Fox Run Redevelopment

Legal Description:

PT SE1/4 SEC 8 & SW1/4 SEC 9 T6N R19E COM SE COR SE1/4, N 153.02' TO BEG, N56 11'57 E 29.89', N22 19'E 198.74', N23 54'E 260.33',S85 41'32 W 206.36', N 183.94', S88 49'42 W 815',S1 10'18 E 433.16',N88 49'42 E 306.08', S1 10'18E 223.7', N88 49'42E418.32', N56 11'57 E 92.84'TO BEG DOC NO 4246692

PT SE1/4 SEC 8 T6N R19E COM SECOR SE1/4, S88 49'42 W ON S LI SE1/4 996.79', DUEN 358.51' TO BEG;DUE N 401.49';N89 49'42 E 181.79'; S1 10'18 E 433.16'; S88 49'42 W 93.92'; N1 10'18 W 31.75'; N88 49'42 E96.08' TO BEG 1.785 AC DOC NO 4246692

Sections 8 and 9, Township 6 North, Range 19 East,
City of Waukesha, Waukesha County, Wisconsin

STORM WATER MANAGEMENT PLAN

March 27, 2020

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STORMWATER MANAGEMENT PLAN NARRATIVE

FOX RUN REDEVELOPMENT
CITY OF WAUKESHA

Executive Summary:

A partnership of VJS Construction Services, Inc., Bedford Development LLC, and Somerstone LLC is proposing to redevelop the Fox Run Shopping Center. Under this plan, the strip mall, grocery store and restaurant are to be razed and the Chase Bank is to remain. The site is to be divided into 7 lots. A medical facility will possibly be located on Lot 1 (where Sentry is now), a future bank will possibly be located on Lot 3 (where Denny's is now), the Chase Bank will remain and 72-unit apartment complex is to be constructed on Lot 5. Lot 4 will be vacant for now and Outlot 6 will be used for storm water management. Outlot 7 has part of the existing detention pond, utilities and a public sidewalk. The parking lot and interior drive network have been reworked. The two existing access points for the property remain and a third right-in / right-out access point on Sunset Drive is being applied for from the County. This new access drive is located between the Lot 1 and the reservoir.

The proposed project is located in the southwest part of the City on the northwest corner of St. Paul Avenue and Sunset Drive and is part of the Southeast ¼ of Section 8 and the Southwest ¼ of Section 9, Township 6 North, Range 19 East. This project is located within the Middle Fox River Watershed.

This analysis will demonstrate that the site complies with the City's Storm Water Management Requirements.

Design Criteria:

This development is required to meet all the requirements found within the City of Waukesha's Stormwater Management and Erosion Control Ordinance (Chp. 23), and the Wisconsin Department of Natural Resources NR 151 and NR 216.

Peak Flow Reduction: The site was analyzed for peak flow reduction in which the 100-year, 10-year, 2-year and 1-year post-development runoff rates from site shall not exceed the corresponding pre-development rates.

Total Suspended Solids: Taxkey WAKC 1328999001 (11.637 acres 86.7% of the site) is classified as a redevelopment site. Taxkey WAKC 1328999002 (1.782 acres 13.3% of the site) is classified as new development. Therefore, the Total Suspended Solids (TSS) from the proposed paved areas must be reduced by 45.32% (blended rate) per Wisconsin NR 151 and the City's requirements.

Infiltration: This site is classified as High Imperviousness which has a requirement to infiltrate at least 60% of the predevelopment infiltration volume or use 2% of the site as the effective infiltration area or to the maximum extent practical.

Existing Conditions:

The existing site has a taxkey numbers of WAKC 1328999001 and 1328999002. The parcels add up to 13.3 acres and are zoned B-5. The existing soils on the site are predominantly Casco

Loam (Type B), Colwood Silt Loam (Type C/D Hydric), Hochheim Loam (Type D), Loamy Land (Type D), Martinton Silt Loam (Type C), Matherton Silt Loam (Type D) and Sebewa Silt Loam (Type D hydric) per the NRCS soil survey. See the soil map in the Appendix. Unfortunately, the main location of Casco Loam (Type B) soil is contaminated with PECs. See the Phase 2 Environmental Assessment.

Post-Development Conditions:

As mentioned above, the strip mall, grocery store and restaurant are to be razed and the Chase Bank is to remain. The site is to be divided into 6 lots. A medical facility will possibly be located on Lot 1 (where Sentry is now), a future bank will possibly be located on Lot 3 (where Denny's is now), the Chase Bank will remain and 72-unit apartment complex is to be constructed on Lot 5. Lot 4 will be vacant for now and Outlot 6 will be used for storm water management. The parking lot and interior drive network have been reworked. The two existing access points for the property remain and a third right-in / right-out access point on Sunset Drive is being applied for from the County. This new access drive is located between the Lot 1 and the reservoir.

The post-development conditions model uses blended CNs per soil type and percent impervious for each basin. This was done because the lot layouts are only conceptual at this point and an assumption had to be made for Lot 5 that has no interested buyer yet. Where possible, the conceptual impervious surface was measured and rounded. The percent impervious and blended CNs are as follows:

Basin	Percent Impervious
P1	65%/35%
P2	50%/50%
P3	80%/20%
P4	70%/30%
P5	80%/20%
P6	10%/90%

Blended CNs were created using 61, 71, and 78 respectively for lawn areas (B-D) and 98 for impervious areas regardless of the soil type. They are as follows:

Percent Impervious	Type B	Type C	Type D
10%/90%	65	74	89
50%/50%	85	87	88
65%/35%	85	89	91
70%/30%	87	90	92
80%/20%	91	93	94

Analysis Methods

HydroCAD (Version 10.00-22) software has been used to analyze stormwater characteristics for this stormwater management plan. HydroCAD uses the accepted TR-55 methodology for determining peak discharge runoff rates. Rainfall depths for the 1-year, 2-year, 10-year and 100-year storm events are 2.4", 2.7", 3.81 and 6.18" respectively, and were obtained from the City's Ordinance Chp. 32. Accordingly, the MSE 3 rainfall distribution curve was used for these models.

Peak Flow Analysis

The whole site and contributing off-site areas were analyzed for peak flow runoff rates in each basin both existing and proposed. The basin maps for the analysis can be found in the Appendix. The pre-development hydrologic parameters for the basins used in the model are as follows:

Pre-Development Hydrologic Parameters				
Subcatchment	Area, sf	Runoff CN	Impervious Area, sf	Time of Concentration, minutes
E1	151,236	87	78,050	4.3
E1A	69,403	82	15,519	8.1
E2	228,279	97	221,388	6.0
E2A	18,526	85	6,127	6.8
E3	102,726	94	83,489	4.2
E4	52,446	90	30,465	7.8
E5	50,737	89	28,041	2.8

The post-development hydrologic parameters for the basins used in the model are as follows:

Post-Development Hydrologic Parameters				
Subcatchment	Area, sf	Runoff CN	Impervious Percentage	Time of Concentration, minutes
P1	378,978	90	65%	8.2
P1A	86,183	83	25%	8.1
P2	9,957	87	50%	3.2
P3	108,222	94	80%	14.7
P4	53,824	92	70%	6.8
P5	9,900	94	80%	4.6
P6	30,596	79	10%	7.4

The results of this analysis are summarized below per discharge point from the site:

Pre / Post-Development Release Rate Comparison								
Discharge Point	Existing 1-yr Storm Q, cfs	Proposed 1-yr Storm Q, cfs	Existing 2-yr Storm Q, cfs	Proposed 2-yr Storm Q, cfs	Existing 10-yr Storm Q, cfs	Proposed 10-yr Storm Q, cfs	Existing 100-yr Storm Q, cfs	Proposed 100-yr Storm Q, cfs
24” Storm Sewer	18.19	10.24	20.69	15.23	29.92	25.36	49.52	29.85
Concrete Channel	10.12	0.91	12.27	1.16	20.50	2.18	38.52	4.55
Kohl’s Pond	7.64	5.53	8.79	6.37	13.03	9.51	21.93	16.08
Highway Ditch	3.27	3.37	3.87	3.92	6.11	5.97	10.89	10.28
Highway Storm Sewer	2.90	0.72	3.42	0.83	5.35	1.23	9.46	2.07
TOTAL DISCHARGE with OFF-SITE	41.00	17.29	47.75	24.04	73.00	42.84	127.06	58.58

Note that the proposed release rates are lower for each storm respectively for the total discharge of the site including the off-site drainage that flows through the site.

It should be noted that the proposed site has less impervious surface than the existing site. Therefore, the bioretention basin is not necessary to meet the peak flow reduction criteria. It is needed to meet the water quality criteria. However, the bioretnention basin does make a significant reduction in peak flows and will help keep the 24" storm sewer going to Pebble Creek from surcharging.

Kohl's Pond

We will call the existing pond to the east the Kohl's pond because it was built when Kohl's was built, even though two other properties including Fox Run also discharge runoff to the pond. It should be noted that the 2001 Storm Water Management Plan for the pond incorrectly characterized the Fox Run property. The report states that 9.88 acres of Fox Run drain the culvert under St. Paul, of which 3.13 are captured by the new (Kohl's) pond. Our survey demonstrates that only 2.36 acres drain to the Kohl's pond (Basin E3) and that only 0.95 acre drain directly to the St. Paul culvert (Basin E4). The majority of the site drains to Pebble Creek either by the storm sewer or by the concrete channel.

The City staff has expressed skepticism about whether the Kohl's pond works as designed. While this analysis seems out of the scope of this project, what can be said is that this development will be sending less acreage to the Kohl's pond then it was designed to take and after redevelopment, the impervious surface will be significantly decreased as well.

Runoff Water Quality

A minimum of 45.32% (blended rate) TSS removal is required per NR 151 and the City's ordinance as discussed above. WinSLAMM (Version 10.3.4) was used for the analysis. By using the bio retention pond, the reduction was achieved.

Sediment Load Reduction				
Area	Area (AC)	Sediment Load (LB)	Sediment Discharge (LB)	Sediment Reduction
Modeled Area	10.95	4252	1484	65.10%

This analysis was conducted for the entire site except for Basin P3, which drains to the Kohl's pond. For the purposes of this report, it is assumed that the Kohl's pond produces the TSS removal that it was designed to in the 2001 SWMP. For the sake of argument, the model was run including Basin P3 and the resulting sediment removal was 52.85%, which is still higher than the required removal rate.

The bottom line on the preliminary bio retention design is that it is oversized based on the City's storm water goals. The pond could be tightened up for the final design.

Infiltration

Most of the site has Type D soils, some with hydric components. There is one large area with Type B soils, however, that is where the contaminated soils are located. Therefore, this site is not suitable for infiltration. However, the bio retention pond will produce a small amount of infiltration.

Soils Investigation

The soil investigation was conducted by Giles Engineering Inc. on March 27, 2020. There were 3 borings in the proposed bio-retention basin. One of the borings found loamy soils with an infiltration rate of 0.50 in/hr at the bottom of the basin excavation. However, the other two borings found clayey soils at the bottom of the basin excavation with infiltration rates of 0.04 in/hr. Therefore, Giles is recommending a drain tile be used as part of the bio-retention basin design.

Preserve Natural Topography

The site has been mass graded in the past. There is no natural topography to preserve.

Installation Schedule of Stormwater Management Practices

The bio retention pond without the engineered soil will be constructed first and the sides stabilized immediately. It will be used as a sediment basin during construction. After the areas upstream are substantially stabilized, the pond will be cleaned out and then engineered soils and plants installed. As the contractor grades the site, he will grade the grassy swales and immediately seed, install erosion mat and ditch checks.

Maintenance Plan and Cost Estimate

The bio retention pond will cost about $50,000 to construct. There will be the occasional wash out, silt build up, or shrub removal and plan replacement that will need to take place. The pond should be inspected on a yearly basis. It is estimated that one or more of these items will need to be address every 5 years at a present day cost of about $2,000 for small repairs to $20,000 for full replacement of engineered soil and plants.

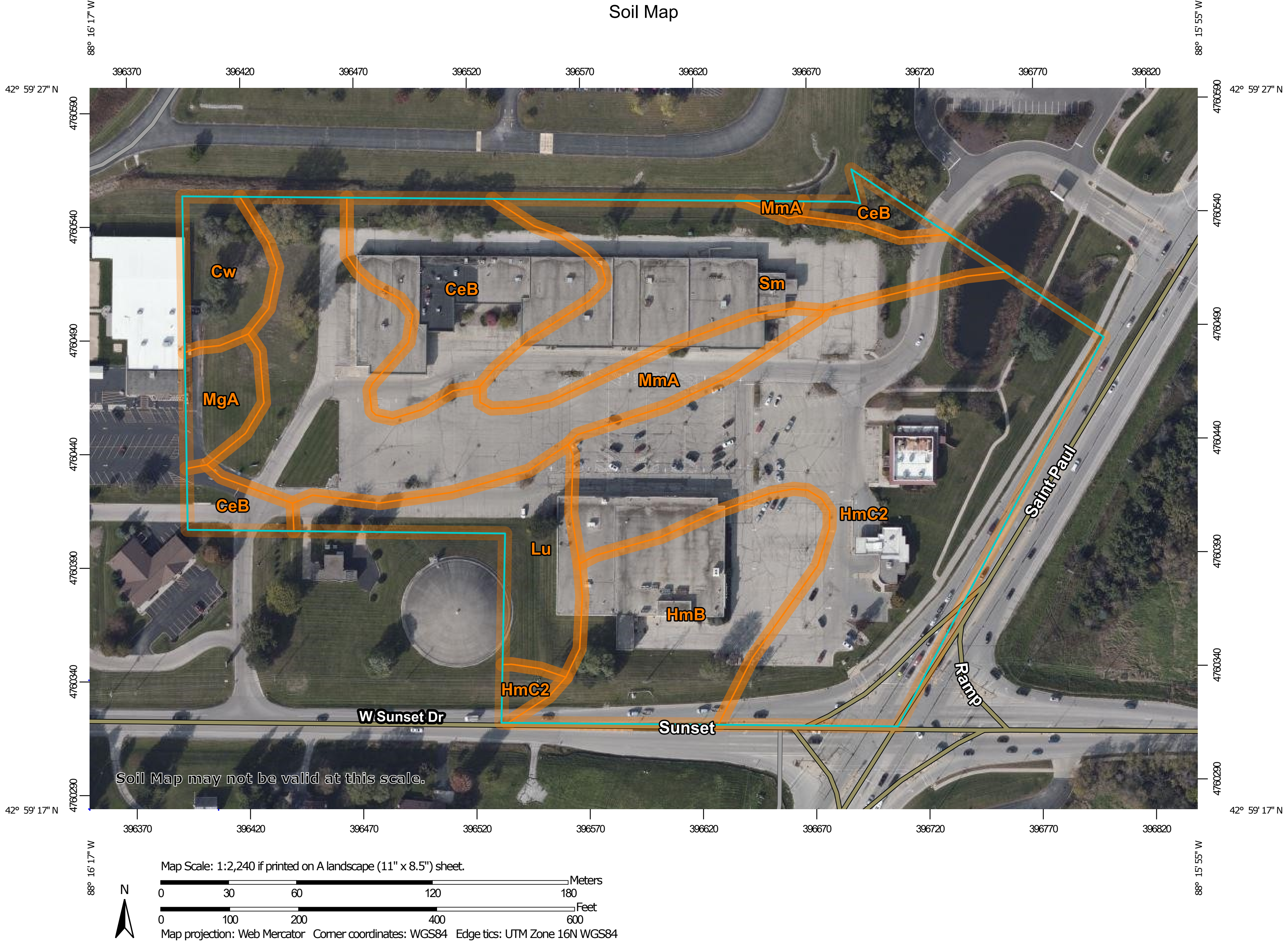
Conclusion

The storm water management features for the development have been designed to comply with the storm water goals set forth by the Wisconsin Department of Natural Resources and the City of Waukesha.

APPENDIX A

SOIL MAP

Soil Map

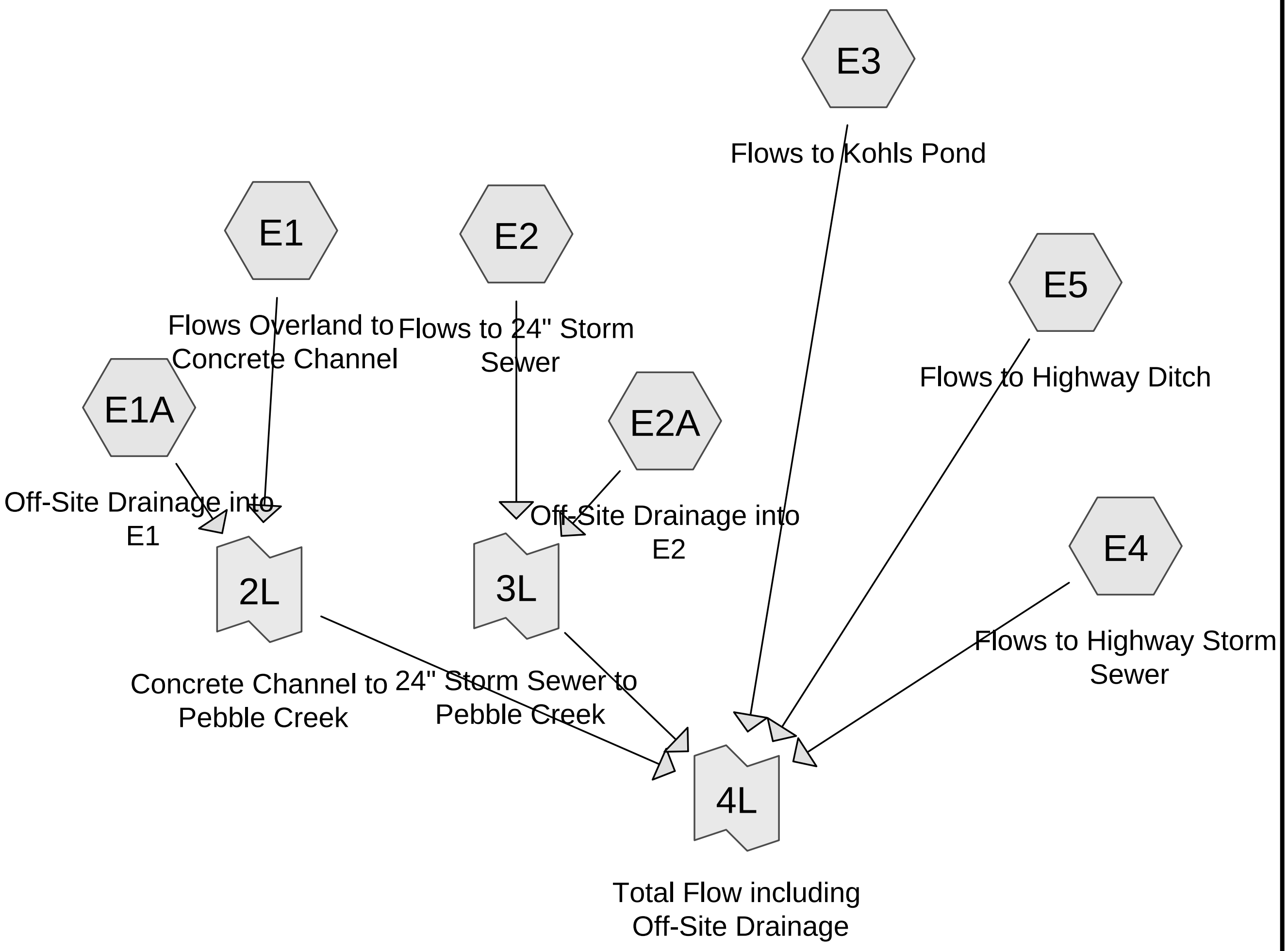


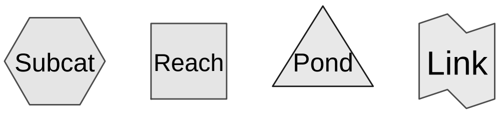
Map Scale: 1:2,240 if printed on A landscape (11" x 8.5") sheet.

