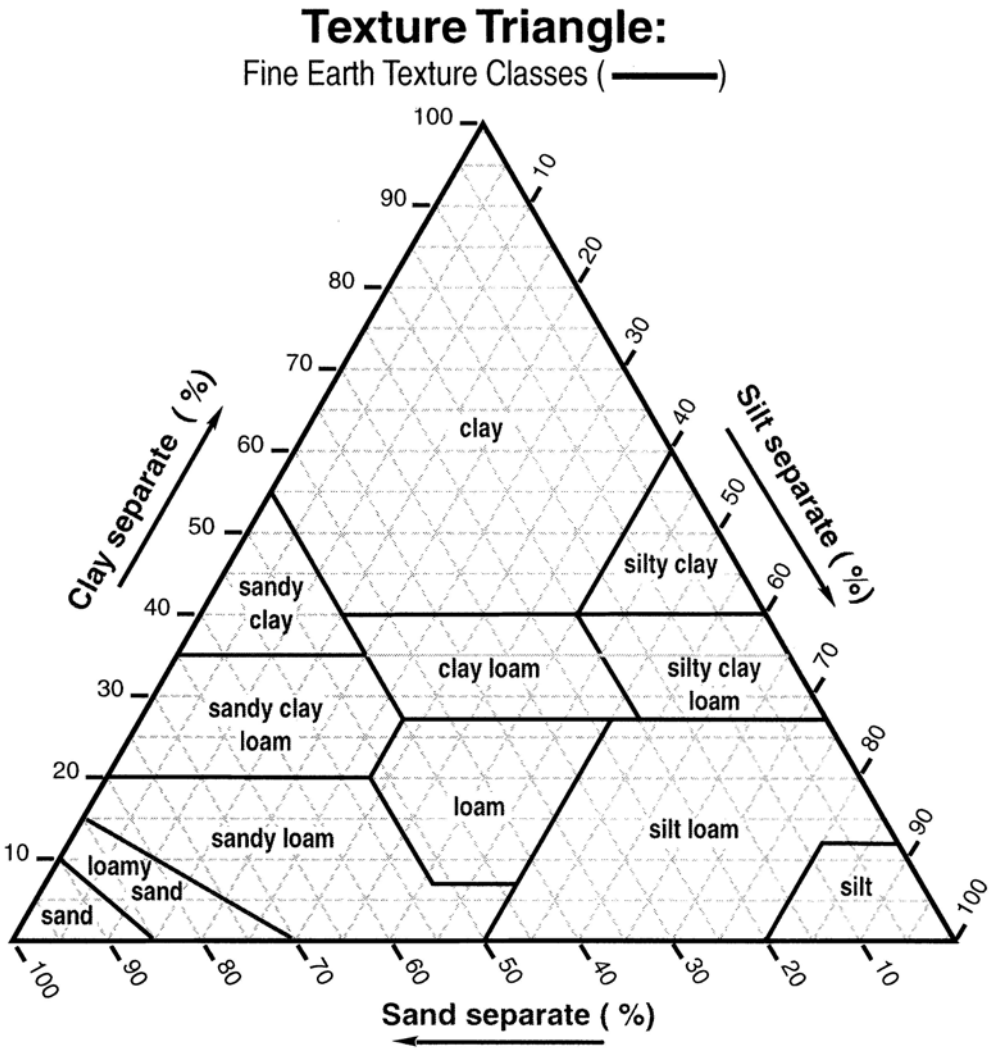


USDA SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS More than 50% of material is LARGER than No. 200 Sieve	GRAVEL & GRAVELLY SOILS More than 50% of coarse fraction RETAINED on No. 4 Sieve	CLEAN GRAVELS (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.
			GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines
		GRAVELS WITH FINES (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures.
			GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS More than 50% of coarse fraction PASSING a No. 4 Sieve	CLEAN SAND (Little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines.
			SP	Poorly-graded sands, gravelly sands, little or no fines.
		SANDS WITH FINES (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS More than 50% of material is SMALLER than No. 200 Sieve.	SILTS AND CLAYS	Liquid limit LESS than 50	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			OL	Organic silts and organic silty clays of low plasticity.
	SILTS AND CLAYS	Liquid limit GREATER than 50	MH	Inorganic silts, micaceous or diatomaceous fine sand or silty soils.
			CH	Inorganic clays of high plasticity, fat clays.
			OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS			PT	Peat, humus, swamp soils with high organic contents

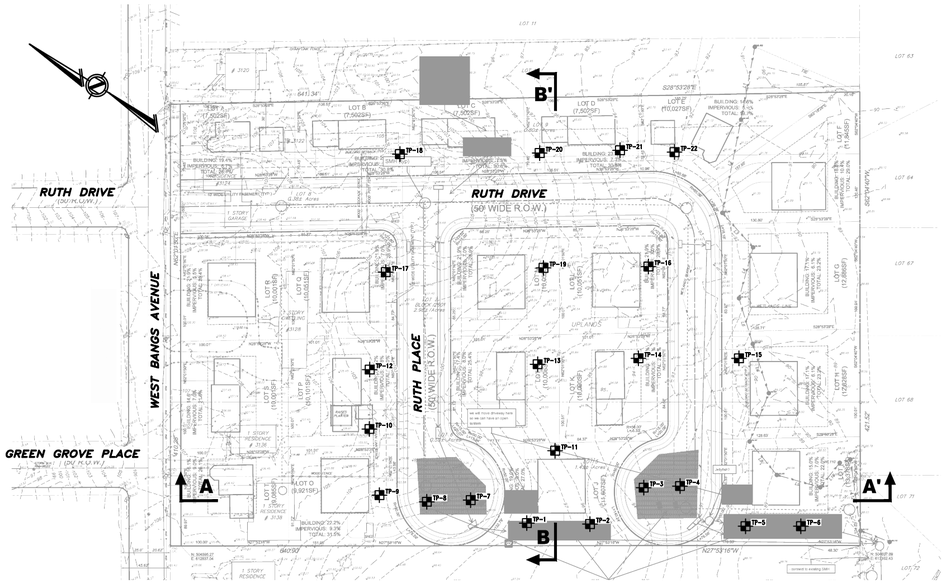
NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS.

GRADATION*		COMPACTNESS* sand and/or gravel		CONSISTENCY* clay and/or silt	
% Finer by Weight		Relative Density		Range of Shearing Strength in Pounds per Square Foot	
Trace	0% to 10%	Loose	0% to 40%	Very Soft	less than 250
Little	10% to 20%	Medium Dense	40% to 70%	Soft	250 to 500
Some	20% to 35%	Dense	70% to 90%	Medium	500 to 1000
And	35% to 50%	Very Dense	90% to 100%	Stiff	1000 to 2000
				Very Stiff	2000 to 4000
				Hard	Greater than 4000

**Values are from laboratory or field test data, where applicable. When no testing was performed, values are estimated.*

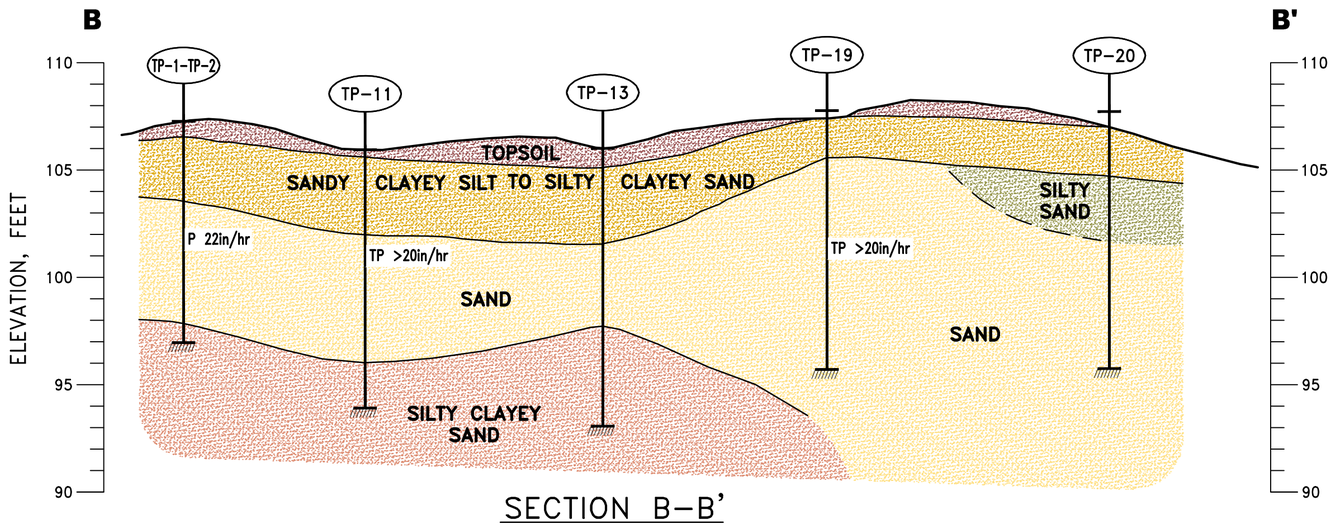
UNIFIED SOIL CLASSIFICATION SYSTEM

SOIL CLASSIFICATION CHART

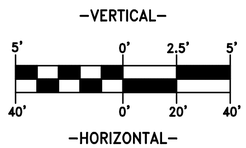


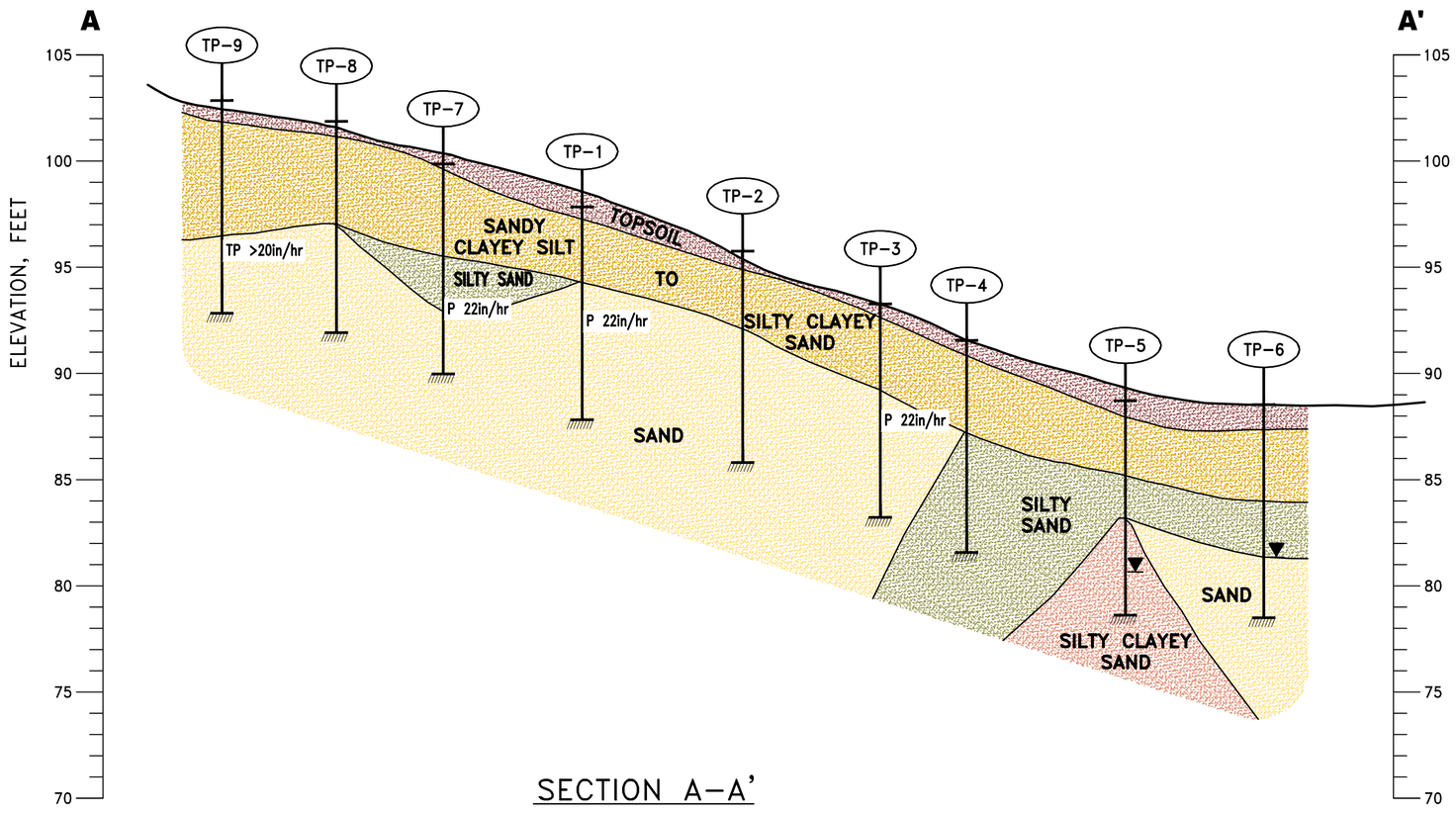
SITE PLAN

SCALE: 1"= 100'



SECTION B–B'





SECTION A–A'

KEY:

TP-1 —— TEST PIT NUMBER AND LOCATION

TP >20in/hr —— TUBE PERMEAMETER TEST

P 22in/hr —— PERCOLATION TEST

▼ —— GROUNDWATER ELEVATION

A A' INDICATES NAME, APPROXIMATE LOCATION AND DIRECTION OF SUBSURFACE PROFILE

NOTES:

1. This drawing is part of Melick–Tully and Associates, Inc. Report No. 9405–001*1D and should be read together with the report for complete evaluation.
2. The stratification lines are based upon interpolations between widely spaced test borings and thus represent the approximate boundaries between soil types. Actual transitions may vary from those shown.
3. Stratum designations are generalized. See report for descriptions of each stratum and the test boring logs for detailed descriptions at specific locations.

