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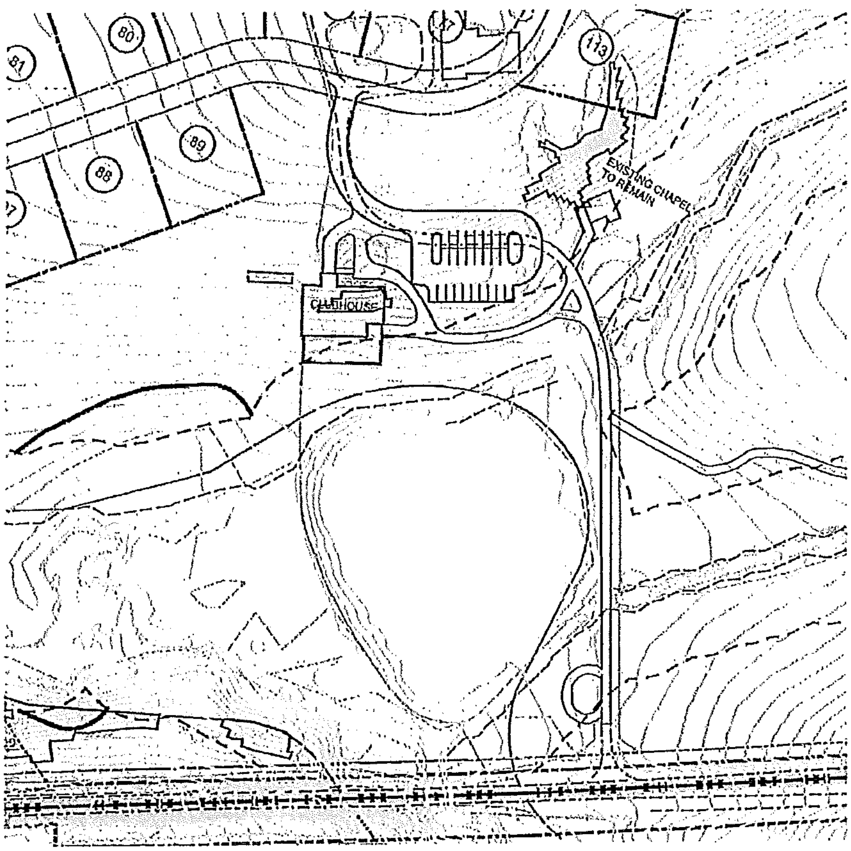
Land Planning
Engineering
Land Surveying

STORMWATER MANAGEMENT NARRATIVE

FOR

CREBILLY FARM



COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
JEFFREY M. MADDEN
ENGINEER
No. PE070760

Jeffrey M. Madden
Professional Engineer
Pennsylvania License No.
PE 070760

October 2016

LOCATED IN:

**WESTTOWN TOWNSHIP, CHESTER COUNTY,
STATE OF PENNSYLVANIA**

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Appendices

I

Site Information

Location and Surrounding Uses

The Crebilly Farm Property in Westtown Township, PA comprises a ± 322.4 acre tract also known as tax parcel numbers 67-4-30, 67-4-31, 67-4-32, 64-4-33, 67-4-33.1, 67-4-134, 67-4-29, 67-4-29.1, 67-4-29.2, 67-4-29.3, and 67-4-29.4. This property is located in the A/C Agricultural / Cluster District with a Flexible Development Option. The product mix is 210 single family, 117 single family attached (carriage homes), and 2 existing dwellings to remain. The development also proposes existing barns and buildings to remain and to be converted into community centers with –yet to be determined- outdoor recreational facilities, and common open space. It is located on the southern corners of West Pleasant Grove Road and Wilmington Pike (S.R. 202), and bounded on the south west by South New Street, and Street Road (S.R. 926) on the south west. The project is located in the Brandywine Creek (WWF, MF, western part) and the Darby-Crum Creeks (TSF, MF, easterly part) watersheds.

Existing Conditions

The site is generally gently sloped with some steeper areas towards the on-site Radley Run and the Tributary 00074 to Radley Run. A small section of the site drains towards an unnamed tributary of the Chester Creek across S.R. 202. The site is currently used for crop farming and includes an equestrian facility with stables, barns, and a chapel. The site also includes two existing residence with ancillary buildings that will remain. Existing site cover consists of Cultivated Land, and impervious areas including existing house, ancillary structures, the equestrian buildings and portions of the surrounding roads as described above..

Soil Types

The soils information for the project is found in the USDA-NRCS Custom Soil Resource Report for Chester County, Pennsylvania. A copy of the Custom Soil Resource Report is included as appendix 1. The following soil types are found on the site:

Soil Type	Symbol	Soil Group
Baile Silt Loam	Ba	D
Chester Silt Loam, 3 to 8 percent slopes	CdB	B
Chrome Silt Loam, 3 to 8 percent slopes	ChB	D
Chrome Silt Loam, 8 to 15 percent slopes	ChC	D
Chrome Silt Loam, 15 to 25 percent slopes	ChD	D
Codorus Silt Loam	Co	C
Gaila Silt Loam, 15 to 25 percent slopes	GaD	B
Gladstone Gravelly Loam, 3 to 8 percent slopes	GdB	B
Gladstone Gravelly Loam, 8 to 15 percent slopes	GdC	A
Gladstone Gravelly Loam, 15 to 25 percent slopes	GdB	A
Glenelg Silt Loam, 3 to 8 percent slopes	GgB	C
Glenelg Silt Loam, 8 to 15 percent slopes	GgC	B
Glenville Silt Loam, 3 to 8 percent slopes	GlB	D
Glenville Silt Loam, 8 to 15 percent slopes	GlC	D
Hatboro Silt Loam	Ha	D
Water	W	

II

Hydrology

Stormwater Management Design Criteria

The Stormwater Management Plan described herein has been designed according to the following publications and criteria:

- Chapter 144, Stormwater Management of the Township of Westtown Ordinance, adopted by the BOS 12-16-2013 by Ord. No 2013-5, with amendments as noted where applicable. Chapter 149, Subdivision of Land of the Township of Westtown Ordinance, adopted by the BOS 8-21-1995, with amendments as noted where applicable. Any and all ordinance chapters of the Township of Westtown where applicable.
- Pennsylvania Stormwater Best Management Practices Manual – Final Draft -April 2006
- "Urban Hydrology for Small Watersheds" (Technical Release No. 55), published by the United States Department of Agriculture, Soil Conservation Service, dated June 1986.

Site Hydrology

The site is currently being farmed for crops, and contains an equestrian facility. The site is traversed by the Radley Run flowing west. The majority of the site (POI A, POI B, and POI D) drains towards the Brandywine Creek watershed and has a Chapter 93 classification of WWF, MF. A smaller portion (POI C) of the site drains across S.R. 202 to a tributary (00615) to Chester Creek within the Darby-Crum Creek watershed and has a Chapter 93 classification of TSF, MF.

Drainage Areas

The site has been analyzed using 4 main study points, POI A, POI B, POI D (Brandywine Creek watershed), and POI C (Darby-Crum Creek watershed). There is no offsite area analyzed because it flows through the existing creek and bypasses the area used for the development. The portion of the site located along West Street Road, south of the Bradley Creek area is not being developed and has therefore not been included in the overall Stormwater Management Analysis.

Per Chapter 144 of the ordinance, the reductions shown in the table below have been applied to the overall site.

Predevelopment Design Storm	Post-Construction Design Storm (new Development)
2-year	1-year
5-year	5-year
10-year	10-year
25-year	25-year
50-year	50-year
100-year	100-year

The *'Crebilly Farm – Watershed Summaries'* table, included in the appendix section, summarizes the peak runoff rates and reductions for each point of interest and each separate watershed. As demonstrated in the table, the post-developed peak rate has been reduced per the above table for each study point and each watershed.

Because this is a cluster-style design, where a large area of the site is to remain as open space (min. 60%) the areas within the drainage areas that are located outside of the Limit-Of-Disturbance (LOD) are not included in the area to be reduced. The *'Allowable Post Developed Flows – SCS'* located in the appendix section, shows how the weighted allowable has been calculated.

Preliminary Infiltration Testing

Preliminary infiltration testing has been performed in the general locations of the basin. For the purpose of this preliminary analysis, a minimum 0.5"/hr infiltration rate has been used, which is generally consistent with the test-results. The test results are included in the appendix section.

Additional impervious surface

To allow for additional impervious on-lot surfaces that might be requested by future home owners, additional impervious is proposed on top of the base footprints. Below is the list of impervious used for each dwelling type for this preliminary analysis:

Estate Lots:
Minimum lot size is 115'x125' = 14,375 sf
Impervious proposed per lot = 2,400 sf base house, 1,350 sf options, 1,200 sf driveway, 170 sf service walk, 630 sf additional impervious for a total of 5,750 sf, or 40% of the lot size.

Executive lots:
Minimum lot size is 90'x125' = 11,250 sf
Impervious proposed per lot = 2,400 sf base house, 800 sf options, 530 sf driveway, 80 sf service walk, 690 sf additional impervious for a total of 4,500 sf, or 40% of the lot size.

Carriage Homes:
Assumed lot size is 30'x110' = 3,300 sf
Impervious proposed per unit = 2,200 sf base house, 500 sf driveway, 100 sf service walk, 500 sf additional impervious for a total of 3,300 sf.

Water Quality Management

Infiltration is provided in all proposed basins. Per section 144-305.A of the Stormwater Management Ordinance, "the post-construction total runoff volume shall not exceed the predevelopment total runoff volume for all storms equal to or less than the two-year, twenty-four-hour duration precipitation (design storm)."
The watershed volume summary can be found in the appendix section. The volumes have been taken from the Hydrograph Summary reports, also located in the appendix section of this report.

Thermal Effects

Thermal effects will be taken into consideration during the design. In order to eliminate raising temperatures, the following (not limited to) will proposed:

- Rooftop disconnection. The rainfall falling on the roofs is dispersed through the gutter system onto the lawn areas, where it will be cooled by the soil and grass cover before it enters the subsoil storm system.

- Subsoil storm sewer system. Water coming from lawn areas and paved road/parking areas is diverted into the subsoil storm sewer where it will be cooled by the pipe system before it enters the pond areas.
- Plantings along the pond perimeter will provide shading to help keep the water cool.

III

Closed Conveyance System

Design Criteria

All closed conveyances will be designed according to Section 144-311 of the Westtown Township Stormwater Management Ordinance.

Storm pipes are required to be designed for a 25-year-return frequency storm. No pipes were designed under pressure flow. Closed conveyances are limited to a minimum 0.5% longitudinal slope to promote adequate flow velocities within the system, which are required by code to be a minimum of three (3) feet per second, and a maximum of eleven (11) feet per second. Storm sewer will be reinforced concrete (RCP) and will be in accordance with the requirements of PennDOT Pub 408 and PennDOT Pub 72, latest editions. The minimum diameter will be fifteen inches (15"). Storm sewer cover will be a minimum of 24". A minimum one foot of freeboard between the HGL of the design storm and the ground elevation will be provided throughout all proposed storm sewer conveyance systems.

IV

Open Conveyance System

Design Criteria and Methodology

Wherever possible, overland runoff will be directed to the discharge points via open channels or swales.

All swales will be lined with NA-Green S75 or C125 lining where required (or equal after township engineer approval).

Summary Report

1

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	50.81	1	729	264,091	------	------	------	Pre Developed Area A1
2	SCS Runoff	21.45	1	725	80,035	------	------	------	Pre Developed Area A2
3	Combine	70.42	1	728	344,125	1, 2	------	------	Pre Developed Area A (A1 + A2)
4	SCS Runoff	1.234	1	727	8,773	------	------	------	Pre Developed Area B1
5	SCS Runoff	1.181	1	726	6,387	------	------	------	Pre Developed Area B2
6	Combine	2.414	1	726	15,160	4, 5	------	------	Pre Developed Area B (B1 + B2)
7	SCS Runoff	4.020	1	722	13,617	------	------	------	Pre Developed Area C1
8	SCS Runoff	0.431	1	721	2,065	------	------	------	Pre Developed Area D1
10	SCS Runoff	24.73	1	725	77,784	------	------	------	Basin A1
11	Reservoir	0.309	1	1209	27,324	10	322.83	53,849	Route Basin A1
12	Reach	0.308	1	1330	27,283	11	------	------	Reach Basin A1
14	SCS Runoff	8.785	1	720	20,549	------	------	------	Basin A2
15	Reservoir	1.009	1	750	14,188	14	287.39	7,679	Route Basin A2
16	Reach	0.841	1	810	14,166	15	------	------	Reach Basin A2
18	SCS Runoff	9.681	1	718	19,451	------	------	------	Basin A4
19	Reservoir	3.597	1	724	18,899	18	330.30	5,132	Route Basin A4
20	Reach	2.396	1	749	18,876	19	------	------	Reach Basin A4
22	SCS Runoff	17.31	1	718	35,336	------	------	------	Basin A5
23	Reservoir	0.000	1	807	0	22	315.84	27,092	Route Basin A5
24	Reach	0.000	1	807	0	23	------	------	Reach Basin A5
26	SCS Runoff	42.18	1	720	98,047	------	------	------	Basin A6
27	Reservoir	0.271	1	1051	25,308	26	297.44	60,281	Route Basin A6
28	Reach	0.271	1	1081	25,172	27	------	------	Reach Basin A6
30	SCS Runoff	29.70	1	720	67,495	------	------	------	Basin A7
31	Reservoir	0.000	1	1396	0	30	263.36	53,551	Route Basin A7
32	Reach	0.000	1	1396	0	31	------	------	Reach Basin A7
34	SCS Runoff	14.13	1	720	33,564	------	------	------	Basin A8
35	Reservoir	0.000	1	738	0	34	273.32	22,057	Route Basin A8
36	Reach	0.000	1	722	0	35	------	------	Reach Basin A8
38	SCS Runoff	7.551	1	720	18,054	------	------	------	Basin A9

Hydrograph Summary Report

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
39	Reservoir	0.000	1	800	0	38	293.24	11,691	Route Basin A9
40	Reach	0.000	1	800	0	39	------	------	Reach Basin A9
42	SCS Runoff	12.94	1	720	30,267	------	------	------	Basin A10
43	Reservoir	0.227	1	910	5,031	42	300.23	17,052	Route Basin A10
44	Reach	0.213	1	953	5,007	43	------	------	Reach Basin A10
46	SCS Runoff	30.92	1	737	175,177	------	------	------	Bypass A11
48	SCS Runoff	1.894	1	727	7,934	------	------	------	Bypass A12
49	Reach	0.615	1	748	7,904	48	------	------	Reach Bypass A12
51	Combine	3.167	1	756	85,497	12, 16, 20, 24, 28, 32,	------	------	Post Developed A1 (1)
52	Combine	31.46	1	737	183,082	36, 46, 49,	------	------	Post Developed A1 (2)
54	Combine	34.08	1	737	268,578	51, 52,	------	------	POST DEVELOPED A1 - TOTAL
56	SCS Runoff	25.21	1	723	77,207	------	------	------	Bypass A13
58	Combine	0.213	1	953	5,007	40, 44,	------	------	Post Developed A2
60	Combine	25.21	1	723	82,214	56, 58,	------	------	POST DEVELOPED A2 - TOTAL
62	Combine	46.07	1	728	350,792	54, 60,	------	------	POST DEVELOPED A - TOTAL (A1
64	SCS Runoff	1.210	1	726	8,469	------	------	------	POST DEVELOPED B - Bypass B1
66	SCS Runoff	0.345	1	720	1,209	------	------	------	POST DEVELOPED B - Bypass B2
68	Combine	1.352	1	725	9,678	64, 66,	------	------	POST DEVELOPED B- TOTAL (B1 +
70	SCS Runoff	1.997	1	719	4,876	------	------	------	POST DEVELOPED C - Bypass C1
72	SCS Runoff	0.326	1	721	1,533	------	------	------	POST DEVELOPED D - Bypass D1

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	105.89	1	728	445,689	------	------	------	Pre Developed Area A1
2	SCS Runoff	39.52	1	724	129,157	------	------	------	Pre Developed Area A2
3	Combine	142.43	1	727	574,846	1, 2	------	------	Pre Developed Area A (A1 + A2)
4	SCS Runoff	3.886	1	725	16,711	------	------	------	Pre Developed Area B1
5	SCS Runoff	3.040	1	724	11,562	------	------	------	Pre Developed Area B2
6	Combine	6.924	1	725	28,274	4, 5	------	------	Pre Developed Area B (B1 + B2)
7	SCS Runoff	8.055	1	721	22,859	------	------	------	Pre Developed Area C1
8	SCS Runoff	1.397	1	719	3,994	------	------	------	Pre Developed Area D1
10	SCS Runoff	37.25	1	725	113,566	------	------	------	Basin A1
11	Reservoir	0.408	1	1342	43,712	10	324.10	83,226	Route Basin A1
12	Reach	0.407	1	1420	42,886	11	------	------	Reach Basin A1
14	SCS Runoff	13.25	1	720	30,270	------	------	------	Basin A2
15	Reservoir	1.525	1	748	23,419	14	288.45	12,184	Route Basin A2
16	Reach	1.277	1	816	23,400	15	------	------	Reach Basin A2
18	SCS Runoff	13.23	1	718	26,729	------	------	------	Basin A4
19	Reservoir	4.132	1	725	25,999	18	330.90	7,616	Route Basin A4
20	Reach	3.106	1	756	25,977	19	------	------	Reach Basin A4
22	SCS Runoff	25.63	1	718	51,592	------	------	------	Basin A5
23	Reservoir	0.000	1	1437	0	22	316.57	41,307	Route Basin A5
24	Reach	0.000	1	1437	0	23	------	------	Reach Basin A5
26	SCS Runoff	62.94	1	720	143,430	------	------	------	Basin A6
27	Reservoir	0.337	1	1047	32,699	26	298.15	91,134	Route Basin A6
28	Reach	0.336	1	1075	32,497	27	------	------	Reach Basin A6
30	SCS Runoff	42.03	1	720	95,093	------	------	------	Basin A7
31	Reservoir	0.000	1	769	0	30	263.91	75,152	Route Basin A7
32	Reach	0.000	1	769	0	31	------	------	Reach Basin A7
34	SCS Runoff	21.80	1	720	50,163	------	------	------	Basin A8
35	Reservoir	0.000	1	780	0	34	273.98	33,212	Route Basin A8
36	Reach	0.000	1	717	0	35	------	------	Reach Basin A8
38	SCS Runoff	11.76	1	720	27,127	------	------	------	Basin A9