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 16N WGS84

APPENDIX B

PRE-DEVELOPMENT FLOW DATA





Routing Diagram for Existing Conditions
Prepared by Microsoft, Printed 1/27/2020
HydroCAD® 10.00-22 s/n 04758 © 2018 HydroCAD Software Solutions LLC

Summary for Subcatchment E1: Flows Overland to Concrete Channel

Runoff = 8.13 cfs @ 12.11 hrs, Volume= 0.340 af, Depth> 1.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 1-YR Rainfall=2.40"

	Area (sf)	CN	Description
	3,652	61	>75% Grass cover, Good, HSG B
	20,009	98	Paved parking, HSG B
	448	98	Roofs, HSG B
*	12,835	71	>75% Grass cover, Good, HSG C
	867	98	Paved parking, HSG C
*	56,699	78	>75% Grass cover, Good, HSG D
	56,268	98	Paved parking, HSG D
	458	98	Roofs, HSG D
	151,236	87	Weighted Average
	73,186		48.39% Pervious Area
	78,050		51.61% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	8	0.0400	0.12		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
1.4	92	0.0150	1.11		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.70"
0.4	67	0.0150	2.49		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.6	170	0.0100	4.54	3.56	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013
0.8	140	0.0400	3.00		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
4.3	477	Total			

Summary for Subcatchment E1A: Off-Site Drainage into E1

Runoff = 2.43 cfs @ 12.16 hrs, Volume= 0.117 af, Depth> 0.88"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 1-YR Rainfall=2.40"

	Area (sf)	CN	Description
*	53,884	78	>75% Grass cover, Good, HSG D
	5,392	98	Paved parking, HSG D
	10,127	98	Roofs, HSG D
	69,403	82	Weighted Average
	53,884		77.64% Pervious Area
	15,519		22.36% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	100	0.0540	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
0.9	195	0.0540	3.49		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
8.1	295	Total			

Summary for Subcatchment E2: Flows to 24" Storm Sewer

Runoff = 17.39 cfs @ 12.13 hrs, Volume= 0.873 af, Depth> 2.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 1-YR Rainfall=2.40"

	Area (sf)	CN	Description
	1,552	61	>75% Grass cover, Good, HSG B
	12,583	98	Paved parking, HSG B
	29,163	98	Roofs, HSG B
*	5,339	78	>75% Grass cover, Good, HSG D
	90,863	98	Paved parking, HSG D
	88,779	98	Roofs, HSG D
	228,279	97	Weighted Average
	6,891		3.02% Pervious Area
	221,388		96.98% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0	50	0.1200	0.28		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
0.6	50	0.0400	1.45		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.70"
1.7	260	0.0150	2.49		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.7	140	0.0050	3.21	2.52	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013
6.0	500	Total			

Summary for Subcatchment E2A: Off-Site Drainage into E2

Runoff = 0.82 cfs @ 12.14 hrs, Volume= 0.037 af, Depth> 1.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 1-YR Rainfall=2.40"

	Area (sf)	CN	Description
*	12,399	78	>75% Grass cover, Good, HSG D
	6,127	98	Roofs, HSG D
	18,526	85	Weighted Average
	12,399		66.93% Pervious Area
	6,127		33.07% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.8	90	0.0500	0.22		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"

Summary for Subcatchment E3: Flows to Kohls Pond

Runoff = 7.64 cfs @ 12.10 hrs, Volume= 0.337 af, Depth> 1.71"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 1-YR Rainfall=2.40"

	Area (sf)	CN	Description
	4,373	61	>75% Grass cover, Good, HSG B
	1,521	98	Paved parking, HSG B
*	14,864	78	>75% Grass cover, Good, HSG D
	74,374	98	Paved parking, HSG D
	3,543	98	Roofs, HSG D
	4,051	98	Water Surface, HSG D
	102,726	94	Weighted Average
	19,237		18.73% Pervious Area
	83,489		81.27% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	100	0.0150	1.13		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.70"
2.7	400	0.0150	2.49		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
4.2	500	Total			

Summary for Subcatchment E4: Flows to Highway Storm Sewer

Runoff = 2.90 cfs @ 12.15 hrs, Volume= 0.139 af, Depth> 1.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 1-YR Rainfall=2.40"

	Area (sf)	CN	Description
*	21,981	78	>75% Grass cover, Good, HSG D
	30,299	98	Paved parking, HSG D
	166	98	Roofs, HSG D
	52,446	90	Weighted Average
	21,981		41.91% Pervious Area
	30,465		58.09% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0	60	0.1660	0.33		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
3.9	40	0.0400	0.17		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
0.2	50	0.0500	3.35		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
0.7	320	0.1500	7.86		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
7.8	470	Total			

Summary for Subcatchment E5: Flows to Highway Ditch

Runoff = 3.27 cfs @ 12.09 hrs, Volume= 0.127 af, Depth> 1.31"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 1-YR Rainfall=2.40"

	Area (sf)	CN	Description
*	22,696	78	>75% Grass cover, Good, HSG D
	21,802	98	Paved parking, HSG D
	6,239	98	Roofs, HSG D
	50,737	89	Weighted Average
	22,696		44.73% Pervious Area
	28,041		55.27% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	100	0.0150	1.13		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.70"
1.1	160	0.0150	2.49		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	45	0.0500	3.35		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
2.8	305	Total			

Summary for Link 2L: Concrete Channel to Pebble Creek

```
Inflow Area =      5.065 ac,  42.41% Impervious,  Inflow Depth >   1.08"    for  1-YR event
Inflow      =     10.12 cfs @   12.12 hrs,  Volume=          0.457 af
Primary     =     10.12 cfs @   12.12 hrs,  Volume=          0.457 af,  Atten= 0%,  Lag= 0.0 min
```

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Link 3L: 24" Storm Sewer to Pebble Creek

```
Inflow Area =          5.666 ac,  92.18% Impervious,  Inflow Depth >   1.93"    for  1-YR event
Inflow      =        18.19 cfs @   12.13 hrs,  Volume=            0.910 af
Primary     =        18.19 cfs @   12.13 hrs,  Volume=            0.910 af,  Atten= 0%,  Lag= 0.0 min
```

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Link 4L: Total Flow including Off-Site Drainage

```
Inflow Area =         15.458 ac,  68.77% Impervious,  Inflow Depth >   1.53"    for  1-YR event
Inflow        =        41.00 cfs @   12.12 hrs,  Volume=             1.970 af
Primary      =        41.00 cfs @   12.12 hrs,  Volume=             1.970 af,  Atten= 0%,  Lag= 0.0 min
```

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Subcatchment E1: Flows Overland to Concrete Channel

Runoff = 9.77 cfs @ 12.11 hrs, Volume= 0.411 af, Depth> 1.42"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 2-YR Rainfall=2.70"

	Area (sf)	CN	Description
	3,652	61	>75% Grass cover, Good, HSG B
	20,009	98	Paved parking, HSG B
	448	98	Roofs, HSG B
*	12,835	71	>75% Grass cover, Good, HSG C
	867	98	Paved parking, HSG C
*	56,699	78	>75% Grass cover, Good, HSG D
	56,268	98	Paved parking, HSG D
	458	98	Roofs, HSG D
	151,236	87	Weighted Average
	73,186		48.39% Pervious Area
	78,050		51.61% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	8	0.0400	0.12		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
1.4	92	0.0150	1.11		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.70"
0.4	67	0.0150	2.49		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.6	170	0.0100	4.54	3.56	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013
0.8	140	0.0400	3.00		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
4.3	477	Total			

Summary for Subcatchment E1A: Off-Site Drainage into E1

Runoff = 3.03 cfs @ 12.16 hrs, Volume= 0.145 af, Depth> 1.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 2-YR Rainfall=2.70"

	Area (sf)	CN	Description
*	53,884	78	>75% Grass cover, Good, HSG D
	5,392	98	Paved parking, HSG D
	10,127	98	Roofs, HSG D
	69,403	82	Weighted Average
	53,884		77.64% Pervious Area
	15,519		22.36% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	100	0.0540	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
0.9	195	0.0540	3.49		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
8.1	295	Total			

Summary for Subcatchment E2: Flows to 24" Storm Sewer

Runoff = 19.71 cfs @ 12.13 hrs, Volume= 0.998 af, Depth> 2.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 2-YR Rainfall=2.70"

	Area (sf)	CN	Description
	1,552	61	>75% Grass cover, Good, HSG B
	12,583	98	Paved parking, HSG B
	29,163	98	Roofs, HSG B
*	5,339	78	>75% Grass cover, Good, HSG D
	90,863	98	Paved parking, HSG D
	88,779	98	Roofs, HSG D
	228,279	97	Weighted Average
	6,891		3.02% Pervious Area
	221,388		96.98% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0	50	0.1200	0.28		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
0.6	50	0.0400	1.45		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.70"
1.7	260	0.0150	2.49		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.7	140	0.0050	3.21	2.52	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013
6.0	500	Total			

Summary for Subcatchment E2A: Off-Site Drainage into E2

Runoff = 1.00 cfs @ 12.14 hrs, Volume= 0.045 af, Depth> 1.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 2-YR Rainfall=2.70"

	Area (sf)	CN	Description
*	12,399	78	>75% Grass cover, Good, HSG D
	6,127	98	Roofs, HSG D
	18,526	85	Weighted Average
	12,399		66.93% Pervious Area
	6,127		33.07% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.8	90	0.0500	0.22		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"

Summary for Subcatchment E3: Flows to Kohls Pond

Runoff = 8.79 cfs @ 12.10 hrs, Volume= 0.392 af, Depth> 1.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 2-YR Rainfall=2.70"

	Area (sf)	CN	Description
	4,373	61	>75% Grass cover, Good, HSG B
	1,521	98	Paved parking, HSG B
*	14,864	78	>75% Grass cover, Good, HSG D
	74,374	98	Paved parking, HSG D
	3,543	98	Roofs, HSG D
	4,051	98	Water Surface, HSG D
	102,726	94	Weighted Average
	19,237		18.73% Pervious Area
	83,489		81.27% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	100	0.0150	1.13		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.70"
2.7	400	0.0150	2.49		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
4.2	500	Total			

Summary for Subcatchment E4: Flows to Highway Storm Sewer

Runoff = 3.42 cfs @ 12.15 hrs, Volume= 0.165 af, Depth> 1.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 2-YR Rainfall=2.70"

	Area (sf)	CN	Description
*	21,981	78	>75% Grass cover, Good, HSG D
	30,299	98	Paved parking, HSG D
	166	98	Roofs, HSG D
	52,446	90	Weighted Average
	21,981		41.91% Pervious Area
	30,465		58.09% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0	60	0.1660	0.33		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
3.9	40	0.0400	0.17		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
0.2	50	0.0500	3.35		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
0.7	320	0.1500	7.86		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
7.8	470	Total			

Summary for Subcatchment E5: Flows to Highway Ditch

Runoff = 3.87 cfs @ 12.09 hrs, Volume= 0.152 af, Depth> 1.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 2-YR Rainfall=2.70"

	Area (sf)	CN	Description
*	22,696	78	>75% Grass cover, Good, HSG D
	21,802	98	Paved parking, HSG D
	6,239	98	Roofs, HSG D
	50,737	89	Weighted Average
	22,696		44.73% Pervious Area
	28,041		55.27% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	100	0.0150	1.13		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.70"
1.1	160	0.0150	2.49		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	45	0.0500	3.35		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
2.8	305	Total			

Summary for Link 2L: Concrete Channel to Pebble Creek

```
Inflow Area =          5.065 ac,  42.41% Impervious,  Inflow Depth >   1.32"    for  2-YR event
Inflow       =        12.27 cfs @   12.12 hrs,  Volume=            0.556 af
Primary      =        12.27 cfs @   12.12 hrs,  Volume=            0.556 af,  Atten= 0%,  Lag= 0.0 min
```

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Link 3L: 24" Storm Sewer to Pebble Creek

```
Inflow Area =          5.666 ac,  92.18% Impervious,  Inflow Depth >   2.21"    for  2-YR event
Inflow        =        20.69 cfs @   12.13 hrs,  Volume=             1.044 af
Primary      =        20.69 cfs @   12.13 hrs,  Volume=             1.044 af,  Atten= 0%,  Lag= 0.0 min
```

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Link 4L: Total Flow including Off-Site Drainage

```
Inflow Area =      15.458 ac, 68.77% Impervious, Inflow Depth >  1.79"   for 2-YR event
Inflow      =      47.75 cfs @  12.12 hrs, Volume=          2.308 af
Primary     =      47.75 cfs @  12.12 hrs, Volume=          2.308 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
```

Summary for Subcatchment E1: Flows Overland to Concrete Channel

Runoff = 15.97 cfs @ 12.11 hrs, Volume= 0.686 af, Depth> 2.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-YR Rainfall=3.81"

	Area (sf)	CN	Description
	3,652	61	>75% Grass cover, Good, HSG B
	20,009	98	Paved parking, HSG B
	448	98	Roofs, HSG B
*	12,835	71	>75% Grass cover, Good, HSG C
	867	98	Paved parking, HSG C
*	56,699	78	>75% Grass cover, Good, HSG D
	56,268	98	Paved parking, HSG D
	458	98	Roofs, HSG D
	151,236	87	Weighted Average
	73,186		48.39% Pervious Area
	78,050		51.61% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	8	0.0400	0.12		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
1.4	92	0.0150	1.11		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.70"
0.4	67	0.0150	2.49		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.6	170	0.0100	4.54	3.56	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013
0.8	140	0.0400	3.00		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
4.3	477	Total			

Summary for Subcatchment E1A: Off-Site Drainage into E1

Runoff = 5.39 cfs @ 12.15 hrs, Volume= 0.260 af, Depth> 1.95"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-YR Rainfall=3.81"

	Area (sf)	CN	Description
*	53,884	78	>75% Grass cover, Good, HSG D
	5,392	98	Paved parking, HSG D
	10,127	98	Roofs, HSG D
	69,403	82	Weighted Average
	53,884		77.64% Pervious Area
	15,519		22.36% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	100	0.0540	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
0.9	195	0.0540	3.49		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
8.1	295	Total			

Summary for Subcatchment E2: Flows to 24" Storm Sewer

Runoff = 28.26 cfs @ 12.13 hrs, Volume= 1.461 af, Depth> 3.35"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-YR Rainfall=3.81"

	Area (sf)	CN	Description
	1,552	61	>75% Grass cover, Good, HSG B
	12,583	98	Paved parking, HSG B
	29,163	98	Roofs, HSG B
*	5,339	78	>75% Grass cover, Good, HSG D
	90,863	98	Paved parking, HSG D
	88,779	98	Roofs, HSG D
	228,279	97	Weighted Average
	6,891		3.02% Pervious Area
	221,388		96.98% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0	50	0.1200	0.28		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
0.6	50	0.0400	1.45		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.70"
1.7	260	0.0150	2.49		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.7	140	0.0050	3.21	2.52	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013
6.0	500	Total			

Summary for Subcatchment E2A: Off-Site Drainage into E2

Runoff = 1.68 cfs @ 12.14 hrs, Volume= 0.078 af, Depth> 2.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-YR Rainfall=3.81"

	Area (sf)	CN	Description
*	12,399	78	>75% Grass cover, Good, HSG D
	6,127	98	Roofs, HSG D
	18,526	85	Weighted Average
	12,399		66.93% Pervious Area
	6,127		33.07% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.8	90	0.0500	0.22		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"

Summary for Subcatchment E3: Flows to Kohls Pond

Runoff = 13.03 cfs @ 12.10 hrs, Volume= 0.597 af, Depth> 3.04"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-YR Rainfall=3.81"

	Area (sf)	CN	Description
	4,373	61	>75% Grass cover, Good, HSG B
	1,521	98	Paved parking, HSG B
*	14,864	78	>75% Grass cover, Good, HSG D
	74,374	98	Paved parking, HSG D
	3,543	98	Roofs, HSG D
	4,051	98	Water Surface, HSG D
	102,726	94	Weighted Average
	19,237		18.73% Pervious Area
	83,489		81.27% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	100	0.0150	1.13		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.70"
2.7	400	0.0150	2.49		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
4.2	500	Total			

Summary for Subcatchment E4: Flows to Highway Storm Sewer

Runoff = 5.35 cfs @ 12.15 hrs, Volume= 0.265 af, Depth> 2.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-YR Rainfall=3.81"

	Area (sf)	CN	Description
*	21,981	78	>75% Grass cover, Good, HSG D
	30,299	98	Paved parking, HSG D
	166	98	Roofs, HSG D
	52,446	90	Weighted Average
	21,981		41.91% Pervious Area
	30,465		58.09% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0	60	0.1660	0.33		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
3.9	40	0.0400	0.17		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
0.2	50	0.0500	3.35		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
0.7	320	0.1500	7.86		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
7.8	470	Total			

Summary for Subcatchment E5: Flows to Highway Ditch

Runoff = 6.11 cfs @ 12.09 hrs, Volume= 0.248 af, Depth> 2.55"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-YR Rainfall=3.81"

	Area (sf)	CN	Description
*	22,696	78	>75% Grass cover, Good, HSG D
	21,802	98	Paved parking, HSG D
	6,239	98	Roofs, HSG D
	50,737	89	Weighted Average
	22,696		44.73% Pervious Area
	28,041		55.27% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	100	0.0150	1.13		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.70"
1.1	160	0.0150	2.49		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	45	0.0500	3.35		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
2.8	305	Total			

Summary for Link 2L: Concrete Channel to Pebble Creek

```
Inflow Area =          5.065 ac,  42.41% Impervious,  Inflow Depth >   2.24"    for  10-YR event
Inflow      =        20.50 cfs @   12.11 hrs,  Volume=            0.946 af
Primary     =        20.50 cfs @   12.11 hrs,  Volume=            0.946 af,  Atten= 0%,  Lag= 0.0 min
```

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Link 3L: 24" Storm Sewer to Pebble Creek

```
Inflow Area =      5.666 ac, 92.18% Impervious, Inflow Depth >  3.26"   for 10-YR event
Inflow      =     29.92 cfs @  12.13 hrs, Volume=         1.539 af
Primary     =     29.92 cfs @  12.13 hrs, Volume=         1.539 af, Atten= 0%, Lag= 0.0 min
```

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Link 4L: Total Flow including Off-Site Drainage

Inflow Area = 15.458 ac, 68.77% Impervious, Inflow Depth > 2.79" for 10-YR event
Inflow = 73.00 cfs @ 12.11 hrs, Volume= 3.595 af
Primary = 73.00 cfs @ 12.11 hrs, Volume= 3.595 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Subcatchment E1: Flows Overland to Concrete Channel

Runoff = 29.37 cfs @ 12.10 hrs, Volume= 1.311 af, Depth> 4.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 100-YR Rainfall=6.18"

	Area (sf)	CN	Description
	3,652	61	>75% Grass cover, Good, HSG B
	20,009	98	Paved parking, HSG B
	448	98	Roofs, HSG B
*	12,835	71	>75% Grass cover, Good, HSG C
	867	98	Paved parking, HSG C
*	56,699	78	>75% Grass cover, Good, HSG D
	56,268	98	Paved parking, HSG D
	458	98	Roofs, HSG D
	151,236	87	Weighted Average
	73,186		48.39% Pervious Area
	78,050		51.61% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	8	0.0400	0.12		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
1.4	92	0.0150	1.11		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.70"
0.4	67	0.0150	2.49		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.6	170	0.0100	4.54	3.56	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013
0.8	140	0.0400	3.00		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
4.3	477	Total			

Summary for Subcatchment E1A: Off-Site Drainage into E1

Runoff = 10.72 cfs @ 12.15 hrs, Volume= 0.531 af, Depth> 4.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 100-YR Rainfall=6.18"

	Area (sf)	CN	Description
*	53,884	78	>75% Grass cover, Good, HSG D
	5,392	98	Paved parking, HSG D
	10,127	98	Roofs, HSG D
	69,403	82	Weighted Average
	53,884		77.64% Pervious Area
	15,519		22.36% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	100	0.0540	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
0.9	195	0.0540	3.49		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
8.1	295	Total			

Summary for Subcatchment E2: Flows to 24" Storm Sewer

Runoff = 46.36 cfs @ 12.13 hrs, Volume= 2.447 af, Depth> 5.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 100-YR Rainfall=6.18"