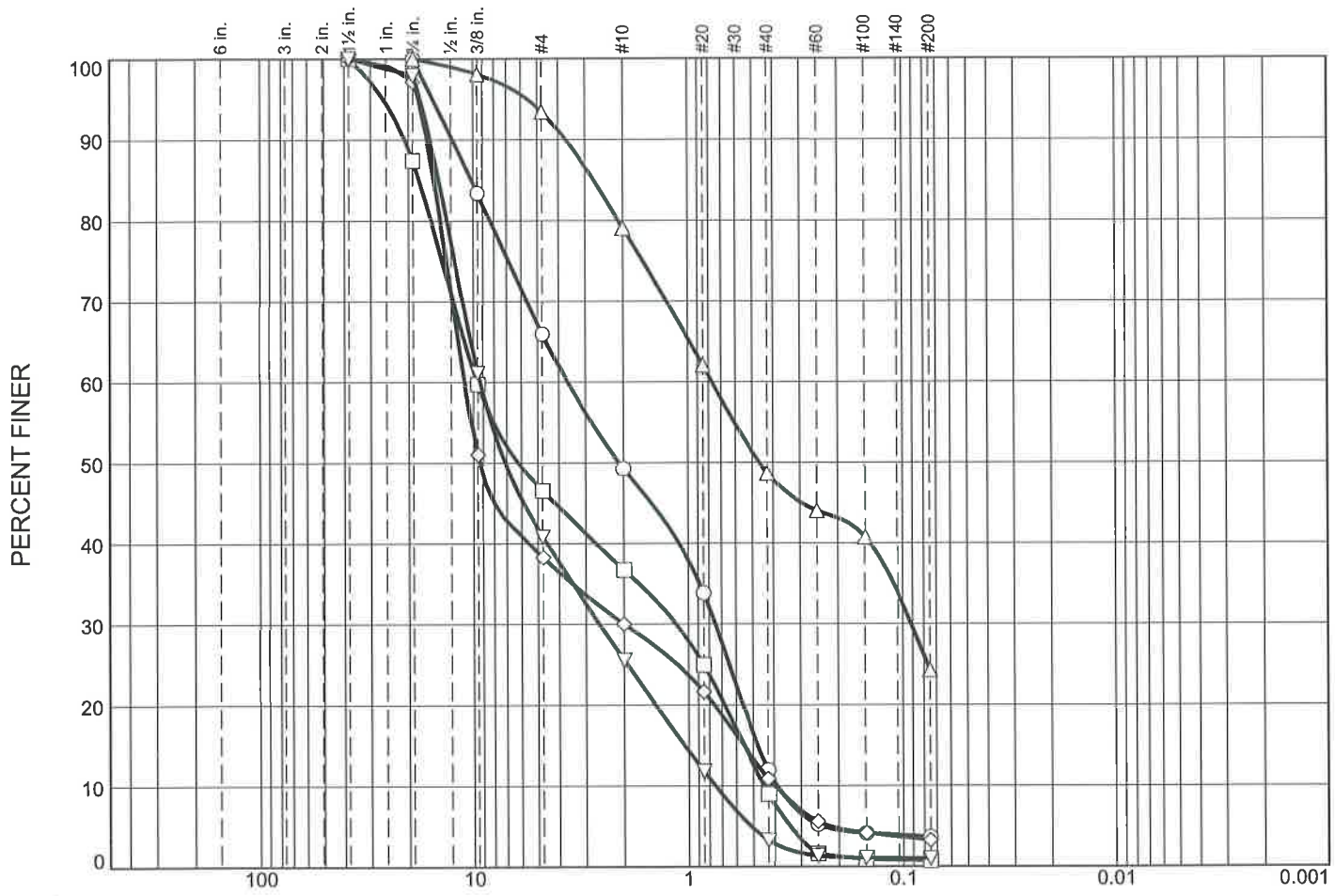
SUBSURFACE PROFILES

PROPOSED WEST BANGS AVENUE ESTATES
NEPTUNE, NEW JERSEY
SCARLET FLIER VENTURE, LLC

MELICK–TULLY AND ASSOCIATES, P.C.
Geotechnical Engineers
& Environmental Consultants
117 Canal Road
South Bound Brook, New Jersey 08880
(732) 356–3400

JOB NO.	FILE NO.			
9405–001*1D	27250			
DR. BY	CHK. BY	DATE	SCALE	PLATE
VJD	SDW	9/22/16	AS NOTED	6

Gradation Curve(s)



	% Cobbles	% Gravel		% Sand			% Fines
		Coarse	Fine	Coarse	Medium	Fine	
○	0.0	0.0	34.0	16.7	37.3	8.3	3.7
□	0.0	12.6	40.8	9.9	27.7	8.3	0.7
△	0.0	0.0	6.6	14.3	30.4	24.4	24.3
◇	0.0	2.8	58.9	8.3	19.1	7.6	3.3
▽	0.0	2.0	57.2	15.3	22.2	2.3	1.0

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	TP-1	S-2	4	Fine to coarse Sand, some fine Gravel, trace Silt. (MC=2.0%)	SP
□	TP-2	S-2	4.5	Fine to coarse Gravel, and f-c Sand, trace Silt. (MC=1.0%)	GP
△	TP-2	S-3	9.0	Fine to coarse Sand, some Silt, trace fine Gravel. (MC=8.2%)	SM
◇	TP-3	S-2	5	Fine Gravel, and f-c Sand, trace Silt. (MC=1.7%)	GP
▽	TP-3	S-3	9	Fine Gravel, and fine to coarse Sand, trace Silt. (MC=2.3%)	GP

Melick-Tully & Associates, P.C.

South Bound Brook, NJ

Client: Derrick Griggs/Scarlet Flier Venture LLC

Project: Proposed Bevjean Estates, Neptune, NJ

Project No.: 9405-001 **Plate** 7A

Gradation Curve(s)

	% Cobbles	% Gravel		% Sand			% Fines
		Coarse	Fine	Coarse	Medium	Fine	
○	0.0	0.0	0.0	0.0	10.5	59.9	29.6
□	0.0	0.0	32.0	8.1	24.9	31.6	3.4
△	0.0	2.1	49.4	13.6	23.1	8.6	3.2

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	TP-4	S-2	5	Fine to medium Sand, and Silt. (MC=7.8%)	SM
□	TP-4	S-3	9	Fine to coarse Sand, some fine Gravel, trace Silt. (MC=7.8%)	SP
△	TP-11	S-2	5.5	Fine Gravel, and fine to coarse Sand, trace Silt. (MC=1.7%)	GP

Melick-Tully & Associates, P.C.

South Bound Brook, NJ

Client: Derrick Griggs/Scarlet Flier Venture LLC

Project: Proposed Bevjean Estates, Neptune, NJ

Project No.: 9405-001 **Plate** 7B

APPENDIX

APPENDIX

Limitations

A. Subsurface Information

Locations: The locations of the explorations were approximately determined by tape measurement from existing site features. Elevations of the explorations were approximately determined by interpolation between contours shown on topographic plans provided to us by the architect. The locations and elevations of the explorations should be considered accurate only to the degree implied by the method used.

Interface of Strata: The stratification lines shown on the individual logs of the subsurface explorations represent the approximate boundaries between soil types, and the transitions may be gradual.

Field Logs/Final Logs: A field log was prepared for each exploration by a member of our staff. The field log contains factual information and interpretation of the soil conditions between samples. Our recommendations are based on the final logs as shown in this report and the information contained therein, and not on the field logs. The final logs represent our interpretation of the contents of the field logs, and the results of the laboratory observations and/or tests of the field samples.

Water Levels: Water level readings have been made in the explorations at times and under conditions stated on the individual logs. These data have been reviewed and interpretations made in the text of this report. However, it must be noted that fluctuations in the level of the groundwater will occur due to variations in rainfall, temperature, and other factors.

Pollution/Contamination: Unless specifically indicated to the contrary in this report, the scope of our services was limited only to investigation and evaluation of the geotechnical engineering aspects of the site conditions, and did not include any consideration of potential site pollution or contamination resulting from the presence of chemicals, metals, radioactive elements, etc. This report offers no facts or opinions related to potential pollution/contamination of the site.

Environmental Considerations: Unless specifically indicated to the contrary in this report, this report does not address environmental considerations which may affect the site development, e.g., wetlands determinations, flora and fauna, wildlife, etc. The conclusions and recommendations of this report are not intended to supersede any environmental conditions which should be reflected in the site planning.

B. Applicability of Report

This report has been prepared in accordance with generally accepted soils and foundation engineering practices for the exclusive use of Scarlet Flier Venture, LLC and its agents for specific application to the design of the proposed new residential buildings described herein. No other warranty, expressed or implied, is made.

C. Reinterpretation of Recommendations

Change in Location or Nature of Facilities: In the event that any changes in the nature, design or location of the building and site improvements are planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and conclusions of this report modified or verified in writing.

Changed Conditions During Construction: The analyses and recommendations submitted in this report are based in part upon the data obtained from 22 widely-spaced test pit excavations performed for this study. The nature and extent of variations between the explorations may not become evident until construction. If variations then appear evident, it will be necessary to reevaluate the recommendations of this report.

Changes in State-of-the-Art: The conclusions and recommendations contained in this report are based upon the applicable standards of our profession at the time this report was prepared.

D. Use of Report by Prospective Bidders

This soil and foundation engineering report was prepared for the project by Melick-Tully and Associates, P.C. for design purposes and may not be sufficient to prepare an accurate bid. Contractors utilizing the information in the report should do so with the express understanding that its scope was developed to address design considerations. Prospective bidders should obtain the owner's permission to perform whatever additional explorations or data gathering they deem necessary to prepare their bid accurately.

E. Construction Observation

We recommend that Melick-Tully and Associates, P.C. be retained to provide on-site soils engineering services during the earthwork construction and foundation phases of the work. This is to observe compliance with the design concepts and to allow changes in the event that subsurface conditions differ from those anticipated prior to the start of construction.

APPENDIX 4
KRAKEN TSS REMOVAL SYSTEM
OPERATIONS AND MAINTENANCE MANUAL
&
NJCAT CERTIFICATION

State of New Jersey
DEPARTMENT OF ENVIRONMENTAL PROTECTION
Bureau of Nonpoint Pollution Control
Division of Water Quality
Mail Code 401-02B
Post Office Box 420
Trenton, New Jersey 08625-0420
609-633-7021 Fax: 609-777-0432
http://www.state.nj.us/dep/dwq/bnpc_home.htm

CHRIS CHRISTIE
Governor

KIM GUADAGNO
Lt. Governor

BOB MARTIN
Commissioner

June 2, 2016

Zach J. Kent
Director of Engineering
BioClean Environment Services, Inc.
398 Via El Centro
Oceanside, CA 92058

Re: MTD Laboratory Certification
Kraken Stormwater Filtration System by BioClean Environmental Services, Inc.
On-Line Installation

TSS Removal Rate 80%

Dear Mr. Kent:

This is an updated certification for the Kraken Stormwater Filtration System ("Kraken") that allows for use of the Kraken for on-line installations. This certification supersedes the New Jersey Department of Environmental Protection (NJDEP) certification dated March 16, 2016.

The New Jersey Corporation for Advanced Technology (NJCAT) original Verification Report of February 2016 for the Kraken limited its use to off-line installation only. In its April 4, 2016, correspondence to the NJDEP, NJCAT submitted an addendum to that February 2016 Report, indicating the NJDEP Filter Protocol dated January 2013 for on-line installations were met or exceeded. No other requirements within the NJDEP's March 16, 2016, certification have changed.

The Stormwater Management rules under N.J.A.C. 7:8-5.5(b) and 5.7(c) allow the use of manufactured treatment devices (MTDs) for compliance with the design and performance standards at N.J.A.C. 7:8-5 if the pollutant removal rates have been verified by the New Jersey Corporation for Advanced Technology (NJCAT) and have been certified by the NJDEP. BioClean Environmental Services, Inc. has requested a Laboratory Certification for the Kraken Stormwater Filtration System.

This project falls under the "Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology" dated January 25, 2013. The applicable protocol is the "New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device" dated January 25, 2013.

NJCAT verification documents submitted to the NJDEP indicate that the requirements of the afore-mentioned protocol have been met or exceeded. The NJCAT letter also included a recommended certification TSS removal rate and the required maintenance plan. The NJCAT Verification Report with the Verification Appendix for this device is published online at http://www.njcat.org/verification-process/technology-verification-database.html.