Hydrograph Summary Report

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Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
39	Reservoir	0.000	1	804	0	38	293.87	17,712	Route Basin A9
40	Reach	0.000	1	804	0	39	------	------	Reach Basin A9
42	SCS Runoff	19.51	1	720	44,585	------	------	------	Basin A10
43	Reservoir	1.079	1	782	17,861	42	300.59	21,464	Route Basin A10
44	Reach	0.995	1	820	17,845	43	------	------	Reach Basin A10
46	SCS Runoff	53.92	1	736	273,611	------	------	------	Bypass A11
48	SCS Runoff	3.514	1	726	12,804	------	------	------	Bypass A12
49	Reach	1.285	1	744	12,779	48	------	------	Reach Bypass A12
51	Combine	4.501	1	762	124,760	12, 16, 20, 24, 28, 32,	------	------	Post Developed A1 (1)
52	Combine	55.09	1	736	286,390	36, 46, 49,	------	------	Post Developed A1 (2)
54	Combine	58.47	1	736	411,150	51, 52,	------	------	POST DEVELOPED A1 - TOTAL
56	SCS Runoff	41.47	1	723	118,677	------	------	------	Bypass A13
58	Combine	0.995	1	820	17,845	40, 44,	------	------	Post Developed A2
60	Combine	41.47	1	723	136,523	56, 58,	------	------	POST DEVELOPED A2 - TOTAL
62	Combine	79.51	1	727	547,673	54, 60,	------	------	POST DEVELOPED A - TOTAL (A1
64	SCS Runoff	3.767	1	725	16,087	------	------	------	POST DEVELOPED B - Bypass B1
66	SCS Runoff	0.869	1	719	2,211	------	------	------	POST DEVELOPED B - Bypass B2
68	Combine	4.165	1	724	18,297	64, 66,	------	------	POST DEVELOPED B- TOTAL (B1 +
70	SCS Runoff	3.671	1	718	8,026	------	------	------	POST DEVELOPED C - Bypass C1
72	SCS Runoff	1.040	1	719	2,954	------	------	------	POST DEVELOPED D - Bypass D1

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	210.38	1	727	774,225	------	------	------	Pre Developed Area A1
2	SCS Runoff	71.49	1	724	215,811	------	------	------	Pre Developed Area A2
3	Combine	276.50	1	726	990,036	1, 2	------	------	Pre Developed Area A (A1 + A2)
4	SCS Runoff	9.742	1	724	32,009	------	------	------	Pre Developed Area B1
5	SCS Runoff	6.836	1	723	21,288	------	------	------	Pre Developed Area B2
6	Combine	16.56	1	724	53,297	4, 5	------	------	Pre Developed Area B (B1 + B2)
7	SCS Runoff	15.39	1	721	39,533	------	------	------	Pre Developed Area C1
8	SCS Runoff	3.374	1	718	7,733	------	------	------	Pre Developed Area D1
10	SCS Runoff	57.90	1	724	172,892	------	------	------	Basin A1
11	Reservoir	2.682	1	847	91,985	10	324.90	105,386	Route Basin A1
12	Reach	2.457	1	903	91,392	11	------	------	Reach Basin A1
14	SCS Runoff	20.54	1	720	46,482	------	------	------	Basin A2
15	Reservoir	10.41	1	726	39,233	14	289.15	16,114	Route Basin A2
16	Reach	4.536	1	739	39,222	15	------	------	Reach Basin A2
18	SCS Runoff	18.74	1	718	38,320	------	------	------	Basin A4
19	Reservoir	10.28	1	722	37,387	18	331.57	10,375	Route Basin A4
20	Reach	4.822	1	733	37,366	19	------	------	Reach Basin A4
22	SCS Runoff	39.09	1	718	78,542	------	------	------	Basin A5
23	Reservoir	0.158	1	1428	7,715	22	317.58	62,055	Route Basin A5
24	Reach	0.158	1	1446	7,681	23	------	------	Reach Basin A5
26	SCS Runoff	96.70	1	720	218,770	------	------	------	Basin A6
27	Reservoir	0.430	1	1142	45,962	26	299.44	153,089	Route Basin A6
28	Reach	0.430	1	1167	45,640	27	------	------	Reach Basin A6
30	SCS Runoff	61.77	1	719	139,784	------	------	------	Basin A7
31	Reservoir	0.176	1	1390	10,987	30	264.68	109,860	Route Basin A7
32	Reach	0.176	1	1403	10,973	31	------	------	Reach Basin A7
34	SCS Runoff	34.46	1	720	78,102	------	------	------	Basin A8
35	Reservoir	0.944	1	839	20,906	34	274.54	44,745	Route Basin A8
36	Reach	0.942	1	848	20,901	35	------	------	Reach Basin A8
38	SCS Runoff	18.72	1	720	42,453	------	------	------	Basin A9

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
39	Reservoir	0.163	1	978	6,672	38	294.60	26,919	Route Basin A9
40	Reach	0.163	1	1024	6,653	39	------	------	Reach Basin A9
42	SCS Runoff	30.25	1	720	68,463	------	------	------	Basin A10
43	Reservoir	2.612	1	753	40,096	42	301.41	31,784	Route Basin A10
44	Reach	2.438	1	793	40,084	43	------	------	Reach Basin A10
46	SCS Runoff	94.15	1	735	443,915	------	------	------	Bypass A11
48	SCS Runoff	6.406	1	726	21,395	------	------	------	Bypass A12
49	Reach	2.665	1	742	21,373	48	------	------	Reach Bypass A12
51	Combine	9.624	1	738	232,273	12, 16, 20, 24, 28, 32,	------	------	Post Developed A1 (1)
52	Combine	96.67	1	735	486,189	36, 46, 49,	------	------	Post Developed A1 (2)
54	Combine	106.23	1	735	718,462	51, 52,	------	------	POST DEVELOPED A1 - TOTAL
56	SCS Runoff	68.89	1	723	189,727	------	------	------	Bypass A13
58	Combine	2.522	1	797	46,737	40, 44,	------	------	Post Developed A2
60	Combine	69.05	1	723	236,464	56, 58,	------	------	POST DEVELOPED A2 - TOTAL
62	Combine	142.40	1	727	954,926	54, 60,	------	------	POST DEVELOPED A - TOTAL (A1
64	SCS Runoff	9.386	1	724	30,750	------	------	------	POST DEVELOPED B - Bypass B1
66	SCS Runoff	1.872	1	718	4,100	------	------	------	POST DEVELOPED B - Bypass B2
68	Combine	10.42	1	723	34,850	64, 66,	------	------	POST DEVELOPED B- TOTAL (B1 +
70	SCS Runoff	6.631	1	718	13,645	------	------	------	POST DEVELOPED C - Bypass C1
72	SCS Runoff	2.497	1	718	5,708	------	------	------	POST DEVELOPED D - Bypass D1

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	308.95	1	727	1,083,098	------	------	------	Pre Developed Area A1
2	SCS Runoff	100.64	1	724	295,838	------	------	------	Pre Developed Area A2
3	Combine	402.78	1	726	1,378,933	1, 2	------	------	Pre Developed Area A (A1 + A2)
4	SCS Runoff	15.65	1	723	47,006	------	------	------	Pre Developed Area B1
5	SCS Runoff	10.53	1	723	30,664	------	------	------	Pre Developed Area B2
6	Combine	26.17	1	723	77,670	4, 5	------	------	Pre Developed Area B (B1 + B2)
7	SCS Runoff	22.16	1	721	55,178	------	------	------	Pre Developed Area C1
8	SCS Runoff	5.344	1	718	11,415	------	------	------	Pre Developed Area D1
10	SCS Runoff	75.93	1	724	225,259	------	------	------	Basin A1
11	Reservoir	7.584	1	767	143,148	10	325.39	118,743	Route Basin A1
12	Reach	6.404	1	808	142,699	11	------	------	Reach Basin A1
14	SCS Runoff	26.90	1	719	60,853	------	------	------	Basin A2
15	Reservoir	19.49	1	724	53,294	14	289.54	18,303	Route Basin A2
16	Reach	9.104	1	733	53,284	15	------	------	Reach Basin A2
18	SCS Runoff	23.38	1	717	48,253	------	------	------	Basin A4
19	Reservoir	16.49	1	721	47,188	18	331.91	11,820	Route Basin A4
20	Reach	7.507	1	730	47,167	19	------	------	Reach Basin A4
22	SCS Runoff	50.73	1	718	102,332	------	------	------	Basin A5
23	Reservoir	0.261	1	1356	20,581	22	318.35	79,674	Route Basin A5
24	Reach	0.261	1	1409	20,551	23	------	------	Reach Basin A5
26	SCS Runoff	126.15	1	719	285,336	------	------	------	Basin A6
27	Reservoir	0.497	1	1186	56,260	26	300.55	209,932	Route Basin A6
28	Reach	0.497	1	1211	55,822	27	------	------	Reach Basin A6
30	SCS Runoff	78.62	1	719	178,549	------	------	------	Basin A7
31	Reservoir	0.268	1	1440	24,660	30	265.41	142,892	Route Basin A7
32	Reach	0.268	1	1443	24,644	31	------	------	Reach Basin A7
34	SCS Runoff	45.55	1	720	103,043	------	------	------	Basin A8
35	Reservoir	2.058	1	794	43,981	34	275.03	55,120	Route Basin A8
36	Reach	2.056	1	802	43,977	35	------	------	Reach Basin A8
38	SCS Runoff	24.83	1	720	56,168	------	------	------	Basin A9

4050-SWM.gpw	Return Period: 10 Year	Tuesday, 10 / 4 / 2016

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
39	Reservoir	0.256	1	968	13,684	38	295.30	36,178	Route Basin A9
40	Reach	0.256	1	1009	13,667	39	------	------	Reach Basin A9
42	SCS Runoff	39.62	1	719	89,630	------	------	------	Basin A10
43	Reservoir	3.494	1	752	59,958	42	302.19	42,707	Route Basin A10
44	Reach	3.348	1	795	59,947	43	------	------	Reach Basin A10
46	SCS Runoff	130.70	1	735	599,020	------	------	------	Bypass A11
48	SCS Runoff	9.048	1	726	29,328	------	------	------	Bypass A12
49	Reach	4.056	1	740	29,309	48	------	------	Reach Bypass A12
51	Combine	16.91	1	732	344,166	12, 16, 20, 24, 28, 32,	------	------	Post Developed A1 (1)
52	Combine	135.64	1	735	672,307	36, 46, 49,	------	------	Post Developed A1 (2)
54	Combine	152.33	1	735	1,016,473	51, 52,	------	------	POST DEVELOPED A1 - TOTAL
56	SCS Runoff	93.43	1	722	253,977	------	------	------	Bypass A13
58	Combine	3.547	1	800	73,614	40, 44,	------	------	Post Developed A2
60	Combine	93.89	1	723	327,590	56, 58,	------	------	POST DEVELOPED A2 - TOTAL
62	Combine	203.41	1	727	1,344,066	54, 60,	------	------	POST DEVELOPED A - TOTAL (A1
64	SCS Runoff	15.04	1	723	45,110	------	------	------	POST DEVELOPED B - Bypass B1
66	SCS Runoff	2.840	1	718	5,928	------	------	------	POST DEVELOPED B - Bypass B2
68	Combine	16.70	1	722	51,038	64, 66,	------	------	POST DEVELOPED B- TOTAL (B1 +
70	SCS Runoff	9.329	1	718	18,877	------	------	------	POST DEVELOPED C - Bypass C1
72	SCS Runoff	3.945	1	718	8,416	------	------	------	POST DEVELOPED D - Bypass D1

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	467.02	1	727	1,582,900	------	------	------	Pre Developed Area A1
2	SCS Runoff	146.73	1	723	423,610	------	------	------	Pre Developed Area A2
3	Combine	604.70	1	726	2,006,509	1, 2	------	------	Pre Developed Area A (A1 + A2)
4	SCS Runoff	25.42	1	723	72,027	------	------	------	Pre Developed Area B1
5	SCS Runoff	16.53	1	723	46,124	------	------	------	Pre Developed Area B2
6	Combine	41.95	1	723	118,151	4, 5	------	------	Pre Developed Area B (B1 + B2)
7	SCS Runoff	32.94	1	721	80,456	------	------	------	Pre Developed Area C1
8	SCS Runoff	8.574	1	718	17,578	------	------	------	Pre Developed Area D1
10	SCS Runoff	103.36	1	724	306,033	------	------	------	Basin A1
11	Reservoir	19.81	1	744	222,428	10	326.39	148,718	Route Basin A1
12	Reach	16.15	1	780	222,080	11	------	------	Reach Basin A1
14	SCS Runoff	36.67	1	719	83,093	------	------	------	Basin A2
15	Reservoir	31.33	1	722	75,061	14	289.97	20,663	Route Basin A2
16	Reach	16.63	1	730	75,053	15	------	------	Reach Basin A2
18	SCS Runoff	30.27	1	717	63,232	------	------	------	Basin A4
19	Reservoir	24.68	1	720	61,987	18	332.19	13,436	Route Basin A4
20	Reach	11.85	1	728	61,965	19	------	------	Reach Basin A4
22	SCS Runoff	68.30	1	718	139,027	------	------	------	Basin A5
23	Reservoir	0.368	1	1381	38,327	22	319.55	109,833	Route Basin A5
24	Reach	0.368	1	1428	37,892	23	------	------	Reach Basin A5
26	SCS Runoff	171.11	1	719	388,085	------	------	------	Basin A6
27	Reservoir	0.581	1	1322	68,891	26	302.17	299,637	Route Basin A6
28	Reach	0.581	1	1346	68,306	27	------	------	Reach Basin A6
30	SCS Runoff	103.79	1	719	237,555	------	------	------	Basin A7
31	Reservoir	0.363	1	1442	40,008	30	266.49	195,415	Route Basin A7
32	Reach	0.363	1	1446	39,881	31	------	------	Reach Basin A7
34	SCS Runoff	62.68	1	719	141,841	------	------	------	Basin A8
35	Reservoir	3.331	1	780	80,102	34	276.03	76,004	Route Basin A8
36	Reach	3.329	1	786	80,099	35	------	------	Reach Basin A8
38	SCS Runoff	34.27	1	719	77,545	------	------	------	Basin A9

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
39	Reservoir	0.352	1	988	24,382	38	296.35	51,649	Route Basin A9
40	Reach	0.352	1	1021	24,367	39	------	------	Reach Basin A9
42	SCS Runoff	54.01	1	719	122,387	------	------	------	Basin A10
43	Reservoir	4.366	1	754	90,498	42	303.18	61,050	Route Basin A10
44	Reach	4.241	1	795	90,487	43	------	------	Reach Basin A10
46	SCS Runoff	187.99	1	735	844,048	------	------	------	Bypass A11
48	SCS Runoff	13.23	1	725	41,995	------	------	------	Bypass A12
49	Reach	6.398	1	739	41,978	48	------	------	Reach Bypass A12
51	Combine	30.40	1	734	505,177	12, 16, 20, 24, 28, 32,	------	------	Post Developed A1 (1)
52	Combine	196.87	1	735	966,126	36, 46, 49,	------	------	Post Developed A1 (2)
54	Combine	227.25	1	735	1,471,300	51, 52,	------	------	POST DEVELOPED A1 - TOTAL
56	SCS Runoff	131.78	1	722	354,924	------	------	------	Bypass A13
58	Combine	4.546	1	799	114,854	40, 44,	------	------	Post Developed A2
60	Combine	132.90	1	722	469,779	56, 58,	------	------	POST DEVELOPED A2 - TOTAL
62	Combine	300.94	1	727	1,941,079	54, 60,	------	------	POST DEVELOPED A - TOTAL (A1
64	SCS Runoff	24.40	1	723	69,055	------	------	------	POST DEVELOPED B - Bypass B1
66	SCS Runoff	4.408	1	718	8,949	------	------	------	POST DEVELOPED B - Bypass B2
68	Combine	27.09	1	722	78,004	64, 66,	------	------	POST DEVELOPED B- TOTAL (B1 +
70	SCS Runoff	13.58	1	718	27,281	------	------	------	POST DEVELOPED C - Bypass C1
72	SCS Runoff	6.319	1	718	12,947	------	------	------	POST DEVELOPED D - Bypass D1

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	609.39	1	727	2,037,335	------	------	------	Pre Developed Area A1
2	SCS Runoff	188.06	1	723	538,565	------	------	------	Pre Developed Area A2
3	Combine	786.16	1	726	2,575,901	1, 2	------	------	Pre Developed Area A (A1 + A2)
4	SCS Runoff	34.42	1	723	95,324	------	------	------	Pre Developed Area B1
5	SCS Runoff	22.00	1	723	60,386	------	------	------	Pre Developed Area B2
6	Combine	56.42	1	723	155,710	4, 5	------	------	Pre Developed Area B (B1 + B2)
7	SCS Runoff	42.59	1	721	103,412	------	------	------	Pre Developed Area C1
8	SCS Runoff	11.54	1	718	23,329	------	------	------	Pre Developed Area D1
10	SCS Runoff	127.02	1	724	376,757	------	------	------	Basin A1
11	Reservoir	26.80	1	743	291,964	10	327.38	181,078	Route Basin A1
12	Reach	22.77	1	777	291,640	11	------	------	Reach Basin A1
14	SCS Runoff	45.10	1	719	102,616	------	------	------	Basin A2
15	Reservoir	39.78	1	722	94,180	14	290.18	22,378	Route Basin A2
16	Reach	23.11	1	729	94,172	15	------	------	Reach Basin A2
18	SCS Runoff	36.09	1	717	76,121	------	------	------	Basin A4
19	Reservoir	31.62	1	720	74,730	18	332.35	14,457	Route Basin A4
20	Reach	15.74	1	727	74,708	19	------	------	Reach Basin A4
22	SCS Runoff	83.37	1	718	171,155	------	------	------	Basin A5
23	Reservoir	0.437	1	1430	48,630	22	320.54	137,381	Route Basin A5
24	Reach	0.437	1	1445	47,943	23	------	------	Reach Basin A5
26	SCS Runoff	209.82	1	719	478,100	------	------	------	Basin A6
27	Reservoir	0.641	1	1440	77,722	26	303.48	380,552	Route Basin A6
28	Reach	0.641	1	1445	77,045	27	------	------	Reach Basin A6
30	SCS Runoff	125.21	1	719	288,686	------	------	------	Basin A7
31	Reservoir	0.427	1	1443	49,085	30	267.39	241,913	Route Basin A7
32	Reach	0.427	1	1448	48,910	31	------	------	Reach Basin A7
34	SCS Runoff	77.56	1	719	176,041	------	------	------	Basin A8
35	Reservoir	4.076	1	780	111,806	34	276.83	96,375	Route Basin A8
36	Reach	4.075	1	786	111,802	35	------	------	Reach Basin A8
38	SCS Runoff	42.51	1	719	96,417	------	------	------	Basin A9