	Area (sf)	CN	Description
	1,552	61	>75% Grass cover, Good, HSG B
	12,583	98	Paved parking, HSG B
	29,163	98	Roofs, HSG B
*	5,339	78	>75% Grass cover, Good, HSG D
	90,863	98	Paved parking, HSG D
	88,779	98	Roofs, HSG D
	228,279	97	Weighted Average
	6,891		3.02% Pervious Area
	221,388		96.98% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0	50	0.1200	0.28		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
0.6	50	0.0400	1.45		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.70"
1.7	260	0.0150	2.49		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.7	140	0.0050	3.21	2.52	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013
6.0	500	Total			

Summary for Subcatchment E2A: Off-Site Drainage into E2

Runoff = 3.19 cfs @ 12.14 hrs, Volume= 0.153 af, Depth> 4.32"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 100-YR Rainfall=6.18"

	Area (sf)	CN	Description
*	12,399	78	>75% Grass cover, Good, HSG D
	6,127	98	Roofs, HSG D
	18,526	85	Weighted Average
	12,399		66.93% Pervious Area
	6,127		33.07% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.8	90	0.0500	0.22		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"

Summary for Subcatchment E3: Flows to Kohls Pond

Runoff = 21.93 cfs @ 12.10 hrs, Volume= 1.042 af, Depth> 5.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 100-YR Rainfall=6.18"

	Area (sf)	CN	Description
	4,373	61	>75% Grass cover, Good, HSG B
	1,521	98	Paved parking, HSG B
*	14,864	78	>75% Grass cover, Good, HSG D
	74,374	98	Paved parking, HSG D
	3,543	98	Roofs, HSG D
	4,051	98	Water Surface, HSG D
	102,726	94	Weighted Average
	19,237		18.73% Pervious Area
	83,489		81.27% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	100	0.0150	1.13		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.70"
2.7	400	0.0150	2.49		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
4.2	500	Total			

Summary for Subcatchment E4: Flows to Highway Storm Sewer

Runoff = 9.46 cfs @ 12.15 hrs, Volume= 0.487 af, Depth> 4.86"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 100-YR Rainfall=6.18"

	Area (sf)	CN	Description
*	21,981	78	>75% Grass cover, Good, HSG D
	30,299	98	Paved parking, HSG D
	166	98	Roofs, HSG D
	52,446	90	Weighted Average
	21,981		41.91% Pervious Area
	30,465		58.09% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0	60	0.1660	0.33		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
3.9	40	0.0400	0.17		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
0.2	50	0.0500	3.35		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
0.7	320	0.1500	7.86		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
7.8	470	Total			

Summary for Subcatchment E5: Flows to Highway Ditch

Runoff = 10.89 cfs @ 12.09 hrs, Volume= 0.461 af, Depth> 4.75"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 100-YR Rainfall=6.18"

	Area (sf)	CN	Description
*	22,696	78	>75% Grass cover, Good, HSG D
	21,802	98	Paved parking, HSG D
	6,239	98	Roofs, HSG D
	50,737	89	Weighted Average
	22,696		44.73% Pervious Area
	28,041		55.27% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	100	0.0150	1.13		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.70"
1.1	160	0.0150	2.49		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	45	0.0500	3.35		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
2.8	305	Total			

Summary for Link 2L: Concrete Channel to Pebble Creek

```
Inflow Area =        5.065 ac,  42.41% Impervious,  Inflow Depth >   4.36"    for  100-YR event
Inflow      =       38.52 cfs @   12.11 hrs,  Volume=            1.842 af
Primary     =       38.52 cfs @   12.11 hrs,  Volume=            1.842 af,  Atten= 0%,  Lag= 0.0 min
```

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Link 3L: 24" Storm Sewer to Pebble Creek

```
Inflow Area =        5.666 ac,  92.18% Impervious,  Inflow Depth >   5.51"    for  100-YR event
Inflow      =       49.52 cfs @   12.13 hrs,  Volume=          2.600 af
Primary     =       49.52 cfs @   12.13 hrs,  Volume=          2.600 af,  Atten= 0%,  Lag= 0.0 min
```

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

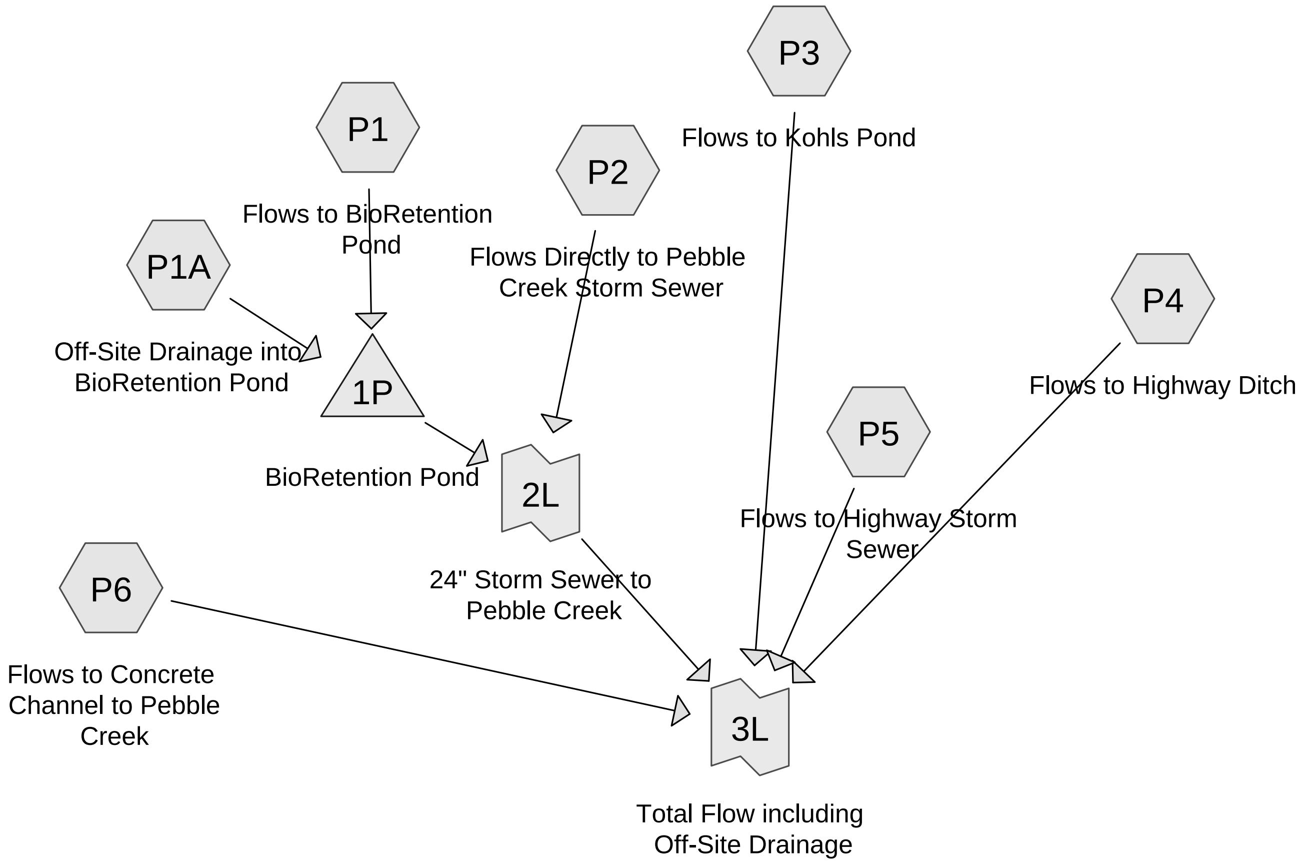
Summary for Link 4L: Total Flow including Off-Site Drainage

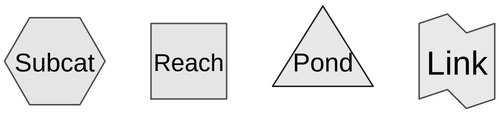
```
Inflow Area =        15.458 ac,  68.77% Impervious,  Inflow Depth >   4.99"    for  100-YR event
Inflow       =      127.06 cfs @   12.11 hrs,  Volume=            6.433 af
Primary      =      127.06 cfs @   12.11 hrs,  Volume=            6.433 af,  Atten= 0%,  Lag= 0.0 min
```

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

APPENDIX C

POST-DEVELOPMENT FLOW DATA





Routing Diagram for Proposed Conditions
Prepared by Microsoft, Printed 3/25/2020
HydroCAD® 10.00-22 s/n 04758 © 2018 HydroCAD Software Solutions LLC

Summary for Subcatchment P1: Flows to BioRetention Pond

Runoff = 20.59 cfs @ 12.15 hrs, Volume= 1.004 af, Depth> 1.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 1-YR Rainfall=2.40"

	Area (sf)	CN	Description
*	51,271	85	Type B 65%
*	10,870	89	Type C 65%
*	316,837	91	Type D 65%
	378,978	90	Weighted Average
	378,978		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.1	40	0.0200	0.13		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
1.0	60	0.0150	1.02		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.70"
2.1	480	0.0050	3.72	4.57	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013
8.2	580	Total			

Summary for Subcatchment P1A: Off-Site Drainage into BioRetention Pond

Runoff = 3.21 cfs @ 12.16 hrs, Volume= 0.154 af, Depth> 0.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 1-YR Rainfall=2.40"

	Area (sf)	CN	Description
*	86,183	83	From Existing Conditions Model
	86,183		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	100	0.0540	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
0.9	195	0.0540	3.49		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
8.1	295	Total			

Summary for Subcatchment P2: Flows Directly to Pebble Creek Storm Sewer

Runoff = 0.57 cfs @ 12.10 hrs, Volume= 0.022 af, Depth> 1.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 1-YR Rainfall=2.40"

	Area (sf)	CN	Description
*	4,051	85	Type B 50%
*	5,906	88	Type D 50%
	9,957	87	Weighted Average
	9,957		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.8	30	0.0500	0.18		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
0.4	40	0.0500	1.52		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.70"
3.2	70	Total			

Summary for Subcatchment P3: Flows to Kohls Pond

Runoff = 5.53 cfs @ 12.23 hrs, Volume= 0.354 af, Depth> 1.71"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 1-YR Rainfall=2.40"

	Area (sf)	CN	Description
*	5,889	91	Type B 80%
*	102,333	94	Type D 80%
	108,222	94	Weighted Average
	108,222		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.7	100	0.0200	0.16		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
3.1	280	0.0100	1.50		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
0.9	270	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013
14.7	650	Total			

Summary for Subcatchment P4: Flows to Highway Ditch

Runoff = 3.37 cfs @ 12.14 hrs, Volume= 0.159 af, Depth> 1.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 1-YR Rainfall=2.40"

	Area (sf)	CN	Description
*	53,824	92	Type D 70%
	53,824		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.8	95	0.0550	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"

Summary for Subcatchment P5: Flows to Highway Storm Sewer

Runoff = 0.72 cfs @ 12.11 hrs, Volume= 0.032 af, Depth> 1.71"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 1-YR Rainfall=2.40"

	Area (sf)	CN	Description
*	9,900	94	Type D 80%
	9,900		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.2	20	0.0400	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
1.2	80	0.0150	1.08		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.70"
1.2	180	0.0150	2.49		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
4.6	280	Total			

Summary for Subcatchment P6: Flows to Concrete Channel to Pebble Creek

Runoff = 0.91 cfs @ 12.15 hrs, Volume= 0.043 af, Depth> 0.73"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 1-YR Rainfall=2.40"

	Area (sf)	CN	Description
*	10,693	65	Type B 10%
*	2,828	74	Type C 10%
*	17,075	89	Type D 10%
	30,596	79	Weighted Average
	30,596		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	100	0.0500	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"

Summary for Pond 1P: BioRetention Pond

```
Inflow Area =       10.679 ac,    0.00% Impervious,  Inflow Depth >   1.30"    for  1-YR event
Inflow       =       23.79 cfs @   12.15 hrs,  Volume=            1.158 af
Outflow      =       10.40 cfs @   12.31 hrs,  Volume=            0.835 af,  Atten= 56%,  Lag= 9.5 min
Discarded  =          0.29 cfs @   12.31 hrs,  Volume=            0.196 af
Primary      =       10.11 cfs @   12.31 hrs,  Volume=            0.639 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 25.48' @ 12.31 hrs   Surf.Area= 15,681 sf   Storage= 21,227 cf

Plug-Flow detention time= 93.3 min calculated for 0.833 af (72% of inflow)
Center-of-Mass det. time= 41.1 min ( 821.7 - 780.6 )

Volume         Invert      Avail.Storage   Storage Description
   #1          24.00'        122,117 cf    Custom Stage Data (Prismatic)Listed below (Recalc)

 Elevation          Surf.Area          Inc.Store          Cum.Store
    (feet)              (sq-ft)       (cubic-feet)       (cubic-feet)
     24.00              13,100                  0                  0
     29.00              21,850             87,375             87,375
     30.50              24,472             34,742            122,117

Device   Routing            Invert   Outlet Devices
    #1   Primary            20.90'   24.0"  Round Culvert
                                     L= 200.0'   CPP, square edge headwall,  Ke= 0.500
                                     Inlet / Outlet Invert= 20.90' / 20.20'   S= 0.0035 '/'   Cc= 0.900
                                     n= 0.013,  Flow Area= 3.14 sf
    #2   Device 1           25.00'   36.0" Horiz. Orifice/Grate    C= 0.600
                                     Limited to weir flow at low heads
    #3   Primary            29.80'   Asymmetrical Weir, C= 3.27
                                     Offset (feet)  -100.00  0.00  100.00
                                     Height (feet)  1.00  0.00  1.00
    #4   Discarded          24.00'   0.600 in/hr Exfiltration over Surface area
                                     Conductivity to Groundwater Elevation = 20.00'

Discarded OutFlow  Max=0.29 cfs @ 12.31 hrs  HW=25.47'   (Free Discharge)
↑
└─4=Exfiltration  ( Controls 0.29 cfs)

Primary OutFlow  Max=9.98 cfs @ 12.31 hrs  HW=25.47'   (Free Discharge)
↑
├─1=Culvert  (Passes 9.98 cfs of 22.82 cfs potential flow)
│  ↑
│  └─2=Orifice/Grate  (Weir Controls 9.98 cfs @ 2.25 fps)
└─3=Asymmetrical Weir ( Controls 0.00 cfs)
```

Summary for Link 2L: 24" Storm Sewer to Pebble Creek

```
Inflow Area =      10.907 ac,    0.00% Impervious,  Inflow Depth >   0.73"    for  1-YR event
Inflow      =      10.24 cfs @   12.31 hrs,  Volume=          0.662 af
Primary     =      10.24 cfs @   12.31 hrs,  Volume=          0.662 af,  Atten= 0%,  Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
```

Summary for Link 3L: Total Flow including Off-Site Drainage

```
Inflow Area =        15.557 ac,    0.00% Impervious,  Inflow Depth >   0.96"    for  1-YR event
Inflow       =       17.29 cfs @   12.27 hrs,  Volume=            1.249 af
Primary      =       17.29 cfs @   12.27 hrs,  Volume=            1.249 af,  Atten= 0%,  Lag= 0.0 min
```

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Subcatchment P1: Flows to BioRetention Pond

Runoff = 24.28 cfs @ 12.15 hrs, Volume= 1.192 af, Depth> 1.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 2-YR Rainfall=2.70"

	Area (sf)	CN	Description
*	51,271	85	Type B 65%
*	10,870	89	Type C 65%
*	316,837	91	Type D 65%
	378,978	90	Weighted Average
	378,978		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.1	40	0.0200	0.13		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
1.0	60	0.0150	1.02		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.70"
2.1	480	0.0050	3.72	4.57	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013
8.2	580	Total			

Summary for Subcatchment P1A: Off-Site Drainage into BioRetention Pond

Runoff = 3.97 cfs @ 12.16 hrs, Volume= 0.190 af, Depth> 1.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 2-YR Rainfall=2.70"

	Area (sf)	CN	Description
*	86,183	83	From Existing Conditions Model
	86,183		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	100	0.0540	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
0.9	195	0.0540	3.49		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
8.1	295	Total			

Summary for Subcatchment P2: Flows Directly to Pebble Creek Storm Sewer

Runoff = 0.68 cfs @ 12.10 hrs, Volume= 0.027 af, Depth> 1.42"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 2-YR Rainfall=2.70"

	Area (sf)	CN	Description
*	4,051	85	Type B 50%
*	5,906	88	Type D 50%
	9,957	87	Weighted Average
	9,957		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.8	30	0.0500	0.18		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
0.4	40	0.0500	1.52		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.70"
3.2	70	Total			

Summary for Subcatchment P3: Flows to Kohls Pond

Runoff = 6.37 cfs @ 12.23 hrs, Volume= 0.412 af, Depth> 1.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 2-YR Rainfall=2.70"

	Area (sf)	CN	Description
*	5,889	91	Type B 80%
*	102,333	94	Type D 80%
	108,222	94	Weighted Average
	108,222		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.7	100	0.0200	0.16		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
3.1	280	0.0100	1.50		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
0.9	270	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013
14.7	650	Total			

Summary for Subcatchment P4: Flows to Highway Ditch

Runoff = 3.92 cfs @ 12.14 hrs, Volume= 0.187 af, Depth> 1.81"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 2-YR Rainfall=2.70"

	Area (sf)	CN	Description
*	53,824	92	Type D 70%
	53,824		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.8	95	0.0550	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"

Summary for Subcatchment P5: Flows to Highway Storm Sewer

Runoff = 0.83 cfs @ 12.11 hrs, Volume= 0.038 af, Depth> 1.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 2-YR Rainfall=2.70"

	Area (sf)	CN	Description
*	9,900	94	Type D 80%
	9,900		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.2	20	0.0400	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
1.2	80	0.0150	1.08		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.70"
1.2	180	0.0150	2.49		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
4.6	280	Total			

Summary for Subcatchment P6: Flows to Concrete Channel to Pebble Creek

```
Runoff      =      1.16 cfs @   12.15 hrs,  Volume=         0.054 af,  Depth>  0.92"
```

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 2-YR Rainfall=2.70"

	Area (sf)	CN	Description
*	10,693	65	Type B 10%
*	2,828	74	Type C 10%
*	17,075	89	Type D 10%
	30,596	79	Weighted Average
	30,596		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	100	0.0500	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"

Summary for Pond 1P: BioRetention Pond

```
Inflow Area =        10.679 ac,    0.00% Impervious,  Inflow Depth >   1.55"    for  2-YR event
Inflow       =       28.25 cfs @   12.15 hrs,  Volume=            1.382 af
Outflow      =       15.35 cfs @   12.27 hrs,  Volume=            1.057 af,  Atten= 46%,  Lag= 7.1 min
Discarded  =          0.30 cfs @   12.27 hrs,  Volume=            0.203 af
Primary      =       15.05 cfs @   12.27 hrs,  Volume=            0.854 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 25.62' @ 12.27 hrs   Surf.Area= 15,935 sf   Storage= 23,520 cf

Plug-Flow detention time= 84.4 min calculated for 1.057 af (76% of inflow)
Center-of-Mass det. time= 35.0 min ( 812.8 - 777.7 )

Volume          Invert      Avail.Storage   Storage Description
   #1           24.00'        122,117 cf    Custom Stage Data (Prismatic)Listed below (Recalc)

 Elevation           Surf.Area          Inc.Store          Cum.Store
      (feet)              (sq-ft)        (cubic-feet)       (cubic-feet)
      24.00              13,100                    0                  0
      29.00              21,850               87,375             87,375
      30.50              24,472               34,742            122,117

Device   Routing              Invert   Outlet Devices
    #1   Primary              20.90'   24.0"  Round Culvert
                                       L= 200.0'   CPP, square edge headwall,  Ke= 0.500
                                       Inlet / Outlet Invert= 20.90' / 20.20'   S= 0.0035 '/'   Cc= 0.900
                                       n= 0.013,  Flow Area= 3.14 sf
    #2   Device 1             25.00'   36.0" Horiz. Orifice/Grate   C= 0.600
                                       Limited to weir flow at low heads
    #3   Primary              29.80'   Asymmetrical Weir, C= 3.27
                                       Offset (feet)  -100.00  0.00  100.00
                                       Height (feet)  1.00  0.00  1.00
    #4   Discarded            24.00'   0.600 in/hr Exfiltration over Surface area
                                       Conductivity to Groundwater Elevation = 20.00'

Discarded OutFlow  Max=0.30 cfs @ 12.27 hrs  HW=25.61'   (Free Discharge)
└─4=Exfiltration  ( Controls 0.30 cfs)

Primary OutFlow  Max=14.68 cfs @ 12.27 hrs  HW=25.61'   (Free Discharge)
├─1=Culvert  (Passes 14.68 cfs of 23.30 cfs potential flow)
│ └─2=Orifice/Grate  (Weir Controls 14.68 cfs @ 2.55 fps)
└─3=Asymmetrical Weir ( Controls 0.00 cfs)
```