The NJDEP certifies the use of the Kraken Stormwater Filtration System by BioClean Environmental Service, Inc., at a TSS removal rate of 80%, when designed, operated and maintained in accordance with the information provided in the Verification Appendix and subject to the following conditions:

1. The maximum treatment flow rate (MTFR) for the manufactured treatment device (MTD) is calculated using to the New Jersey Water Quality Design Storm (1.25 inches in 2 hrs) in N.J.A.C. 7:8-5.5. The MTFR is calculated based on a verified loading rate of $1.11x10^{-4}$ cfs/sf (0.05 gpm/sf) of effective filtration treatment area.

2. The Kraken Stormwater Filtration System shall be installed using the same configuration as the unit tested by NJCAT, and sized in accordance with the criteria specified in item 6 below.

3. This device cannot be used in series with another MTD or a media filter (such as a sand filter), to achieve an enhance removal rate for total suspended solids (TSS) removal under N.J.A.C. 7:8-5.5.

4. Additional design criteria for MTDs can be found in Chapter 9.6 of the New Jersey Stormwater Best Management Practices (NJ Stormwater BMP) Manual which can be found on-line at www.njstormwater.org.

5. The maintenance plan for a site using this device shall incorporate, at a minimum, the maintenance requirements for the Kraken Stormwater Filtration System which is attached to this document. However, it is recommended to review the maintenance website at http://www.biocleanenvironmental.com/kraken-operation-and-maintenance/ for any changes to the maintenance requirements.

6. Sizing Requirements

   The example below demonstrates the sizing procedure for a Kraken Stormwater Filtrtration System.

   Example: A 0.25 acre impervious site is to be treated to 80% TSS removal using a Kraken Stormwater Filtration System. The impervious site runoff (Q) based on the New Jersey Water Quality Design Storm was determined to be 0.79 cfs.

   The selection of the appropriate model of the Kraken Stormwater Filtration System is based upon both the MTFR and the maximum inflow drainage area. It is necessary to calculate the required model using both methods and to use the largest model determined by the two methods.

Inflow Drainage Area Evaluation:

The drainage area to the Kraken Stormwater Filtration System in this example is 0.25 acres. Based upon the information in Table 1 below the Kraken Model KF-2.5-4 has a maximum inflow drainage area of 0.439 acres.

Maximum Treatment Flow Rate (MTFR) Evaluation:

The site runoff (Q) was determined based on the following:

time of concentration = 10 minutes
i=3.2 in/hr (page 5-8, Fig. 5-3 of the NJ Stormwater BMP Manual)
c=0.99 (curve number for impervious)
Q=ciA=0.99x3.2x0.25=0.79 cfs

Given the site runoff is 0.79 cfs and based on Table 1 below the KF-8-8 has a MTFR of 0.909 cfs. The KF-8-8 model is the smallest model approved that could be used for this site that would treat the impervious area without exceeding the MTFR.

The sizing tables corresponding to the available system models are noted below:

Table 1 KRAKEN FILTER MODEL MTFRs, SEDIMENT STORAGE CAPACITY AND MAXIMUM ALLOWABLE DRAINAGE AREA

Model	# of Cartridges	Maximum Treatment Flow Rate, MTFR[1] (cfs)	50% Maximum Sediment Storage Volume (ft^3)	Maximum Allowable Drainage Area Based on Loading[2] (acres)
KF-2.5-4	8	0.152	1.37	0.439
KF-4-4	16	0.303	1.70	0.723
KF-4-6	24	0.455	2.59	1.099
KF-4-8	32	0.606	3.44	1.465
KF-8-8	48	0.909	8.38	2.623
KF-8-10	66	1.250	11.5	3.58
KF-8-12	78	1.477	13.4	4.219
KF-8-14	96	1.818	16.9	5.288
KF-8-16	114	2.159	19.9	6.203
KF-10-16	152	2.879	24.0	7.874

Notes:

1. *Calculated based on $1.11x10^{-4}$ cfs/sf (0.05gpm/sf) of effective filtration treatment area*
2. *Based upon the equation found in the NJDEP Filter Protocol Maximum Inflow Drainage Area (acres) = weight of TSS before 10% loss in MTFR (lbs)/600 lbs/acre of drainage area annually*

Be advised a detailed maintenance plan is mandatory for any project with a Stormwater BMP subject to the Stormwater Management Rules, N.J.A.C. 7:8. The plan must include all of the items identified in Stormwater Management Rules, N.J.A.C. 7:8-5.8. Such items include, but are not limited to, the list of

inspection and maintenance equipment and tools, specific corrective and preventative maintenance tasks, indication of problems in the system, and training of maintenance personnel. Additional information can be found in Chapter 8: Maintenance of the New Jersey Stormwater Best Management Manual.

If you have any questions regarding the above information, please contact Titus Magnanao of my office at (609) 633-7021.

Sincerely,

James J. Murphy, Chief
Bureau of Nonpoint Pollution Control

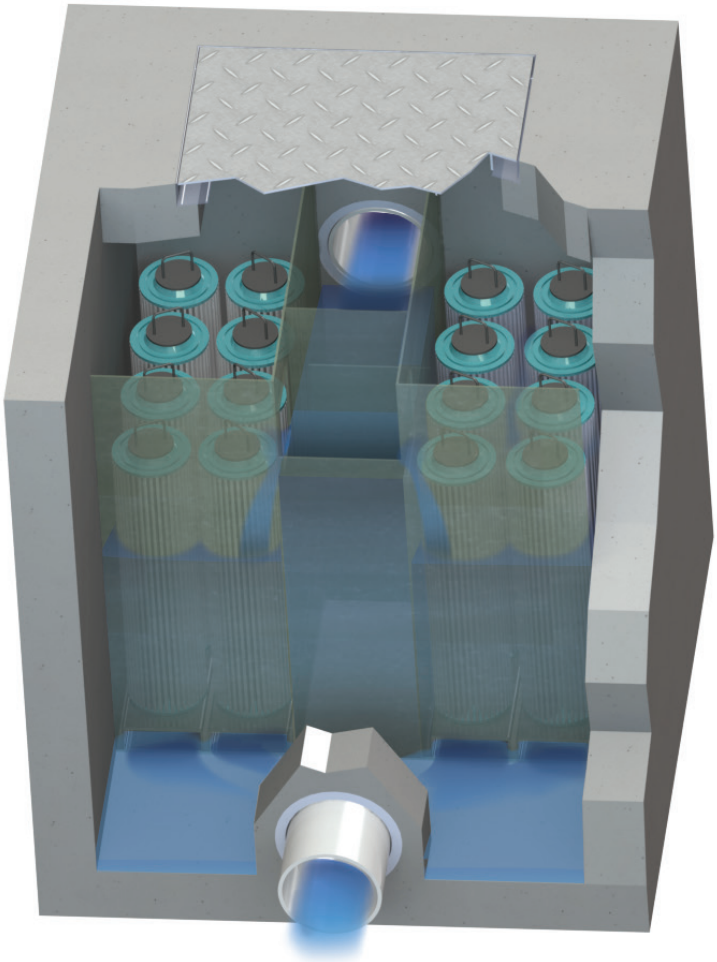
Attachment: Kraken Filter Operation & Maintenance Manual

cc: Chron File
Richard Magee, NJCAT
Vincent Mazzei, DLUR
Gabriel Mahon, BNPC
Ravi Patraju, NJDEP

THE KRAKEN FILTER™

BIO CLEAN ENVIRONMENTAL SERVICES, INC.

OPERATION & MAINTENANCE



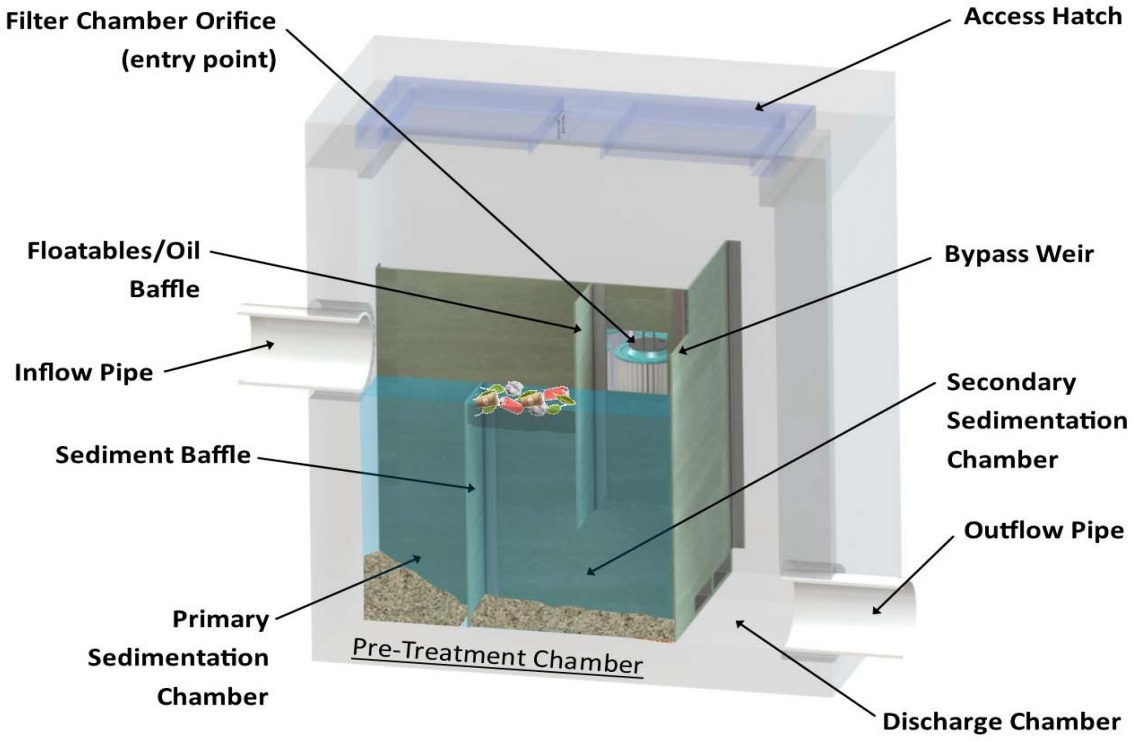
Bio Clean Environmental Services, Inc.
2972 San Luis Rey Road
Oceanside, CA 92054

www.BioCleanEnvironmental.com
P 760-433-7640
F 760-433-3176

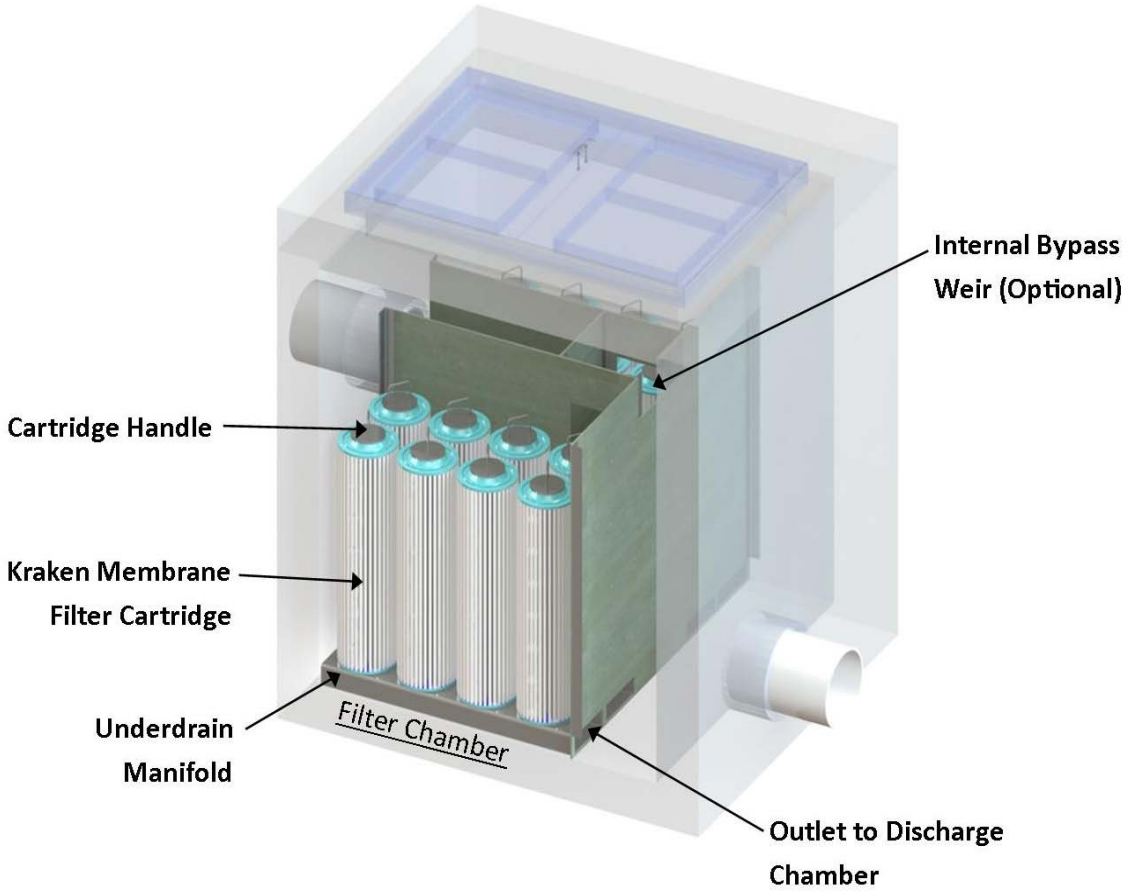
OPERATION & MAINTENANCE

The Kraken® Filter is designed at a minimal loading rate of only 0.05 gpm/sq ft of media surface to maximize longevity and minimize maintenance requirements. This is lower than any other system available. Passive backwash and pretreatment also helps to minimize system maintenance requirements. The Kraken® Filter has proven to be able to handle up to at least 18 months sediment loading with no maintenance or loss of treatment capacity assuming 600 pounds of sediment per acre of impervious surface annually.