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
39	Reservoir	0.412	1	1015	33,688	38	297.16	66,027	Route Basin A9
40	Reach	0.412	1	1042	33,673	39	------	------	Reach Basin A9
42	SCS Runoff	66.43	1	719	151,143	------	------	------	Basin A10
43	Reservoir	5.723	1	752	117,157	42	304.04	77,224	Route Basin A10
44	Reach	5.149	1	768	117,148	43	------	------	Reach Basin A10
46	SCS Runoff	238.66	1	735	1,062,666	------	------	------	Bypass A11
48	SCS Runoff	16.98	1	725	53,391	------	------	------	Bypass A12
49	Reach	8.586	1	738	53,375	48	------	------	Reach Bypass A12
51	Combine	43.69	1	732	634,418	12, 16, 20, 24, 28, 32,	------	------	Post Developed A1 (1)
52	Combine	250.63	1	735	1,227,845	36, 46, 49,	------	------	Post Developed A1 (2)
54	Combine	293.79	1	735	1,862,261	51, 52,	------	------	POST DEVELOPED A1 - TOTAL
56	SCS Runoff	165.40	1	722	444,605	------	------	------	Bypass A13
58	Combine	5.464	1	769	150,821	40, 44,	------	------	Post Developed A2
60	Combine	167.15	1	722	595,426	56, 58,	------	------	POST DEVELOPED A2 - TOTAL
62	Combine	388.17	1	727	2,457,685	54, 60,	------	------	POST DEVELOPED A - TOTAL (A1
64	SCS Runoff	33.00	1	723	91,339	------	------	------	POST DEVELOPED B - Bypass B1
66	SCS Runoff	5.832	1	718	11,740	------	------	------	POST DEVELOPED B - Bypass B2
68	Combine	36.64	1	722	103,079	64, 66,	------	------	POST DEVELOPED B- TOTAL (B1 +
70	SCS Runoff	17.36	1	718	34,878	------	------	------	POST DEVELOPED C - Bypass C1
72	SCS Runoff	8.494	1	718	17,173	------	------	------	POST DEVELOPED D - Bypass D1

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	769.95	1	726	2,550,189	------	------	------	Pre Developed Area A1
2	SCS Runoff	233.90	1	723	667,341	------	------	------	Pre Developed Area A2
3	Combine	988.96	1	725	3,217,530	1, 2	------	------	Pre Developed Area A (A1 + A2)
4	SCS Runoff	44.64	1	723	122,054	------	------	------	Pre Developed Area B1
5	SCS Runoff	28.21	1	722	76,647	------	------	------	Pre Developed Area B2
6	Combine	72.83	1	722	198,702	4, 5	------	------	Pre Developed Area B (B1 + B2)
7	SCS Runoff	53.42	1	720	129,298	------	------	------	Pre Developed Area C1
8	SCS Runoff	14.89	1	718	29,939	------	------	------	Pre Developed Area D1
10	SCS Runoff	152.71	1	724	454,494	------	------	------	Basin A1
11	Reservoir	32.71	1	742	368,482	10	328.44	218,679	Route Basin A1
12	Reach	28.87	1	777	368,174	11	------	------	Reach Basin A1
14	SCS Runoff	54.25	1	719	124,112	------	------	------	Basin A2
15	Reservoir	49.08	1	722	115,256	14	290.38	23,947	Route Basin A2
16	Reach	30.13	1	729	115,249	15	------	------	Reach Basin A2
18	SCS Runoff	42.32	1	717	90,121	------	------	------	Basin A4
19	Reservoir	38.54	1	719	88,576	18	332.48	15,377	Route Basin A4
20	Reach	19.99	1	726	88,555	19	------	------	Reach Basin A4
22	SCS Runoff	99.83	1	717	206,470	------	------	------	Basin A5
23	Reservoir	0.499	1	1441	57,485	22	321.58	168,432	Route Basin A5
24	Reach	0.499	1	1447	56,617	23	------	------	Reach Basin A5
26	SCS Runoff	251.77	1	719	577,082	------	------	------	Basin A6
27	Reservoir	0.698	1	1442	86,015	26	304.84	470,480	Route Basin A6
28	Reach	0.697	1	1448	85,259	27	------	------	Reach Basin A6
30	SCS Runoff	148.23	1	719	344,490	------	------	------	Basin A7
31	Reservoir	1.558	1	1102	73,757	30	268.06	277,538	Route Basin A7
32	Reach	1.556	1	1109	73,612	31	------	------	Reach Basin A7
34	SCS Runoff	93.76	1	719	213,807	------	------	------	Basin A8
35	Reservoir	4.787	1	781	146,471	34	277.74	119,614	Route Basin A8
36	Reach	4.785	1	787	146,466	35	------	------	Reach Basin A8
38	SCS Runoff	51.49	1	719	117,279	------	------	------	Basin A9

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
39	Reservoir	0.731	1	943	44,569	38	298.02	81,244	Route Basin A9
40	Reach	0.687	1	966	44,528	39	------	------	Reach Basin A9
42	SCS Runoff	79.90	1	719	182,806	------	------	------	Basin A10
43	Reservoir	16.87	1	730	147,599	42	304.45	87,328	Route Basin A10
44	Reach	12.16	1	746	147,591	43	------	------	Reach Basin A10
46	SCS Runoff	294.71	1	734	1,306,132	------	------	------	Bypass A11
48	SCS Runoff	21.15	1	725	66,158	------	------	------	Bypass A12
49	Reach	11.10	1	738	66,143	48	------	------	Reach Bypass A12
51	Combine	58.06	1	730	787,466	12, 16, 20, 24, 28, 32,	------	------	Post Developed A1 (1)
52	Combine	309.85	1	735	1,518,742	36, 46, 49,	------	------	Post Developed A1 (2)
54	Combine	366.58	1	734	2,306,207	51, 52,	------	------	POST DEVELOPED A1 - TOTAL
56	SCS Runoff	202.28	1	722	544,181	------	------	------	Bypass A13
58	Combine	12.46	1	746	192,119	40, 44,	------	------	Post Developed A2
60	Combine	205.07	1	722	736,300	56, 58,	------	------	POST DEVELOPED A2 - TOTAL
62	Combine	486.86	1	727	3,042,506	54, 60,	------	------	POST DEVELOPED A - TOTAL (A1
64	SCS Runoff	42.76	1	723	116,900	------	------	------	POST DEVELOPED B - Bypass B1
66	SCS Runoff	7.434	1	718	14,927	------	------	------	POST DEVELOPED B - Bypass B2
68	Combine	47.56	1	721	131,826	64, 66,	------	------	POST DEVELOPED B- TOTAL (B1 +
70	SCS Runoff	21.54	1	718	43,417	------	------	------	POST DEVELOPED C - Bypass C1
72	SCS Runoff	10.96	1	718	22,029	------	------	------	POST DEVELOPED D - Bypass D1

Allowable Flows and Volumes

2

Crebilly Farm
Westtown Township
Chester County, PA

Date: 1-Oct-16
By: J.W.J.
Chk'd: –
Rev'd: –

Allowable Post Developed Flows - SCS

Area Summaries

Area	Pre Q -1 yr (cfs)	Pre Q -2 yr (cfs)	Pre Q -5 yr (cfs)	Pre Q -10 yr (cfs)	Pre Q -25 yr (cfs)	Pre Q - 50 yr (cfs)	Pre Q - 100 yr (cfs)	Pre Total Area (Ac.)	Total Area Disturbed (Ac.)	% of shed (%)	Total Area Undisturbed (Ac.)	% of shed (%)
POI A1	50.81	105.89	210.38	308.95	467.02	609.39	769.95	199.69	126.86	63.5%	72.83	36.5%
POI A2	21.45	39.52	71.49	100.64	146.73	188.06	233.90	47.92	13.69	28.6%	34.23	71.4%
POI A - Total	70.42	142.43	276.50	402.78	604.70	786.16	988.96	247.61	140.55	56.8%	107.06	43.2%
POI B1	1.23	3.89	9.74	15.65	25.42	34.42	44.64	11.60	0.51	4.4%	11.09	95.6%
POI B2	1.18	3.04	6.84	10.53	16.53	22.00	28.21	6.79	4.83	71.1%	1.96	28.9%
POI B - Total	2.41	6.92	16.56	26.17	41.95	56.42	72.83	18.39	5.34	29.0%	13.05	71.0%
POI C1	4.02	8.06	15.39	22.16	32.94	42.59	53.42	9.95	8.13	81.7%	1.82	18.3%
POI D1	0.43	1.40	3.37	5.34	8.57	11.54	14.89	2.81	0.64	22.8%	2.17	77.2%

Weighted Allowable

Area	Post Q-2 yr (cfs)	Post Q-5 yr (cfs)	Post Q-10 yr (cfs)	Post Q-25 yr (cfs)	Post Q-50 yr (cfs)	Post Q-100 yr (cfs)
POI A1	70.90	210.38	308.95	467.02	609.39	769.95
POI A2	34.36	71.49	100.64	146.73	188.06	233.90
POI A - Total	101.56	276.50	402.78	604.70	786.16	988.96
POI B1	3.77	9.74	15.65	25.42	34.42	44.64
POI B2	1.72	6.84	10.53	16.53	22.00	28.21
POI B - Total	5.61	16.56	26.17	41.95	56.42	72.83
POI C1	4.76	15.39	22.16	32.94	42.59	53.42
POI D1	1.18	3.37	5.34	8.57	11.54	14.89

Note 1: The allowable post developed flow for the 2-year post developed storm is calculated by using the 1-year pre developed design flow multiplied with the percent **UN**-disturbed of the shed. That number is then added to the product of the actual year frequency storm multiplied by the percent disturbed of the shed.
As follows: (Q-1-pre * % disturbed) + (Q-2-pre * % undisturbed) = Q-2 post-allowable

Note 2: Per Table 308.1 of Chapter 144, Stormwater Management, the peak rate control standards are 2-year post reduced to the 1-year pre, and for the 5-, 10-, 25-, 50-, and 100-year post developed storms are to be reduced to the 5-, 10-, 25-, 50-, and 100-year pre development runoff, respectively.

Crebilly Farm
Westtown Township
Chester County, PA

Date: 1-Oct-16
By: J.W.J.
Chk'd: --
Rev'd: --

CREBILLY FARM - WATERSHED SUMMARIES to Brandywine Creek Watershed								
WATERSHED DESCRIPTION		PEAK RUNOFF RATES (CFS)						
		1 Year	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
POI A1	Pre-Developed Study Point No. A1 (Hyd. No. 1)	50.81	105.89	210.38	308.95	467.02	609.39	769.95
	Post Developed flow to POI A1 (Hyd. No. 54)	--	58.47	106.23	152.33	227.25	293.79	366.58
	ALLOWABLE POST DEVELOPED FLOW (from allowable excel sheet)	--	*70.90*	*210.38*	*308.95*	*467.02*	*609.39*	*769.95*
POI A2	Pre-Developed Study Point No. A2 (Hyd. No. 2)	21.45	39.52	71.49	100.64	146.73	188.06	233.90
	Post Developed flow to POI A2 (Hyd. No. 60)	--	41.47	69.05	93.89	132.90	167.15	205.07
	ALLOWABLE POST DEVELOPED FLOW (from allowable excel sheet)	--	*34.36*	*71.49*	*100.64*	*146.73*	*188.06*	*233.90*
POI A - TOTAL	Pre-Developed Study Point No. A (Hyd. No. 3)	70.42	142.43	276.50	402.78	604.70	786.16	988.96
	Post Developed flow to POI A (Hyd. No. 62)	--	79.51	142.40	203.41	300.94	388.17	486.86
	ALLOWABLE POST DEVELOPED FLOW (from allowable excel sheet)	--	*101.56*	*276.50*	*402.78*	*604.70*	*786.16*	*988.96*
POI B1	Pre-Developed flow to POI B1 (on-site) (Hyd. No. 4)	1.23	3.89	9.74	15.65	25.42	34.42	44.64
	Total flow to POI B1 (Hyd. Nos. 64)	--	3.77	9.39	15.04	24.40	33.00	42.76
	ALLOWABLE POST DEVELOPED FLOW (from allowable excel sheet)	--	*3.77*	*9.74*	*15.65*	*25.42*	*34.42*	*44.64*
POI B2	Pre-Developed Study Point No. B2 (Hyd. No. 5)	1.18	3.04	6.84	10.53	16.53	22.00	28.21
	Post Developed flow to POI B2 (Hyd. No. 66)	--	0.87	1.87	2.84	4.41	5.83	7.43
	ALLOWABLE POST DEVELOPED FLOW (from allowable excel sheet)	--	*1.72*	*6.84*	*10.53*	*16.53*	*22.00*	*28.21*
POI B - TOTAL	Pre-Developed Study Point No. B (Hyd. No. 6)	2.41	6.92	16.56	26.17	41.95	56.42	72.83
	Post Developed flow to POI B (Hyd. No. 68)	--	4.17	10.42	16.70	27.09	36.64	47.56
	ALLOWABLE POST DEVELOPED FLOW (from allowable excel sheet)	--	*5.61*	*16.56*	*26.17*	*41.95*	*56.42*	*72.83*
POI D1	Pre-Developed Study Point No. D1 (Hyd. No. 8)	0.43	1.40	3.37	5.34	8.57	11.54	14.89
	Post Developed flow to POI D1 (Hyd. No. 72)	--	1.04	2.50	3.95	6.32	8.49	10.96
	ALLOWABLE POST DEVELOPED FLOW (from allowable excel sheet)	--	*1.18*	*3.37*	*5.34*	*8.57*	*11.54*	*14.89*

		2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
TOTAL PRE DEVELOPED		150.75	296.43	434.29	655.22	854.12	1076.68
TOTAL ALLOWABLE POST DEVELOP		108.35	296.43	434.29	655.22	854.12	1076.68
TOTAL POST DEVELOPED		84.72	155.32	224.06	334.35	433.30	545.38

CREBILLY FARM - WATERSHED SUMMARIES to Darby-Crum Creek Watershed								
WATERSHED DESCRIPTION		PEAK RUNOFF RATES (CFS)						
		1 Year	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
POI C1	Pre-Developed Study Point No. C1 (Hyd. No. 7)	4.02	8.06	15.39	22.16	32.94	42.59	53.42
	Post Developed flow to POI C1 (Hyd. No. 70)	--	3.67	6.63	9.33	13.58	17.36	21.54
	ALLOWABLE POST DEVELOPED FLOW (from allowable excel sheet)	--	*4.76*	*15.39*	*22.16*	*32.94*	*42.59*	*53.42*

Crebilly Farm
Westtown Township
Chester County, PA

Date: 1-Oct-16
By: J.W.J.
Chk'd: --
Rev'd: --

CREBILLY FARM - WATERSHED VOLUME SUMMARIES to Brandywine Creek Watershed		
WATERSHED DESCRIPTION		2 Year
POI A1	Pre-Developed Study Point No. A1 (Hyd. No. 1)	445,689
	Post Developed flow to POI A1 (Hyd. No. 54)	411,150
POI A2	Pre-Developed Study Point No. A2 (Hyd. No. 2)	129,157
	Post Developed flow to POI A2 (Hyd. No. 60)	136,523
POI A - TOTAL	Pre-Developed Study Point No. A (Hyd. No. 3)	574,846
	Post Developed flow to POI A (Hyd. No. 62)	547,673
POI B1	Pre-Developed flow to POI B1 (on-site) (Hyd. No. 4)	16,711
	Total flow to POI B1 (Hyd. Nos. 64)	16,087
POI B2	Pre-Developed Study Point No. B2 (Hyd. No. 5)	11,562
	Post Developed flow to POI B2 (Hyd. No. 66)	2,211
POI B - TOTAL	Pre-Developed Study Point No. B (Hyd. No. 6)	28,274
	Post Developed flow to POI B (Hyd. No. 68)	18,297
POI D1	Pre-Developed Study Point No. D1 (Hyd. No. 8)	3,994
	Post Developed flow to POI D1 (Hyd. No. 72)	2,954

	2-year
TOTAL PRE DEVELOPED	1,210,233
TOTAL POST DEVELOP	1,134,895

CREBILLY FARM - WATERSHED VOLUME SUMMARIES to Darby-Crum Creek Watershed		
WATERSHED DESCRIPTION		2 Year
POI C1	Pre-Developed Study Point No. C1 (Hyd. No. 7)	22,859
	Post Developed flow to POI C1 (Hyd. No. 70)	8,026

Pre-developed Tc

3

TR55 Tc Worksheet

Hyd. No. 1

Pre Developed Area A1

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.170		0.011		0.011		
Flow length (ft)	=	100.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.27		0.00		0.00		
Land slope (%)	=	1.50		0.00		0.00		
Travel Time (min)	**=**	**12.02**	**+**	**0.00**	**+**	**0.00**	**=**	**12.02**
Shallow Concentrated Flow								
Flow length (ft)	=	443.00		202.00		0.00		
Watercourse slope (%)	=	2.82		5.45		0.00		
Surface description	=	Unpaved		Unpaved		Paved		
Average velocity (ft/s)	=2.71			3.77		0.00		
Travel Time (min)	**=**	**2.73**	**+**	**0.89**	**+**	**0.00**	**=**	**3.62**
Channel Flow								
X sectional flow area (sqft)	=	16.00		22.00		0.00		
Wetted perimeter (ft)	=	12.00		15.00		0.00		
Channel slope (%)	=	2.55		0.24		0.00		
Manning's n-value	=	0.030		0.015		0.015		
Velocity (ft/s)	=9.62							
				6.29				
						0.00		
Flow length (ft)	({0})2162.0			341.0		0.0		
Travel Time (min)	**=**	**3.75**	**+**	**0.90**	**+**	**0.00**	**=**	**4.65**