Summary for Link 2L: 24" Storm Sewer to Pebble Creek

```
Inflow Area =        10.907 ac,    0.00% Impervious,  Inflow Depth >   0.97"    for  2-YR event
Inflow       =        15.23 cfs @   12.27 hrs,  Volume=            0.881 af
Primary      =        15.23 cfs @   12.27 hrs,  Volume=            0.881 af,  Atten= 0%,  Lag= 0.0 min
```

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Link 3L: Total Flow including Off-Site Drainage

```
Inflow Area =      15.557 ac,    0.00% Impervious,  Inflow Depth >   1.21"    for  2-YR event
Inflow       =      24.04 cfs @   12.25 hrs,  Volume=          1.571 af
Primary      =      24.04 cfs @   12.25 hrs,  Volume=          1.571 af,  Atten= 0%,  Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
```

Summary for Subcatchment P1: Flows to BioRetention Pond

Runoff = 38.07 cfs @ 12.15 hrs, Volume= 1.915 af, Depth> 2.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-YR Rainfall=3.81"

	Area (sf)	CN	Description
*	51,271	85	Type B 65%
*	10,870	89	Type C 65%
*	316,837	91	Type D 65%
	378,978	90	Weighted Average
	378,978		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.1	40	0.0200	0.13		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
1.0	60	0.0150	1.02		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.70"
2.1	480	0.0050	3.72	4.57	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013
8.2	580	Total			

Summary for Subcatchment P1A: Off-Site Drainage into BioRetention Pond

```
Runoff      =        6.94 cfs @   12.15 hrs,  Volume=          0.335 af,  Depth>  2.03"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3  10-YR Rainfall=3.81"

       Area (sf)   CN   Description
*         86,183   83   From Existing Conditions Model
          86,183        100.00% Pervious Area

    Tc  Length   Slope  Velocity  Capacity  Description
 (min)  (feet)  (ft/ft)  (ft/sec)     (cfs)
   7.2     100  0.0540      0.23            Sheet Flow,
                                            Grass: Short   n= 0.150   P2= 2.70"
   0.9     195  0.0540      3.49            Shallow Concentrated Flow,
                                            Grassed Waterway   Kv= 15.0 fps
   8.1     295  Total
```

Summary for Subcatchment P2: Flows Directly to Pebble Creek Storm Sewer

Runoff = 1.11 cfs @ 12.09 hrs, Volume= 0.045 af, Depth> 2.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-YR Rainfall=3.81"

	Area (sf)	CN	Description
*	4,051	85	Type B 50%
*	5,906	88	Type D 50%
	9,957	87	Weighted Average
	9,957		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.8	30	0.0500	0.18		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
0.4	40	0.0500	1.52		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.70"
3.2	70	Total			

Summary for Subcatchment P3: Flows to Kohls Pond

Runoff = 9.51 cfs @ 12.22 hrs, Volume= 0.628 af, Depth> 3.03"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-YR Rainfall=3.81"

	Area (sf)	CN	Description
*	5,889	91	Type B 80%
*	102,333	94	Type D 80%
	108,222	94	Weighted Average
	108,222		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.7	100	0.0200	0.16		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
3.1	280	0.0100	1.50		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
0.9	270	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013
14.7	650	Total			

Summary for Subcatchment P4: Flows to Highway Ditch

Runoff = 5.97 cfs @ 12.14 hrs, Volume= 0.292 af, Depth> 2.84"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-YR Rainfall=3.81"

	Area (sf)	CN	Description
*	53,824	92	Type D 70%
	53,824		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.8	95	0.0550	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"

Summary for Subcatchment P5: Flows to Highway Storm Sewer

Runoff = 1.23 cfs @ 12.11 hrs, Volume= 0.058 af, Depth> 3.04"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-YR Rainfall=3.81"

	Area (sf)	CN	Description
*	9,900	94	Type D 80%
	9,900		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.2	20	0.0400	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
1.2	80	0.0150	1.08		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.70"
1.2	180	0.0150	2.49		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
4.6	280	Total			

Summary for Subcatchment P6: Flows to Concrete Channel to Pebble Creek

Runoff = 2.18 cfs @ 12.15 hrs, Volume= 0.101 af, Depth> 1.73"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-YR Rainfall=3.81"

	Area (sf)	CN	Description
*	10,693	65	Type B 10%
*	2,828	74	Type C 10%
*	17,075	89	Type D 10%
	30,596	79	Weighted Average
	30,596		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	100	0.0500	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"

Summary for Pond 1P: BioRetention Pond

Inflow Area = 10.679 ac, 0.00% Impervious, Inflow Depth > 2.53" for 10-YR event
Inflow = 45.00 cfs @ 12.15 hrs, Volume= 2.251 af
Outflow = 25.41 cfs @ 12.26 hrs, Volume= 1.920 af, Atten= 44%, Lag= 6.6 min
Discarded = 0.34 cfs @ 12.26 hrs, Volume= 0.228 af
Primary = 25.07 cfs @ 12.26 hrs, Volume= 1.692 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 26.15' @ 12.26 hrs Surf.Area= 16,857 sf Storage= 32,161 cf

Plug-Flow detention time= 64.4 min calculated for 1.914 af (85% of inflow)
Center-of-Mass det. time= 26.7 min (796.4 - 769.7)

Volume	Invert	Avail.Storage	Storage Description
#1	24.00'	122,117 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
24.00	13,100	0	0
29.00	21,850	87,375	87,375
30.50	24,472	34,742	122,117

Device	Routing	Invert	Outlet Devices
#1	Primary	20.90'	**24.0" Round Culvert** L= 200.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 20.90' / 20.20' S= 0.0035 '/' Cc= 0.900 n= 0.013, Flow Area= 3.14 sf
#2	Device 1	25.00'	**36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Primary	29.80'	**Asymmetrical Weir, C= 3.27** Offset (feet) -100.00 0.00 100.00 Height (feet) 1.00 0.00 1.00
#4	Discarded	24.00'	**0.600 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 20.00'

Discarded OutFlow Max=0.34 cfs @ 12.26 hrs HW=26.14' (Free Discharge)
└─**4=Exfiltration** (Controls 0.34 cfs)

Primary OutFlow Max=25.04 cfs @ 12.26 hrs HW=26.14' (Free Discharge)
├─**1=Culvert** (Barrel Controls 25.04 cfs @ 7.97 fps)
│ └─**2=Orifice/Grate** (Passes 25.04 cfs of 36.31 cfs potential flow)
└─**3=Asymmetrical Weir** (Controls 0.00 cfs)

Summary for Link 2L: 24" Storm Sewer to Pebble Creek

```
Inflow Area =    10.907 ac,   0.00% Impervious,  Inflow Depth >   1.91"    for  10-YR event
Inflow      =     25.36 cfs @   12.25 hrs,  Volume=          1.737 af
Primary     =     25.36 cfs @   12.25 hrs,  Volume=          1.737 af,  Atten= 0%,  Lag= 0.0 min
```

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Link 3L: Total Flow including Off-Site Drainage

```
Inflow Area =        15.557 ac,    0.00% Impervious,  Inflow Depth >   2.17"    for  10-YR event
Inflow       =        42.84 cfs @   12.17 hrs,  Volume=            2.816 af
Primary      =        42.84 cfs @   12.17 hrs,  Volume=            2.816 af,  Atten= 0%,  Lag= 0.0 min
```

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Subcatchment P1: Flows to BioRetention Pond

Runoff = 67.34 cfs @ 12.15 hrs, Volume= 3.522 af, Depth> 4.86"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 100-YR Rainfall=6.18"

	Area (sf)	CN	Description
*	51,271	85	Type B 65%
*	10,870	89	Type C 65%
*	316,837	91	Type D 65%
	378,978	90	Weighted Average
	378,978		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.1	40	0.0200	0.13		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
1.0	60	0.0150	1.02		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.70"
2.1	480	0.0050	3.72	4.57	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013
8.2	580	Total			

Summary for Subcatchment P1A: Off-Site Drainage into BioRetention Pond

Runoff = 13.59 cfs @ 12.15 hrs, Volume= 0.676 af, Depth> 4.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 100-YR Rainfall=6.18"

	Area (sf)	CN	Description
*	86,183	83	From Existing Conditions Model
	86,183		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	100	0.0540	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
0.9	195	0.0540	3.49		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
8.1	295	Total			

Summary for Subcatchment P2: Flows Directly to Pebble Creek Storm Sewer

Runoff = 2.04 cfs @ 12.09 hrs, Volume= 0.086 af, Depth> 4.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 100-YR Rainfall=6.18"

	Area (sf)	CN	Description
*	4,051	85	Type B 50%
*	5,906	88	Type D 50%
	9,957	87	Weighted Average
	9,957		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.8	30	0.0500	0.18		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
0.4	40	0.0500	1.52		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.70"
3.2	70	Total			

Summary for Subcatchment P3: Flows to Kohls Pond

Runoff = 16.08 cfs @ 12.22 hrs, Volume= 1.096 af, Depth> 5.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 100-YR Rainfall=6.18"

	Area (sf)	CN	Description
*	5,889	91	Type B 80%
*	102,333	94	Type D 80%
	108,222	94	Weighted Average
	108,222		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.7	100	0.0200	0.16		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
3.1	280	0.0100	1.50		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
0.9	270	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013
14.7	650	Total			

Summary for Subcatchment P4: Flows to Highway Ditch

Runoff = 10.28 cfs @ 12.14 hrs, Volume= 0.523 af, Depth> 5.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 100-YR Rainfall=6.18"

	Area (sf)	CN	Description
*	53,824	92	Type D 70%
	53,824		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.8	95	0.0550	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"

Summary for Subcatchment P5: Flows to Highway Storm Sewer

Runoff = 2.07 cfs @ 12.11 hrs, Volume= 0.100 af, Depth> 5.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 100-YR Rainfall=6.18"

	Area (sf)	CN	Description
*	9,900	94	Type D 80%
	9,900		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.2	20	0.0400	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"
1.2	80	0.0150	1.08		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.70"
1.2	180	0.0150	2.49		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
4.6	280	Total			

Summary for Subcatchment P6: Flows to Concrete Channel to Pebble Creek

Runoff = 4.55 cfs @ 12.15 hrs, Volume= 0.216 af, Depth> 3.69"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 100-YR Rainfall=6.18"

	Area (sf)	CN	Description
*	10,693	65	Type B 10%
*	2,828	74	Type C 10%
*	17,075	89	Type D 10%
	30,596	79	Weighted Average
	30,596		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	100	0.0500	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.70"

Summary for Pond 1P: BioRetention Pond

```
Inflow Area =      10.679 ac,   0.00% Impervious,  Inflow Depth >   4.72"    for  100-YR event
Inflow      =      80.93 cfs @   12.15 hrs,  Volume=         4.198 af
Outflow     =      29.88 cfs @   12.33 hrs,  Volume=         3.858 af,  Atten= 63%,  Lag= 10.5 min
Discarded   =       0.47 cfs @   12.33 hrs,  Volume=         0.277 af
Primary     =      29.41 cfs @   12.33 hrs,  Volume=         3.581 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 27.64' @ 12.33 hrs   Surf.Area= 19,461 sf   Storage= 59,180 cf

Plug-Flow detention time= 53.9 min calculated for 3.858 af (92% of inflow)
Center-of-Mass det. time= 27.4 min ( 786.4 - 759.0 )

Volume        Invert     Avail.Storage   Storage Description
   #1         24.00'       122,117 cf    Custom Stage Data (Prismatic)Listed below (Recalc)

 Elevation          Surf.Area           Inc.Store           Cum.Store
    (feet)            (sq-ft)        (cubic-feet)        (cubic-feet)
     24.00             13,100                   0                   0
     29.00             21,850              87,375              87,375
     30.50             24,472              34,742             122,117

Device   Routing             Invert   Outlet Devices
    #1   Primary             20.90'   24.0"  Round Culvert
                                      L= 200.0'   CPP, square edge headwall,  Ke= 0.500
                                      Inlet / Outlet Invert= 20.90' / 20.20'   S= 0.0035 '/'   Cc= 0.900
                                      n= 0.013,  Flow Area= 3.14 sf
    #2   Device 1            25.00'   36.0" Horiz. Orifice/Grate   C= 0.600
                                      Limited to weir flow at low heads
    #3   Primary             29.80'   Asymmetrical Weir, C= 3.27
                                      Offset (feet)  -100.00  0.00  100.00
                                      Height (feet)  1.00  0.00  1.00
    #4   Discarded           24.00'   0.600 in/hr Exfiltration over Surface area
                                      Conductivity to Groundwater Elevation = 20.00'

Discarded OutFlow  Max=0.47 cfs @ 12.33 hrs  HW=27.63'   (Free Discharge)
└─4=Exfiltration  ( Controls 0.47 cfs)

Primary OutFlow  Max=29.40 cfs @ 12.33 hrs  HW=27.63'   (Free Discharge)
├─1=Culvert  (Barrel Controls 29.40 cfs @ 9.36 fps)
│  └─2=Orifice/Grate  (Passes 29.40 cfs of 55.17 cfs potential flow)
└─3=Asymmetrical Weir  ( Controls 0.00 cfs)
```

Summary for Link 2L: 24" Storm Sewer to Pebble Creek

```
Inflow Area =        10.907 ac,    0.00% Impervious,  Inflow Depth >   4.03"    for  100-YR event
Inflow       =       29.85 cfs @   12.31 hrs,  Volume=            3.667 af
Primary      =       29.85 cfs @   12.31 hrs,  Volume=            3.667 af,  Atten= 0%,  Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
```

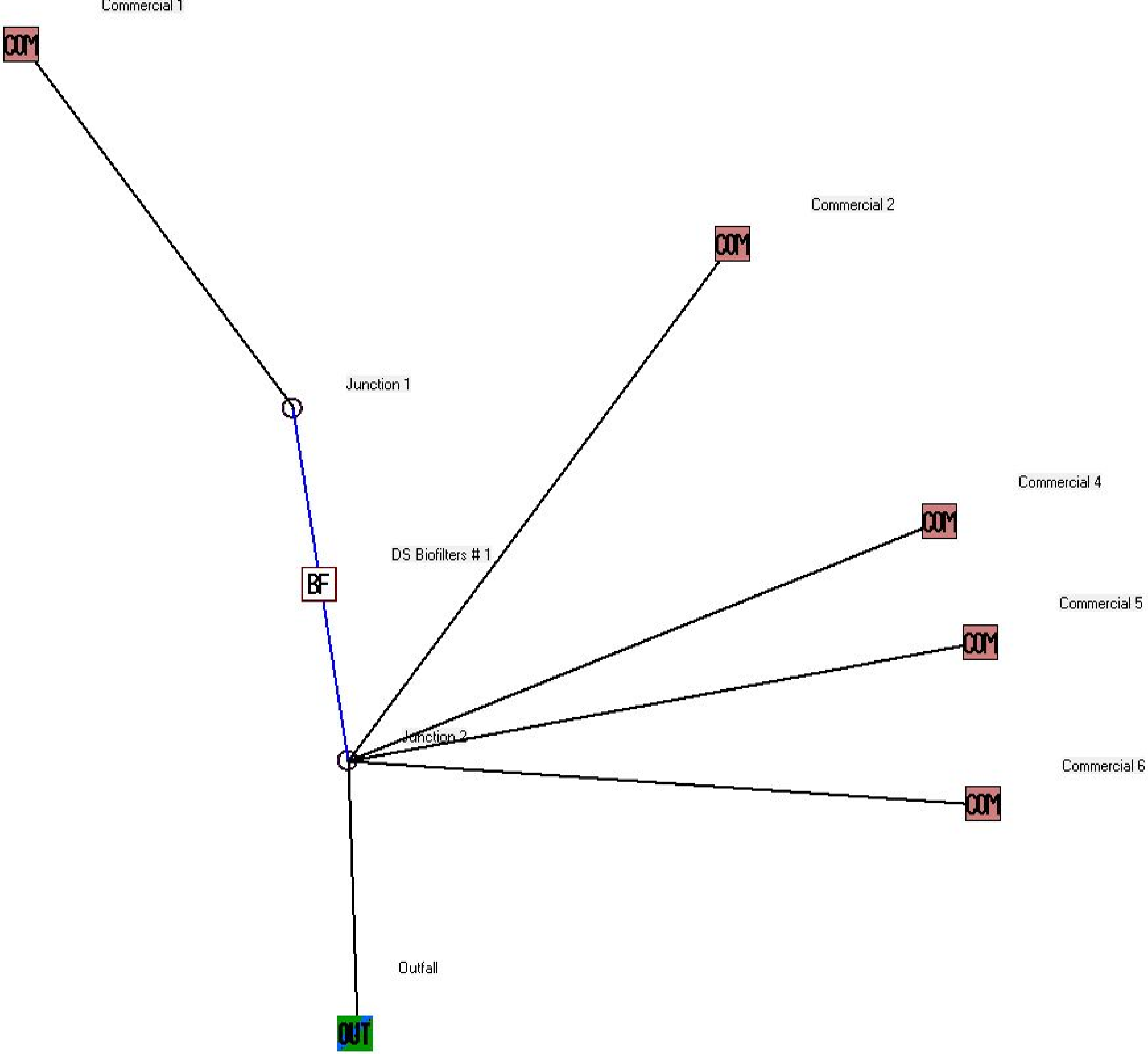
Summary for Link 3L: Total Flow including Off-Site Drainage

```
Inflow Area =        15.557 ac,    0.00% Impervious,  Inflow Depth >   4.32"    for  100-YR event
Inflow      =        58.58 cfs @   12.16 hrs,  Volume=            5.602 af
Primary     =        58.58 cfs @   12.16 hrs,  Volume=            5.602 af,  Atten= 0%,  Lag= 0.0 min
```