Yet, as with all stormwater BMPs inspection and maintenance on the Kraken® Filter is necessary. Stormwater regulations require that all BMPs be inspected and maintained to ensure they are operating as designed to allow for effective pollutant removal and provide protection to receiving water bodies. It is recommended that inspections be performed multiple times during the first year to assess the site specific loading conditions. This is recommended because pollutant loading and pollutant characteristics can vary greatly from site to site. Variables such as nearby soil erosion or construction sites, winter sanding on roads, amount of daily traffic and land use can increase pollutant loading on the system. The first year of inspections can be used to set inspection and maintenance intervals for subsequent years to ensure appropriate maintenance is provided. Without appropriate maintenance a BMP will exceed its storage capacity which can negatively affect its continued performance in removing and retaining captured pollutants.



Pre-Treatment Chamber Diagram:



Filter Chamber Diagram:

Inspection Equipment

Following is a list of equipment to allow for simple and effective inspection of the Kraken® Filter:

- Bio Clean Environmental Inspection Form
- Flashlight
- Manhole hook or appropriate tools to access hatches and covers
- Appropriate traffic control signage and procedures
- Measuring pole and/or tape measure.
- Protective clothing and eye protection.
- Note: entering a confined space requires appropriate safety and certification. It is generally not required for routine inspections of the system.

Inspection Steps

The core to any successful stormwater BMP maintenance program is routine inspections. The inspection steps required on the Kraken® Filter are quick and easy. As mentioned above the first year or two should be seen as the maintenance interval establishment phase. During the first two years more frequent inspections should occur in order to gather loading data and maintenance requirements for that specific site. This information can be used to establish a base for long term inspection and maintenance interval requirements.

The Kraken® Filter can be inspected though visual observation without entery into the system. All necessary pre-inspection steps must be carried out before inspection occurs, especially traffic control and other safety measures to protect the inspector and near-by pedestrians from any dangers associated with an open access hatch or manhole. Once these access covers have been safely opened the inspection process can proceed:

- Prepare the inspection form by writing in the necessary information including project name, location, date & time, unit number and other info (see inspection form).
- Observe the inside of the system through the access hatches. If minimal light is available and vision into the unit is impaired utilize a flashlight to see inside the system and all of its chambers.
- Look for any out of the ordinary obstructions in the inflow pipe, pre-treatment chamber, filter chambers, discharge chamber or outflow pipe. Write down any observations on the inspection form.
- Through observation and/or digital photographs estimate the amount of floatable debris accumulated in the pre-treatment chambers. Record this information on the inspection form. Next utilizing a tape measure or measuring stick estimate the amount of sediment accumulated in the primary and secondary sedimentation chambers. Record this depth on the inspection form. Through visual observation inspect the condition of the filter cartridges. Look for excessive build-up of sediments on the surface and any build-up on the top of the cartridges. Record this information on the inspection form.
- Finalize inspection report for analysis by the maintenance manager to determine if maintenance is required.

Maintenance Indicators

Based upon observations made during inspection, maintenance of the system may be required based on the following indicators:

- Missing or damaged internal components or cartridges.
- Obstructions in the system or its inlet or outlet.

- Excessive accumulation of floatables in the pre-treatment chambers in which the length and width of the chamber behind oil/floatables skimmer is fully impacted.
- Excessive accumulation of sediment in the primary sedimentation chamber of more than 12” in depth.
- Excessive accumulation of sediment in the secondary sedimentation chamber of more than 6” in depth.
- Excessive accumulation of sediment in the filter chambers of more than 3” on average.
- Substantial build-up of sediments on the filter membrane of the filter cartridges which will have a very dark appearance indicating the membrane may be fully saturated with sediment.

Maintenance Equipment

While maintenance can be done fully by hand it is recommended that a vacuum truck be utilized to minimize time requirements required to maintain the Kraken® Filter:

- Bio Clean Environmental Maintenance Form
- Flashlight
- Manhole hook or appropriate tools to access hatches and covers
- Appropriate traffic control signage and procedures
- Measuring pole and/or tape measure.
- Protective clothing and eye protection.
- Note: entering a confined space requires appropriate safety and certification. It is generally not required for routine inspections of the system. Entry into the system will be required if it is determine the cartridge filters need washing/cleaning.
- Vacuum truck
- Trash can
- Pressure washer

Maintenance Procedures

It is recommended that maintenance occurs at least three days after the most recent rain even to allow for drain down of the system and any upstream detention systems designed to drain down over an extended period of time. Maintaining the system while flows are still entering it will increase the time and complexity required for maintenance. Cleaning of the pre-treatment chamber can be performed from finish surface without entry into the vault utilizing a vacuum truck. Once all safety measures have been set up cleaning of the pre-treatment chamber can proceed as followed:

- Using an extension on a boom on the vacuum truck position the hose over the opened access hatch and lower into the center of the primary sedimentation chamber. Remove all floating debris, standing water and sediment from the chamber. A power washer can be used to assist if sediments have become hardened and stuck to the walls or the flow of the chamber. Repeat the same procedure for the secondary sedimentation chamber. This completes the maintenance procedure required on the pre-treatment chamber.

If maintenance is required on the filter cartridges the following procedure can be followed after maintenance on the pre-treatment chamber is performed:

- Following rules for confined space entry use a gas meter to detect the presence of any hazardous gases. If hazardous gases are present to not enter the vault. Following appropriate confined space procedures takes steps, such as utilizing venting system, to address the hazard. Once it is determined to be safe to enter utilizing appropriate entry equipment such as a ladder and tripod with harness.
- Once entry into the system has been established the maintenance technician should position themselves to stand in the pre-treatment chamber. From here the removal of the cartridges can commence.
- Each cartridge is pressure fitted in place and includes a handle for easy removal. To remove a cartridge simply grab the handle and pull straight up. It may be required to gently shift pressure from side to side while pulling up to break the pressure seal. Removal of the cartridge should be done by hand with minimal effort and requires no tools.
- Once the cartridges are removed they should be removed from the vault and brought up to finish surface for cleaning. Using a standard size garbage can and a standard garden hose (low pressure nozzle) each cartridge should be rinsed off from the outside to remove accumulated sediments and debris. Once each cartridge is rinsed it should be placed to the side for re-installation.
- Each filter chamber should be power washed and vacuumed clean before re-inserting the cleaned cartridges.
- After all cartridges have been washed they can be replaced back into the vault. To replace each cartridge simply slide cartridge over each pressure fitted coupler. Push down on the handle to ensure the cartridge has been fully seated and the bottom of the cartridge is making contact with the floor.
- The last step is to close up and replace all access hatches and remove all traffic control.
- All removed debris and pollutants shall be disposed of following local and state requirements.

Maintenance Sequence

Remove Access Hatches Set Up Vacuum Truck to Clean The Pretreatment Chamber.

Insert Vacuum Hose in the Sedimentation Chamber and Vacuum Out All Trash, Sediment and Standing Water.

Assess the Condition of the Filter Cartridges and Determine If Cleaning is Required.

To Wash Cartridges Remove from Vault. Place Over Trash Can and Use a Garden Hose to Spray Clean.

Once Cleaned Install Back Into the Vault. This Completes Maintenance. Ensure Access Lids are Properly Replaced.

For Maintenance Services or Replacement Media Please Contact Us At:
760-433-7640
info@biocleanenvironmental.com

Inspection and Maintenance Report
Bio Clean Kraken Filter

Project Name _____

Project Address _____
(city) (Zip Code)

Owner / Management Company _____

Contact _____ Phone ( ) –

Inspector Name _____ Date ____ / ____ / _____ Time _____ AM / PM

Type of Inspection ☐ Routine ☐ Follow Up ☐ Complaint ☐ Storm Storm Event in Last 72-hours? ☐ No ☐ Yes

Weather Condition _____ Additional Notes _____

For Office Use Only
(Reviewed By)
(Date)
Office personnel to complete section to the left.

Site Map #	GPS Coordinates of Vault	Model #	Sediment Accumulation Sedimentation Chambers (lbs) & Filter Chambers (lbs)	Condition of Filter Cartridges & Were Filter Cartridges Cleaned	Structural Notes	Operational Per Manufactures' Specifications (If not, why?)
	Lat: Long:					
	Lat: Long:					
	Lat: Long:					

Comments:

2972 San Luis Rey Road, Oceanside, CA 92058 P. 760.433.7640 F. 760.433.3176

APPENDIX 5
RAINSTORE3™ STORMWATER RETENTION SYSTEM

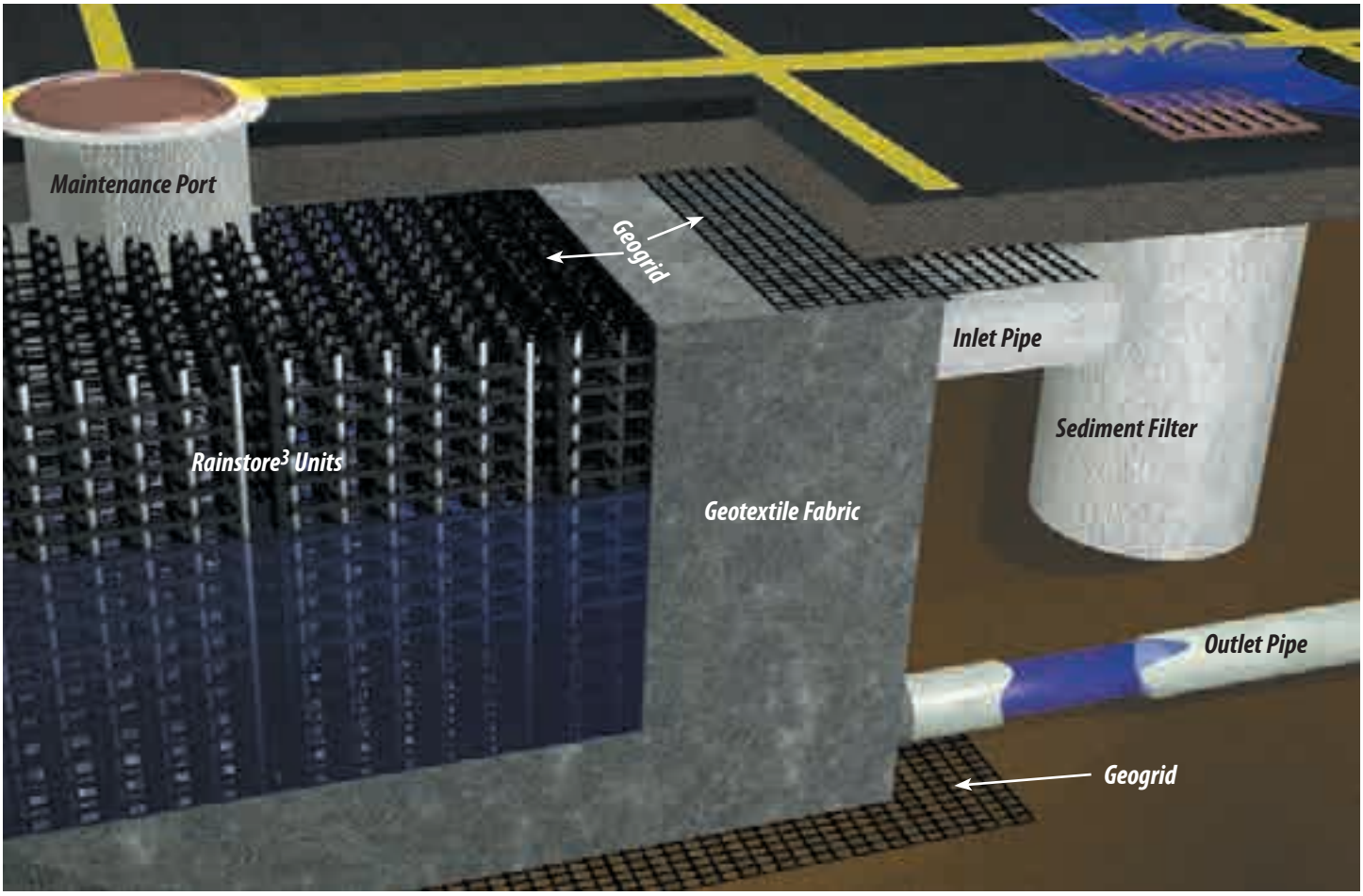
(MAINTENANCE INFORMATION ON PAGE 8)

Rainstore^3

On the cover: Rainstore³ chamber under parking lot, Broomfield, CO. Without Rainstore³'s high water storage capacity at shallow depths, the flexibility in design, and the convenience of exfiltration, the owners of this site would have been unable to develop this site and would have been forced to find a different location for their new construction.

Above: Two views of a completed RS³ install under a parking lot in Big Fork, MT. Parking lot and off-street bays for approximately 48 cars, drains into a 26,250-gallon Rainstore³ stormwater detention structure. Diagonal parking is graded toward the center concrete strip, which drains toward the catch basin.