Total Travel Time, Tc .... 20.30 min

TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No. 2

Pre Developed Area A2

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.170		0.011		0.011		
Flow length (ft)	= 100.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 3.27		0.00		0.00		
Land slope (%)	= 7.00		0.00		0.00		
Travel Time (min)	**= 6.49**	**+**	**0.00**	**+**	**0.00**	**=**	**6.49**
Shallow Concentrated Flow							
Flow length (ft)	= 233.00		196.00		0.00		
Watercourse slope (%)	= 7.30		10.20		0.00		
Surface description	= Unpaved		Unpaved		Paved		
Average velocity (ft/s)	=4.36		5.15		0.00		
Travel Time (min)	**= 0.89**	**+**	**0.63**	**+**	**0.00**	**=**	**1.52**
Channel Flow							
X sectional flow area (sqft)	= 16.00		0.00		0.00		
Wetted perimeter (ft)	= 12.00		0.00		0.00		
Channel slope (%)	= 1.38		0.00		0.00		
Manning's n-value	= 0.030		0.015		0.015		
Velocity (ft/s)	=7.07		0.00		0.00		
Flow length (ft)	({0})3114.0		0.0		0.0		
Travel Time (min)	**= 7.34**	**+**	**0.00**	**+**	**0.00**	**=**	**7.34**

Total Travel Time, Tc .... **15.40 min**

TR55 Tc Worksheet

Hyd. No. 4

Pre Developed Area B1

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.170		0.011		0.011		
Flow length (ft)	= 100.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 3.27		0.00		0.00		
Land slope (%)	= 3.00		0.00		0.00		
Travel Time (min)	**= 9.11**	**+**	**0.00**	**+**	**0.00**	**=**	**9.11**
Shallow Concentrated Flow							
Flow length (ft)	= 1024.00		0.00		0.00		
Watercourse slope (%)	= 4.49		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=3.42		0.00		0.00		
Travel Time (min)	**= 4.99**	**+**	**0.00**	**+**	**0.00**	**=**	**4.99**
Channel Flow							
X sectional flow area (sqft)	= 0.00		0.00		0.00		
Wetted perimeter (ft)	= 0.00		0.00		0.00		
Channel slope (%)	= 0.00		0.00		0.00		
Manning's n-value	= 0.015		0.015		0.015		
Velocity (ft/s)	=0.00		0.00		0.00		
Flow length (ft)	({0})0.0		0.0		0.0		
Travel Time (min)	**= 0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc .... 14.10 min

TR55 Tc Worksheet

Hyd. No. 5

Pre Developed Area B2

Description	A	B	C	Totals
Sheet Flow				
Manning's n-value	= 0.170	0.011	0.011	
Flow length (ft)	= 100.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 3.27	0.00	0.00	
Land slope (%)	= 2.00	0.00	0.00	
Travel Time (min)	**= 10.71**	**+ 0.00**	**+ 0.00**	**= 10.71**
Shallow Concentrated Flow				
Flow length (ft)	= 622.00	0.00	0.00	
Watercourse slope (%)	= 3.54	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=3.04	0.00	0.00	
Travel Time (min)	**= 3.41**	**+ 0.00**	**+ 0.00**	**= 3.41**
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=0.00	0.00	0.00	
Flow length (ft)	({0})0.0	0.0	0.0	
Travel Time (min)	**= 0.00**	**+ 0.00**	**+ 0.00**	**= 0.00**

Total Travel Time, Tc .... 14.10 min

TR55 Tc Worksheet

Hyd. No. 7

Pre Developed Area C1

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.240		0.011		0.011		
Flow length (ft)	=	100.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.27		0.00		0.00		
Land slope (%)	=	5.00		0.00		0.00		
Travel Time (min)	=	**9.78**	+	**0.00**	+	**0.00**	=	**9.78**
Shallow Concentrated Flow								
Flow length (ft)	=	430.00		0.00		0.00		
Watercourse slope (%)	=	5.80		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	3.89		0.00		0.00		
Travel Time (min)	=	**1.84**	+	**0.00**	+	**0.00**	=	**1.84**
Channel Flow								
X sectional flow area (sqft)	=	0.00		0.00		0.00		
Wetted perimeter (ft)	=	0.00		0.00		0.00		
Channel slope (%)	=	0.00		0.00		0.00		
Manning's n-value	=	0.015		0.015		0.015		
Velocity (ft/s)	=	0.00		0.00		0.00		
Flow length (ft)		({0})0.0		0.0		0.0		
Travel Time (min)	=	**0.00**	+	**0.00**	+	**0.00**	=	**0.00**

Total Travel Time, Tc .... **11.60 min**

Pre-developed Cn

4

Crebilly Farm
Westtown Township
Chester County, Pennsylvania

By: J.W.J.
Date: 10/1/2016
Chk'd:
Rev'd:

Watershed: **Pre Developed A1**

RUNOFF CURVE NUMBER CALCULATIONS:

(S.C.S. TR-55 method)

Soil name and hydrologic group	Cover Description	Cn	Area (acres)	Product of CN x Area
--	Impervious	98	0.00	0.00
A	Woods - Good Condition	30	0.00	0.00
B	Woods - Good Condition	55	4.32	237.60
C	Woods - Good Condition	70	0.33	23.10
D	Woods - Good Condition	77	3.99	307.23
A	Meadow	30	1.23	36.90
B	Meadow	58	120.18	6970.44
C	Meadow	71	20.71	1470.41
D	Meadow	78	48.93	3816.54
		Totals =	199.69	12862.22

$$\text{Composite Cn} = \frac{12862.22}{199.69} = 64.41$$

USE Cn = 64.4

24 hr RAINFALL for Westtown Township

(per NOA Atlas 14)

1 year	2 year	5 year	10 year	25 year	50 year	100 year
2.71	3.27	4.11	4.80	5.81	6.66	7.57

Crebilly Farm
Westtown Township
Chester County, Pennsylvania

By: J.W.J.
Date: 10/1/2016
Chk'd:
Rev'd:

Watershed: **Pre Developed A2**

RUNOFF CURVE NUMBER CALCULATIONS:

(S.C.S. TR-55 method)

Soil name and hydrologic group	Cover Description	Cn	Area (acres)	Product of CN x Area
--	Impervious	98	1.86	182.28
A	Woods - Good Condition	30	0.00	0.00
B	Woods - Good Condition	55	1.61	88.55
C	Woods - Good Condition	70	0.00	0.00
D	Woods - Good Condition	77	9.20	708.40
A	Meadow	30	0.00	0.00
B	Meadow	58	25.46	1476.68
C	Meadow	71	0.20	14.20
D	Meadow	78	9.59	748.02

Totals = 47.92 | 3218.13

Composite Cn = $\frac{3218.13}{47.92}$ = 67.16

USE Cn = 67.2

24 hr RAINFALL for Westtown Township

(per NOA Atlas 14)

1 year	2 year	5 year	10 year	25 year	50 year	100 year
2.71	3.27	4.11	4.80	5.81	6.66	7.57

Crebilly Farm
Westtown Township
Chester County, Pennsylvania

By: J.W.J.
Date: 10/1/2016
Chk'd:
Rev'd:

Watershed: **Pre Developed B1**

RUNOFF CURVE NUMBER CALCULATIONS:

(S.C.S. TR-55 method)

Soil name and hydrologic group	Cover Description	Cn	Area (acres)	Product of CN x Area
--	Impervious	98	0.27	26.46
A	Woods - Good Condition	30	0.00	0.00
B	Woods - Good Condition	55	0.00	0.00
C	Woods - Good Condition	70	0.00	0.00
D	Woods - Good Condition	77	0.00	0.00
A	Meadow	30	0.00	0.00
B	Meadow	58	11.33	657.14
C	Meadow	71	0.00	0.00
D	Meadow	78	0.00	0.00
		Totals =	11.60	683.60

$$\text{Composite Cn} = \frac{683.60}{11.60} = 58.93$$

USE Cn = 58.9

24 hr RAINFALL for Westtown Township

(per NOA Atlas 14)

1 year	2 year	5 year	10 year	25 year	50 year	100 year
2.71	3.27	4.11	4.80	5.81	6.66	7.57

Crebilly Farm
Westtown Township
Chester County, Pennsylvania

By: J.W.J.
Date: 10/1/2016
Chk'd:
Rev'd:

Watershed: **Pre Developed B2**

RUNOFF CURVE NUMBER CALCULATIONS:

(S.C.S. TR-55 method)

Soil name and hydrologic group	Cover Description	Cn	Area (acres)	Product of CN x Area
--	Impervious	98	0.50	49.00
A	Woods - Good Condition	30	0.00	0.00
B	Woods - Good Condition	55	0.00	0.00
C	Woods - Good Condition	70	0.00	0.00
D	Woods - Good Condition	77	0.00	0.00
A	Meadow	30	0.00	0.00
B	Meadow	58	6.29	364.82
C	Meadow	71	0.00	0.00
D	Meadow	78	0.00	0.00
		Totals =	6.79	413.82

$$\text{Composite Cn} = \frac{413.82}{6.79} = 60.95$$

USE Cn = 60.9

24 hr RAINFALL for Westtown Township

(per NOA Atlas 14)

1 year	2 year	5 year	10 year	25 year	50 year	100 year
2.71	3.27	4.11	4.80	5.81	6.66	7.57

Crebilly Farm
Westtown Township
Chester County, Pennsylvania

By: J.W.J.
Date: 10/1/2016
Chk'd:
Rev'd:

Watershed: **Pre Developed C1**

RUNOFF CURVE NUMBER CALCULATIONS:

(S.C.S. TR-55 method)

Soil name and hydrologic group	Cover Description	Cn	Area (acres)	Product of CN x Area
--	Impervious	98	0.00	0.00
A	Woods - Good Condition	30	0.00	0.00
B	Woods - Good Condition	55	0.00	0.00
C	Woods - Good Condition	70	0.00	0.00
D	Woods - Good Condition	77	0.00	0.00
A	Meadow	30	0.00	0.00
B	Meadow	58	4.85	281.30
C	Meadow	71	5.05	358.55
D	Meadow	78	0.05	3.90
		Totals =	9.95	643.75

Composite Cn = $\frac{643.75}{9.95}$ = 64.70

USE Cn = 64.7

---

24 hr RAINFALL for Westtown Township

(per NOA Atlas 14)

1 year	2 year	5 year	10 year	25 year	50 year	100 year
2.71	3.27	4.11	4.80	5.81	6.66	7.57

Crebilly Farm
Westtown Township
Chester County, Pennsylvania

By: J.W.J.
Date: 10/1/2016
Chk'd:
Rev'd:

Watershed: **Pre Developed D1**

RUNOFF CURVE NUMBER CALCULATIONS:
(S.C.S. TR-55 method)

Soil name and hydrologic group	Cover Description	Cn	Area (acres)	Product of CN x Area
--	Impervious	98	0.00	0.00
A	Woods - Good Condition	30	0.00	0.00
B	Woods - Good Condition	55	0.00	0.00
C	Woods - Good Condition	70	0.00	0.00
D	Woods - Good Condition	77	0.00	0.00
A	Meadow	30	0.00	0.00
B	Meadow	58	2.73	158.34
C	Meadow	71	0.08	5.68
D	Meadow	78	0.00	0.00
		Totals =	2.81	164.02

Composite Cn = $\frac{164.02}{2.81}$ = 58.37

USE Cn = 58.4

24 hr RAINFALL for Westtown Township
(per NOA Atlas 14)

1 year	2 year	5 year	10 year	25 year	50 year	100 year
2.71	3.27	4.11	4.80	5.81	6.66	7.57

Post-developed Cn

5

Crebilly Farm
Westtown Township
Chester County, Pennsylvania

By: J.W.J.
Date: 10/1/2016
Chk'd:
Rev'd:

Watershed: **Basin A1**

RUNOFF CURVE NUMBER CALCULATIONS:

(S.C.S. TR-55 method)

Soil name and hydrologic group	Cover Description	Cn	Area (acres)	Product of CN x Area
--	Impervious on lot	98	5.55	543.90
--	Impervious in ROW (2460 x 35)	98	2.98	292.04
B	On-Site Disturbed Lawn (good)	61	12.00	732.00
C	On-Site Disturbed Lawn (good)	74	5.23	387.02
C	Woods - Good Condition	70	0.99	69.30

Totals = 26.75 | 2024.26

Composite Cn = $\frac{2024.26}{26.75}$ = 75.67

USE Cn = 75.7

24 hr RAINFALL for Westtown Township

(per NOA Atlas 14)

1 year	2 year	5 year	10 year	25 year	50 year	100 year
2.71	3.27	4.11	4.80	5.81	6.66	7.57

Crebilly Farm
Westtown Township
Chester County, Pennsylvania

By: J.W.J.
Date: 10/1/2016
Chk'd:
Rev'd:

Watershed: **Basin A2**

RUNOFF CURVE NUMBER CALCULATIONS:
(S.C.S. TR-55 method)

Soil name and hydrologic group	Cover Description	Cn	Area (acres)	Product of CN x Area
--	Impervious on lot	98	1.81	177.38
--	Impervious in ROW (741 x 35 and 9500 cds)	98	0.81	79.38
B	On-Site Disturbed Lawn (good)	61	4.39	267.79
C	On-Site Disturbed Lawn (good)	74	0.37	27.38
		Totals =	7.38	551.93

Composite Cn = $\frac{551.93}{7.38}$ = 74.79

USE Cn = 74.8

24 hr RAINFALL for Westtown Township
(per NOA Atlas 14)

1 year	2 year	5 year	10 year	25 year	50 year	100 year
2.71	3.27	4.11	4.80	5.81	6.66	7.57

Crebilly Farm
Westtown Township
Chester County, Pennsylvania

By: J.W.J.
Date: 10/1/2016
Chk'd:
Rev'd:

Watershed: **Basin A4**

RUNOFF CURVE NUMBER CALCULATIONS:
(S.C.S. TR-55 method)

Soil name and hydrologic group	Cover Description	Cn	Area (acres)	Product of CN x Area
--	Impervious on lot	98	0.96	93.79
--	Impervious in ROW (523 x 35)	98	0.42	41.18
B	On-Site Disturbed Lawn (good)	61	0.35	21.35
C	On-Site Disturbed Lawn (good)	74	0.44	32.56
D	On-Site Disturbed Lawn (good)	78	2.19	170.82

Totals = 4.36 | 359.70

Composite Cn = $\frac{359.70}{4.36}$ = 82.55

USE Cn = 82.6

24 hr RAINFALL for Westtown Township
(per NOA Atlas 14)

1 year	2 year	5 year	10 year	25 year	50 year	100 year
2.71	3.27	4.11	4.80	5.81	6.66	7.57

ESE Consultants, Inc.

Crebilly Farm
Westtown Township
Chester County, Pennsylvania

By: J.W.J.
Date: 10/1/2016
Chk'd:
Rev'd:

Watershed: **Basin A5**

RUNOFF CURVE NUMBER CALCULATIONS:

(S.C.S. TR-55 method)

Soil name and hydrologic group	Cover Description	Cn	Area (acres)	Product of CN x Area
--	Impervious on lot	98	1.95	191.10
--	Impervious in ROW (2283 x 35)	98	1.83	179.34
B	On-Site Disturbed Lawn (good)	61	6.00	366.00
D	On-Site Disturbed Lawn (good)	78	1.84	143.52

Totals = 11.62 | 879.96

$$\text{Composite Cn} = \frac{879.96}{11.62} = 75.73$$

USE Cn = 75.7

24 hr RAINFALL for Westtown Township

(per NOA Atlas 14)

1 year	2 year	5 year	10 year	25 year	50 year	100 year
2.71	3.27	4.11	4.80	5.81	6.66	7.57

Crebilly Farm
Westtown Township
Chester County, Pennsylvania

By: J.W.J.
Date: 10/1/2016
Chk'd:
Rev'd:

Watershed: **Basin A6**

RUNOFF CURVE NUMBER CALCULATIONS:

(S.C.S. TR-55 method)

Soil name and hydrologic group	Cover Description	Cn	Area (acres)	Product of CN x Area
--	Impervious on lot	98	7.76	760.48
--	Impervious in ROW (5725 x 35)	98	4.61	451.78
B	On-Site Disturbed Lawn (good)	61	18.65	1137.65
C	On-Site Disturbed Lawn (good)	74	2.14	158.36
D	On-Site Disturbed Lawn (good)	78	0.58	45.24
		Totals =	33.74	2553.51

Composite Cn = $\frac{2553.51}{33.74}$ = 75.68

USE Cn = 75.7

24 hr RAINFALL for Westtown Township

(per NOA Atlas 14)

1 year	2 year	5 year	10 year	25 year	50 year	100 year
2.71	3.27	4.11	4.80	5.81	6.66	7.57

Crebilly Farm
Westtown Township
Chester County, Pennsylvania

By: J.W.J.
Date: 10/1/2016
Chk'd:
Rev'd:

Watershed: **Basin A7**

RUNOFF CURVE NUMBER CALCULATIONS:

(S.C.S. TR-55 method)

Soil name and hydrologic group	Cover Description	Cn	Area (acres)	Product of CN x Area
--	Impervious on lot	98	4.06	397.88
--	Impervious in ROW (2771 x 35)	98	2.23	218.54
B	On-Site Disturbed Lawn (good)	61	5.70	347.70
D	On-Site Disturbed Lawn (good)	78	6.34	494.52

Totals = 18.33 | 1458.64

$$\text{Composite Cn} = \frac{1458.64}{18.33} = 79.58$$

USE Cn = 79.6

24 hr RAINFALL for Westtown Township

(per NOA Atlas 14)

1 year	2 year	5 year	10 year	25 year	50 year	100 year
2.71	3.27	4.11	4.80	5.81	6.66	7.57

ESE Consultants, Inc.