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

APPENDIX D

WINSLAMM DATA


Commercial 1
COM
Commercial 2
COM
Junction 1
Commercial 4
COM
DS Biofilters # 1
BF
Commercial 5
COM
Junction 2
Commercial 6
COM
Outfall
OUT

```
Data file name:  P:\WinSLAMM v10\19-9043 Fox Run\Fox Run Redevelopment.mdb
WinSLAMM Version 10.3.4
Rain file name:  C:\WinSLAMM Files\Rain Files\WisReg - Milwaukee WI 1969.RAN
Particulate Solids Concentration file name:  C:\WinSLAMM Files\v10.1 WI_AVG01.pscx
Runoff Coefficient file name:  C:\WinSLAMM Files\WI_SL06 Dec06.rsvx
Residential Street Delivery file name:  C:\WinSLAMM Files\WI_Res and Other Urban Dec06.std
Institutional Street Delivery file name:  C:\WinSLAMM Files\WI_Com Inst Indust Dec06.std
Commercial Street Delivery file name:  C:\WinSLAMM Files\WI_Com Inst Indust Dec06.std
Industrial Street Delivery file name:  C:\WinSLAMM Files\WI_Com Inst Indust Dec06.std
Other Urban Street Delivery file name:  C:\WinSLAMM Files\WI_Res and Other Urban Dec06.std
Freeway Street Delivery file name:  C:\WinSLAMM Files\Freeway Dec06.std
Apply Street Delivery Files to Adjust the After Event Load Street Dirt Mass Balance:  False
Pollutant Relative Concentration file name:  C:\WinSLAMM Files\WI_GEO03.ppdx
Source Area PSD and Peak to Average Flow Ratio File:  C:\WinSLAMM Files\NURP Source Area PSD Files.csv
Cost Data file name:
Seed for random number generator:  -42
Study period starting date:  01/05/69       Study period ending date:  12/31/69
Start of Winter Season:  12/06             End of Winter Season:  03/28
Date:  03-26-2020                          Time:  12:11:12
Site information:

LU# 1 - Commercial:  Commercial 1     Total area (ac):  8.700
    1 - Roofs 1:  1.410 ac.    Flat    Connected    Source Area PSD File: C:\WinSLAMM Files\NURP.cpz
    13 - Paved Parking 1:  1.410 ac.    Connected    Source Area PSD File: C:\WinSLAMM Files\NURP.cpz
    25 - Driveways 1:  2.830 ac.    Connected    Source Area PSD File: C:\WinSLAMM Files\NURP.cpz
    45 - Large Landscaped Areas 1:  3.050 ac.    Normal Silty    Source Area PSD File: C:\WinSLAMM Files\NURP.cpz



LU# 2 - Commercial:  Commercial 2     Total area (ac):  0.220
    25 - Driveways 1:  0.110 ac.    Connected    Source Area PSD File: C:\WinSLAMM Files\NURP.cpz
    45 - Large Landscaped Areas 1:  0.110 ac.    Normal Silty    Source Area PSD File: C:\WinSLAMM Files\NURP.cpz



LU# 3 - Commercial:  Commercial 4     Total area (ac):  1.240
    1 - Roofs 1:  0.220 ac.    Flat    Connected    Source Area PSD File: C:\WinSLAMM Files\NURP.cpz
    13 - Paved Parking 1:  0.220 ac.    Connected    Source Area PSD File: C:\WinSLAMM Files\NURP.cpz
    25 - Driveways 1:  0.430 ac.    Connected    Source Area PSD File: C:\WinSLAMM Files\NURP.cpz
    45 - Large Landscaped Areas 1:  0.370 ac.    Normal Silty    Source Area PSD File: C:\WinSLAMM Files\NURP.cpz



LU# 4 - Commercial:  Commercial 5     Total area (ac):  0.220
    13 - Paved Parking 1:  0.060 ac.    Connected    Source Area PSD File: C:\WinSLAMM Files\NURP.cpz
    25 - Driveways 1:  0.120 ac.    Connected    Source Area PSD File: C:\WinSLAMM Files\NURP.cpz
    45 - Large Landscaped Areas 1:  0.040 ac.    Normal Silty    Source Area PSD File: C:\WinSLAMM Files\NURP.cpz



LU# 5 - Commercial:  Commercial 6     Total area (ac):  0.570
    25 - Driveways 1:  0.060 ac.    Connected    Source Area PSD File: C:\WinSLAMM Files\NURP.cpz
```

45 - Large Landscaped Areas 1: 0.510 ac. Normal Silty Source Area PSD File: C:\WinSLAMM Files\NURP.cpz

Control Practice 1: Biofilter CP# 1 (DS) - DS Biofilters # 1

1. Top area (square feet) = 26457
2. Bottom aea (square feet) = 20018
3. Depth (ft): 5
4. Biofilter width (ft) - for Cost Purposes Only: 80
5. Infiltration rate (in/hr) = 0.5
6. Random infiltration rate generation? No
7. Infiltration rate fraction (side): 1
8. Infiltration rate fraction (bottom): 1
9. Depth of biofilter that is rock filled (ft) 0
10. Porosity of rock filled volume = 0
11. Engineered soil infiltration rate: 13
12. Engineered soil depth (ft) = 2
13. Engineered soil porosity = 0.45
14. Percent solids reduction due to flow through engineered soil = 0
15. Biofilter peak to average flow ratio = 3.8
16. Number of biofiltration control devices = 1
17. Particle size distribution file: Not needed - calculated by program
18. Initial water surface elevation (ft): 0

Soil Data	Soil Type Fraction in Eng. Soil
Sands	0.700
Compost as Amendment	0.300

Saturation water content percent (Porosity) = 0
Field capacity (%) = 0
Permanent Wilting Point (%) = 0
Infiltration rate (in/hr) = 13

Biofilter Outlet/Discharge Characteristics:

Outlet type: Broad Crested Weir
1. Weir crest length (ft): 4
2. Weir crest width (ft): 4
3. Height of datum to bottom of weir opening: 4.8

Outlet type: Vertical Stand Pipe
1. Stand pipe diameter (ft): 48
2. Stand pipe height above datum (ft): 3.5

Outlet type: Drain Tile/Underdrain
1. Underdrain outlet diameter (ft): 0.33
2. Invert elevation above datum (ft): 0
3. Number of underdrain outlets: 1

```
SLAMM for Windows Version 10.3.4
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Data file name:  P:\WinSLAMM v10\19-9043 Fox Run\Fox Run Redevelopment.mdb
Data file description:
Rain file name:  C:\WinSLAMM Files\Rain Files\WisReg - Milwaukee WI 1969.RAN
Particulate Solids Concentration file name:  C:\WinSLAMM Files\v10.1 WI_AVG01.pscx
Runoff Coefficient file name:  C:\WinSLAMM Files\WI_SL06 Dec06.rsvx
Residential Street Delivery file name:  C:\WinSLAMM Files\WI_Res and Other Urban Dec06.std
Institutional Street Delivery file name:  C:\WinSLAMM Files\WI_Com Inst Indust Dec06.std
Commercial Street Delivery file name:  C:\WinSLAMM Files\WI_Com Inst Indust Dec06.std
Industrial Street Delivery file name:  C:\WinSLAMM Files\WI_Com Inst Indust Dec06.std
Other Urban Street Delivery file name:  C:\WinSLAMM Files\WI_Res and Other Urban Dec06.std
Freeway Street Delivery file name:  C:\WinSLAMM Files\Freeway Dec06.std
Pollutant Relative Concentration file name:  C:\WinSLAMM Files\WI_GEO03.ppdx
Start of Winter Season:  12/06            End of Winter Season:  03/28
Model Run Start Date:  01/05/69    Model Run End Date:  12/31/69
Date of run:  03-26-2020    Time of run:  12:10:50
Total Area Modeled (acres):  10.950
Years in Model Run:  0.99

                                          Runoff     Percent Particulate Particulate     Percent
                                          Volume     Runoff      Solids      Solids Particulate
                                         (cu ft)     Volume      Conc.       Yield      Solids
                                                   Reduction     (mg/L)      (lbs)   Reduction

Total of all Land Uses without Controls:   556720        -       122.4       4252         -
Outfall Total with Controls:               203022     63.53%     117.1       1484      65.10%
Annualized Total After Outfall Controls:   205842                            1505
```

APPENDIX E

BASIN MAPS

RE: VJS CONSTRUCTION SERVICES, INC.

DRAWN BY: A.C.L. | CHECKED BY: P.J.J. | JOB NUMBER: 19-9043 | DATE: JANUARY 27, 2020

FILE NUMBER: XXXXXXXX XXXX | BOOK NUMBER: WAUK 191/201 - PAGE NUMBER: 1-6

711 WEST MORELAND BOULEVARD, WAUKESHA, WISCONSIN 53188
PHONE #: (262) 542-5797 - EMAIL: SURVEY@JAHNKEANDJAHNKE.COM
WEBSITE: JAHNKEANDJAHNKE.COM

JAHNKE & JAHNKE
ASSOCIATES, LLC.
ENGINEERS·PLANNERS·SURVEYORS
ENGINEERING SOLUTIONS SINCE 1964

EXISTING DRAINAGE BASIN

ADDRESS: 2300 WEST ST. PAUL AVENUE
PART OF THE SE 1/4 OF SECTION 8, T 6 N, R 19 E
& PART OF THE SW 1/4 OF SECTION 9, T 6 N, R 19 E
CITY OF WAUKESHA, WAUKESHA COUNTY, WISCONSIN.

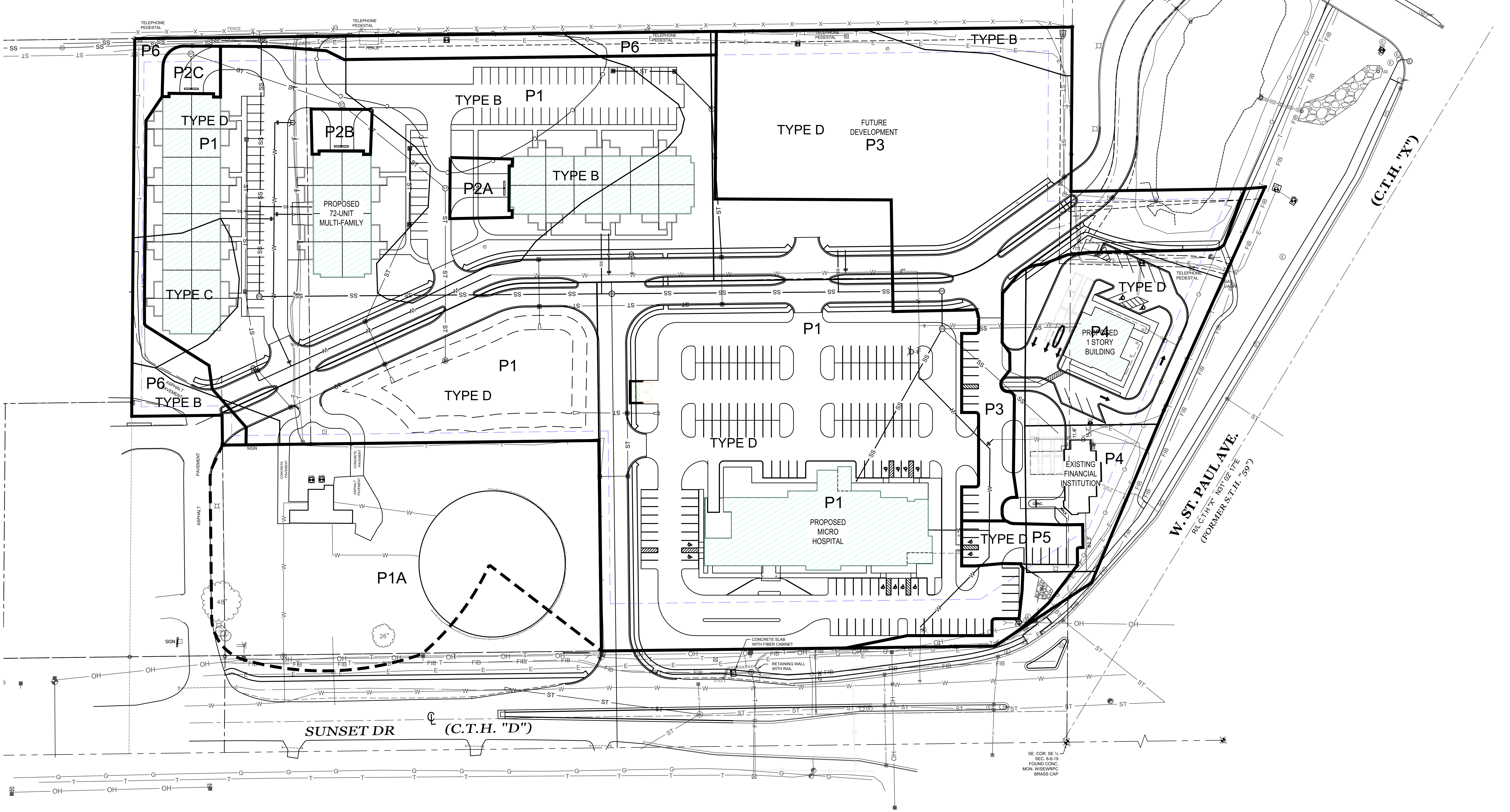
REVISIONS

SHEET:
01 OF 01

FILE NAME: S:\projects\19-9043 (S8560)\dwg\19-9043_Basin.dwg

LEGEND:

-xxxxxxxx-	PROP. SAW CUT	■	EX. POWER POLE	⊕	BENCHMARK	Ⓢ	EX. STORM MANHOLE
-xxxxxxxx-	EX. RETAINING WALL	○	EX. PULL BOX	⊗	EX. PK NAIL	⊕	EX. CATCH BASIN ROUND
—W—	EX. UNDERGROUND WATER	—<	EX. GUY WIRE	●	EX. IRON PIPE	▦	EX. CATCH BASIN SQUARE
—ST—	EX. STORM SEWER	Ⓣ	EX. TELEPHONE MANHOLE	⊕	EX. MONUMENT	INV ○	EX. INVERT
—SS—	EX. SANITARY LINE	⊠	EX. TELEPHONE PEDESTAL	FP ○	EX. FLAG POLE	ETR	EX. ELECTRIC TRANSFORMER
—G—	EX. UNDERGROUND GAS	Ⓤ	EX. UTILITY MANHOLE	•	EX. BOLLARD	Ⓔ	EX. ELECTRIC MANHOLE
—OH—	EX. OVERHEAD WIRE	GM ⊗	EX. GAS METER	Ⓦ	EX. WATER MANHOLE	¤	EX. LIGHTPOLE
—E—	EX. UNDERGROUND ELECTRIC	◐	EX. GAS VALVE	♉	EX. HYDRANT		
—FIB—	EX. FIBER OPTIC CABLE	CLO ●	EX. CLEAN OUT	⋈	EX. WATER VALVE		
—T—	EX. UNDERGROUND TELEPHONE	Ⓢ	EX. SANITARY MANHOLE	SPV	EX. SPRINKLER VALVE		
—CATV—	EX. CABLE TV UNDERGROUND	SEPTIC VENT ⊗	EX. SEPTIC VENT	EM ⊗	EX. ELECTRIC METER		
—C—	EX. CONTAMINATED AREA	AIR ⊡	EX. AIR CONDITIONER	⊡	EX. ELECTRIC PEDESTAL		



N
W E
S

SCALE IN FEET
0 50'

RE: VJS CONSTRUCTION SERVICES, INC.

DRAWN BY: A.C.L. | CHECKED BY: P.J.J. | JOB NUMBER: 19-9043 | DATE: JANUARY 27, 2020
FILE NUMBER: XXXXXXXX XXXX | BOOK NUMBER: WAUK 191/201 - PAGE NUMBER: 1-6

711 WEST MORELAND BOULEVARD, WAUKESHA, WISCONSIN 53188
PHONE #: (262) 542-5797 - EMAIL: SURVEY@JAHNKEANDJAHNKE.COM
WEBSITE: JAHNKEANDJAHNKE.COM

JAHNKE & JAHNKE
ASSOCIATES, LLC.
ENGINEERS•PLANNERS•SURVEYORS
ENGINEERING SOLUTIONS SINCE 1964

PROPOSED DRAINAGE BASINS

ADDRESS: 2300 WEST ST. PAUL AVENUE
PART OF THE SE 1/4 OF SECTION 8, T 6 N, R 19 E
& PART OF THE SW 1/4 OF SECTION 9, T 6 N, R 19 E
CITY OF WAUKESHA, WAUKESHA COUNTY, WISCONSIN.

REVISIONS
3/17/2020 - REV. CURB ENTRY
3/25/2020 - REV. BASINS

SHEET:
01 OF 01

FILE NAME: S:\projects\19-9043 (S8560)\dwg\Storm Sewer and Storm Water Basins\19-9043_Proposed Drainage Basins Revised.dwg

APPENDIX F

GEOTECHNICAL INVESTIGATION

Geotechnical Engineering Exploration and Analysis

Proposed Bioretention Basin
2300 West St. Paul Avenue
Waukesha, Wisconsin

Prepared for:

VJS Construction Services, Inc.
Pewaukee, Wisconsin

March 27, 2020
Giles Project No. 1G-2003009

GILES
Engineering Associates, Inc.

GILES
ENGINEERING ASSOCIATES, INC.
GEOTECHNICAL, ENVIRONMENTAL & CONSTRUCTION MATERIALS CONSULTANTS

- Atlanta, GA
- Baltimore, MD
- Dallas, TX
- Los Angeles, CA
- Manassas, VA
- Milwaukee, WI

March 27, 2020

VJS Construction Services, Inc.
c/o Jahnke & Jahnke Associates, Inc.
711 W. Moreland Blvd.
Waukesha, WI 53188

Attention: Mr. Paul Jenswold, P.E.
Vice President of Engineering

Subject: Geotechnical Engineering Exploration and Analysis
Proposed Bioretention Basin
2300 West St. Paul Avenue
Waukesha, Wisconsin
Proposal No. 1G-2003009

Dear Mr. Jenswold:

As requested, Giles Engineering Associates, Inc. ("Giles") conducted a *Geotechnical Engineering Exploration and Analysis* for the proposed project. The accompanying report describes the services that were conducted, and it provides geotechnical-related findings, conclusions, and recommendations that were derived from those services.

We sincerely appreciate the opportunity to provide consulting services for the proposed project. Please contact the undersigned if there are questions concerning the report, or if we may be of further service.

Very truly yours,

GILES ENGINEERING ASSOCIATES, INC.

Benjamin M. Stark, E.I.T., CST
Staff Professional I

David M. Cornale, P.E.
Sr. Geotechnical Consultant

WISCONSIN
DAVID M.
CORNALE
E-43336
GREENFIELD
WI
PROFESSIONAL ENGINEER

Distribution: Jahnke & Jahnke Associates, Inc.
Attn: Mr. Paul Jenswold (1 via email: pjenswold@jahnkeandjahnke.com)

N8 W22350 Johnson Drive • Suite A1 • Waukesha, WI 53186
262/544-0118 • Fax 262/549-5868 • E-Mail milwaukee@gilesengr.com

TABLE OF CONTENTS

GEOTECHNICAL ENGINEERING EXPLORATION AND ANALYSIS

PROPOSED BIORETENTION BASIN
2300 WEST ST. PAUL AVENUE
WAUKESHA, WISCONSIN
PROPOSAL NO. 1G-2003009

© Giles Engineering Associates, Inc. 2020

GEOTECHNICAL ENGINEERING EXPLORATION AND ANALYSIS

PROPOSED BIORETENTION BASIN
2300 WEST ST. PAUL AVENUE
WAUKESHA, WISCONSIN
PROPOSAL NO. 1G-2003009

1.0 SCOPE OF SERVICES

This report provides the results of the *Geotechnical Engineering Subsurface Exploration and Analysis* that Giles Engineering Associates, Inc. (“Giles”) conducted regarding the proposed stormwater infiltration areas at the site. The *Geotechnical Engineering Subsurface Exploration and Analysis* included a Geotechnical Subsurface Exploration Program, Geotechnical Laboratory Services, and Geotechnical Engineering Services. The scope of each service area was narrow and limited, as directed by our client, and based on our understanding and assumptions about the proposed project. Service areas are briefly described later.

Geotechnical-related recommendations regarding the feasibility of performing stormwater infiltration within the proposed bioretention basin area is provided in this report. Evaluation of the site for construction of non-stormwater management improvements, or evaluation in areas outside the stormwater infiltration areas, was beyond our scope of services for this project. Environmental consulting was also beyond our authorized scope.

2.0 SITE & PROJECT DESCRIPTION

The site of the proposed bioretention basin is located within the parking lot on the south side of the existing Fox Run Shopping Center located at 2300 West St. Paul Avenue in Waukesha, Wisconsin. At the time of our field services, the site was an asphalt paved parking lot that contained drive lanes and parking stalls. Retail buildings were north and southwest of the site, and an existing water reservoir was directly to the south. Topographically, the site was relatively flat and the ground surface gently sloped downward to the north. Ground surface elevations were between approximately El. 30 and El. 33 in the project area. Those elevations are based on topographic contours shown on the *Existing Boundary Survey* (dated March 12, 2020) prepared by Jahnke & Jahnke Associates, LLC. A depiction of the project site is shown on the *Test Boring Location Plan* enclosed in Appendix A.

It is understood that new stormwater bioretention basin is planned to be constructed at the site, in the area of the test borings. Based on information provided by Jahnke & Jahnke Associates, it is understood that the bottom of the bioretention basin will be at ±El. 24. The basin will have approximately 2 feet of biofiltration media, underlain by a 12-inch thick gravel layer that will serve as an underdrain. Therefore, excavations for bioretention basin construction will extended to ±El. 21, which is between approximately 9.5 and 11.5 feet below the surface grades at the test boring locations.