Below: Graphic representation of asphalt parking lot with Rainstore³ detention showing individual components. Drawing not to scale.



NOW IT IS POSSIBLE!

Invisible Structures, Inc., (ISI) has created a new class of subsurface water storage system, Rainstore^3 (RS^3). It is not pipe or arched chamber, but a structure with strength throughout its shape. The unique design places the plastic entirely in compression rather than bending or tension, resulting in an excess of H-20 loading, and high void storage volume of 94%! Minimum cover is only 0.3 meter (12″).

The structure can be as shallow as 0.1 meter (4″) or as deep as 2.4 meters (94″), and with any length and width in 1 m (40″) increments. Rainstore^3 eliminates site restrictions by conforming to custom project requirements.

RS^3 does not require any stone backfill between structures. Calculating the void (storage) volume is as simple as dividing storage demand by 94%. This means significant savings in amount of excavation, soil transport, imported stone, installation time, and labor.

Rainstore^3 can be utilized for long-term water storage for irrigation, fire protection, toilet flushing, and potable by encasing the structures in an impervious liner.

Porous lining materials around RS^3 offer 100% surface area coverage for water infiltration/exfiltration.

Above: Workers cover Rainstore^3 units with geogrid and geotextile fabric at Adams Street Station in Jacksonville, FL. Two separate Rainstore^3 detention chambers were designed at only 2 units high (20 cm) to account for the high water table.

Below: Portland State University designed a comprehensive stormwater harvesting system to be used for irrigation and toilet flushing. A Rainstore^3 harvesting system is used to hold and deliver stormwater to the plaza garden and treated and used for residence hall toilet flushing.

STORMWATER QUALITY IS OLD BUSINESS

Company Background and Product Line

Invisible Structures, Inc., has been in the stormwater management business since 1982 with our porous paving systems Grasspave^2 and Gravelpave^2, ring and grid structures for grass and gravel drivable surfaces. Large rolls sizes cover areas quickly while either protecting grass roots from compaction or containing small gravel to eliminate gravel migration. These products have extensive design brochures that cover all aspects from project photographs to latest technology and specifications. Check our web site www.invisiblestructures.com for a full display of information and downloadable details.

Draincore^2 (DC^2) collects excess irrigation and rainfall from recreational grass surfaces such as lawns, sports fields, and bio-swales, and transports filtered water to RS^3. This water may be recycled for irrigation or other uses. Draincore^2 conveys water in a shallow horizontal plane, eliminating trenching and backfill requirements of pipe.

Slopetame^2 (ST^2) is a three dimensional soil, vegetation, pre-vegetation containment mat used to reduce soil loss due to water erosion on slopes, river banks, channels, and bio-swales. Crossbars between rings serve to prevent rill erosion. ST^2 provides support for grasses and a variety of plant material whose roots furnish natural fibrous anchorage. ST^2 bio-swales will help clean debris and pollutants from stormwater prior to entering Rainstore^3.

RS^3 evolved from the ring and grid concept by allowing stackability to greater depths, and increased lateral compressive strength to resist deep soil pressures. The 94% void capacity was attained for RS^3 while satisfying structural criteria.

Water Quality Background

Water quality is critical and must be considered when dealing with stormwater management. In the past, point-source pollution (contaminates from a concentrated source) was of primary concern. Today, non-point source pollution (contaminates from a large area such as a parking lot) is important due to the magnitude of its effect and its prevalence.

The EPA has regulated point source pollution for years and is now implementing strict regulations to control non-point source pollution, which is cumulative and presents long term negative impacts upon our water resources.

Stormwater traveling across hard surfaces will collect contaminates from hydrocarbons to solid waste. The most effective pollution control incorporates treatment at the point of origin before reaching community waterways or water tables.

In nature, stormwater percolates into vegetated and non-vegetated areas where suspended solids are filtered and many chemicals neutralized. Research has shown that hydrocarbons are consumed by bio-organisms found in the root zone without killing the vegetation.

Invisible Structures' porous pavement and bio-swale products provide one of the most effective means of removing pollutants at the source. Refer to Porous Paving Inflow Method Detail for ways to reduce or eliminate catch basins and elaborate cleaning systems. Rainstore^3 in combination with ISI's other outstanding products provide a complete stormwater management package.

PRODUCT DESCRIPTION

Basic Structure

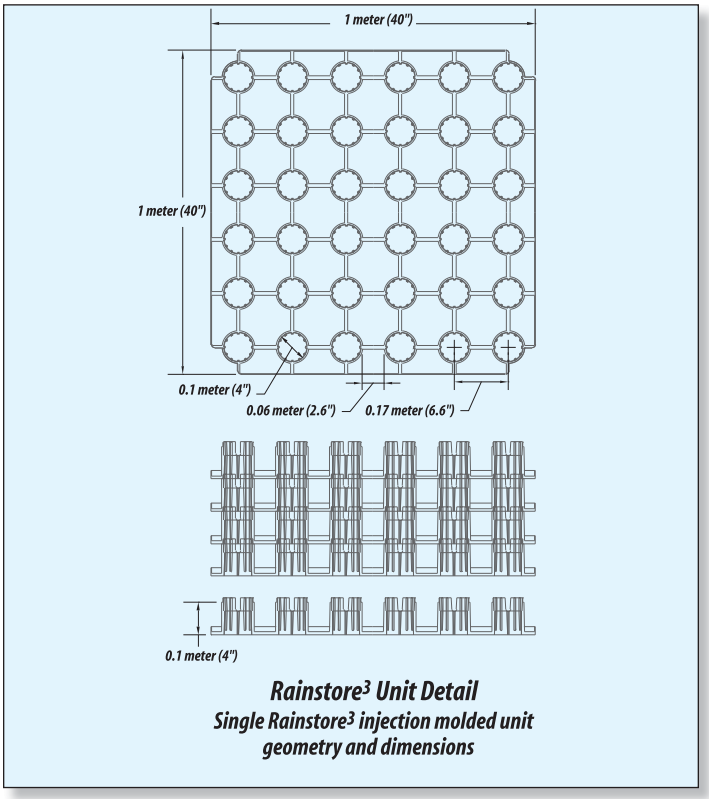
Rainstore^3 is a structure of thin-walled cylindrical columns injection molded of recycled resin of polypropylene (PP) plastic for strength, durability, and green industry benefit. Cylinders are 10 cm (4″) diameter, 5mm (0.2″) average wall thickness, 10 cm (4″) tall, and spaced 16.7 cm (4.6″) apart. T-shaped beams connect the cylinders and resist external lateral soil/water pressure. Compression fittings between layers create a rigid structure for ease of transport and installation.

Four archway openings in the top of each cylinder allow water to move freely throughout assembled columns. A single Rainstore^3 injection molded unit weighs 15 pounds and is comprised of 36 cylindrical columns that occupy one square meter (40″ × 40″ × 4″). A stack of 10 units will comprise one cubic meter (35.31 cubic feet), with approximately 248 gallons of net water storage.

RS^3 allows for water containment depths from 10 cm to 2.4 meters (4" to 7.9'). The following standard depths are stocked: *in meters* (0.2, 0.3, 0.4, 0.6, 0.8, 1.2, and 2.4) *in feet* (0.7, 1.0, 1.3, 2.0, 2.6, 4.0, and 7.9). Custom depths are also available.

Side bumpers provide foolproof, accurate spacing. Structures may be moved by hand. A layer of geogrid, below the cells and above the existing subsoil, provides a stable surface and will insure proper alignment.

RS³ withstands repeated freeze-thaw cycles, will not rust, break down, crack, is not affected by chemicals, extremes of pH, oils, salts, or fertilizers. Polypropylene plastics have a projected service life in excess of 100 years provided they are not exposed to UV light.



Rainstore³ Unit Detail
Single Rainstore³ injection molded unit geometry and dimensions

Overall System

RS³, wrapped with a geotextile filter fabric or geomembrane, and placed side by side in an excavated void create a variety of water storage structures. Inflow, outflow, visual inspection pipes, catch basins, pumps and water filters are installed as needed. Backfilling and compacting the sides, geogrid, base course, and surfacing complete the system.

STORMWATER MANAGEMENT APPLICATIONS

Land development significantly affects the natural course of stormwater. Prior to development, land is semi-porous enabling rainfall to directly infiltrate, which filters pollutants, recharges subsurface water tables, and reduces flooding. Sealing the earth's surface with parking lots, roads, walks, and roofs, results in rapid runoff to storm sewers and rivers, causing flooding and unacceptable pollution of valuable water resources.

To combat these serious problems, national (EPA) and regional regulatory agencies require all or a portion of stormwater to be managed on site.

Surface detention basins and ponds are common, but often occupy valuable real estate and create safety hazards, insects, weeds, and odor problems. Increasingly, the most economical and convenient solution is an "underground pond," where the water may be stored temporarily before it is released to a storm sewer (detention), stored until it exfiltrates (retention), or stored for reuse (harvesting).

Porous Paving

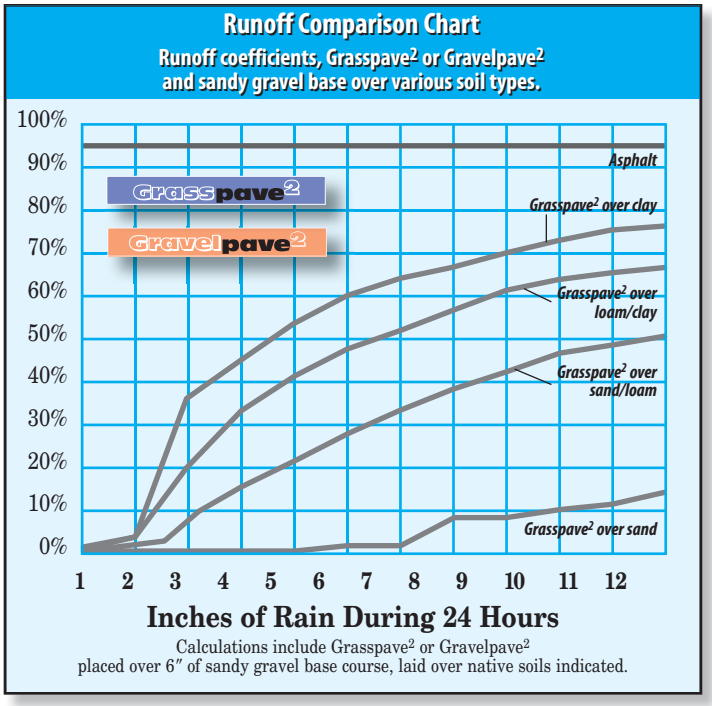
The most direct stormwater management technique is to allow the rain to penetrate the surface where it falls. This can be done with Grasspave² or Gravelpave² porous paving. The base course below these plastic reinforcement structures will typically store at least 2.5″ of rain, or more, if subsoils are porous. Firelanes and overflow parking areas are frequently used as infiltration basins.

Rainstore³ Detention

Short term storage and releasing stormwater at a predetermined rate through the use of small outlet pipes or pumps is detention. Downstream stormwater facilities may exist but have a limited flow rate capacity. While the water is held awaiting gradual release, it may or may not be allowed to exfiltrate into the site soils. A porous non-woven geotextile is used to encase RS³. Geomembranes are used when exfiltration must be avoided.

Rainstore³ Retention

When downstream stormwater facilities do not exist or the amount of water released from a site is limited for some other reason, stormwater retention is utilized. Typically, there are no outflow pipes. RS³ is encased in non-woven geotextile and placed above porous soil. Replenishing existing aquifers is a benefit.



Unique shapes and cutouts can easily be designed into Rainstore3 systems. This Rainstore³ detention system at a supermarket parking lot in Mt Pleasant, SC, has cutouts for tree islands and to fit the limited space on site. Over 23,000 pieces of Rainstore³ were used in three separate chambers to store 75,000 cubic feet of water.

Water Harvesting

As population centers expand in arid climates, traditional water sources such as rivers and aquifers have been significantly depleted. With increased water prices, it becomes more economical to harvest rainfall with Rainstore³. Also, demands upon ground resources are reduced, making some water critical projects possible. The choice for long term storage with Rainstore³ is influenced by site opportunities and constraints, access to community infrastructure (water, sewer, fire protection), government regulations, and owner principles and guidelines.

Stormwater falling on a site is collected from roofs, bio-swales, and parking areas. A strong impermeable liner surrounding the

Product Performance Analysis

Performance Criteria	Rainstore³ 2.4 meter (7.9') heigh	Arched Chambers (34″ × 75″ × 16″)	Corrugated Plastic Pipe (60″ dia.)	Corrugated Metal Pipe (72″ dia.)	Concrete Pipe (72″ dia.) Non-perforated
% of excavated volume available for water storage	~75%*	~40%*	~60%*	~53%*	~38%*
% of storage volume occupied by stone	0%	~59%	~60%	~70%	0%
Maximum water storage volume/ surface area	7.9 ft³ water storage/ft² surface area	~1.4 ft³ water storage/ft² surface area	3.8 ft³ water storage/ft² surface area	4.7 ft³ water storage/ft² surface area	3.2 ft³ water storage/ft² surface area
Chamber depth design flexibility	4″ min., 94″ max., in 4″ increments	12″ min., 30.5″ max.	12″ dia. min., 60″ dia. max., 6″ increments	12″ dia. min., 240″ dia. max., 6″ increments	12″ dia. min., 240″ dia. max., 6″ increments
Cover depth required	12″	18″	12″ – 30″ based on diameter	12″ – 24″ based on diameter	6″
On-site handling and manual installation	Easy	Easy	Difficult	Difficult	Difficult
Maintenance, inspection, clean-out	Moderate	Moderate	Easy	Easy	Easy
% of chamber surface area available for infiltration	100%	~75%, including side cuts	~15%, based on perforation area to pipe surface area	~15%, based on perforation area to pipe surface area	0%

*Calculations based on an average sized (10 meter × 10 meter) footprint installed per manufacturer's specifications.

chamber prevents evaporation and contamination. The water may be used for landscape irrigation, fire protection, potable applications, and industrial processes, such as water for heating and cooling with geothermal energy transfer. For long term storage, water may require chemical treatment or oxygenation to preserve water quality.