Crebilly Farm
Westtown Township
Chester County, Pennsylvania

By: J.W.J.
Date: 10/1/2016
Chk'd:
Rev'd:

Watershed: **Basin A8**

RUNOFF CURVE NUMBER CALCULATIONS:
(S.C.S. TR-55 method)

Soil name and hydrologic group	Cover Description	Cn	Area (acres)	Product of CN x Area
--	Impervious on lot	98	2.08	203.84
--	Impervious in ROW (2644 x 35)	98	2.03	198.94
B	On-Site Disturbed Lawn (good)	61	8.08	492.88
C	On-Site Disturbed Lawn (good)	74	0.80	59.20
D	On-Site Disturbed Lawn (good)	78	0.17	13.26

Totals = 13.16 | 968.12

$$\text{Composite Cn} = \frac{968.12}{13.16} = 73.57$$

USE Cn = 73.6

24 hr RAINFALL for Westtown Township
(per NOA Atlas 14)

1 year	2 year	5 year	10 year	25 year	50 year	100 year
2.71	3.27	4.11	4.80	5.81	6.66	7.57

Crebilly Farm
Westtown Township
Chester County, Pennsylvania

By: J.W.J.
Date: 10/1/2016
Chk'd:
Rev'd:

Watershed: **Basin A9**

RUNOFF CURVE NUMBER CALCULATIONS:
(S.C.S. TR-55 method)

Soil name and hydrologic group	Cover Description	Cn	Area (acres)	Product of CN x Area
--	Impervious on lot	98	1.60	156.80
--	Impervious in ROW (830 x 35)	98	0.67	65.66
B	On-Site Disturbed Lawn (good)	61	4.15	253.15
D	On-Site Disturbed Lawn (good)	78	0.10	7.80
B	Meadow	58	0.70	40.60
--	Impervious pleasant grove Rd	98	0.09	8.82
		Totals =	7.31	532.83

Composite Cn = $\frac{532.83}{7.31}$ = 72.89

USE Cn = 72.9

24 hr RAINFALL for Westtown Township
(per NOA Atlas 14)

1 year	2 year	5 year	10 year	25 year	50 year	100 year
2.71	3.27	4.11	4.80	5.81	6.66	7.57

ESE Consultants, Inc.

Crebilly Farm
Westtown Township
Chester County, Pennsylvania

By: J.W.J.
Date: 10/1/2016
Chk'd:
Rev'd:

Watershed: **Basin A10**

RUNOFF CURVE NUMBER CALCULATIONS:

(S.C.S. TR-55 method)

Soil name and hydrologic group	Cover Description	Cn	Area (acres)	Product of CN x Area
--	Impervious on lot	98	2.75	269.50
--	Impervious in ROW (1333 x 35)	98	1.08	105.84
B	On-Site Disturbed Lawn (good)	61	2.70	164.70
D	On-Site Disturbed Lawn (good)	78	0.38	29.64
B	Woods - Good Condition	55	0.92	50.60
D	Woods - Good Condition	77	0.20	15.40
B	Meadow	58	2.51	145.58
--	impervious pleasant grove Rd	98	0.33	32.34

Totals = 10.87 | 813.60

Composite Cn = $\frac{813.60}{10.87}$ = 74.85

USE Cn = 74.8

---

24 hr RAINFALL for Westtown Township

(per NOA Atlas 14)

1 year	2 year	5 year	10 year	25 year	50 year	100 year
2.71	3.27	4.11	4.80	5.81	6.66	7.57

Crebilly Farm
Westtown Township
Chester County, Pennsylvania

By: J.W.J.
Date: 10/1/2016
Chk'd:
Rev'd:

Watershed: **Bypass A11**

RUNOFF CURVE NUMBER CALCULATIONS:

(S.C.S. TR-55 method)

Soil name and hydrologic group	Cover Description	Cn	Area (acres)	Product of CN x Area
--	Impervious on lot	98	3.88	380.24
--	Impervious in ROW (904 x 35)	98	0.73	71.54
--	Existing Impervious	98	0.58	57.23
B	On-Site Disturbed Lawn (good)	61	10.69	652.09
C	On-Site Disturbed Lawn (good)	74	0.71	52.54
D	On-Site Disturbed Lawn (good)	78	4.46	347.88
A	On-Site Meadow (good)	30	1.23	36.90
B	On-Site Meadow (good)	58	23.17	1343.86
C	On-Site Meadow (good)	71	9.79	695.09
D	On-Site Meadow (good)	78	26.69	2081.82
B	Woods - Good Condition	55	2.86	157.30
D	Woods - Good Condition	77	3.99	307.23

Totals =	88.78	6183.72

88.78

Composite Cn = $\frac{6183.72}{88.78}$ = 69.65

USE Cn = 69.6

24 hr RAINFALL for Westtown Township

(per NOA Atlas 14)

1 year	2 year	5 year	10 year	25 year	50 year	100 year
2.71	3.27	4.11	4.80	5.81	6.66	7.57

Crebilly Farm
Westtown Township
Chester County, Pennsylvania

By: J.W.J.
Date: 10/1/2016
Chk'd:
Rev'd:

Watershed: **Bypass A12**

RUNOFF CURVE NUMBER CALCULATIONS:

(S.C.S. TR-55 method)

Soil name and hydrologic group	Cover Description	Cn	Area (acres)	Product of CN x Area
--	Impervious on lot	98	0.05	5.10
C	On-Site Disturbed Lawn (good)	74	0.09	6.29
D	On-Site Disturbed Lawn (good)	78	0.08	6.47
B	On-Site Meadow (good)	58	0.93	53.94
C	On-Site Meadow (good)	71	1.08	76.68
D	On-Site Meadow (good)	78	1.22	95.16
B	Woods - Good Condition	55	1.03	56.65
C	Woods - Good Condition	70	0.33	23.10
		Totals =	4.81	323.38

Composite Cn = $\frac{323.38}{4.81}$ = 67.23

USE Cn = 67.2

24 hr RAINFALL for Westtown Township

(per NOA Atlas 14)

1 year	2 year	5 year	10 year	25 year	50 year	100 year
2.71	3.27	4.11	4.80	5.81	6.66	7.57

Crebilly Farm
Westtown Township
Chester County, Pennsylvania

By: J.W.J.
Date: 10/1/2016
Chk'd:
Rev'd:

Watershed: **Bypass A13**

RUNOFF CURVE NUMBER CALCULATIONS:
(S.C.S. TR-55 method)

Soil name and hydrologic group	Cover Description	Cn	Area (acres)	Product of CN x Area
--	Impervious on lot	98	0.19	18.62
C	On-Site Disturbed Lawn (good)	74	1.90	140.60
D	On-Site Disturbed Lawn (good)	78	1.30	101.40
B	On-Site Meadow (good)	58	12.95	751.10
C	On-Site Meadow (good)	71	0.00	0.00
D	On-Site Meadow (good)	78	8.34	650.52
B	Woods - Good Condition	55	0.90	49.50
C	Woods - Good Condition	70	0.00	0.00
D	Woods - Good Condition	77	8.28	637.56
--	Impervious - Existing remaining	98	1.86	182.28
	Totals =		35.72	2531.58

$$\text{Composite Cn} = \frac{2531.58}{35.72} = 70.87$$

USE Cn = 70.9

24 hr RAINFALL for Westtown Township
(per NOA Atlas 14)

1 year	2 year	5 year	10 year	25 year	50 year	100 year
2.71	3.27	4.11	4.80	5.81	6.66	7.57

Crebilly Farm
Westtown Township
Chester County, Pennsylvania

By: J.W.J.
Date: 10/1/2016
Chk'd:
Rev'd:

Watershed: **Bypass B1**

RUNOFF CURVE NUMBER CALCULATIONS:

(S.C.S. TR-55 method)

Soil name and hydrologic group	Cover Description	Cn	Area (acres)	Product of CN x Area
--	Impervious	98	0.27	26.46
A	Woods - Good Condition	30	0.00	0.00
B	Woods - Good Condition	55	0.00	0.00
C	Woods - Good Condition	70	0.00	0.00
D	Woods - Good Condition	77	0.00	0.00
A	Meadow	30	0.00	0.00
B	Meadow	58	10.80	626.40
C	Meadow	71	0.00	0.00
D	Meadow	78	0.00	0.00
		Totals =	11.07	652.86

Composite Cn = $\frac{652.86}{11.07}$ = 58.98

USE Cn = 59.0

24 hr RAINFALL for Westtown Township

(per NOA Atlas 14)

1 year	2 year	5 year	10 year	25 year	50 year	100 year
2.71	3.27	4.11	4.80	5.81	6.66	7.57

Crebilly Farm
Westtown Township
Chester County, Pennsylvania

By: J.W.J.
Date: 10/1/2016
Chk'd:
Rev'd:

Watershed: **Bypass B2**

RUNOFF CURVE NUMBER CALCULATIONS:

(S.C.S. TR-55 method)

Soil name and hydrologic group	Cover Description	Cn	Area (acres)	Product of CN x Area
--	Impervious	98	0.08	7.84
B	On-Site Meadow (good)	58	1.22	70.76

Totals = 1.30 | 78.60

Composite Cn = $\frac{78.60}{1.30}$ = 60.46

USE Cn = 60.5

24 hr RAINFALL for Westtown Township

(per NOA Atlas 14)

1 year	2 year	5 year	10 year	25 year	50 year	100 year
2.71	3.27	4.11	4.80	5.81	6.66	7.57

Crebilly Farm
Westtown Township
Chester County, Pennsylvania

By: J.W.J.
Date: 10/1/2016
Chk'd:
Rev'd:

Watershed: **Bypass C1**

RUNOFF CURVE NUMBER CALCULATIONS:

(S.C.S. TR-55 method)

Soil name and hydrologic group	Cover Description	Cn	Area (acres)	Product of CN x Area
--	Impervious on lot	98	0.00	0.00
C	On-Site Disturbed Lawn (good)	74	0.23	17.02
D	On-Site Disturbed Lawn (good)	78	0.59	46.02
B	On-Site Meadow (good)	58	1.76	102.08
C	On-Site Meadow (good)	71	0.49	34.79
D	On-Site Meadow (good)	78	0.05	3.90
B	Woods - Good Condition	55	0.00	0.00
C	Woods - Good Condition	70	0.00	0.00
--	Impervious in ROW (70 x 35)	98	0.06	5.88
		Totals =	3.18	209.69

$$\text{Composite Cn} = \frac{209.69}{3.18} = 65.94$$

USE Cn = 65.9

24 hr RAINFALL for Westtown Township

(per NOA Atlas 14)

1 year	2 year	5 year	10 year	25 year	50 year	100 year
2.71	3.27	4.11	4.80	5.81	6.66	7.57

Crebilly Farm
Westtown Township
Chester County, Pennsylvania

By: J.W.J.
Date: 10/1/2016
Chk'd:
Rev'd:

Watershed: **Bypass D1**

RUNOFF CURVE NUMBER CALCULATIONS:

(S.C.S. TR-55 method)

Soil name and hydrologic group	Cover Description	Cn	Area (acres)	Product of CN x Area
--	Impervious on lot	98	0.00	0.00
C	On-Site Disturbed Lawn (good)	74	0.00	0.00
D	On-Site Disturbed Lawn (good)	78	0.00	0.00
B	On-Site Meadow (good)	58	1.98	114.84
C	On-Site Meadow (good)	71	0.08	5.68
D	On-Site Meadow (good)	78	0.00	0.00
B	Woods - Good Condition	55	0.00	0.00
C	Woods - Good Condition	70	0.00	0.00

Totals = 2.06 | 120.52

Composite Cn = $\frac{120.52}{2.06}$ = 58.50

USE Cn = 58.5

24 hr RAINFALL for Westtown Township

(per NOA Atlas 14)

1 year	2 year	5 year	10 year	25 year	50 year	100 year
2.71	3.27	4.11	4.80	5.81	6.66	7.57

Pond Report

6

Pond Report

Pond No. 1 - Basin A1

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 319.00 ft. Voids = 95.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	319.00	10	0	0
1.00	320.00	11,640	3,797	3,797
3.00	322.00	21,560	31,057	34,853
5.00	324.00	26,490	45,563	80,416
7.00	326.00	31,860	55,349	135,765
9.00	328.00	37,615	65,919	201,684
11.00	330.00	43,770	77,234	278,918

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 24.00	3.00	18.00	0.00
Span (in)	= 24.00	3.00	30.00	0.00
No. Barrels	= 1	1	1	0
Invert El. (ft)	= 319.00	321.00	324.50	0.00
Length (ft)	= 100.00	0.00	0.00	0.00
Slope (%)	= 1.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	Yes	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 11.50	0.00	0.00	0.00
Crest El. (ft)	= 329.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	---	---	---
Multi-Stage	= Yes	No	No	No

Exfil.(in/hr) = 0.500 (by Contour)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	319.00	0.00	0.00	0.00	---	0.00	---	---	---	0.000	---	0.000
1.00	3,797	320.00	0.00	0.00	0.00	---	0.00	---	---	---	0.135	---	0.135
3.00	34,853	322.00	0.22 ic	0.22 ic	0.00	---	0.00	---	---	---	0.250	---	0.471
5.00	80,416	324.00	0.41 ic	0.40 ic	0.00	---	0.00	---	---	---	0.307	---	0.707
7.00	135,765	326.00	16.16 ic	0.52 ic	15.64 ic	---	0.00	---	---	---	0.369	---	16.53
9.00	201,684	328.00	30.41 ic	0.47 ic	29.94 ic	---	0.00	---	---	---	0.435	---	30.85
11.00	278,918	330.00	46.53 ic	0.17 ic	13.24 ic	---	33.11 s	---	---	---	0.507	---	47.03

Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Tuesday, 10 / 4 / 2016

Pond No. 2 - Basin A2

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 284.00 ft. Voids = 95.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	284.00	950	0	0
2.00	286.00	2,440	3,111	3,111
4.00	288.00	4,595	6,575	9,686
6.00	290.00	7,270	11,174	20,860
8.00	292.00	10,425	16,719	37,579

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 36.00	6.00	0.00	0.00
Span (in)	= 36.00	6.00	0.00	0.00
No. Barrels	= 1	1	0	0
Invert El. (ft)	= 284.00	286.00	0.00	0.00
Length (ft)	= 65.00	0.00	0.00	0.00
Slope (%)	= 1.50	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 6.50	3.00	2.00	0.00
Crest El. (ft)	= 290.00	288.50	288.50	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	Rect	Rect	---
Multi-Stage	= Yes	Yes	Yes	No

Exfil.(in/hr) = 1.000 (by Contour)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	284.00	0.00	0.00	---	---	0.00	0.00	0.00	---	0.000	---	0.000
2.00	3,111	286.00	0.00	0.00	---	---	0.00	0.00	0.00	---	0.056	---	0.056
4.00	9,686	288.00	1.32 ic	1.25 ic	---	---	0.00	0.00	0.00	---	0.106	---	1.357
6.00	20,860	290.00	32.58 ic	1.79 ic	---	---	0.00	18.35	12.24	---	0.168	---	32.55
8.00	37,579	292.00	84.66 ic	0.53 ic	---	---	34.40 s	29.84 s	19.89 s	---	0.241	---	84.90

Pond Report

Pond No. 4 - Basin A4

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 328.00 ft. Voids = 95.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	328.00	1,100	0	0
2.00	330.00	3,200	3,911	3,911
4.00	332.00	5,640	8,288	12,200
6.00	334.00	8,430	13,277	25,476

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 36.00	10.00	0.00	0.00
Span (in)	= 36.00	10.00	0.00	0.00
No. Barrels	= 1	1	0	0
Invert El. (ft)	= 326.00	328.00	0.00	0.00
Length (ft)	= 70.00	0.00	0.00	0.00
Slope (%)	= 2.90	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 8.50	2.00	2.00	0.00
Crest El. (ft)	= 332.00	331.00	331.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	Rect	Rect	---
Multi-Stage	= Yes	Yes	Yes	No
Exfil.(in/hr)	= 1.000 (by Contour)			
TW Elev. (ft)	= 0.00			

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	328.00	0.00	0.00	---	---	0.00	0.00	0.00	---	0.000	---	0.000
2.00	3,911	330.00	24.21 ic	3.30 ic	---	---	0.00	0.00	0.00	---	0.074	---	3.378
4.00	12,200	332.00	24.21 ic	4.97 ic	---	---	0.00	6.66	6.66	---	0.131	---	18.42
6.00	25,476	334.00	84.33 ic	1.57 ic	---	---	47.44 s	17.65 s	17.65 s	---	0.195	---	84.52

Pond Report

Pond No. 5 - Basin A5

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 314.00 ft. Voids = 95.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	314.00	11,650	0	0
2.00	316.00	19,644	29,398	29,398
4.00	318.00	24,090	41,471	70,869
6.00	320.00	28,930	50,294	121,163
8.00	322.00	34,180	59,879	181,042
10.00	324.00	39,840	70,243	251,285

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 24.00	3.00	0.00	0.00
Span (in)	= 24.00	3.00	0.00	0.00
No. Barrels	= 1	1	0	0
Invert El. (ft)	= 314.00	317.00	0.00	0.00
Length (ft)	= 94.00	0.00	0.00	0.00
Slope (%)	= 0.50	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 11.50	0.00	0.00	0.00
Crest El. (ft)	= 322.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	---	---	---
Multi-Stage	= Yes	No	No	No

Exfil.(in/hr) = 0.500 (by Contour)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	314.00	0.00	0.00	---	---	0.00	---	---	---	0.000	---	0.000
2.00	29,398	316.00	0.00	0.00	---	---	0.00	---	---	---	0.227	---	0.227
4.00	70,869	318.00	0.22 ic	0.22 ic	---	---	0.00	---	---	---	0.279	---	0.500
6.00	121,163	320.00	0.41 ic	0.40 ic	---	---	0.00	---	---	---	0.335	---	0.736
8.00	181,042	322.00	0.52 ic	0.52 ic	---	---	0.00	---	---	---	0.396	---	0.917
10.00	251,285	324.00	44.64 oc	0.09 ic	---	---	44.54 s	---	---	---	0.461	---	45.08

Pond Report

Pond No. 6 - Basin A6

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 296.00 ft. Voids = 95.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	296.00	40,940	0	0
2.00	298.00	47,270	83,719	83,719
4.00	300.00	54,020	96,145	179,864
6.00	302.00	61,180	109,359	289,222
8.00	304.00	68,750	123,351	412,574
10.00	306.00	76,710	138,104	550,678
12.00	308.00	85,085	153,621	704,299
14.00	310.00	93,855	169,908	874,207

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 24.00	3.00	0.00	0.00
Span (in)	= 24.00	3.00	0.00	0.00
No. Barrels	= 1	1	0	0
Invert El. (ft)	= 294.00	296.00	0.00	0.00
Length (ft)	= 100.00	0.00	0.00	0.00
Slope (%)	= 1.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 11.50	0.00	0.00	0.00
Crest El. (ft)	= 308.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	---	---	---
Multi-Stage	= Yes	No	No	No
Exfil.(in/hr)	= 1.000 (by Contour)			
TW Elev. (ft)	= 0.00			