3.0 GEOTECHNICAL SUBSURFACE EXPLORATION PROGRAM

To explore subsurface conditions, three geotechnical test borings were conducted at the site, using a mechanical drill-rig. The test borings were positioned at locations requested by the project civil engineer, which are understood to be in the area of the proposed stormwater management device. Each test boring was advanced to ±21 feet below-grade, as planned. Test boring locations were positioned on-site relative to apparent property lines, features of the site, and by estimating right angles. Approximate locations of the test borings are shown on the *Test Boring Location Plan*.

Samples were collected from each test boring, at certain depths, using the Standard Penetration Test (SPT), conducted with the drill rig. A brief description of the SPT is given in Appendix B, along with descriptions of other field procedures. Immediately after sampling, select portions of the SPT samples were placed in containers that were labeled at the site for identification. Retained samples were transported to Giles' geotechnical laboratory. A Standard Penetration Resistance value (N-value) was determined from each SPT. N-values are reported on the *Test Boring Logs* (in Appendix A), which are records of the test borings.

Ground elevations at the test borings were estimated using the elevation contours shown on the provided site survey. The test boring elevations are noted on the *Test Boring Logs*, and are considered accurate within about one foot.

The boreholes were backfilled upon completion. However, backfill material will likely settle and/or heave, creating a hazard that can injure people and animals. Borehole areas should, therefore, be carefully and routinely monitored by the property owner or others; settlement and/or heave of backfill materials should be repaired immediately. Giles will not monitor or repair boreholes.

4.0 GEOTECHNICAL LABORATORY SERVICES

The retained samples were classified using the descriptive terms and particle-size criteria shown on the *General Notes* in Appendix D, and by using the Unified Soil Classification System (ASTM D 2488) as a general guide. The classifications are shown on the *Test Boring Logs*, along with horizontal lines that show estimated depths of material change. Field-related information pertaining to the test borings is also shown on the *Test Boring Logs*. For simplicity and abbreviation, terms and symbols are used on the *Test Boring Logs;* the terms and symbols are defined on the *General Notes*.

The soil samples obtained from the test borings were also visually classified using the USDA textural classification system, in general accordance with the guidelines provided in the *Field Book for Describing and Sampling Soils* (USDA, Sept. 2012). The USDA classifications of the retained samples are shown on the Wisconsin DSPS *Soil Evaluation – Storm* logs, enclosed in Appendix A. Supplemental information regarding soil classifications, including the USDA and USCS soil classification systems, is included in the *Soil Classification Notes* enclosure within Appendix D.

Sieve analyses to determine the percent of material passing the No. 10 (P10) and No. 270 (P270) sieves were performed on three soil samples obtained from the test borings to assist soil classification and evaluation of the soils' infiltration capacity. Results of the sieve tests are summarized below and noted on *Test Boring Logs*. Laboratory procedures are briefly described in Appendix C.

RESULTS OF SIEVE TESTS			
Test Boring	**Sample Depth (feet)**	**Percentage of Sample Finer than No. 10 Sieve**	**Percentage of Sample Finer than the No. 270 Sieve**
1	9½ to 11	100%	94.7%
3	7 to 8½	92.1%	56.5%
3	12 to 13½	84.1%	15.2%
(a) Referenced to the site grades during the Geotechnical Subsurface Exploration Program.			

5.0 MATERIAL CONDITIONS

5.1. Pavement

Pavement was at the surface of each test boring. The pavement consisted of asphalt concrete, which was underlain by an aggregate base course at Test Borings 1 and 2. A base course was not encountered at Test Boring 3. The asphalt concrete was ±3 to ±4 inches thick at the test borings and the base course was ±4 and ±10 inches thick at Test Borings 2 and 1, respectively.

5.2. Clayey Soils

Fill material consisting of sandy silt, silty sand and lean clay (loam and silty clay) was encountered in the test borings to a depth of approximately 4 feet at Test Borings 2 and 3 and a depth of ±12 feet at Test Boring 1.

5.3. Native Soils

Below the existing fill, native soils consisting of silt, sandy silt, sandy clay and lean clay (silt loam, loam, silty clay loam and sandy clay loam) clay were encountered below the fill materials. These native soils extended to the test boring depths of ±21 feet at Test Borings 1 and 2 and a depth of ±10 feet at Test Boring 3. At Test Boring 3, fine sand with gravel, cobbles and boulders was encountered below ±10 feet and extended to the test boring termination depth of ±21 feet.

6.0 GROUNDWATER CONDITIONS

Water was not encountered in the test borings during drilling. Based on soil coloration, it is estimated that perched water conditions may develop seasonally at a depth of approximately ±12 feet below grade.

Giles' estimate of the groundwater conditions is only an approximation based on the colors of observed soil and the water encountered within the test borings. The water table could be higher or lower than estimated. A more precise estimate of the groundwater conditions could be determined by installing and monitoring observation wells at the site. Giles can install and monitor observations wells at the site if requested.

7.0 CONCLUSIONS AND RECOMMENDATIONS

7.1. Stormwater Infiltration Recommendations

Stormwater Infiltration Feasibility

Due to the low permeability of the native cohesive soil (silty clay loam and sandy clay loam) encountered in Test Borings 1 and 2 at and below the planned bioretention basin depth, the site is considered to have a very limited capacity for the infiltration of stormwater.

Because of the low infiltration capacity of the site soils encountered below the proposed bioretention basin bottom, the bioretention basin is recommended to have an underdrainage system that is discharges infiltrated water to the storm sewer or other suitable outlet. With an underdrainage system, the bioretention basin may be designed as a partially infiltrating device using a relatively low infiltration rate. A design infiltration rate 0.04 inches per hour is considered appropriate for bioretention device design. The recommended design infiltration rate is based on the limiting silty clay loam encountered in two of test borings and the correlated infiltration rate and guidelines provided in the WDNR Conservation Practice Standard 1002. The USDA soil classifications of the soils encountered in the test borings, along with the correlated design infiltration rates, are provided on the *Site and Soil Evaluation – Storm* logs, enclosed in Appendix A.

Details of the proposed bioretention basin were not available at the time of preparation of this report; it is recommended *Giles* review infiltration device plans, when available. Additionally, it recommended that *Giles* provide observation and testing during infiltration device construction.

8.0 BASIS OF REPORT

This report is strictly based on the project description given in this report. Giles must be notified if any part of the project description or our assumptions are not accurate so that this report can be amended, if needed. This report is based on the assumption that the facility will be designed and constructed according to the codes that govern construction at the site.

The conclusions and recommendations in this report are based on estimated subsurface conditions as shown on the Test Boring logs and *Soil Evaluation – Storm* Logs. Giles must be notified if the subsurface conditions that are encountered during construction of the proposed development differ from those shown on the Test Boring logs and *Soil Evaluation – Storm* Logs because this report will likely need to be revised. General comments and limitations of this report are given in the appendix.

The conclusions and recommendations presented in this report have been promulgated in accordance with generally accepted professional engineering practices in the field of geotechnical engineering. No other warranty is either expressed or implied.

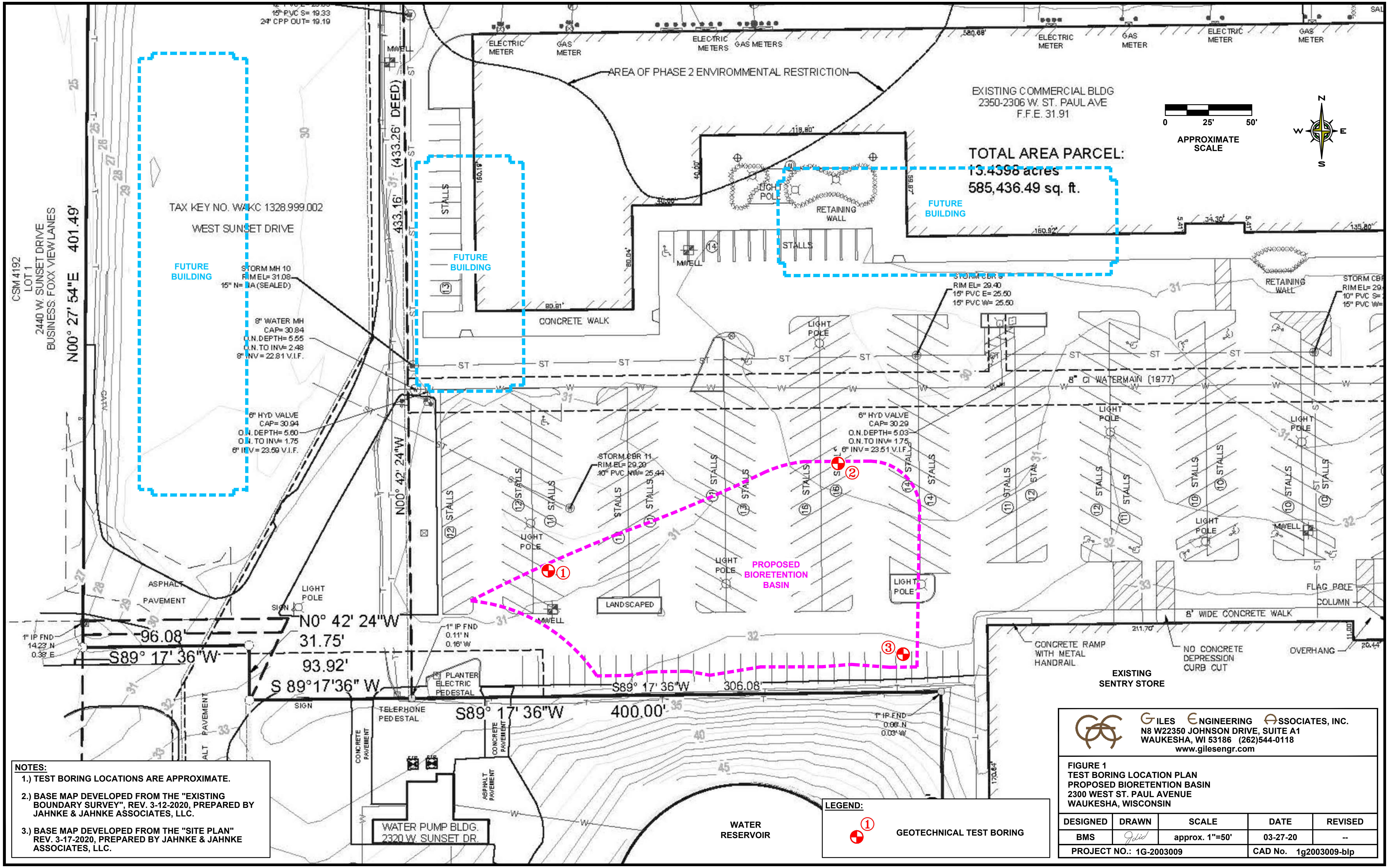
© Giles Engineering Associates, Inc. 2020

APPENDIX A

FIGURES AND TEST BORING LOGS

The Test Boring Location Plan contained herein was prepared based upon information supplied by *Giles'* client, or others, along with *Giles'* field measurements and observations. The diagram is presented for conceptual purposes only and is intended to assist the reader in report interpretation.

The Test Boring Logs and related information enclosed herein depict the subsurface (soil and water) conditions encountered at the specific boring locations on the date that the exploration was performed. Subsurface conditions may differ between boring locations and within areas of the site that were not explored with test borings. The subsurface conditions may also change at the boring locations over the passage of time.



NOTES:

1.) TEST BORING LOCATIONS ARE APPROXIMATE.

2.) BASE MAP DEVELOPED FROM THE "EXISTING BOUNDARY SURVEY", REV. 3-12-2020, PREPARED BY JAHNKE & JAHNKE ASSOCIATES, LLC.

3.) BASE MAP DEVELOPED FROM THE "SITE PLAN" REV. 3-17-2020, PREPARED BY JAHNKE & JAHNKE ASSOCIATES, LLC.

LEGEND:

① GEOTECHNICAL TEST BORING

GILES ENGINEERING ASSOCIATES, INC.
N8 W22350 JOHNSON DRIVE, SUITE A1
WAUKESHA, WI 53186 (262)544-0118
www.gilesengr.com

FIGURE 1
TEST BORING LOCATION PLAN
PROPOSED BIORETENTION BASIN
2300 WEST ST. PAUL AVENUE
WAUKESHA, WISCONSIN

DESIGNED	DRAWN	SCALE	DATE	REVISED
BMS		approx. 1"=50'	03-27-20	--

PROJECT NO.: 1G-2003009

CAD No. 1g2003009-blp

BORING NO. & LOCATION:
1

SURFACE ELEVATION:
30.5 feet

COMPLETION DATE:
03/26/20

FIELD REP:
JAMES BLAIR

TEST BORING LOG

PROPOSED BIORETENTION BASIN

2300 WEST ST. PAUL AVENUE
WAUKESHA, WISCONSIN

PROJECT NO: 1G-2003009

GILES ENGINEERING ASSOCIATES, INC.

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
±3" Asphalt Concrete		30								
±10" Aggregate Base Course			1-SS	11						
Fill: Gray Sandy Silt, trace Gravel-Moist			2-SS	23				12		
Gray and Brown mottled Silt, trace fine Sand-Moist	5	25	3-SS	30				21		
Gray-Brown lean Clay, trace Gravel-Very Moist			4-SS	17				22		
	10	20	5-SS	10		0.6		22		P10=100% P270=94.7%
Gray lean Clay-Moist			6-SS	8		1.2		23		
Gray Sandy Clay, little Gravel-Moist (Contains Cobbles and Boulders)	15	15	7-SS	37				20		
			8-SS	43				12		
	20	10	9-SS	50/0"				11		

Boring Terminated at about 21 feet (EL. 9.5')

	Water Observation Data	Remarks:
▽	Water Encountered During Drilling:	
▼	Water Level At End of Drilling:	
░	Cave Depth At End of Drilling: 17 ft.	
▼	Water Level After Drilling:	
▒	Cave Depth After Drilling:	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION:
2

SURFACE ELEVATION:
30.8 feet

COMPLETION DATE:
03/26/20

FIELD REP:
JAMES BLAIR

TEST BORING LOG

PROPOSED BIORETENTION BASIN

2300 WEST ST. PAUL AVENUE
WAUKESHA, WISCONSIN

PROJECT NO: 1G-2003009

GILES ENGINEERING ASSOCIATES, INC.

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
±4" Asphalt Concrete **±4" Aggregate Base Course** **Fill:**Brown Silty fine Sand, little Gravel-Moist		30	1-SS	17						
Fill: Gray Silty fine Sand, trace Gravel-Moist (Contains Cobbles and Boulders)			2-SS	22				8		
	5	25	3-SS	50/1"				8		
Fill: Dark Gray lean Clay, little fine Sand-Moist			4-SS	14				14		
	10	20	5-SS	12				13		
Gray and Brown mottled lean Clay-Moist			6-SS	13		2.7		20		
Gray lean Clay-Moist	15	15	7-SS	11		2.2		22		
Gray Sandy Clay, little Gravel-Moist			8-SS	19				11		
	20	10	9-SS	18		1.5		8		

Boring Terminated at about 21 feet (EL. 9.8')

	Water Observation Data	Remarks:
▽	Water Encountered During Drilling:	
▼	Water Level At End of Drilling:	
░	Cave Depth At End of Drilling: 14 ft.	
▼	Water Level After Drilling:	
▒	Cave Depth After Drilling:	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION: 3	# TEST BORING LOG	**GILES ENGINEERING ASSOCIATES, INC.**
SURFACE ELEVATION: 32.5 feet	PROPOSED BIORETENTION BASIN 2300 WEST ST. PAUL AVENUE WAUKESHA, WISCONSIN PROJECT NO: 1G-2003009	
COMPLETION DATE: 03/26/20		
FIELD REP: JAMES BLAIR		

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
±3" Asphalt Concrete										
Fill: Brown and Dark Gray lean Clay, little Sand and Gravel-Moist			1-SS	8						
Fill: Brown Silty fine to medium Sand, little Gravel-Very Moist		30	2-SS	6		1.0		10		
Dark Brown lean Clay, little Sand-Moist	5		3-SS	20		0.9		13		
Brown and Gray Sandy Silt-Moist		25	4-SS	30				12		P10=92% P270=56.5%
Brown Silty fine Sand, trace Gravel-Moist (Contains Cobbles and Boulders)	10		5-SS	94				12		
		20	6-SS	71						P10=84.1% P270=15.2%
	15		7-SS	56						
Brown Silty fine Sand, little Gravel, trace Silt-Moist (Contains Cobbles and Boulders)		15	8-SS	70						
	20		9-SS	50/5"						

Boring Terminated at about 21 feet (EL. 11.5')

	Water Observation Data	**Remarks:**
▽	Water Encountered During Drilling:	
▼	Water Level At End of Drilling:	
░	Cave Depth At End of Drilling: 13.5 ft.	
▼	Water Level After Drilling:	
▒	Cave Depth After Drilling:	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

Wisconsin Department of Safety and Professional Services

DSPS

1002-CPS-23
Division of Industry Services
P. O. Box 2658
Madison, Wisconsin 53701
Scott Walker, Governor
Laura Gutierrez, Secretary

Attachment 2:

SOIL AND SITE EVALUATION – STORM

In accordance with SPS 382.365, 385, Wis. Adm. Code, and WDNR Standard 1002

Page 1 of 2

Attach a complete site plan on paper not less than 8 ½ x 11 inches in size. Plan must include, but not limited to: vertical and horizontal reference point (BM), direction and percent of slope, scale or dimensions, north arrow, and BM referenced to nearest road

Please print all information

Personal information you provide may be used for secondary purposes [Privacy Law, s. 15.04(1)(m)]

County
Waukesha

Parcel I.D.
WAKC1328999001

Reviewed by:
Date:

Property Owner
Fox Run 3 LLC

Property Location
Govt. Lot SE ¼ SE ¼ S8 T6N R19E

Property Owner' Mail Address
19035 W Capitol Drive, Suite 108

Lot #

Block #

Subd. Name or CSM #

City
Brookfield

State
WI

Zip Code
53045

Phone Number

☒ City ☐ Village ☐ Town Nearest Road
Waukesha West St. Paul Avenue

Drainage area sq. ft. acres

Test site suitable for (check all that apply) ☐ Site not suitable:

☐ Bioretention ☐ Subsurface Dispersal System:

☐ Reuse: ☐ Irrigation: ☐ Other:

Hydraulic Application Test Method
x Morphological Evaluation
__ Double Ring Infiltrometer
__ Other: (specify) ____________ .