PRODUCT PERFORMANCE COMPARISON

Crushed rock wrapped in geotextile, concrete, corrugated metal or plastic pipe, and plastic arch chambers have been historical subsurface water storage options available to designers. Invisible Structures closely studied the performance of these systems and obtained feedback from engineers and contractors as to what they liked and disliked about available solutions.

With this information, ISI designers developed Rainstore^3 which boasts a highly efficient excavated volume, economical installation, reduced stone requirements, improved design flexibility, safety, strength, and exceptional longevity.

DESIGNING WITH RAINSTORE^3

Design Steps

1. *Choose system application:* Determine whether porous paving, detention, retention, and/or water harvesting methods will be used. Function will determine whether outflow pipes will be needed, and choice of liner to encase the structures.

2. *Determine the location and quantity of storage systems:* Pick the most appropriate site location to minimize excavation, grading, and piping — usually downhill from runoff sources. Use soil boring information to determine subsoil conditions and water table depth. Exfiltration requires porosity. Rainstore^3 can be located below most landscaped or paved surfaces. It may be desirable to use more than one location for storage.

3. *Choose surfacing to be placed above storage structure:* RS^3 allows for many different surfacing options — parking, green space, recreation, landscaping, and light weight buildings. Landscaping directly above a storage structure should be restricted to shallow rooted materials such as grasses, groundcovers, and low growing shrubs. Long term chemical root barrier materials are available if RS^3 must be kept root free.

If parking is the surface use, then choose between porous paving and hard surface options. Grasspave^2 and Gravelpave^2 filter stormwater directly by allowing percolation through the parking surface and base course into RS^3 without the use of pipe.

4. *Determine required capacity:* Local regulating agencies establish rainfall storage requirements. Calculate by multiplying the hard surface area (roads, parking lots, walks, roofs, etc.) by the "design rainfall" required, then by the runoff coefficient (refer to Runoff Comparison Chart on page 3). Determine supplemental storage requirements for irrigation, process, fire safety, or potable uses, and add to regulated storage demand.

5. *Determine quantity of Rainstore^3:* Convert the storage requirement to cubic meters, divide by 0.94 to determine volume of Rainstore^3 in cubic meters. Gallon storage reference is 1 m^3 of water = 264 gallons × .94 = 248 gallons/m^3 RS^3.

6. *Depth of Rainstore^3:* Factors such as depth of water table, bedrock and available excavation area affect the optimal depth of retention/ detention capability. Choose a RS^3 bottom elevation that is higher than the water table maximum level. In cases where surface area is very limited and storage volume is great, deeper structures are usually more cost effective. Include 12″ of gravel fill and surfacing cover in the decision. The Rainstore^3 cells are assembled to the desired depth prior to shipment. The following depths are available to avoid additional shipping costs: *in meters* (0.2, 0.3, 0.4, 0.6, 0.8, 1.2, and 2.4), *in feet* (0.7, 1.0, 1.3, 2.0, 2.6, 4.0, and 7.9).

Provide an appropriate safety factor when depth of structure is near the maximum water table level because water rising into RS^3 reduces storage volume. Please refer to the Product Description section for standard and custom depths.

7. *Choose the length and width of Rainstore^3:* Having already chosen RS^3 depth, pick the length and width that occupies the required volume of RS^3 (L × W = V/height). Adjust length or width as necessary to meet site criteria. The length and width must be in full meter increments.

8. *Determine catch basin and inflow locations:* **All water entering the Rainstore^3 structure must be reasonably silt and debris free to minimize maintenance and extend the system's useful life.**

Typical Soil Permeabilities

Soil Group	Typical Coefficient	Inches /Day	Description	Suitable for Exfiltration
GW	2.5 EE-2	850.4	well graded, clean gravels, gravel-sand mixtures	Yes
GP	5 EE-2	170.1	poorly graded clean gravels, gravel-sand mixtures	Yes
SW	>5 EE-4	17.0	well-graded clean sands, gravelly sands	Yes
SP	>5 EE-4	17.0	poorly graded clean sands, sand-gravel mix	Yes

Note: The following soil groups are not suitable for exfiltration (silty, clayey soils): GM, GC, SM, SM-SC, SC, ML, ML-CL, CL, OL, MH, CH, OH.

The preferred filtration method is a sand or bio-filter constructed with Gravelpave2 or Grasspave2 (refer to Porous Paving Inflow Method Detail). A catch basin or other structural means may also be used. Choose an inflow location that best suits site conditions and minimizes waterborne debris. Standard pipe made of PVC, HDPE, steel, concrete, tile, copper, or any other material may be used to convey water to or away from Rainstore3.

9. *Determine outflow locations (if necessary):* For gravity fed outflow, ensure that site topography allows the outflow pipe to travel to a lower elevation stormwater facility. Size the pipe to limit outflow to the desired rate. If gravity outflow is not possible, pumps may be used (refer to Water Harvest or Maintenance Port Details). **A fail safe power supply is essential if outflow pumps are used.**

10. *Select Rainstore3 liner:* First, choose between permeable and impermeable. Non-woven filter fabrics are typically used except when water harvesting or stormwater exfiltration is prohibited by regulation.

Acceptable impermeable liners are at least 40 mil PVC or equal. Permeable liners must be at least 8 ounce non-woven. Properly match fabric pore sizes to surrounding soils to prevent clogging and blinding. **Fabric seams must have a 24″ minimum overlap unless sewn.**

To make pipe connections to geotextile fabric, cut an "X" in the fabric, insert the pipe, gather fabric, and fasten tightly with a pipe clamp. If using a geomembrane, construct a "boot" of material and bond it to the circular opening. Insert the pipe through the boot and fasten with two pipe clamps (refer to the Water Harvest Detail).

11. *Determine quantity of geogrid:* **Three layers of geogrid Tensar BX1200 or TriAx160, Tenax MS330, Huesker Fornit 30 or equivalent) must be placed. One layer on the soil below the RS3 (see step 12), one layer directly on top of the RS3 cells — to stabilize with adjacent cells and to provide a walking surface — and the final layer placed on fabric-encased chamber and extended 0.5 meter (20″) beyond the sides of the structure.**

12. *Compute length, width, and depth of excavation:* **Excavation must extend at least 0.5 meter (20") beyond all sides of RS3 structures to allow for ease of product installation and backfill compaction with powered compactor. Soil below RS3 must be leveled with minimal compaction. A layer of geogrid (Tensar BX1200 or TriAx160, Huesker Fornit 30 or equivalent) must be placed on the subsoil and extended 0.5 meter (20″) beyond the sides of the structure.** Large and deep storage volumes may demand a drivable access route for excavation, leveling, compaction and placing Rainstore3 structures. **0.3 meters (12″) minimum, 0.9 meters (36″) maximum, structural base course (no greater than 1″ particle size) must cover the geogrid and extend past all RS3 sides by 0.5 meter (20″). Compact this layer to a minimum of 95% modified Proctor density.**

Native excavated soil or imported backfill may be used as long as it is considered structural and a 95% Proctor density is achieved. Compact in lifts as needed to attain proper compaction. Water saturated backfill should not be used as it is difficult to compact and creates excessive hydrostatic pressure on bottom sides of RS3.

Warning: Take extreme care when driving and/or compacting over the chamber and do not drive over exposed Rainstore3 units — wait until ALL the units are installed, the side backfill is complete, fabric and geogrid layers are completed, and an adequate amount of cover material is placed. Mark area to identify chamber location.

13. *Choose maintenance port locations:* Check local regulations proper size and placement of maintenance ports. An inside corner section of Rainstore3 may be removed to create a suitable opening for inspection and inserting cleanout pumps. (Refer to the Maintenance Port Detail.)

MAINTENANCE OF A RAINSTORE3 STORMWATER STORAGE CHAMBER

Invisible Structures, Inc. recommends that stormwater be pretreated prior to discharging into the chambers to avoid foreign matter accumulation inside the chamber. This can be accomplished by a variety of techniques or products. Some examples are:

Short Term Storage (Detention Basin)

"Zero" Maintenance — the Preferred Method

Use a natural, or "Bio-Filter," inlet device — essentially a porous pavement or swale, to pre-filter trash and sediment laden runoff before capture and conveyance into a Rainstore3 chamber. Use of a simple 10-12″ deep sand, or sand/gravel, filter pavement or swale will provide adequate vertical flow capacity (20 to 35+ inches per hour) and residence time to capture coarse debris and trash at the surface, with sediment and hydrocarbons (and even most traffic generated metals) kept in voids of the section for treatment action by bacteria and oxidation.

Water passing through the filter section can pass directly into the top of a Rainstore3 chamber, or be collected and transported over larger distances via Draincore2.

Only super fine sediments will pass through this section and be conveyed into the chamber. With relatively short storage times (24 to 48 hours) most of these sediments shall remain suspended,

or be easily re-suspended by the next rain event for removal. Long-term accumulations to a depth affecting exfiltration rates can be measured in decades, not years.

Trash pickup from the surface requires that Zero be in quotes. Also be aware that grass surface porous pavements (Grasspave^2) offer greater biological activity, but at a higher surface maintenance cost — mowing, fertilization and irrigation. Gravel surface porous pavements (Gravelpave^2) still provide biological activity at a level lower than with grass, but with lower maintenance required.

Short Term Storage (Detention Basin)

Low, but Periodic, Maintenance

Use a structural form of catch basin with a deep sump prior to use of a hooded elbow inlet into the chamber. Whether standard catch basins or sophisticated cyclonic flow devices are used, the objective is to remove any coarse debris and sediment (sand and larger) from entering the Rainstore^3 chamber. Periodic maintenance will be required to remove trash and sediment that accumulates in the device. Frequency shall depend upon the physical nature of sediments carried and allowed into the "screening" device.

Fine sediments may still be transported into the chamber via the inlet pipe and will likely be dispersed rather evenly over the entire chamber bottom surface area, where they will then settle to the bottom — depending upon the duration of time water is left in the chamber and the size of the particle. Particles smaller than the AOS of the porous fabric liner will pass through the liner and continue migration until stopped by underlying soils. Particles larger than the AOS shall remain inside the chamber, and can be periodically re-suspended by injecting high-pressure water into a Maintenance Port, with removal of the sediment laden water via sump pump from the same, or other, port.

Eventually, especially if maintenance is too infrequent, the bottom of the chamber may develop a thick sediment layer sufficient to obstruct exfiltration through the bottom of the chamber. The sides of the chamber shall continue to function, but time for total water evacuation will increase.

This approach is most closely related to more traditional design responses, but is not the best solution long term for the client. Standard catch basins are lowest initial cost, but much higher in maintenance cost. Commercial cyclonic devices may have lower maintenance cost, but offer higher levels of cleaning efficiency at much higher initial investment cost.