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	296.00	0.00	0.00	---	---	0.00	---	---	---	0.000	---	0.000
2.00	83,719	298.00	15.12 ic	0.32 ic	---	---	0.00	---	---	---	1.094	---	1.418
4.00	179,864	300.00	15.12 ic	0.47 ic	---	---	0.00	---	---	---	1.250	---	1.716
6.00	289,222	302.00	15.12 ic	0.57 ic	---	---	0.00	---	---	---	1.416	---	1.989
8.00	412,574	304.00	15.12 ic	0.66 ic	---	---	0.00	---	---	---	1.591	---	2.255
10.00	550,678	306.00	15.12 ic	0.74 ic	---	---	0.00	---	---	---	1.776	---	2.518
12.00	704,299	308.00	15.12 ic	0.81 ic	---	---	0.00	---	---	---	1.970	---	2.784
14.00	874,207	310.00	58.05 ic	0.12 ic	---	---	57.92 s	---	---	---	2.173	---	60.21

Pond Report

Pond No. 7 - Basin A7

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 262.00 ft. Voids = 95.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	262.00	38,450	0	0
2.00	264.00	44,640	78,855	78,855
4.00	266.00	51,245	91,010	169,864
6.00	268.00	58,245	103,934	273,798
8.00	270.00	65,650	117,618	391,417

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 24.00	3.00	0.00	0.00
Span (in)	= 24.00	3.00	0.00	0.00
No. Barrels	= 1	1	0	0
Invert El. (ft)	= 262.00	264.00	0.00	0.00
Length (ft)	= 80.00	0.00	0.00	0.00
Slope (%)	= 0.50	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 11.50	0.00	0.00	0.00
Crest El. (ft)	= 268.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	---	---	---
Multi-Stage	= Yes	No	No	No

Exfil.(in/hr) = 0.500 (by Contour)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	262.00	0.00	0.00	---	---	0.00	---	---	---	0.000	---	0.000
2.00	78,855	264.00	0.00	0.00	---	---	0.00	---	---	---	0.517	---	0.517
4.00	169,864	266.00	0.32 ic	0.32 ic	---	---	0.00	---	---	---	0.593	---	0.917
6.00	273,798	268.00	0.48 ic	0.47 ic	---	---	0.00	---	---	---	0.674	---	1.139
8.00	391,417	270.00	39.73 ic	0.07 ic	---	---	39.64 s	---	---	---	0.760	---	40.48

Pond Report

Pond No. 8 - Basin A8

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 272.00 ft. Voids = 95.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	272.00	15,600	0	0
2.00	274.00	19,770	33,520	33,520
4.00	276.00	24,335	41,821	75,341
6.00	278.00	29,300	50,875	126,216
8.00	280.00	34,675	60,699	186,914

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 24.00	10.00	0.00	0.00
Span (in)	= 24.00	10.00	0.00	0.00
No. Barrels	= 1	1	0	0
Invert El. (ft)	= 272.00	274.00	0.00	0.00
Length (ft)	= 100.00	0.00	0.00	0.00
Slope (%)	= 0.50	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 11.50	0.00	0.00	0.00
Crest El. (ft)	= 278.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	---	---	---
Multi-Stage	= Yes	No	No	No

Exfil.(in/hr) = 1.000 (by Contour)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	272.00	0.00	0.00	---	---	0.00	---	---	---	0.000	---	0.000
2.00	33,520	274.00	0.00	0.00	---	---	0.00	---	---	---	0.458	---	0.458
4.00	75,341	276.00	3.39 ic	3.30 ic	---	---	0.00	---	---	---	0.563	---	3.867
6.00	126,216	278.00	5.01 ic	4.97 ic	---	---	0.00	---	---	---	0.678	---	5.649
8.00	186,914	280.00	38.62 oc	0.78 ic	---	---	37.83 s	---	---	---	0.803	---	39.41

Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Tuesday, 10 / 4 / 2016

Pond No. 9 - Basin A9

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 292.00 ft. Voids = 95.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	292.00	8,300	0	0
2.00	294.00	11,730	18,933	18,933
4.00	296.00	16,330	26,534	45,467
6.00	298.00	21,070	35,431	80,898
8.00	300.00	26,210	44,823	125,721

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 24.00	3.00	0.00	0.00
Span (in)	= 24.00	3.00	0.00	0.00
No. Barrels	= 1	1	0	0
Invert El. (ft)	= 292.00	294.00	0.00	0.00
Length (ft)	= 85.00	0.00	0.00	0.00
Slope (%)	= 3.50	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 11.50	0.00	0.00	0.00
Crest El. (ft)	= 298.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	---	---	---
Multi-Stage	= Yes	No	No	No
Exfil.(in/hr)	= 1.000 (by Contour)			
TW Elev. (ft)	= 0.00			

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	292.00	0.00	0.00	---	---	0.00	---	---	---	0.000	---	0.000
2.00	18,933	294.00	0.00	0.00	---	---	0.00	---	---	---	0.272	---	0.272
4.00	45,467	296.00	0.32 ic	0.32 ic	---	---	0.00	---	---	---	0.378	---	0.702
6.00	80,898	298.00	0.48 ic	0.47 ic	---	---	0.00	---	---	---	0.488	---	0.953
8.00	125,721	300.00	39.73 ic	0.07 ic	---	---	39.65 s	---	---	---	0.607	---	40.33

Pond Report

Pond No. 10 - Basin A10

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 298.00 ft. Voids = 95.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	298.00	4,860	0	0
2.00	300.00	10,340	14,115	14,115
4.00	302.00	16,335	25,123	39,238
6.00	304.00	22,730	36,941	76,179
8.00	306.00	29,520	49,492	125,671

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 24.00	10.00	0.00	0.00
Span (in)	= 24.00	10.00	0.00	0.00
No. Barrels	= 1	1	0	0
Invert El. (ft)	= 298.00	300.00	0.00	0.00
Length (ft)	= 70.00	0.00	0.00	0.00
Slope (%)	= 2.70	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 11.50	0.00	0.00	0.00
Crest El. (ft)	= 304.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	---	---	---
Multi-Stage	= Yes	No	No	No
Exfil.(in/hr)	= 1.000 (by Contour)			
TW Elev. (ft)	= 0.00			

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	298.00	0.00	0.00	---	---	0.00	---	---	---	0.000	---	0.000
2.00	14,115	300.00	0.00	0.00	---	---	0.00	---	---	---	0.239	---	0.239
4.00	39,238	302.00	3.39 ic	3.30 ic	---	---	0.00	---	---	---	0.378	---	3.682
6.00	76,179	304.00	5.01 ic	4.97 ic	---	---	0.00	---	---	---	0.526	---	5.497
8.00	125,671	306.00	39.75 ic	0.81 ic	---	---	38.92 s	---	---	---	0.683	---	40.41

Preliminary Infiltration Report

7

REPORT OF PRELIMINARY GEOTECHNICAL EXPLORATION

CREBILLY FARM
Westtown Township, Chester County, Pennsylvania

August 2016

Prepared For:

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REPORT OF PRELIMINARY GEOTECHNICAL EXPLORATION

CREBILLY FARM
WESTTOWN TOWNSHIP, CHESTER COUNTY, PENNSYLVANIA
AUGUST 2016

INTRODUCTION

This report presents the results of our preliminary geotechnical exploration performed on the property located in the northwest corner of West Street Road and Wilmington Pike in Westtown Township, Chester County, Pennsylvania. We understand that Toll Brothers is considering the purchase of the subject site for construction of a residential community. The gross site area is 322.4 acres. GTA was proved two concept plans designated Plan B and C, prepared by Eastern States Engineering. The concept plans indicate the two alternate layouts of the subdivision and stormwater management areas. The proposed subdivision will be a mix of estate/executive lots, executive/courtyard lots, and carriage homes. According to the concept plans, the house totals range from 300 to 347 units. The plans included boundary information, potential lot and roadway configuration, and the locations of the proposed stormwater management facilities. Proposed and existing grades and utility locations were not provided for our review at the time this report was prepared.

In conjunction with the proposed development, Geo-Technology Associates, Inc. (GTA) was retained to perform a preliminary geotechnical exploration of the project site. The scope of this study included a field exploration, laboratory testing, and engineering analysis. Included in our field exploration were SPT borings performed at 40 locations to scheduled depths of 15 feet below the existing ground surface, test pits excavated at 22 locations to depths of approximately 7½ to 11½ feet below the existing ground surface, and field infiltration testing at 13 locations. Limited laboratory testing was performed to confirm the visual classifications and characterize general subsurface conditions. Conclusions and recommendations regarding the site development were derived from engineering analysis of field and laboratory data, and review of the previously referenced concept plans. It should be noted that structural details and final site grading or utility plans were not available at the time our exploration was performed. As such, GTA recommends that a design phase geotechnical review of the site be performed upon finalization of the site layout to verify that geotechnical considerations are addressed.

SITE DESCRIPTION

The subject site is located northwest of the intersection of Wilmington-West Chester Pike (Route 202) and West Street Road (Route 926), in Westtown Township, Chester County, Pennsylvania, as shown on the *Site Location Map, Figure 1,* included in Appendix A. Specifically, the subject site is comprised of eleven lots, identified as Tax Parcels 67-4-029, 67-4-029.1 through 67-4-029.4, 67-4-030 through 67-4-033, 67-4-033.1, and 67-4-134, totaling approximately 322.4 acres. The site is bound by West Pleasant Grove Road followed by residential properties to the north, by West Street Road followed by residential and agricultural properties to the south, by Wilmington-West Chester Pike followed by residential and commercial properties to the east, and South New Street followed by agricultural property and wooded land to the west. At the time the field exploration was performed, the subject site was primarily an undeveloped property containing a few single-story and two-story residential structures, barns, stables, and horse training facilities in the central and western portions of the site. The site also contained asphalt paved and gravel driveways and various utilities associated with the existing structures. GTA understands that there were residential structures on the eastern portion of the site that were demolished. Remnant slabs and demolition debris were present on this portion of the site at the time our field exploration was performed.

The eastern and northwestern portions of the site were utilized for agricultural crop production. The northeast, eastern-central, and southwestern portions of the site is comprised of wooded property containing small to large trees and light to moderate underbrush. A small pond was located in the south-central portion of site. A stream, identified as Radley Run, is located in the southwest portion of the site near the farm entrance. Additionally, unnamed tributaries and associated wetlands were observed in the southern-central and northwestern portions of the site bisecting the property. The site topography is generally gently to steeply sloping, with surface drainage generally directed toward Radley Run and the unnamed tributaries to the south and west. Ground surface elevations range from approximately elevation (EL) 380 in the southeast corner of the site, near the residential structure located adjacent to the intersection of West Street Road and Wilmington-West Chester Pike, to approximately EL 250 in the southwest portion of the site, near Radley Run. Ground surface elevations were based on Google Earth Imagery from 2011 and limited survey data and should be considered approximate.

PROPOSED CONSTRUCTION

Based on the concept plans provided by Eastern States Engineering, GTA understands that the subject property is planned to be developed as a residential community, which will include up to 347 homes. The subdivision will have access points from Wilmington-West Chester Pike, West Pleasant Grove Road and West Street Road; and a network of interior roadways and cul-de-sacs will provide access to the residential units. The proposed site grading and utility plans were not available at the time our exploration was performed. GTA anticipates that significant cuts and fills will be required for general site grading, given the moderately to steeply sloping topography and significant relief changes on portions of the property. Also, it is anticipated that deep excavations may be required for basement construction and utility installation. Specific building construction types and structural loading information were not available at the time this report was prepared. For the purposes of this report, the structures are assumed to be cast-in-place concrete and timber frame construction. Based on previous projects of similar scope, maximum wall loads of four kips per linear foot and maximum column loads of 20 kips were assumed in our analyses.

The preliminary concept plans for stormwater management (SWM) within the proposed subdivision includes construction of 13 basins located at various points across the planned community. At the time our investigation was performed, specific details regarding the types of stormwater management practices were not available. It is anticipated that best management practices for water quality and quantity management will be utilized to comply with Pennsylvania and Chester County specifications and regulations regarding stormwater design.

RELEVANT GEOLOGY

According to *The Preliminary Bedrock Geologic Map of a Portion of The Wilmington 30- by 60- Minute Quadrangle, Southeastern Pennsylvania*, published by Pennsylvania Department of Conservation and Natural Resources (2005), the subject site is primarily located within the Glenarm Wissahickon formation of the Piedmont Physiographic Province. Specifically, the map indicates that the majority if the site is underlain by the Doe Run schist which is identified as garnet-staurolite-kyanite pelitic schist with abundant biotite and muscovite. The residual soils resulting from the weathering of the parent bedrock of the Doe Run schist can result in low plasticity silts and clays transitioning to non-plastic sands with lesser percentages of silt and clay. These materials generally become increasingly stiff or dense with depth; although, differential weathering can often result in softer zones within otherwise very dense weathered rock material.

The above-referenced bedrock geology map also indicates that a small potion site along the western property boundary may underlain by Ultramafic rock, which is described as primarily serpentinite containing magnesium-rich rocks derived from pyroxenite and peridotite. The residual soils resulting from the weathering of the parent bedrock of the Ultramafic rock can result in high plasticity soils with low unit weights.

According to the U.S. Department of Agriculture (USDA) web soil survey, the soils underlying the site are mapped as the Glenville silt loam (GlB, GlC), Glenelg silt loam (GgB, GgC), Chester silt loam (CdB), Baile silt loam (Ba), Codorus silt loam (Co), Gaila silt loam (GaD) and Hatboro silt loam (Ha) series soils. The Glenelg, Chester and Gaila series soils are described as being well-drained, with depths to the water of more than 6 feet and a depth to bedrock generally ranging from 60 to 120 inches. The Glenville and Codorus series soils are described as being moderately well-drained, with depths to the water of approximately 6 to 36 inches and a depth to bedrock generally ranging from 15 to 99 inches. The Baile and Hatboro series soils are described as being poorly-drained, with depths to the water of approximately 0 to 6 inches and a depth to bedrock generally ranging from 60 to 99 inches. These soils were typically mapped in the low lying areas. Refer to the publications for additional information.

SUBSURFACE EXPLORATION

The subsurface conditions at the subject site were explored by performing SPT borings at 40 locations and excavating test pits at 22 locations. The test borings, identified as Borings B-1 through B-40, were drilled from July 27 through August 2, 2016 at various points along the proposed roadway alignments to scheduled depths of 15 feet below the existing ground surface. The test pits, identified as TP-1 through TP-13, were excavated on July 25 through 26, 2016 within the proposed SWM areas and proposed roadway alignments to depths of approximately 7½ to 11½ feet below existing ground surface. The test pits were excavated by R. Keating and

Sons, Inc. using a Case 580 Super M backhoe. The test pit and boring locations were field surveyed by representatives of Northeast Surveyors, LLC with the approximate locations depicted on *Figure 2: Exploration Location Plan*, included in Appendix A.

The test borings were drilled on July 27 with an ATV-mounted Diedrich D50 drill rig equipped with 3¼-inch hollow-stem augers and an automatic hammer. Standard Penetration Testing was performed in the boreholes with sampling performed at approximate 2-foot intervals in the upper 10 feet of drilling and at 5-foot intervals thereafter. Standard Penetration Testing involves driving a 2-inch outside diameter (O.D.), 1⅜-inch inside diameter (I.D.) split-spoon sampler with a 140-pound hammer free-falling 30 inches. The number of blows required to drive the sampler was recorded in intervals of 6 inches. The total number of hammer blows required to drive the sampler from the 6 to 18-inch interval is the SPT N-value.

The soil samples retrieved from the test pits and borings were delivered GTA's laboratory for visual classification by engineering personnel and limited laboratory testing. The soil descriptions indicated on the logs are based on visual observations using the Unified Soil Classification System (USCS) of the individual soil samples as summarized in the *Notes for Exploration Logs* included in Appendix B, supplemented by the laboratory test results.

SUBSURFACE CONDITIONS

In agreement with the published geology, the test borings and test pits typically encountered surficial topsoil underlain by residual soils consistent with the Glenarm Wissahickon Formation throughout the maximum depths explored. Topsoil/cultivated soil was encountered at the ground surface of the exploration holes and measured about 2 to 15 inches thick. Below the surficial topsoil, Boring B-28 encountered existing fill materials comprised of silt and sand mixtures with lesser amounts of rock fragments. The existing fill was encountered to a depth of approximately 2 feet below the ground surface and is likely native material that was placed for construction of the local farm road where Boring B-28 was performed. It was also located near the residential dwellings that have been razed.

Below the topsoil and/or existing fill, the borings and test pits encountered fine-grained residual soils visually classified as silts and clays with lesser percentages of sand and rock fragments to depths of approximately 2 to 9½ feet blow existing grades. Underlying the fine-grained soils, the borings and test pits typically encountered granular residual soils visually classified as silty sand with varying amounts of rock fragments, generally transitioning into highly weathered rock. Highly weathered rock was encountered at boring locations B-5, B-9, B-11 through B-16, B-18 through B-20, B-23 through B-27, B-34, B-35, and B-37 through B-40 at depths of approximately 8½ to 14 feet below ground surface. At several locations the drill rig was able to auger through the weathered rock. Auger refusal was not encountered to the explored depths. Highly weathered rock was also identified at Test Pit locations TP-2, TP-5, TP-8, and TP-12 through TP-17 at depths of approximately 7 to 10½ feet below ground surface. Refusal of the excavation equipment was encountered in TP-2, TP-8, and TP-12 through TP-17 at depths of about 7½ to 10½ feet below the existing grades.

Uncorrected SPT N-values for the encountered surficial fine-grained soils ranged from 2 to 14 blows per foot, averaging 6 bpf, indicating these soils are generally medium stiff. The uncorrected N-Values for the granular materials ranged from 4 to 50, averaging 16, which indicates the soils were generally medium dense. The silty sands generally transformed into highly weathered rock materials with uncorrected N-values of 50 or more blows per increment. Hard augering and excavation difficulties were also experienced in the highly weathered rock at depths ranging from about 5 to 13 feet below existing grades and as indicated on the logs.

Groundwater was observed at 11 of the exploration locations at depths ranging from 4.4 to 12.9 feet below the ground surface, corresponding to elevations ranging from approximately EL 302 to 337. The remaining test locations were dry to their cave depths or termination depths. Groundwater levels were recorded during the exploration and again prior to backfilling the exploration holes. Most of the test borings were left open to collect 24-hour groundwater measurements; however, test borings conducted within the horse pastures and the test pits were backfilled upon completion for safety considerations. The observed water levels in the higher areas of the site are likely perched water trapped in sandy lenses over dense weathered rock. Water levels encountered in the exploration locations in the low lying areas are considered to be the seasonal water table. It should be noted that fluctuations of ground water levels of several feet typically occur seasonally with variations in precipitation and runoff. During the wet season of the year (late winter/early spring) groundwater or "perched" water conditions can develop locally within existing granular soils above the less permeable layers such as the very dense weathered rock and/or bedrock surface. Refer to the boring and test pit logs included in Appendix B for detailed information.