Soil Moisture
Date of soil borings:
USDA-NRCS WETS Value:
__ Dry = 1;
__ Normal = 2;
__ Wet = 3

1 OBS. ☐ Pit ☒ Boring Ground surface elevation 30.5 ft. Elevation of limiting factor 12 ft.

Horizon	Depth in.	Dominant Color Munsell	Redox Description Qu. Sz. Cont. Color	Texture	Structure Gr. Sz. Sh.	Consistence	Boundary	% Rock Frags.	% Fines	Hydraulic App Rate inches/Hr
PVMNT	0-13	--	--	--	--	--	--	--	--	--
FILL	13-48	10YR 5/2		L	0, F, GR	M, FI	A-I	10	60	0.24
B	48-78	10YR 6/1	f, 1, d, 10YR 5/6	SIL	1, F, GR	M, FI	G-S	<5	75	0.13
B	78-144	10YR 5/3		SICL	0, F, SBK	M, VFI	G-S	<5	90	0.04
C	144-180	10YR 4/1		SICL	0, F, SBK	M, F	G-W	<5	95*	0.04
C	180-252	10YR 4/1		SCL	MA	M, FI	--	10	50	0.11

Comments:
*Percent fines estimated from percentage of material passing No. 270 sieve (P270)

2 OBS. ☐ Pit ☒ Boring Ground surface elevation 30.8 ft. Elevation of limiting factor 12 ft.

Horizon	Depth in.	Dominant Color Munsell	Redox Description Qu. Sz. Cont. Color	Texture	Structure Gr. Sz. Sh.	Consistence	Boundary	% Rock Frags.	% Fines	Hydraulic App Rate inches/Hr
PVMNT	0-8	--	--	--	--	--	--	--	--	--
FILL	8-24	10YR 3/3		L	0, F, GR	M, FI	G-I	15	60	0.24
FILL	24-78	10YR 4/1		L	0, F, GR	M, FI	G-I	15	60	0.24
FILL	78-144	10YR 3/1		SICL	0, F, ABK	M, FI	A-I	5	90	0.04
B	144-168	10YR 5/3	f, 1, d, 10YR 5/1	SICL	1, F, ABK	M, FI	G-S	<5	90	0.04
C	168-198	10YR 5/1		SICL	1, F, SBK	M, FI	G-S	<5	90	0.04
C	198-252	10YR 4/1		SCL	MA	M, FI	--	10	75	0.11

Comments:

Name (Please Print)
Benjamin M. Stark

Signature

Credential Number
984619

Address
N8 W22350 Johnson Drive

Date Evaluation Conducted
March 26, 2020

Telephone Number
262-544-0118

3 OBS. ☐ Pit ☒ Boring Ground surface elevation 32.5 ft. Elevation of limiting factor ______ ft.

Horizon	Depth in.	Dominant Color Munsell	Redox Description Qu. Sz. Cont. Color	Texture	Structure Gr. Sz. Sh.	Consistence	Boundary	% Rock Frags.	% Fines	Hydraulic App Rate inches/Hr
PVMNT	0-3	--	--	--	--	--	--	--	--	--
FILL	3-24	10YR 3/1		SICL	0, F, ABK	M, FI	G-W	10	90	0.04
FILL	24-48	10YR 5/4		L	0, F, GR	M, FI	A-I	10	60	0.24
B	48-78	10YR 3/4		SICL	1, F, SBK	M, FI	G-S	<5	90	0.04
B	78-120	10YR 4/4		SIL	1, F, SBK	M, FI	G-S	<5	58*	0.13
C	120-198	10YR 5/4		LS	MA	M, FI	G-S	10	16*	0.50
C	198-252	10YR 5/4		LS	MA	M, FI	--	20	15	0.50

Comments:
*Percent fines estimated from percentage of material passing No. 270 sieve (P270)

Overall Site Comments:

APPENDIX B

FIELD PROCEDURES

The field operations were conducted in general accordance with the procedures recommended by the American Society for Testing and Materials (ASTM) designation D

420 entitled “Standard Guide for Sampling Rock and Rock” and/or other relevant specifications. Soil samples were preserved and transported to *Giles’* laboratory in general accordance with the procedures recommended by ASTM designation D 4220 entitled “Standard Practice for Preserving and Transporting Soil Samples.” Brief descriptions of the sampling, testing and field procedures commonly performed by *Giles* are provided herein.

GENERAL FIELD PROCEDURES

Test Boring Elevations

The ground surface elevations reported on the Test Boring Logs are referenced to the assumed benchmark shown on the Boring Location Plan (Figure 1). Unless otherwise noted, the elevations were determined with a conventional hand-level and are accurate to within about 1 foot.

Test Boring Locations

The test borings were located on-site based on the existing site features and/or apparent property lines. Dimensions illustrating the approximate boring locations are reported on the Boring Location Plan (Figure 1).

Water Level Measurement

The water levels reported on the Test Boring Logs represent the depth of “free” water encountered during drilling and/or after the drilling tools were removed from the borehole. Water levels measured within a granular (sand and gravel) soil profile are typically indicative of the water table elevation. It is usually not possible to accurately identify the water table elevation with cohesive (clayey) soils, since the rate of seepage is slow. The water table elevation within cohesive soils must therefore be determined over a period of time with groundwater observation wells.

It must be recognized that the water table may fluctuate seasonally and during periods of heavy precipitation. Depending on the subsurface conditions, water may also become perched above the water table, especially during wet periods.

Borehole Backfilling Procedures

Each borehole was backfilled upon completion of the field operations. If potential contamination was encountered, and/or if required by state or local regulations, boreholes were backfilled with an “impervious” material (such as bentonite slurry). Borings that penetrated pavements, sidewalks, etc. were “capped” with Portland Cement concrete, asphaltic concrete, or a similar surface material. It must, however, be recognized that the backfill material may settle, and the surface cap may subside, over a period of time. Further backfilling and/or re-surfacing by *Giles’* client or the property owner may be required.

FIELD SAMPLING AND TESTING PROCEDURES

Auger Sampling (AU)

Soil samples are removed from the auger flights as an auger is withdrawn above the ground surface. Such samples are used to determine general soil types and identify approximate soil stratifications. Auger samples are highly disturbed and are therefore not typically used for geotechnical strength testing.

Split-Barrel Sampling (SS) – (ASTM D-1586)

A split-barrel sampler with a 2-inch outside diameter is driven into the subsoil with a 140-pound hammer free-falling a vertical distance of 30 inches. The summation of hammer-blows required to drive the sampler the final 12-inches of an 18-inch sample interval is defined as the “Standard Penetration Resistance” or N-value is an index of the relative density of granular soils and the comparative consistency of cohesive soils. A soil sample is collected from each SPT interval.

Shelby Tube Sampling (ST) – (ASTM D-1587)

A relatively undisturbed soil sample is collected by hydraulically advancing a thin-walled Shelby Tube sampler into a soil mass. Shelby Tubes have a sharp cutting edge and are commonly 2 to 5 inches in diameter.

Bulk Sample (BS)

A relatively large volume of soils is collected with a shovel or other manually-operated tool. The sample is typically transported to *Giles’* materials laboratory in a sealed bag or bucket.

Dynamic Cone Penetration Test (DC) – (ASTM STP 399)

This test is conducted by driving a 1.5-inch-diameter cone into the subsoil using a 15-pound steel ring (hammer), free-falling a vertical distance of 20 inches. The number of hammer-blows required to drive the cone 1¾ inches is an indication of the soil strength and density, and is defined as “N”. The Dynamic Cone Penetration test is commonly conducted in hand auger borings, test pits and within excavated trenches.

- Continued -

Ring-Lined Barrel Sampling – (ASTM D 3550)

In this procedure, a ring-lined barrel sampler is used to collect soil samples for classification and laboratory testing. This method provides samples that fit directly into laboratory test instruments without additional handling/disturbance.

Sampling and Testing Procedures

The field testing and sampling operations were conducted in general accordance with the procedures recommended by the American Society for Testing and Materials (ASTM) and/or other relevant specifications. Results of the field testing (i.e. N-values) are reported on the Test Boring Logs. Explanations of the terms and symbols shown on the logs are provided on the appendix enclosure entitled “General Notes”.

APPENDIX C

LABORATORY TESTING AND CLASSIFICATION

The laboratory testing was conducted under the supervision of a geotechnical engineer in accordance with the procedures recommended by the American Society for Testing and Materials (ASTM) and/or other relevant specifications. Brief descriptions of laboratory tests commonly performed by *Giles* are provided herein.

LABORATORY TESTING AND CLASSIFICATION

Photoionization Detector (PID)

In this procedure, soil samples are “scanned” in *Giles’* analytical laboratory using a Photoionization Detector (PID). The instrument is equipped with an 11.7 eV lamp calibrated to a Benzene Standard and is capable of detecting a minute concentration of **certain** Volatile Organic Compound (VOC) vapors, such as those commonly associated with petroleum products and some solvents. Results of the PID analysis are expressed in HNu (manufacturer’s) units rather than actual concentration.

Moisture Content (w) (ASTM D 2216)

Moisture content is defined as the ratio of the weight of water contained within a soil sample to the weight of the dry solids within the sample. Moisture content is expressed as a percentage.

Unconfined Compressive Strength (qu) (ASTM D 2166)

An axial load is applied at a uniform rate to a cylindrical soil sample. The unconfined compressive strength is the maximum stress obtained or the stress when 15% axial strain is reached, whichever occurs first.

Calibrated Penetrometer Resistance (qp)

The small, cylindrical tip of a hand-held penetrometer is pressed into a soil sample to a prescribed depth to measure the soils capacity to resist penetration. This test is used to evaluate unconfined compressive strength.

Vane-Shear Strength (qs)

The blades of a vane are inserted into the flat surface of a soil sample and the vane is rotated until failure occurs. The maximum shear resistance measured immediately prior to failure is taken as the vane-shear strength.

Loss-on-Ignition (ASTM D 2974; Method C)

The Loss-on-Ignition (L.O.I.) test is used to determine the organic content of a soil sample. The procedure is conducted by heating a dry soil sample to 440°C in order to burn-off or “ash” organic matter present within the sample. The L.O.I. value is the ratio of the weight loss due to ignition compared to the initial weight of the dry sample. L.O.I. is expressed as a percentage.

Particle Size Distribution (ASTB D 421, D 422, and D 1140)

This test is performed to determine the distribution of specific particle sizes (diameters) within a soil sample. The distribution of coarse-grained soil particles (sand and gravel) is determined from a “sieve analysis,” which is conducted by passing the sample through a series of nested sieves. The distribution of fine-grained soil particles (silt and clay) is determined from a “hydrometer analysis” which is based on the sedimentation of particles suspended in water.

Consolidation Test (ASTM D 2435)

In this procedure, a series of cumulative vertical loads are applied to a small, laterally confined soil sample. During each load increment, vertical compression (consolidation) of the sample is measured over a period of time. Results of this test are used to estimate settlement and time rate of settlement.

Classification of Samples

Each soil sample was visually-manually classified, based on texture and plasticity, in general accordance with the Unified Soil Classification System (ASTM D-2488-75). The classifications are reported on the Test Boring Logs.

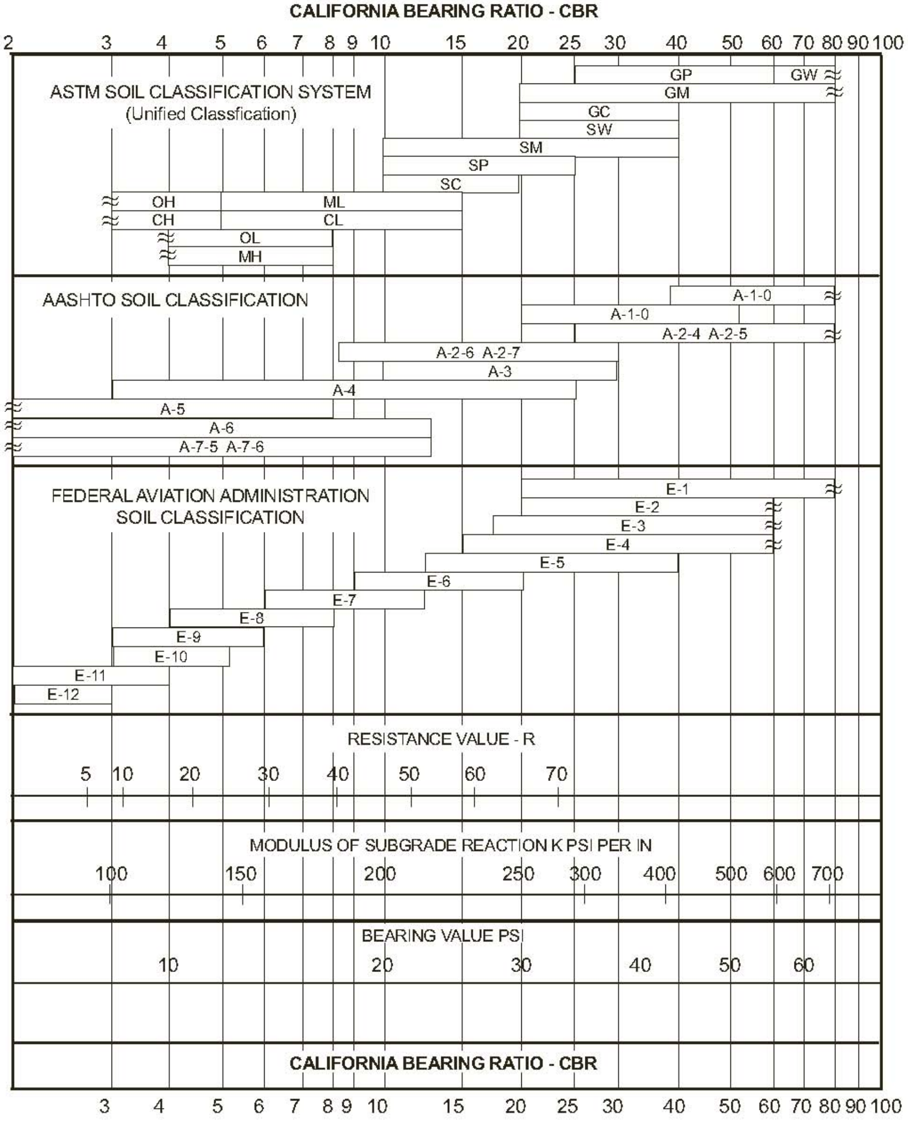
Laboratory Testing

The laboratory testing operations were conducted in general accordance with the procedures recommended by the American Society for Testing and Materials (ASTM) and/or other relevant specifications. Results of the laboratory tests are provided on the Test Boring Logs or other appendix enclosures. Explanation of the terms and symbols used on the logs is provided on the appendix enclosure entitled “General Notes.”

California Bearing Ratio (CBR) Test ASTM D-1833

The CBR test is used for evaluation of a soil subgrade for pavement design. The test consists of measuring the force required for a 3-square-inch cylindrical piston to penetrate 0.1 or 0.2 inch into a compacted soil sample. The result is expressed as a percent of force required to penetrate a standard compacted crushed stone.

Unless a CBR test has been specifically requested by the client, the CBR is estimated from published charts, based on soil classification and strength characteristics. A typical correlation chart is below.



APPENDIX D

GENERAL INFORMATION

AND
IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL REPORT

GENERAL COMMENTS

The soil samples obtained during the subsurface exploration will be retained for a period of thirty days. If no instructions are received, they will be disposed of at that time.

This report has been prepared exclusively for the client in order to aid in the evaluation of this property and to assist the architects and engineers in the design and preparation of the project plans and specifications. Copies of this report may be provided to contractor(s), with contract documents, to disclose information relative to this project. The report, however, has not been prepared to serve as the plans and specifications for actual construction without the appropriate interpretation by the project architect, structural engineer, and/or civil engineer. Reproduction and distribution of this report must be authorized by the client and *Giles*.

This report has been based on assumed conditions/characteristics of the proposed development where specific information was not available. It is recommended that the architect, civil engineer and structural engineer along with any other design professionals involved in this project carefully review these assumptions to ensure they are consistent with the actual planned development. When discrepancies exist, they should be brought to our attention to ensure they do not affect the conclusions and recommendations provided herein. The project plans and specifications may also be submitted to *Giles* for review to ensure that the geotechnical related conclusions and recommendations provided herein have been correctly interpreted.

The analysis of this site was based on a subsoil profile interpolated from a limited subsurface exploration. If the actual conditions encountered during construction vary from those indicated by the borings, *Giles* must be contacted immediately to determine if the conditions alter the recommendations contained herein.

The conclusions and recommendations presented in this report have been promulgated in accordance with generally accepted professional engineering practices in the field of geotechnical engineering. No other warranty is either expressed or implied.

GUIDE SPECIFICATIONS FOR SUBGRADE AND GRADE PREPARATION FOR FILL, FOUNDATION, FLOOR SLAB AND PAVEMENT SUPPORT; AND SELECTION, PLACEMENT AND COMPACTION OF FILL SOILS USING STANDARD PROCTOR PROCEDURES

1. Construction monitoring and testing of subgrades and grades for fill, foundation, floor slab and pavement; and fill selection, placement and compaction shall be performed by an experienced soils engineer and/or his representatives.

2. All compaction fill, subgrades and grades shall be (a) underlain by suitable bearing material; (b) free of all organic, frozen, or other deleterious material, and (c) observed, tested and approved by qualified engineering personnel representing an experienced soils engineer. Preparation of subgrades after stripping vegetation, organic or other unsuitable materials shall consist of (a) proof-rolling to detect soil, wet yielding soils or other unstable materials that must be undercut, (b) scarifying top 6 to 8 inches, (c) moisture conditioning the soils as required, and (d) recompaction to same minimum in-situ density required for similar materials indicated under Item 5. Note: compaction requirements for pavement subgrade are higher than other areas. Weather and construction equipment may damage compacted fill surface and reworking and retesting may be necessary to assure proper performance.

3. In overexcavation and fill areas, the compacted fill must extend (a) a minimum 1 foot lateral distance beyond the exterior edge of the foundation at bearing grade or pavement subgrade and down to compacted fill subgrade on a maximum 0.5(H):1(V) slope, (b) 1 foot above footing grade outside the building, and (c) to floor subgrade inside the building. Fill shall be placed and compacted on a 5(H):1(V) slope or must be stepped or benched as required to flatten if not specifically approved by qualified personnel under the direction of an experienced soil engineer.

4. The compacted fill materials shall be free of deleterious, organic, or frozen matter, shall contain no chemicals that may result in the material being classified as “contaminated”, and shall be low-expansive with a maximum Liquid Limit (ASTM D-423) and Plasticity Index (ASTM D-424) of 30 and 15, respectively, unless specifically tested and found to have low expansive properties and approved by an experienced soils engineer. The top 12 inches of compacted fill should have a maximum 3-inch-particle diameter and all underlying compacted fill a maximum 6-inch-diameter unless specifically approved by an experienced soils engineer. All fill materials must be tested and approved under the direction of an experienced soils engineer prior to placement. If the fill is to provide non-frost susceptible characteristics, it must be classified as a clean GW, GP, SW or SP per the Unified Soil Classification System (ASTM D-2487).

5. For structural fill depths less than 20 feet, the density of the structural compacted fill and scarified subgrade and grades shall not be less than 95 percent of the maximum dry density as determined by Standard Proctor (ASTM-698) with the exception of the top 12 inches of pavement subgrade which shall have a minimum in-situ density of 100 percent of maximum dry density, or 5 percent higher than underlying fill materials. Where the structural fill depth is greater than 20 feet, the portions below 20 feet should have a minimum in-place density of 100 percent of its maximum dry density of 5 percent greater than the top 20 feet. The moisture content of cohesive soil shall not vary by more than -1 to +3 percent and granular soil ±3 percent of the optimum when placed and compacted or recompacted, unless specifically recommended/approved by the soils engineer monitoring the placement and compaction. Cohesive soils with moderate to high expansion potentials (PI>15) should, however, be placed, compacted and maintained prior to construction at a moisture content 3±1 percent above optimum moisture content to limit further heave. The fill shall be placed in layers with a maximum loose thickness of 8 inches for foundations and 10 inches for floor slabs and pavement, unless specifically approved by the soils engineer taking into consideration the type of materials and compaction equipment being used. The compaction equipment should consist of suitable mechanical equipment specifically designed for soil compaction. Bulldozers or similar tracked vehicles are typically not suitable for compaction.

6. Excavation, filling, subgrade and grade preparation shall be performed in a manner and sequence that will provide drainage at all times and proper control of erosion. Precipitation, springs and seepage water encountered shall be pumped or drained to provide a suitable working platform. Springs or water seepage encountered during grading/foundation construction must be called to the soil engineer’s attention immediately for possible construction procedure revision or inclusion of an underdrain system.

7. Non-structural fill adjacent to structural fill should typically be placed in unison to provide lateral support. Backfill along walls must be placed and compacted with care to ensure excessive unbalanced lateral pressures do not develop. The type of fill material placed adjacent to below-grade walls (i.e. basement walls and retaining walls) must be properly tested and approved by an experienced soils engineer with consideration for the lateral pressure used in the wall design.

8. Whenever, in the opinion of the soils engineer or the Owner’s Representatives, an unstable condition is being created either by cutting or filling, the work shall not proceed into that area until an appropriate geotechnical exploration and analysis has been performed and the grading plan revised, if found necessary.