Long Term Storage (Water Harvest Basin)

"Zero" Maintenance — the Preferred Method

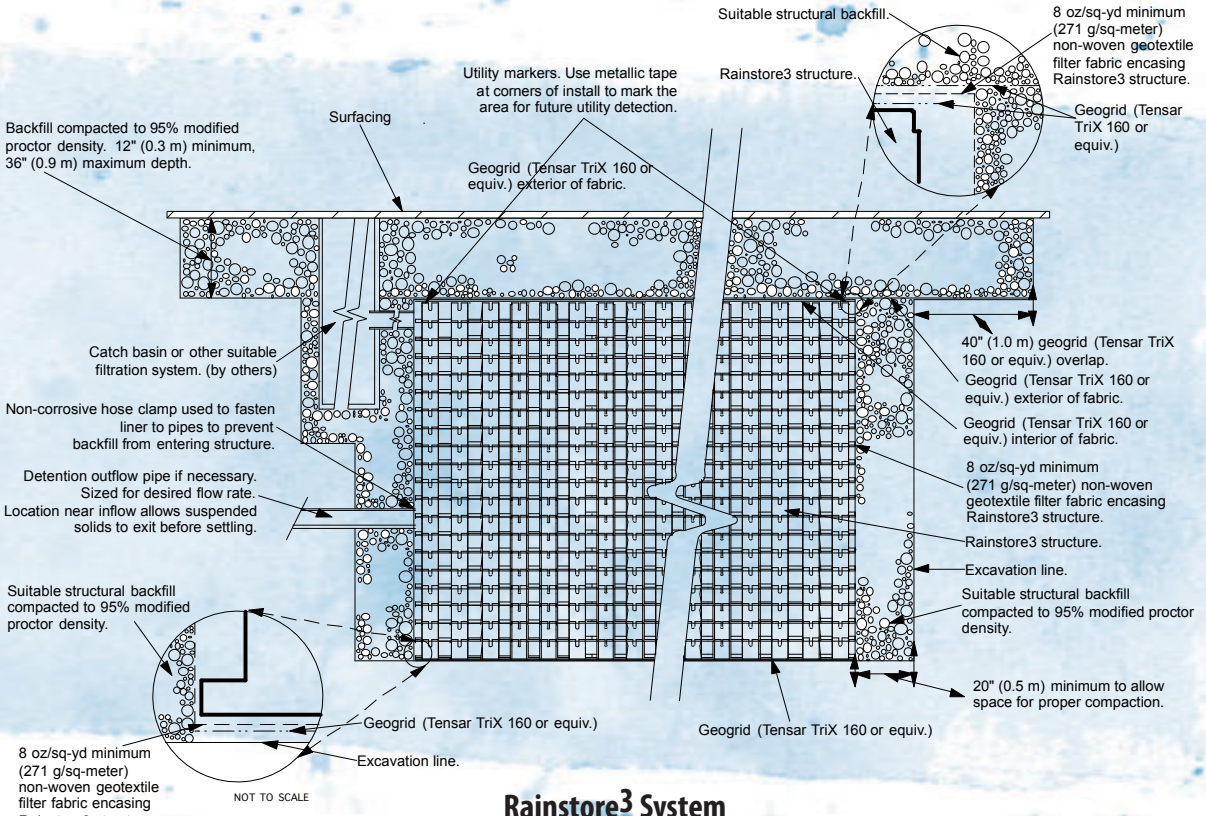
Again, use a natural, or "Bio-Filter", inlet device—essentially a porous pavement or swale, to pre-filter trash and sediment laden runoff before capture and conveyance into a Rainstore^3 chamber. Use of a simple 10-12″ deep sand, or sand/gravel, filter pavement or swale will provide adequate vertical flow capacity (20 to 35+ inches per hour) and residence time to capture coarse debris and trash at the surface, with sediment and hydrocarbons (and even most traffic generated metals) kept in voids of the section for treatment action by bacteria and oxidation.

Water passing through the filter section can pass directly into the top of a Rainstore^3 chamber, or be collected and transported over larger distances via Draincore^2.

Only super fine sediments will pass through this section and be conveyed into the chamber. With relatively short storage times (24 to 48 hours) most of these sediments shall be easily re-suspended by the next rain event for removal. This level of sediment can be safely captured and transported via pumps for water reuse in irrigation or gray water applications, or further filtered by an automatic sand filter device with "back-flush" capabilities.

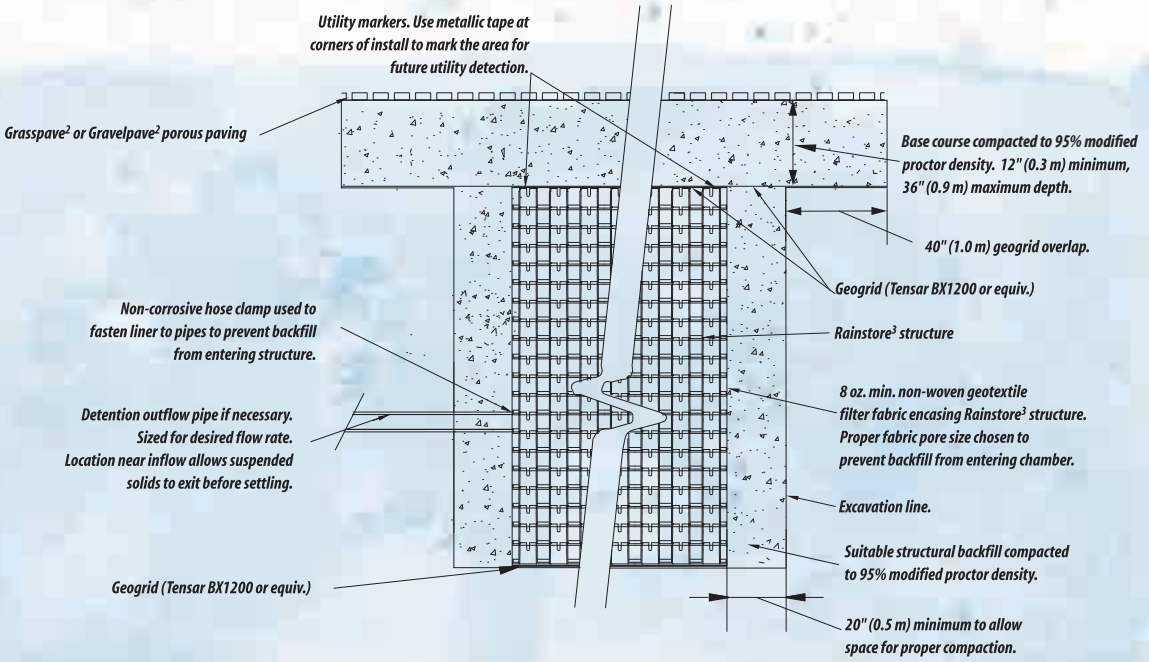
Above: Taller can be better for your design with 7.9 feet or 2.4 meters high versatility. H-20 loading capability allows use underneath all parking lots and a variety of structures.

DESIGN DETAILS



Rainstore^3 System

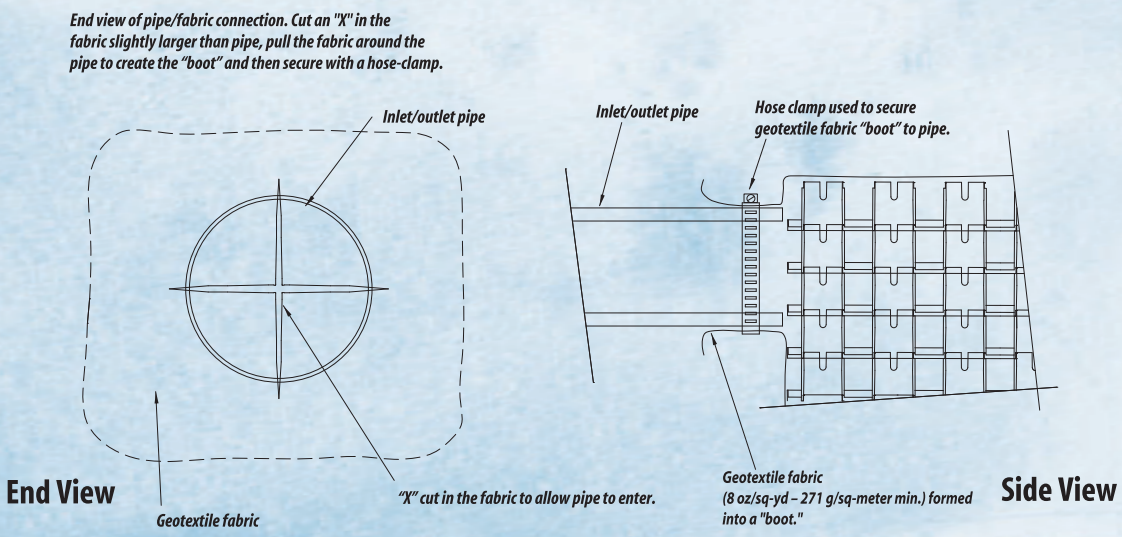
Typical Rainstore^3 installation below paving for stormwater retention or detention



Porous Paving Inflow Method

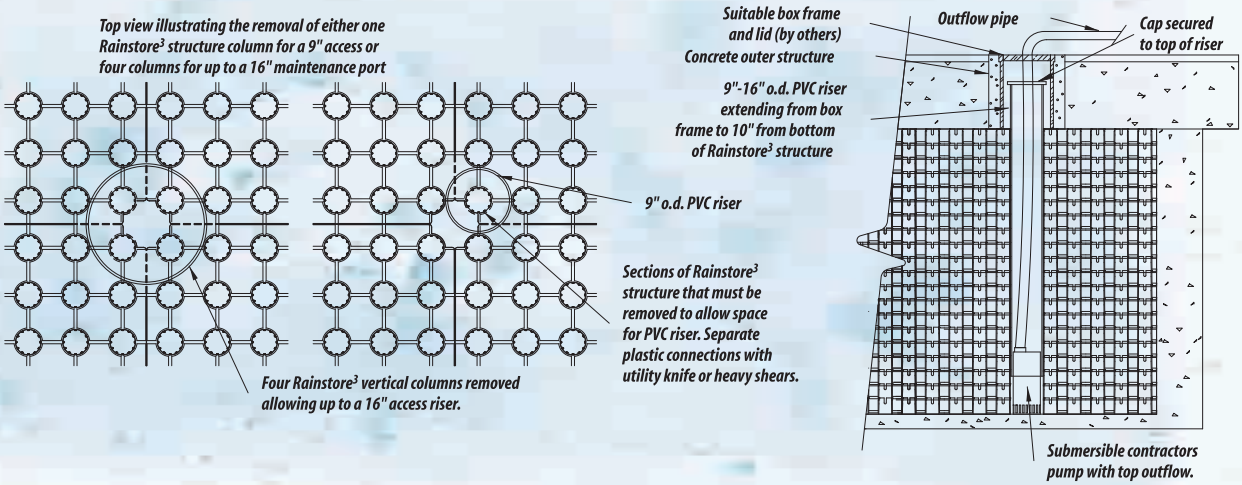
Eliminates structural inlets and provides thorough filtration

DESIGN DETAILS



Rainstore³ Inlets/Outlets With Fabric

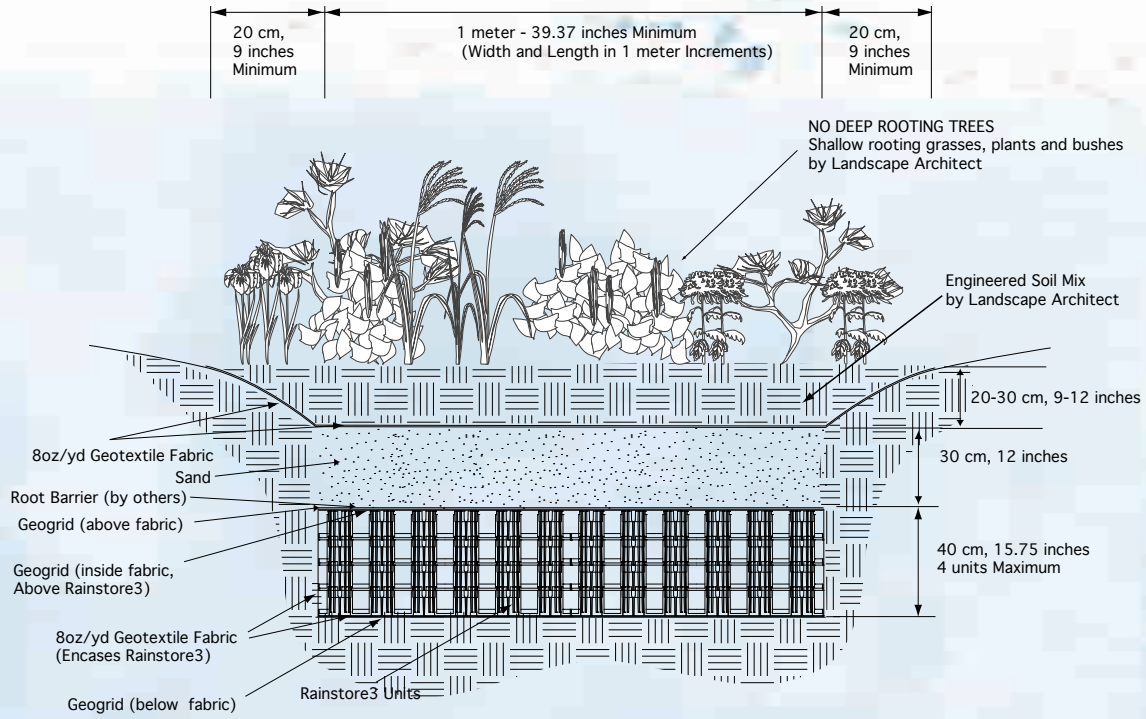
Connecting pipe to the Rainstore³ structure