INFILTRATION TESTING

Thirteen proposed stormwater management (SWM) facility locations were evaluated for infiltration potential of the underlying soils. In order to estimate the unsaturated hydraulic conductivity or infiltration rate of the soils at these locations, a single-ring infiltrometer test (ASTM D5126) was performed within holes offset from Test Pits TP-1 through TP-13. The test depths were established to maintain a minimum of 3 feet of separation between the test elevations and hydraulically limiting zones.

The testing consisted of seating an open-bottom 12-inch diameter casing approximately 4 inches into the hand-trimmed subgrade soils. The holes were then pre-soaked, and water level measurements were taken with time until a steady state condition was observed. The tests were conducted for approximately 2 hours, and the unfactored steady-state values recorded over the last 1-hour time period are listed below. It should be noted that infiltration rates can vary widely with variations in soil texture and gradation.

Test Pit	Test Depth (ft)	Soil Description	Uncorrected Field Infiltration Rate
TP-1	4	Silty SAND, contains rock fragments	2 inches per hour
TP-2	2 ½	Silty GRAVEL with sand	2 inches per hour
TP-3	4 ½	Silty SAND, contains rock fragments	1 inches per hour
TP-4	5 ½	SILT, contains rock fragments	No discernible movement
TP-5	3 ½	Silty Clayey SAND with gravel	½ inches per hour
TP-6	4 ½	Silty SAND, contains rock fragments	2 inches per hour

Test Pit	Test Depth (ft)	Soil Description	Uncorrected Field Infiltration Rate
TP-7	3	Silty SAND, contains rock fragments	2 inches per hour
TP-8	3	Silty SAND, contains rock fragments	1 inches per hour
TP-9	5	Silty Clayey SAND	½ inches per hour
TP-10	4	Sandy SILT, contains rock fragments	No discernible movement
TP-11	4	Silty SAND with gravel	1 inch per hour
TP-12	4 ½	Silty SAND with gravel	2 inches per hour
TP-13	3 ½	Well-graded GRAVEL with silt and sand	4 inches per hour

LABORATORY ANALYSIS

Selected samples obtained from the test pits were tested for grain-size analysis, Atterberg Limits, and natural moisture contents. The grain-size analysis and Atterberg Limit testing were performed to determine the Unified Soil Classification System (USCS) designation and the USDA soil classification for the soil. USCS classifications provide information regarding soil behavior beneath pavement and foundation systems and the USDA soil classification can provide information regarding hydraulic conductivity of the soils. The results of testing are as summarized in the table below:

SUMMARY OF LABORATORY TESTING

Test Pit	Depth (ft)	USCS Classification	USDA Classification	LL%	PI%	NMC %
TP-1	4	Silty SAND (SM)	Sandy Loam	33	8	16.7
TP-2	2 ½	Silty GRAVEL with sand (GM)	Sandy Loam	32	6	12.4
TP-3	4 ½	Silty SAND (SM)	Sandy Loam	26	2	15.2
TP-4	2-5	SILT (ML)	---	33	8	24.8
TP-5	3 ½	Silty Clayey SAND with gravel (SM-SC)	Sandy Loam	28	6	13.1
TP-6	4 ½	Silty SAND (SM)	Sandy Loam	38	8	19.8

TP-7	3	Silty SAND (SM)	Sandy Loam	36	7	20.2
TP-8	3	Silty SAND (SM)	Loam	28	NP	10.2
TP-9	2-6	Silty SAND with gravel (SM)	---	33	5	14.0
TP-9	5	Silty Clayey SAND (SC-SM)	Sandy Loam	29	7	13.8
TP-10	4	Sandy SILT (ML)	Loam	31	7	15.1
TP-11	4	Silty SAND (SM)	Loam	43	7	33.2
TP-12	4 ½	Silty Sand with gravel (SM)	Sandy Loam	29	4	16.0
TP-13	3 ½	Well-graded GRAVEL with silt and sand	Sandy Loam	32	7	9.2

NP= Non-Plastic, LL = Liquid Limit, PI = Plastic Index, NMC=Natural Moisture Content

Two bulk samples obtained from Test Pits TP-4 and TP-9 were tested for moisture-density relationships in accordance with the Standard Proctor (ASTM D698) testing for use in evaluating the suitability of these soils for reuse as fill. The bulk samples were also subjected to California Bearing Ratio (ASTM D1583) (CBR) testing for use in evaluation of pavement subgrade support quality. Results of these tests are summarized in the following table.

SUMMARY OF COMPACTION AND CBR TESTING
(ASTM D698, Standard Proctor; ASTM D1883, CBR)

Test Pit No.	Depth (ft)	Maximum Dry Density (PCF)	Optimum Moisture (%)	NMC (%)	CBR at 0.1 at 95% Compaction
TP-4	2 to 5	105.4	19.1	24.8	6.1
TP-9	2 to 6	111.6	16.3	14.0	7.4

Natural soil moisture contents for the samples tested ranged from 7.8 to 59.0 percent, averaging approximately 17 percent. The higher moisture contents were generally associated with the more fine-grained samples near the ground surface and moderately plastic soils. Grain-size distribution test reports, moisture-density relationship curves, CBR test reports and natural moisture test results are included in Appendix C.

ANALYSIS AND RECOMMENDATIONS

Based upon the results of this study, it is our opinion that construction of the proposed subdivision is feasible, given that the following recommendations are followed, and that the standard level of care is maintained during construction. It should be noted that problems associated with perched groundwater, shallow weathered rock, and wet, sensitive soils could be encountered during construction. Discussions of these issues, as well as general site development procedures are included in the following paragraphs.

Earthwork

As previously discussed, the subject site contains a few residential structures, barns, stables, and horse training facilities in the central and western portions. Additionally, the site contains asphalt and gravel driveways and various utilities associated with existing structures, as well as remnant slabs and demolition debris on the eastern portion. The general sequence of construction should consist of demolition and removal of existing and abandoned structures not to remain; including their below grade components such as underground storage tanks, foundations, concrete floor slabs, and utilities. Any excavations made for the removal of below grade tanks, foundations, utilities or drain tiles in structural areas should be backfilled with compacted structural fill meeting the requirements outlined below.

Prior to the placement of any structural fill, the area should be stripped to remove any vegetation, cultivated soil/topsoil, organic material, surface debris, existing fill materials or other unsuitable materials. Topsoil/cultivated soil was encountered at depths ranging approximately 2 to 15 inches and root balls from the larger trees may extend 2 to 3 feet. The actual stripping thickness will be dependent on localized topsoil development, root mat thickness, precipitation, soil moisture, construction traffic disturbance and contractor care. Topsoil should be stripped from within a minimum of 5 feet beyond the proposed building and pavement limits. The topsoil may be stockpiled onsite for future use in landscaped areas but would not be suitable for reuse in structural areas. Based on our on-site observations, localized areas of existing fill associated with the on-site farming roads and previous development will likely be encountered. These fill materials are not considered suitable for foundation support and should be evaluated before leaving in place for any slabs or roadway support. Additional subsurface explorations may be necessary in areas that had been previously developed if structures or infrastructure are planned.

Following stripping, the building and pavement areas to receive fill should be proof-rolled to locate any soft or loose areas on the subgrade. Any surficial materials identified as unstable or unsuitable should be undercut to a stable stratum and backfilled with structural fill or stabilized as recommended in the field by the Geotechnical Engineer. It should be noted that the stripping of organics, subgrade evaluations, undercutting of any unsuitable/unstable material, and placement of controlled, compacted fill should be observed by a geotechnical engineer or their qualified representative. Near surface fine-grained soils will generally be wet of their optimum moisture and will be sensitive to heavy construction traffic. Care should be taken during mass grading to not disturb the subgrade soils in structure areas. Drying of the subgrade may be necessary before placing compacted structural fill. New structural fill should be placed in lifts and compacted in accordance with the specifications included in this report.

We recommend that positive drainage be maintained across the site during construction to prevent ponding of water, since the exposed subgrades could destabilize in combination with construction traffic and precipitation. Furthermore, heavy construction traffic should generally be run on designated haul roads during periods of wet weather to reduce the potential for destabilization of more subgrade areas than necessary. If the subgrade is disturbed by construction traffic and becomes unstable, undercutting and replacement of these surficial materials will be required.

The on-site materials classified as ML (silt), SM (silty sand), SC-SM (silty, clayey sand) and with some limitations CL (lean clay), are considered suitable for use in structural fill construction. Any large rock fragments encountered during construction should be removed or processed to less than 6 inches in size and mixed with suitable residual soils. Any materials classifying as CL, CH, and MH, if encountered, should generally not be used for structural fill within the upper 1 to 2 feet of pavement subgrade or beneath foundations without chemical stabilization, but can be used for construction of stormwater management berms or in the nonstructural areas.

At the time this study was performed, some of the soils were wet of the optimum moisture content for compaction, with moisture contents in the range of 8 to 59 percent, compared to optimum moisture contents in the range of 16 to 19 percent. Moisture conditioning of the on-site, non-plastic granular soils should not be a significant problem during favorable weather conditions. However, the fine-grained or plastic, granular soils will require significantly more drying effort if they are wet of optimum at the time earthwork proceeds. The excavated materials will generally need to be within 2 to 3 percentage points of the optimum moisture for compaction before compactive effort is applied. Off-site borrow, if required, should meet Unified Soil Classification System (USCS) designation SC, SM, SP, GP, GM, or GW and be approved by the Geotechnical Engineer prior to use. All structural fill should be constructed in maximum 8-inch thick loose lifts and be compacted to the following specifications:

COMPACTION SPECIFICATIONS

Fills supporting foundations, retaining walls, floor slabs, and within walls or slopes steeper than 5H:1V	95% of ASTM D698 Moisture: within 3% of optimum
Fills within top 1 foot of pavement subgrade	98% of ASTM D698 Moisture: within 2% of optimum
Fills below 1 foot of pavement subgrade	95% of ASTM D698 Moisture: within 3% of optimum

Fill subgrades and each lift of fill should be observed and tested by a soils technician on a full-time basis, under the supervision of a registered engineer as required per the International Residential Code. All compactive effort should be verified by in-place density testing. New fills constructed on slopes steeper than 5H:1V (horizontal to vertical) should be keyed into existing slopes for stability considerations. All fill slopes steeper than 5H:1V should generally be placed as structural fill and be controlled and compacted to minimum densities as specified above. Slopes constructed steeper than 3H:1V should be evaluated for stability and may need to be designed with reinforcement.

Subsurface Utilities

The natural soils are considered suitable for support of below grade utilities. Granular bedding may be required to provide uniform support if soft/loose soils, groundwater, or rock are encountered as dictated by site conditions or as required by local code. Refusal was encountered within the highly weathered rock at Test Pits TP-2, TP-8, and TP-12 through TP-17, at depths of approximately 7½ to 10½ feet below existing grades. As such, deeper trench excavations may be difficult in these areas. It should be expected that excavations into the weathered rock or beyond the bucket refusal depth may not be possible without the use of large excavation equipment equipped with rock teeth or rippers, blasting, or other special rock removal techniques. We recommend that the rock excavation be completed prior to construction of foundations, subsurface utilities, or site retaining walls to avoid the potential problems that could result from vibrations caused by the rock removal operations.

We recommend that the construction documents identify all excavation as "unclassified" to avoid disputes that often arise as to the definition of rock. If excavation must be bid as "classified" then your agreement must include a definition of rock. An example definition of rock for contractual purposes is presented below:

> Rock is defined as massive bedrock that cannot be dislodged by a D-9 Caterpillar tractor, or equivalent, equipped with a hydraulically operated power ripper, or by a Caterpillar 245 excavator, or equivalent, equipped with rock teeth but without the use of hoe rams or other breaking techniques. Boulders or masses of rock exceeding 1 cubic yard in volume shall also be considered rock excavation. This classification does not include materials such as loose rock, concrete or other materials that can be removed by means other than breaking by hoe rams, etc., but which for reasons of economy in excavating the Contractor chooses to remove by other methods.

If excavation is bid as "classified" then a rock excavation allowance should be established and be included in the base bid with add/deduct unit prices per cubic yard (measured in-place) to adjust the base allowance. It should be noted that variations in the depth to partially weathered rock will exist between boring locations and rock may be encountered at shallower depths across the site during mass excavation.

Groundwater or perched water was encountered in some of the test borings and test pits at depths of approximately 4 ½ to 13 feet below the existing ground surface. Therefore, groundwater could impact utility construction, particularly in the low-lying areas of the site adjacent to the streams and wetlands, and perched water could be encountered at the soil/weathered rock interface during the wet season. Problems associated with groundwater include seepage into the excavation, loss of stability, sidewall collapse, and sloughing of soils. These problems can be reduced through the use of dewatering techniques, such as sumps, but will likely be marginally effective. Trench shields may also be required for support of vertical cut excavations where utilities are deeper than 4 feet to reduce sidewall collapse. Due to the potential for collapse of unsupported excavations in granular soils, the utility contractor should be prepared to provide adequate earth support and dewatering systems during utility construction.

Utility pipe systems below pavement and other structural areas should be backfilled using compacted structural fill. The backfill should be placed and compacted in accordance with our *Earthwork* recommendations.

Foundations

Assuming maximum wall loads of 4 klf and column loads of 20 kips; the proposed structures may be supported on shallow spread footings designed for a net allowable bearing pressure of up to 3,000 pounds per square foot (psf). Minimum widths for wall footings of 16 inches and column footings of 24 inches are recommended when design based on 3,000 psf results in a more narrow footing. Settlement on the order of 1-inch total and ½-inch differential can be anticipated, based on the assumed loads. Exterior footings should be founded a minimum of 36 inches below the final exterior grades to provide protection from frost action, unless otherwise required by local code.

Footings should be supported on the medium dense or stiff natural soils or on new properly compacted structural fill. In localized areas, it may be necessary to undercut foundations at saturated zones or where soft/loose soils are encountered. The decision to undercut footings should be made in the field during footing construction. Based on the test borings and test pits excavations of basements can generally be accomplished by conventional means provided the site grades are not lowered significantly. However, difficult excavation may be encountered in the vicinity of Test Pits TP-2, TP-8, and TP-12 through TP-17 where refusal was encountered within the dense weathered rock materials.

GTA recommends that concrete placement be performed the same day footings are excavated to prevent exposure of the soils at footings level and potential weakening of the soils.

Groundwater was encountered at 11 locations at depths ranging from 4.4 to 12.9 feet below the ground surface. It is believed that the encountered water was a result of perched conditions and/or water influenced by nearby wetlands or streams. Depending on the site grades and basement elevations, problems may be encountered during foundation construction during the wet season or after periods of heavy precipitation. If perched water or groundwater in encountered, a layer of open-graded aggregate can be placed across the basement subgrade to facilitate drainage and protect the subgrade soils. Additionally, the use of dewatering devices such as sumps or gravity flow trenches will likely be sufficient in aiding in dewatering. Construction of permanent exterior and interior drains with interior sump pumps are recommended to direct accumulated subsurface drainage away from the foundation.

Detailed foundation evaluations should be performed in each footing excavation prior to the placement of reinforcing steel or concrete. These evaluations should be performed by a representative of the Geotechnical Engineer to confirm that the allowable soil bearing capacity is available. The foundation bearing surface evaluations should be performed using a combination of visual observation, comparison with the test pits, hand-rod probing, and Dynamic Cone Penetrometer (DCP) testing.

Floor Design

Floor slabs can be designed as concrete slabs on grade. GTA recommends that the concrete floor slabs supported on grade be founded on a 4-inch (minimum) coarse granular layer covered with polyethylene vapor barrier to interrupt the rise of capillary moisture through the slab. Imported washed gravel or crushed stone materials meeting the gradation of AASHTO No.

57 aggregate are considered suitable for the granular layer. Natural and compacted fill subgrades for support of the floor slabs should be observed to evaluate stability prior to placement of concrete. The slabs may bear on wall or footing projections, but they should be isolated and jointed so that the foundation walls can settle slightly without affecting the slab.

Lateral Earth Pressure

Below grade walls and retaining walls will have to be designed to resist lateral earth pressures from the retained soils. The following properties may be used in the design of below grade foundation walls and retaining walls. These properties consider the use of either the on-site granular soils or on-site fine-grained soils as structural fill.

LATERAL EARTH PRESSURE SUMMARY

Soil Property	On-Site, Granular Soils
Unit Weight, γ	125 pcf
Angle of Internal Friction, Φ	30°
Coefficient of Active Earth Pressure (Ka)	0.33
Coefficient of Passive Earth Pressure (Kp)	3.00
Coefficient of Earth Pressure at Rest (Ko)	0.5
Base Friction, tan δ	0.5
Equivalent Fluid Pressure (Unrestrained Top of Wall)	42 psf/ft
Equivalent Fluid Pressure (Restrained Top of Wall)	63 psf/ft

Drainage panels and a perimeter drain should be provided behind below grade walls and retaining walls to carry away any infiltrating surface water so that hydrostatic pressures do not develop. The perimeter drain should consist of a minimum 4-inch diameter slotted or perforated pipe encased in a minimum of 6 inches of crushed stone that is wrapped by a geotextile filter. The crushed stone should meet the gradational requirements of AASHTO Size No. 57 aggregate. The perimeter drain should tie into a sump pit, adjacent storm sewer, or off-site drainage system. Where retaining walls are used, the collection system should discharge water to weepholes, which are at least two inches in diameter and spaced at maximum eight feet on center. All below grade foundation walls adjacent to occupied spaces should be waterproofed.

Pavements

GTA recommends that the upper 12 to 18 inches of pavement subgrade be constructed of on-site granular soils with characteristics tabulated below:

Liquid Limit (AASHTO T89)	35% or less
Plasticity Index (AASHTO T89, T90)	15% or less
Maximum Dry Density (AASHTO T99)	105 pcf or greater
California Bearing Ratio	5% or greater

Based on the results of our laboratory testing, soils with these characteristics should be readily available at the site. However, some of the surficial fine-grained soils are moisture sensitive and micaceous and generally have a low sheer strength without confinement. Undercutting, replacing with granular soils, crushed stone, or the use of geosynthetics may be necessary in some areas where destabilization of the subgrade occur. Prior to construction of pavement sections, the pavement subgrade should be reviewed to verify design parameters and proof-rolled with a loaded tri-axle dump truck under the direct supervision of the Geotechnical Engineer to evaluate stability. Unsuitable soils should be over-excavated to a stable layer.