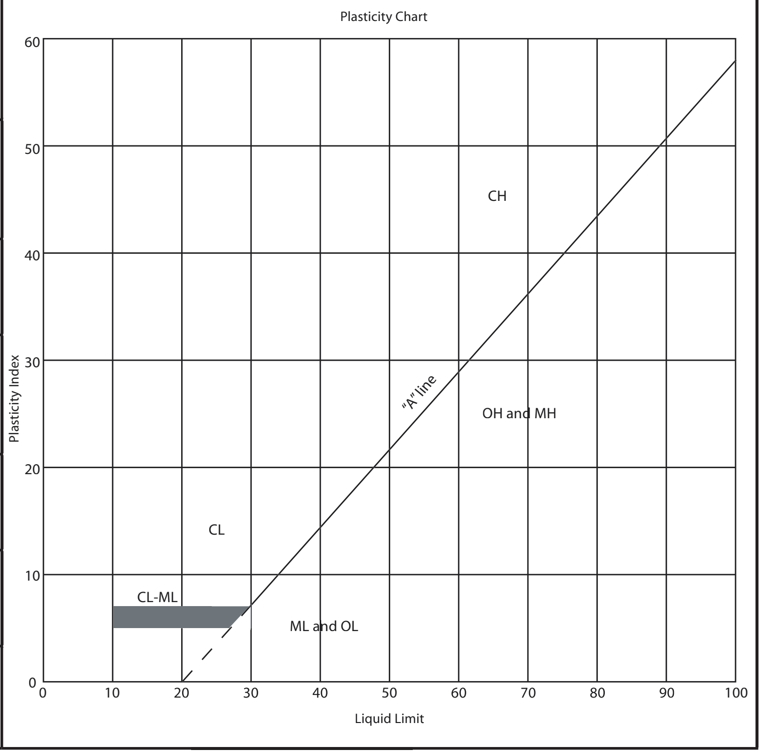
CHARACTERISTICS AND RATINGS OF UNIFIED SOIL SYSTEM CLASSES FOR SOIL CONSTRUCTION *

Class	Compaction Characteristics	Max. Dry Density Standard Proctor (pcf)	Compressibility and Expansion	Drainage and Permeability	Value as an Embankment Material	Value as Subgrade When Not Subject to Frost	Value as Base Course	Value as Temporary Pavement	
								With Dust Palliative	With Bituminous Treatment
GW	Good: tractor, rubber-tired, steel wheel or vibratory roller	125-135	Almost none	Good drainage, pervious	Very stable	Excellent	Good	Fair to poor	Excellent
GP	Good: tractor, rubber-tired, steel wheel or vibratory roller	115-125	Almost none	Good drainage, pervious	Reasonably stable	Excellent to good	Poor to fair	Poor	
GM	Good: rubber-tired or light sheepsfoot roller	120-135	Slight	Poor drainage, semipervious	Reasonably stable	Excellent to good	Fair to poor	Poor	Poor to fair
GC	Good to fair: rubber-tired or sheepsfoot roller	115-130	Slight	Poor drainage, impervious	Reasonably stable	Good	Good to fair **	Excellent	Excellent
SW	Good: tractor, rubber-tired or vibratory roller	110-130	Almost none	Good drainage, pervious	Very stable	Good	Fair to poor	Fair to poor	Good
SP	Good: tractor, rubber-tired or vibratory roller	100-120	Almost none	Good drainage, pervious	Reasonably stable when dense	Good to fair	Poor	Poor	Poor to fair
SM	Good: rubber-tired or sheepsfoot roller	110-125	Slight	Poor drainage, impervious	Reasonably stable when dense	Good to fair	Poor	Poor	Poor to fair
SC	Good to fair: rubber-tired or sheepsfoot roller	105-125	Slight to medium	Poor drainage, impervious	Reasonably stable	Good to fair	Fair to poor	Excellent	Excellent
ML	Good to poor: rubber-tired or sheepsfoot roller	95-120	Slight to medium	Poor drainage, impervious	Poor stability, high density required	Fair to poor	Not suitable	Poor	Poor
CL	Good to fair: sheepsfoot or rubber-tired roller	95-120	Medium	No drainage, impervious	Good stability	Fair to poor	Not suitable	Poor	Poor
OL	Fair to poor: sheepsfoot or rubber-tired roller	80-100	Medium to high	Poor drainage, impervious	Unstable, should not be used	Poor	Not suitable	Not suitable	Not suitable
MH	Fair to poor: sheepsfoot or rubber-tired roller	70-95	High	Poor drainage, impervious	Poor stability, should not be used	Poor	Not suitable	Very poor	Not suitable
CH	Fair to poor: sheepsfoot roller	80-105	Very high	No drainage, impervious	Fair stability, may soften on expansion	Poor to very poor	Not suitable	Very poor	Not suitable
OH	Fair to poor: sheepsfoot roller	65-100	High	No drainage, impervious	Unstable, should not be used	Very poor	Not suitable	Not suitable	Not suitable
Pt	Not suitable		Very high	Fair to poor drainage	Should not be used	Not suitable	Not suitable	Not suitable	Not suitable

* "The Unified Classification: Appendix A - Characteristics of Soil, Groups Pertaining to Roads and Airfields, and Appendix B - Characteristics of Soil Groups Pertaining to Embankments and Foundations," Technical Memorandum 357, U.S. Waterways Ixperiment Station, Vicksburg, 1953.

** Not suitable if subject to frost.

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D-2487)

<table>
<tr><th colspan="3"><i>Major Divisions</i></th><th colspan="2"><i>Group Symbols</i></th><th><i>Typical Names</i></th><th colspan="3"><i>Laboratory Classification Criteria</i></th></tr>
<tr><td rowspan="10">Coarse-grained soils (more than half of material is larger than No. 200 sieve size)</td><td rowspan="5">Gravels (More than half of coarse fraction is larger than No. 4 sieve size)</td><td rowspan="2">Clean gravels (little or no fines)</td><td colspan="2">GW</td><td>Well-graded gravels, gravel-sand mixtures, little or no fines</td><td rowspan="10">Determine percentages of sand and gravel from grain-size curve.
Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:
Less than 5 percent: GW, GP, SW, SP
More than 12 percent: GM, GC, SM, SC
5 to 12 percent: <i>Borderline</i> cases requiring dual symbols[b]</td><td colspan="2">$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3</td></tr>
<tr><td colspan="2">GP</td><td>Poorly graded gravels, gravel-sand mixtrues, little or no fines</td><td colspan="2">Not meeting all gradation requirements for GW</td></tr>
<tr><td rowspan="3">Gravels with fines (appreciable amount of fines)</td><td rowspan="2">GM[a]</td><td>d</td><td rowspan="2">Silty gravels, gravel-sand-silt mixtures</td><td rowspan="2">Atterberg limits below "A" line or P.I. less than 4</td><td rowspan="3">Limits plotting within shaded area, above "A" line with P.I. between 4 and 7 are <i>borderline</i> cases requiring use of dual symbols</td></tr>
<tr><td>u</td></tr>
<tr><td colspan="2">GC</td><td>Clayey gravels, gravel-sand-clay mixtures</td><td>Atterberg limits above "A" line or P.I. greater than 7</td></tr>
<tr><td rowspan="5">Sands (More than half of coarse fraction is smaller than No. 4 sieve size)</td><td rowspan="2">Clean sands (Little or no fines)</td><td colspan="2">SW</td><td>Well-graded sands, gravelly sands, little or no fines</td><td colspan="2">$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3</td></tr>
<tr><td colspan="2">SP</td><td>Poorly graded sands, gravelly sands, little or no fines</td><td colspan="2">Not meeting all gradation requirements for SW</td></tr>
<tr><td rowspan="3">Sands with fines (Appreciable amount of fines)</td><td rowspan="2">SM[a]</td><td>d</td><td rowspan="2">Silty sands, sand-silt mixtures</td><td rowspan="2">Atterberg limits below "A" line or P.I. less than 4</td><td rowspan="3">Limits plotting within shaded area, above "A" line with P.I. between 4 and 7 are <i>borderline</i> cases requiring use of dual symbols</td></tr>
<tr><td>u</td></tr>
<tr><td colspan="2">SC</td><td>Clayey sands, sand-clay mixtures</td><td>Atterberg limits above "A" line or P.I. greater than 7</td></tr>
<tr><td rowspan="7">Fine-grained soils (More than half material is smaller than No. 200 sieve size)</td><td colspan="2" rowspan="3">Silts and clays (Liquid limit less than 50)</td><td colspan="2">ML</td><td>Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity</td><td colspan="3" rowspan="7">
</td></tr>
<tr><td colspan="2">CL</td><td>Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays</td></tr>
<tr><td colspan="2">OL</td><td>Organic silts and organic silty clays of low plasticity</td></tr>
<tr><td colspan="2" rowspan="3">Silts and clays (Liquid limit greater than 50)</td><td colspan="2">MH</td><td>Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts</td></tr>
<tr><td colspan="2">CH</td><td>Inorganic clays of high plasticity, fat clays</td></tr>
<tr><td colspan="2">OH</td><td>Organic clays of medium to high plasticity, organic silts</td></tr>
<tr><td colspan="2">Highly organic soils</td><td colspan="2">Pt</td><td>Peat and other highly organic soils</td></tr>
</table>

[a] Division of GM and SM groups into subdivisions of d and u are for roads and airfields only. Subdivision is based on Atterberg limits, suffix d used when L.L. is 28 or less and the P.I. is 6 or less; the suffix u is used when L.L. is greater than 28.

[b] Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group sympols. For example GW-GC, well-graded gravel-sand mixture with clay binder.

GENERAL NOTES

SAMPLE IDENTIFICATION

All samples are visually classified in general accordance with the Unified Soil Classification System (ASTM D-2487-75 or D-2488-75)

DESCRIPTIVE TERM (% BY DRY WEIGHT)

Trace: 1-10%
Little: 11-20%
Some: 21-35%
And/Adjective 36-50%

PARTICLE SIZE (DIAMETER)

Boulders: 8 inch and larger
Cobbles: 3 inch to 8 inch
Gravel: coarse - ¾ to 3 inch
fine – No. 4 (4.76 mm) to ¾ inch
Sand: coarse – No. 4 (4.76 mm) to No. 10 (2.0 mm)
medium – No. 10 (2.0 mm) to No. 40 (0.42 mm)
fine – No. 40 (0.42 mm) to No. 200 (0.074 mm)
Silt: No. 200 (0.074 mm) and smaller (non-plastic)
Clay: No 200 (0.074 mm) and smaller (plastic)

SOIL PROPERTY SYMBOLS

Dd: Dry Density (pcf)
LL: Liquid Limit, percent
PL: Plastic Limit, percent
PI: Plasticity Index (LL-PL)
LOI: Loss on Ignition, percent
Gs: Specific Gravity
K: Coefficient of Permeability
w: Moisture content, percent
qp: Calibrated Penetrometer Resistance, tsf
qs: Vane-Shear Strength, tsf
qu: Unconfined Compressive Strength, tsf
qc: Static Cone Penetrometer Resistance (correlated to Unconfined Compressive Strength, tsf)
PID: Results of vapor analysis conducted on representative samples utilizing a Photoionization Detector calibrated to a benzene standard. Results expressed in HNU-Units. (BDL=Below Detection Limit)
N: Penetration Resistance per 12 inch interval, or fraction thereof, for a standard 2 inch O.D. (1⅜ inch I.D.) split spoon sampler driven with a 140 pound weight free-falling 30 inches. Performed in general accordance with Standard Penetration Test Specifications (ASTM D-1586). N in blows per foot equals sum of N-Values where plus sign (+) is shown.
Nc: Penetration Resistance per 1¾ inches of Dynamic Cone Penetrometer. Approximately equivalent to Standard Penetration Test N-Value in blows per foot.
Nr: Penetration Resistance per 12 inch interval, or fraction thereof, for California Ring Sampler driven with a 140 pound weight free-falling 30 inches per ASTM D-3550. Not equivalent to Standard Penetration Test N-Value.

DRILLING AND SAMPLING SYMBOLS

SS: Split-Spoon
ST: Shelby Tube – 3 inch O.D. (except where noted)
CS: 3 inch O.D. California Ring Sampler
DC: Dynamic Cone Penetrometer per ASTM Special Technical Publication No. 399
AU: Auger Sample
DB: Diamond Bit
CB: Carbide Bit
WS: Wash Sample
RB: Rock-Roller Bit
BS: Bulk Sample
Note: Depth intervals for sampling shown on Record of Subsurface Exploration are not indicative of sample recovery, but position where sampling initiated

SOIL STRENGTH CHARACTERISTICS

COHESIVE (CLAYEY) SOILS

COMPARATIVE CONSISTENCY	**BLOWS PER FOOT (N)**	**UNCONFINED COMPRESSIVE STRENGTH (TSF)**
Very Soft	0 - 2	0 - 0.25
Soft	3 - 4	0.25 - 0.50
Medium Stiff	5 – 8	0.50 - 1.00
Stiff	9 – 15	1.00 - 2.00
Very Stiff	16 – 30	2.00 - 4.00
Hard	31+	4.00+

NON-COHESIVE (GRANULAR) SOILS

RELATIVE DENSITY	**BLOWS PER FOOT (N)**
Very Loose	0 - 4
Loose	5 - 10
Firm	11 - 30
Dense	31 - 50
Very Dense	51+

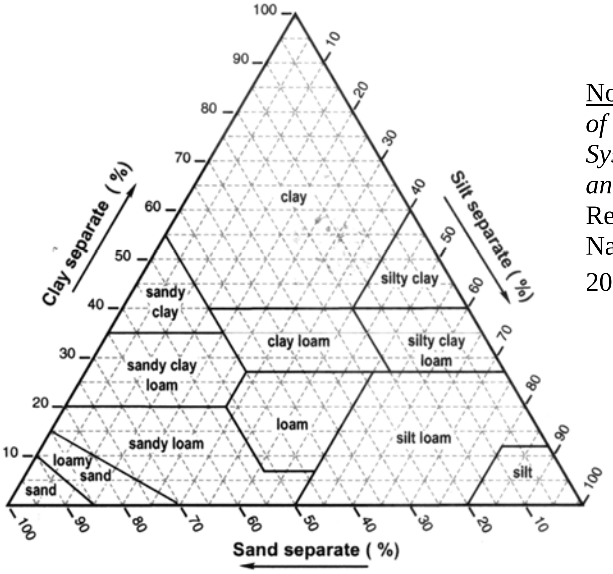
DEGREE OF PLASTICITY	**PI**
None to Slight	0 - 4
Slight	5 - 10
Medium	11 - 30
High to Very High	31+

DEGREE OF EXPANSIVE POTENTIAL	**PI**
Low	0 - 15
Medium	15 - 25
High	25+

SOIL CLASSIFICATION NOTES

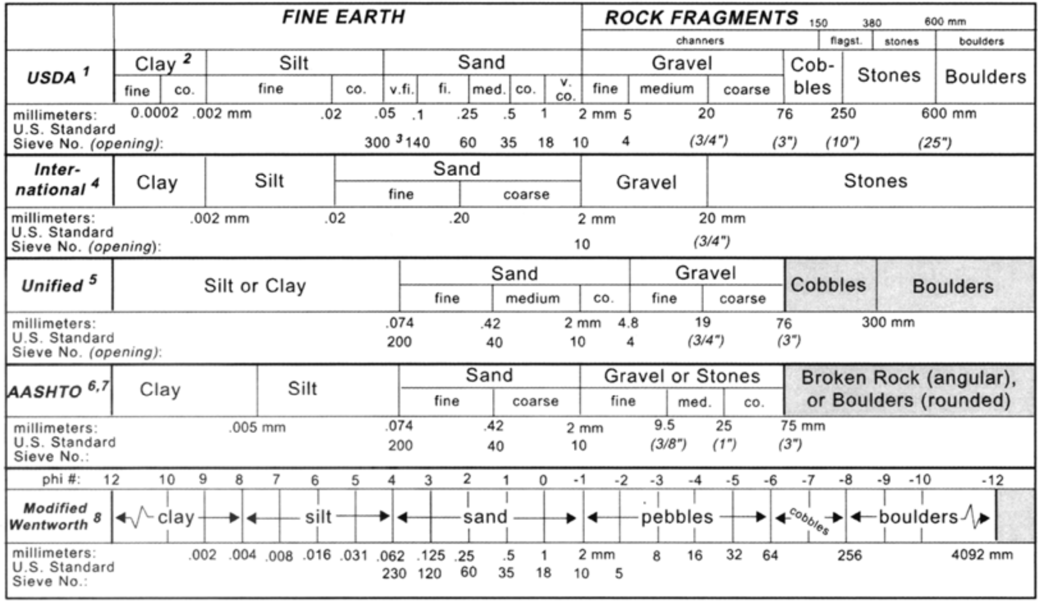
Texture Triangle:

Fine Earth Texture Classes (▬▬)



Note: *Texture Triangle* and *Comparison of Particle Size Classes in Different Systems* from *Field Book for Describing and Sampling Soil*, USDA Natural Resources Conservation Service National Soil Survey Center (September 2002).

Comparison of Particle Size Classes in Different Systems



FINE EARTH | ROCK FRAGMENTS 150 380 600 mm

channers | flagst. | stones | boulders

USDA 1: Clay 2 (fine, co.) | Silt (fine, co.) | Sand (v.fi., fi., med., co., v. co.) | Gravel (fine, medium, coarse) | Cob-bles | Stones | Boulders

millimeters: 0.0002 .002 mm .02 .05 .1 .25 .5 1 2 mm 5 20 76 250 600 mm

U.S. Standard Sieve No. *(opening)*: 300 3 140 60 35 18 10 4 *(3/4")* *(3")* *(10")* *(25")*

International 4: Clay | Silt | Sand (fine, coarse) | Gravel | Stones

millimeters: .002 mm .02 .20 2 mm 20 mm

U.S. Standard Sieve No. *(opening)*: 10 *(3/4")*

Unified 5: Silt or Clay | Sand (fine, medium, co.) | Gravel (fine, coarse) | Cobbles | Boulders

millimeters: .074 .42 2 mm 4.8 19 76 300 mm

U.S. Standard Sieve No. *(opening)*: 200 40 10 4 *(3/4")* *(3")*

AASHTO 6,7: Clay | Silt | Sand (fine, coarse) | Gravel or Stones (fine, med., co.) | Broken Rock (angular), or Boulders (rounded)

millimeters: .005 mm .074 .42 2 mm 9.5 25 75 mm

U.S. Standard Sieve No.: 200 40 10 *(3/8")* *(1")* *(3")*

phi #: 12 10 9 8 7 6 5 4 3 2 1 0 -1 -2 -3 -4 -5 -6 -7 -8 -9 -10 -12

Modified Wentworth 8: clay | silt | sand | pebbles | cobbles | boulders

millimeters: .002 .004 .008 .016 .031 .062 .125 .25 .5 1 2 mm 8 16 32 64 256 4092 mm

U.S. Standard Sieve No.: 230 120 60 35 18 10 5

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2. Soil Survey Staff. 1995. Soil Survey Lab information manual. USDA-NRCS, Soil Survey Investigation Report #45, version 1.0, National Soil Survey Center, Lincoln, NE. Note: Mineralogy studies may subdivide clay into three size ranges; fine (<0.08μm), medium (0.08-0.2μm), and coarse (0.2-2μm); Jackson, 1969.
3. The Soil Survey Lab (Lincoln, NE) uses a no. 300 sieve (0.047 mm opening) for the USDA-sand/silt measurement. A no. 270 sieve (0.053 mm opening) is more readily available and widely used.
4. International Soil Science Society. 1951. *In*: Soil Survey Manual. Soil Survey Staff, USDA-Soil Conservation Service, Agricultural Handbook No. 18, U.S. Gov. Print. Office, Washington, D.C. 214 p.
5. ASTM. 1993. Standard classification of soils for engineering purposes (Unified Soil Classification System). ASTM designation D2487-92. *In*: Soil and rock; dimension stone; geosynthetics. Annual book of ASTM standards-Vol. 04.08.
6. AASHTO. 1986a. Recommended practice for the classification of soils and soil-aggregate mixtures for highway construction purposes. AASHTO designation M145-82. *In*: Standard specifications for transportation materials and methods of sampling and testing; Part 1: Specifications (14th ed.). American Association of State Highway and Transportation Officials, Washington, D.C.
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8. Ingram, R.L. 1982. Modified Wentworth scale. *In*: Grain-size scales. AGI Date Sheet 29.1. *In*: Dutro, J.T., Dietrich, R.V., and Foose, R.M. 1989. AGI data sheets for geology in the field, laboratory, and office, 3rd edition. American Geological Institute, Washington, D.C.

GILES
ENGINEERING ASSOCIATES, INC.

Important Information About Your
Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

The following information is provided to help you manage your risks.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you ASFE-member geotechnical engineer for more information.

ASFE
The Best People on Earth

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