Rainstore³ Maintenance Port

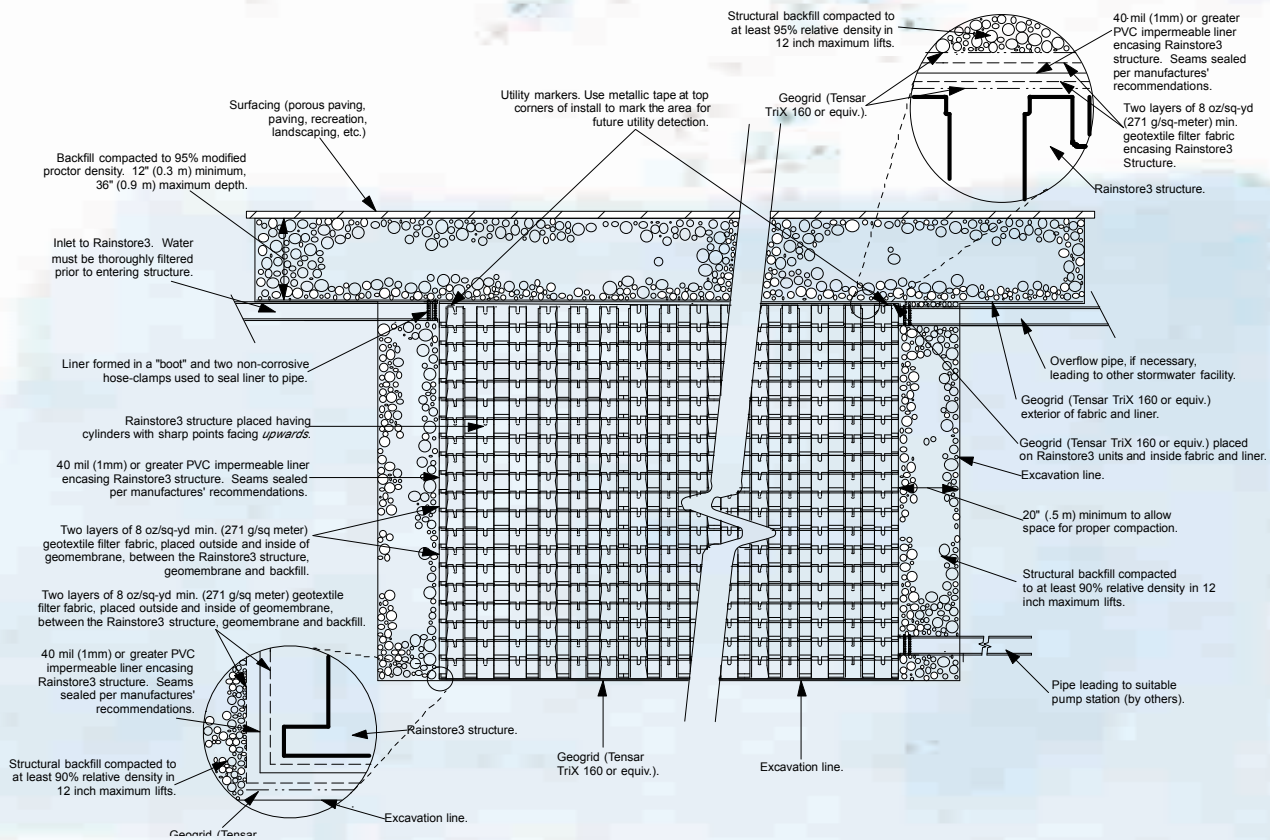
Method for providing inspection and cleanout access

DESIGN DETAILS



Rainstore³ Bio-Retention Rain Garden System

Rain Garden Design for Water Quality Improvement through Infiltration and Bioremediation



Rainstore³ Water Harvest

Long term water storage for irrigation, fire-protection, toilet flushing and others

Rainstore^3 Materials and Budgeting Worksheet

Online version of the materials estimator available at: http://www.invisiblestructures.com/RS3/estimator.htm

Item	Description	Formula	Quantity	Unit	$/Unit	Budget Total $	Notes
1	Required Water Volume (V_w)	–		m^3	N/A	N/A	Minimum agency requirements+client/site requirements
2	RS^3 Storage Volume (V_r)	$V_r = V_w/.94$		m^3			RS^3 is 94% void
3	Depth RS^3 (D)	see note		m	N/A	N/A	in meters (0.2, 0.3, 0.4, 0.6, 0.8, 1.2, and 2.4) in feet (0.7, 1.0, 1.3, 2.0, 2.6, 4.0, and 7.9)
4	Length RS^3 (L)	$L=V_r/H \times W$		m	N/A	N/A	Site dimensions, round up to nearest meter
5	Width RS^3 (W)	$W=V_r/H \times L$		m	N/A	N/A	Site dimensions, round up to nearest meter
6	Geotextile Fabric Area (A_f) for detention†	$A_f=2.1 \times ((L \times W)+(L \times D+W \times D))$		m^2			Top+bottom+sides+5%, 8 oz. min., includes labor
7	Geogrid Area (A_g)	$A_g=((L+1\text{ m}) \times (W+1\text{ m})/0.95) \times 3)$		m^2			RS^3 area+1 meter on each side+5%, includes labor
8	**Total Materials**	Add items 1-8	N/A	$	N/A		
9	Excavation Volume (V_e)	$V_e=(D+0.4\text{ m}) \times (L+1\text{ m}) \times (W+1\text{ m})$		m^3			Equipment, labor and hauling included
10	RS^3 installation labor (L_r)	$L_r=V_r/15$		man-hours			Estimation assuming installation of 15m^3/man-hour
11	**Total***	Add items 9-11	N/A	$	N/A		

† For harvesting applications, budget for twice the fabric area (A_f) and include cost for 40 mil PVC liner = A_f
*Overhead and contingency expenses not included

USEFUL CONVERSIONS

1 gallon = .1337 ft^3	1 ft^2 = .0929 m^2	1 m^3 = 264.15 gallons
1 gallon = .003785 m^3	1 m^2 = 10.76 ft^2	1 m^3 = 35.314 ft^3
1 gallon = 3.7854 liters	1 m^2 = 1.196 yd^2	1 m^3 = 1.308 yd^3
1 inch = 2.54 cm	1 acre = 43,560 ft^2	1 yd^3 = .8361 m^3
1 cm = .3937 inches	1 acre = 4,047 m^2	1 ton @ 125/ft^3 = 16 ft^3
1 foot = .3048 m	1 acre foot = 1,233.5 m^3	1 ton @ 125/ft^3 = .593 yd^3
1 meter = 3.28 ft	1 ft^3 = .0283 m^3	1 ton @ 125/ft^3 = .453 m^3
	1 ft^3 = 7.48 gallons	

DESIGN AND TECHNICAL SUPPORT

Invisible Structures welcomes the opportunity to review project designs and answer technical questions. AutoCAD design details may be downloaded from our website. ISI staff is available for on-site construction guidance.

See a comprehensive list of project profiles with photos, project sizes, descriptions, locations, and designs on the web at www.invisiblestructures.com

CONTACT INFORMATION

Invisible Structures, Inc.
1600 Jackson Street, Suite 310
Golden, CO 80401
800-233-1510, 303-233-8383 overseas
Fax 303-233-8282
www.invisiblestructures.com
e-mail sales@invisiblestructures.com

LIMITED WARRANTY — RAINSTORE^3

INVISIBLE STRUCTURES, INC., warrants to the Owner the structural integrity of Rainstore^3 structures themselves when installed in accordance with Invisible Structures' written specifications at the time of installation. This warranty applies against defective materials for two (2) years from the date of purchase.

This warranty shall be the sole and exclusive warranty granted by Invisible Structures, Inc., and shall be the sole and exclusive remedy available to Owner. INVISIBLE STRUCTURES, INC., DISCLAIMS ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, THAT ARISE BY THE OPERATION OF LAW, SPECIFICALLY INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. INVISIBLE STRUCTURES, INC., SHALL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES WHICH MAY HAVE RESULTED FROM ANY ALLEGED BREACH OF WARRANTY.

SPECIFICALLY EXCLUDED FROM WARRANTY COVERAGE ARE DAMAGES ARISING FROM ORDINARY WEAR AND TEAR; ALTERATION, ACCIDENT, MISUSE, ABUSE, OR NEGLECT, THE RAINSTORE^3 STRUCTURE BEING SUBJECTED TO USES OTHER THAN THOSE PRESCRIBED IN INVISIBLE STRUCTURES, INC.'S WRITTEN SPECIFICATIONS, OR ANY OTHER EVENT NOT CAUSED BY INVISIBLE STRUCTURES, INC.

Some states do not allow limitations on how long an implied warranty lasts or the exclusion or limitation of incidental or consequential damages, so the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Neither the sales personnel of the seller nor any other person is authorized to make any warranties other than those described herein or to extend the duration of any warranties beyond the time period described herein on behalf of Invisible Structures, Inc.

Should a defect appear in the warranty period, the Owner must inform Invisible Structures, Inc. of the defect in writing within ten (10) days of the discovery of the defect to the following address:

Kevin F. Wright, President
Invisible Structures, Inc.
1600 Jackson Street, Suite 310
Golden, CO 80401

Invisible Structures, Inc., agrees to supply replacement Rainstore^3 structures for those parts found by Invisible Structures, Inc., to be defective. THE COST OF REMOVAL OR INSTALLATION, OR A COMBINATION THEREOF, OF THE RAINSTORE^3 STRUCTURE IS SPECIFICALLY EXCLUDED FROM THIS WARRANTY. Shipping costs shall be the responsibility of the Owner.

Under no circumstances shall Invisible Structures, Inc. be liable to the Owner or to any third party for claims arising from the design of the Rainstore^3 structure, shipment of the components of the Rainstore^3 structure, or installation of the Rainstore^3 structure.

This warranty may not be amended except by a written instrument signed by an officer of Invisible Structures, Inc., at its corporate headquarters in Golden, Colorado. This warranty does not apply to any party other than to the Owner.

Common Installation Components of Rainstore^3

Preparing the excavated area

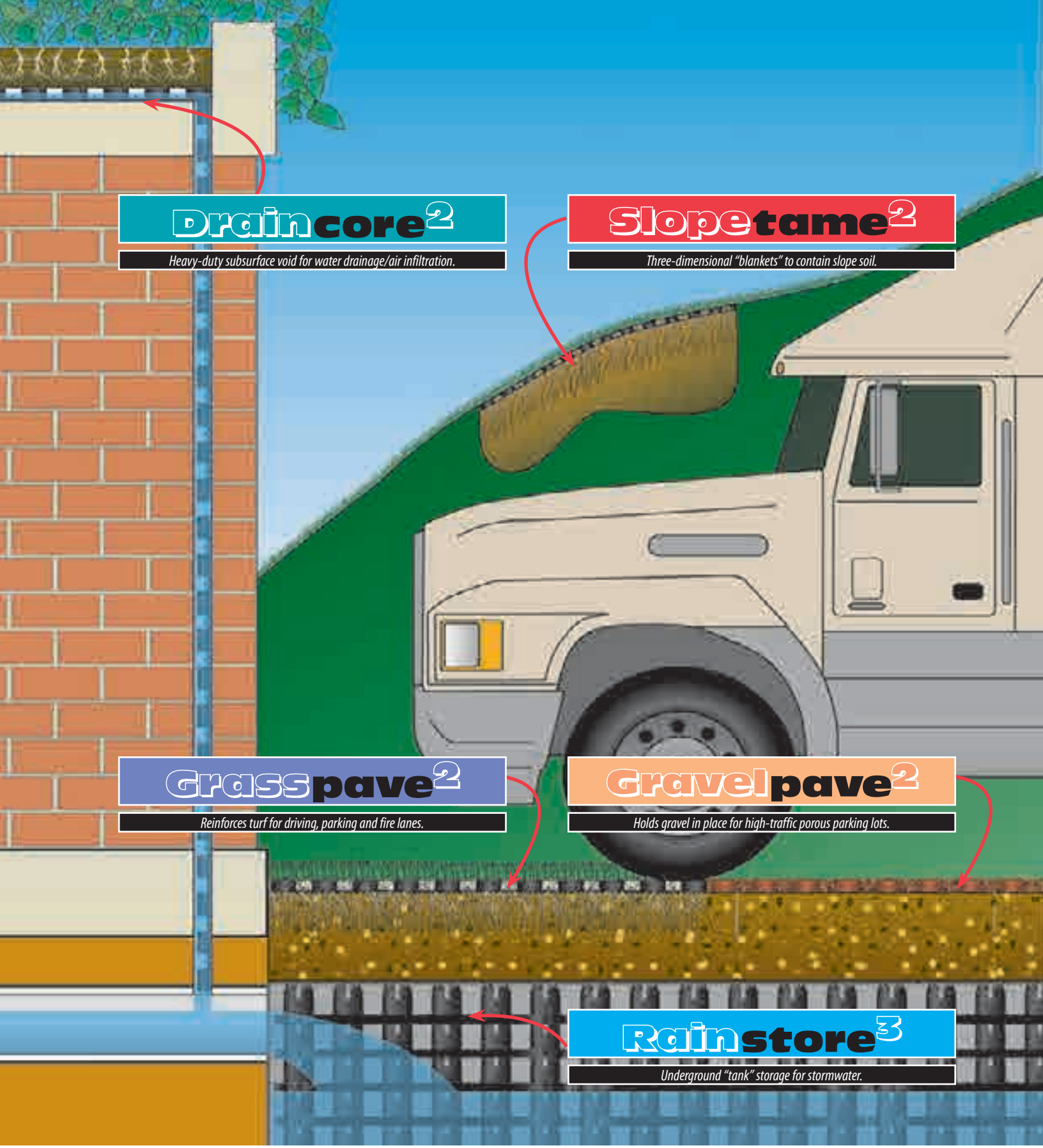
Placing and installing stacks of Rainstore^3

Inlet and pipe interface with Rainstore^3

Maintenance/access port configuration

Left: Heavy equipment begins to put the cover material over an installed Rainstore³ chamber. Take extreme care when driving and/or compacting over the chamber and do not drive over exposed Rainstore³ units — wait until ALL the units are installed, the side backfill is complete, fabric and geogrid layers are completed, and an adequate amount of cover material is placed.

Below: A completed Rainstore³ installation at a chemical plant's loading dock in Chicago Heights, IL. Stormwater drains via multiple inlets to a Rainstore³ retention area beneath a concrete loading dock pad. The outflow into the city system is controlled by a shut off valve on a single 6" pipe. For safety, if there is a chemical spill, the valve can be closed, the contents can be pumped out, and the spill cleaned up.



Invisible Structures, Inc.

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