The natural site soils may become disturbed and softened from excess moisture and construction equipment traffic. Contractors should anticipate that remedial work could be required to achieve a stable subgrade prior to placing stone and paving, even if the subgrade soils had previously been compacted to the required densities. Prudent planning and earthwork procedures will reduce the potential necessity for remedial work. Road fills should be placed and compacted in accordance with the recommendations outlined in the *Earthwork* section of this report.

Heavy construction traffic should not be allowed on partial pavement sections since such traffic can damage the pavement. The paving contractor should be advised that they must control construction traffic to limit disturbance of previously approved subgrade, stone base course, or completed asphalt. Some patching and repair may be necessary prior to placement of the final wearing surface layer of asphalt due to construction traffic.

SWM Facilities

Based on our observations made during the subsurface exploration, it is our opinion that managing stormwater quality through the use of infiltration will be feasible with some limitations in portions of the site. However, the surficial fine-grained soils could impact the design and construction of the proposed facilities. Where infiltration is desired, it is recommended that the proposed subgrades be extended through the fine-grained soils in to the sandy residual soils. If the subgrades need to be undercut below the design grade, the proposed subgrade elevations can be re-established with ASTM C33 sand (concrete sand) or AASHTO #57 stone.

The guidelines established in the Pennsylvania Stormwater Best Management Practices Manual, Appendix C *Site Evaluation and Soil Testing* indicates that the minimum infiltration rate for all runoff reduction and infiltration practices is 0.1-inch per hour. Also, a vertical separation of two (2) feet from the seasonal high groundwater elevation is required. Infiltration is not considered practical in the areas near test pits TP-4 and TP-10 due to shallow limiting zones and/or lower infiltration rates.

Unfactored field measured infiltration rates ranged from no discernable rate to greater than 4 inches per hour at the tested locations and depths. However, we recommend that a design infiltration rate of no more than 25 to 50 percent of the field measured rate be used for the final design of the facility. We do not recommend averaging rates at various locations and applying the averaged rate to the site or per facility. This recommendation is based on the inherent problems associated with these systems as they become less permeable due to densification during construction and partial clogging or siltation occurring over time. Additionally, design phase infiltration testing should be performed to confirm the preliminary rates in this report.

Once the design of the proposed facilities has been completed, GTA should be provided the opportunity to review the plans to evaluate if the geotechnical issues have been addressed. Also, GTA should be provided the opportunity to review the facility subgrade during construction and perform additional field testing, if warranted. This is to observe compliance with the design concepts, specifications or recommendations, and to allow for field changes in the event that the soils conditions differ from that anticipated prior to that start of construction.

CONSTRUCTION OBSERVATION

We recommended that during construction of the subject project, a geotechnical engineer be retained to provide observation and testing services for the following items.

- Perform a supplemental subsurface investigation for the building, retaining wall, and deep utility excavations.
- Perform additional infiltration testing at alternate depths and/or locations.
- Review final civil and structural plans to evaluate if they conform with the intent of this report.
- Observe the proof-rolling of fill and pavement subgrades prior to placing fill or base course to evaluate stability.
- Provide observation and testing services during fill placement to evaluate if the work is being performed in accordance with the project specifications and intent of this report.
- Review excavated footings for compliance with the project drawings and the intent of this geotechnical report.
- Provide Special Inspections as required by the project specifications and Westtown Township requirements for the clubhouse.

LIMITATIONS

This report, including all supporting test boring, test pit logs, field data, field notes, laboratory test data, calculations, estimates, and other documents prepared by GTA in connection with this project, has been prepared for the exclusive use of Toll Brothers pursuant to the agreement between GTA and Toll Brothers, Inc., and in accordance with generally accepted engineering practice. All terms and conditions set forth in the Agreement and the General Provisions attached thereto are incorporated herein by reference. No warranty, express or implied, is given herein. Use and reproduction of this report by any other person without the expressed written permission of GTA and Toll Brothers, Inc. is unauthorized and such use is at the sole risk of the user.

The analysis and recommendations contained in this report are based on the data obtained from limited observation and testing of the encountered materials. Test borings and test pits indicate soil conditions only at specific locations and times and only to the depths penetrated. They do not necessarily reflect strata variations that may exist between the test pit locations. Consequently, the analysis and recommendations must be considered preliminary until the subsurface conditions can be verified by direct observation at the time of construction. If variations in subsurface conditions from those described are noted during construction, recommendations in this report may need to be re-evaluated.

In the event that any changes in the nature, design, or location of the facilities or lots are planned, the conclusions and recommendations contained in this report should not be considered valid unless the changes are reviewed and conclusions of this report are verified in writing. Geo-Technology Associates, Inc. is not responsible for any claims, damages, or liability associated with interpretation of subsurface data or re-use of the subsurface data or engineering analysis without the expressed written authorization of Geo-Technology Associates, Inc.

The scope of our services for this geotechnical exploration did not include any environmental assessment or investigation for the presence or absence of wetlands, or hazardous or toxic materials in the soil, surface water, groundwater or air, on or below or around this site. Any statements in this report or on the logs regarding odors or unusual or suspicious items or conditions observed are strictly for the information of our Client.

This report and the attached logs are instruments of service. The subject matter of this report is limited to the facts and matters stated herein. Absence of a reference to any other conditions or subject matter shall not be construed by the reader to imply approval by the writer.

161348 **GEO-TECHNOLOGY ASSOCIATES, INC.**

Important Information about This

Geotechnical-Engineering Report

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

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, clients can benefit from a lowered exposure to the subsurface problems that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed below, contact your GBA-member geotechnical engineer. Active involvement in the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Geotechnical-Engineering 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 given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. *Those who rely on a geotechnical-engineering report prepared for a different client can be seriously misled.* No one except authorized client representatives should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one – not even you – should apply this report for any purpose or project except the one originally contemplated.*

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read it *in its entirety*. Do not rely on an executive summary. Do not read selected elements only. *Read this report in full.*

You Need to Inform Your Geotechnical Engineer about Change

Your geotechnical engineer considered unique, project-specific factors when designing the study behind this report and developing the confirmation-dependent recommendations the report conveys. A few typical factors include:

- the client's goals, objectives, budget, schedule, and risk-management preferences;
- the general nature of the structure involved, its size, configuration, and performance criteria;
- the structure's location and orientation on the site; and
- other planned or existing site improvements, such as retaining walls, access roads, parking lots, and underground utilities.

Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- 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;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the 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. *The geotechnical engineer who prepared this report cannot accept responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

This Report May Not Be Reliable

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, that it could be unwise to rely on a geotechnical-engineering report whose reliability may have been affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If your geotechnical engineer has not indicated an "apply-by" date on the report, ask what it should be,* and, in general, *if you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying it. A minor amount of additional testing or analysis – if any is required at all – could prevent major problems.

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface through various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing were performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgment to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team from project start to project finish, so the individual can provide informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, *they are not final*, because the geotechnical engineer who developed them relied heavily on judgment and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* revealed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a full-time member of the design team, to:

- confer with other design-team members,
- help develop specifications,
- review pertinent elements of other design professionals' plans and specifications, and
- be on hand quickly whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction observation.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for informational purposes only.* To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report, but they may rely on the factual data relative to the specific times, locations, and depths/elevations referenced. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include 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 personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. As a general rule, *do not rely on an environmental report prepared for a different client, site, or project, or that is more than six months old.*

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, none of the engineer's services were designed, conducted, or intended to prevent uncontrolled migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration.*** Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

Telephone: 301/565-2733
e-mail: info@geoprofessional.org www.geoprofessional.org

APPENDIX A

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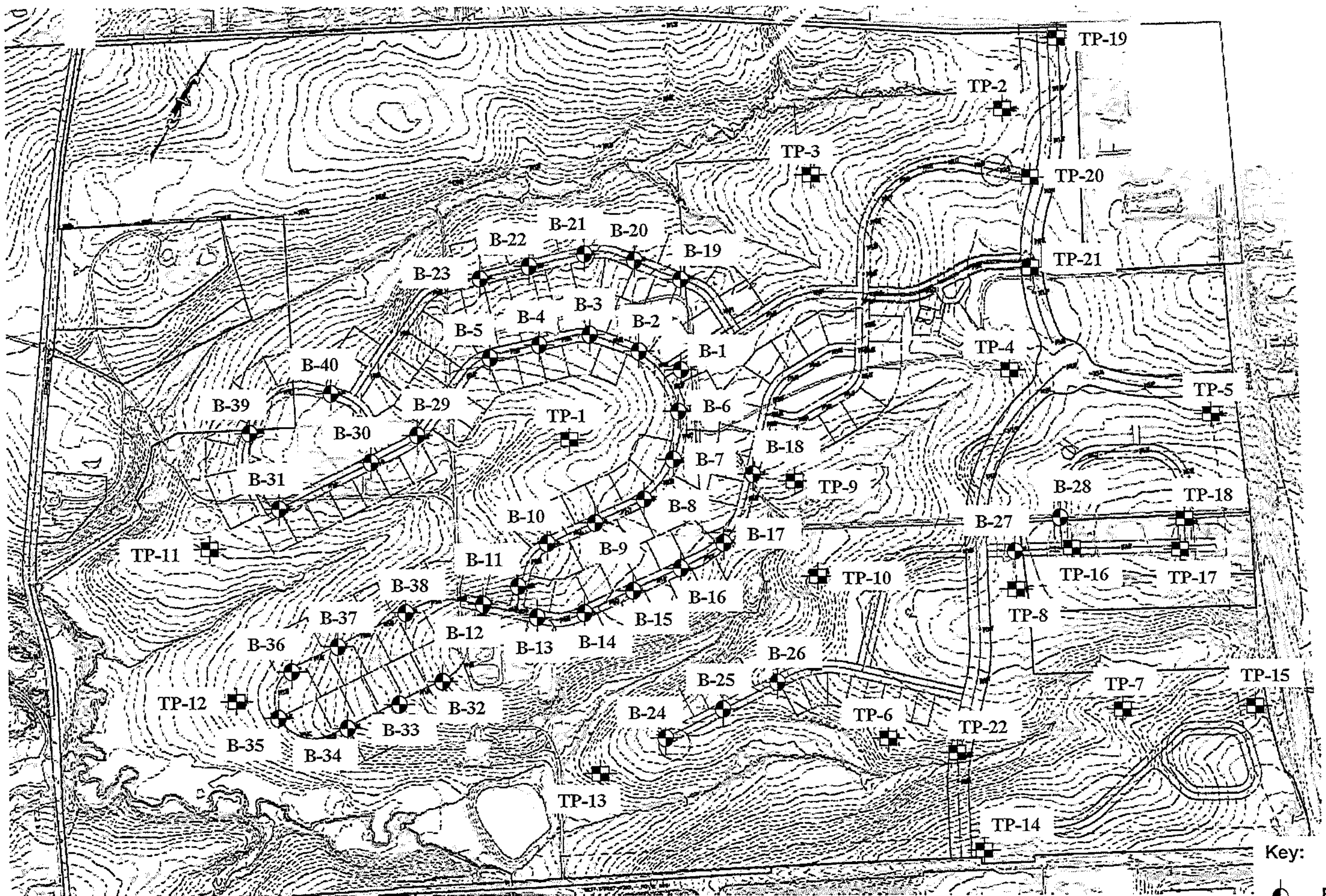
Notes: (1) Layout was obtained from a Google Earth Imagery, dated October 7, 2011.

GTA	GEO-TECHNOLOGY ASSOCIATES, INC. *Geotechnical and Environmental Consultants* 18 Boulden Circle, Suite 36 New Castle, Delaware 19720 (302) 326-2100 Fax (302) 326-2399	SITE LOCATION MAP **CREBILLY FARM** WESTTOWN TOWNSHIP CHESTER COUNTY, PENNSYLVANIA

SCALE	DATE	DRAWN BY	REVIEW BY	JOB NO.	FIGURE:
NTS	AUG 2016	GOOGLE	CMR	161348	1



Notes: (1) Layout was obtained from an untitled and undated test locations plan, prepared by ESE Consultants, Inc.
(2) Exploration Location Plan should be read together with GTA Report, Job No. 161348 for complete evaluation.

Key:

B-# Number and approximate location of Standard Penetration Test Borings performed for this study

TP-# Number and approximate location of Test Pits performed for this study

JOB NUMBER:	161348
FIGURE:	2
REVIEW BY:	CMR
SCALE:	NTS
DATE:	AUG 2016

EXPLORATION LOCATION PLAN

CREBILLY FARM

WESTTOWN TOWNSHIP
CHESTER COUNTY, PENNSYLVANIA

GEO-TECHNOLOGY ASSOCIATES, INC.
Geotechnical and Environmental Consultants
18 Boulden Circle, Suite 36
New Castle, Delaware 19720
(302) 326-2100
Fax (302) 326-2399

Drainage Area Plans

8

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PRELIMINARY DRAINAGE AREA PLAN

CREBILLY FARM

WESTTOWN TOWNSHIP, CHESTER COUNTY, PENNSYLVANIA

DATE: 2018/10/7 | SCALE: 1"=200' | DESIGN: JMJ | DRAWN: JMJ | JOB NO.: 4050 | FILE NAME: 4050-S-DR-PRE | REF. NO.: DR40.01 | SHEET NO.: 1 of 2

REV.	DATE	DESCRIPTION	DRAWN

ESE Land Planning Engineering Land Surveying

ESE Consultants, Inc.
250 Gibraltar Road,
Suite 2E
Horsham, PA 19044
Tel: 215-914-2050
Fax: 215-293-5488

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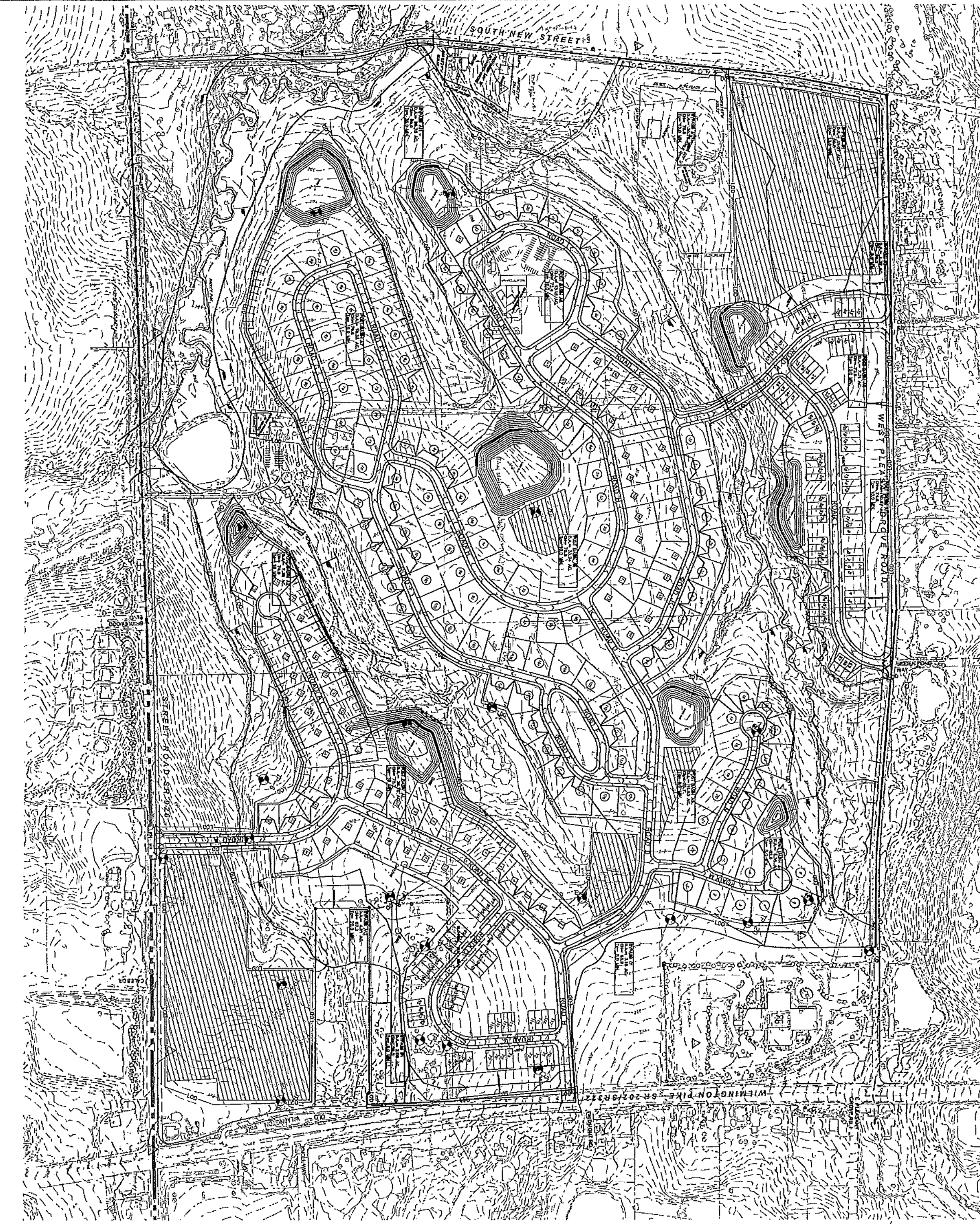

HORIZONTAL GRAPHIC SCALE
200 0 200 400
(IN FEET)
1" = 200 FEET

POST DEVELOPED
DRAINAGE AREA PLAN

CREBILLY FARM
WESTTOWN TOWNSHIP, CHESTER COUNTY, PENNSYLVANIA

REV.	DATE	DESCRIPTION	DRAWN

ESE
Land Planning
Engineering
Land Surveying

ESE Consultants, Inc.
250 Gibraltar Road,
Suite 2E
Horsham, PA 19044
Tel: 215-914-2050
Fax: 215-293-5488

DATE: 2018/10/7
SCALE: 1"=200'
DESIGN: JMJ
DRAWN: JMJ
JOB NO.: 4050
FILE NAME: 4050-S-DR-POST
REF. NO.: DR40.02
SHEET NO.: 2 of 2