Sweetland Engineering & Associates, Inc.
600 Science Park Road
State College, PA 16803
(814) 237-6518
Fax: (814) 237-1488

Saybrook Stormwater Management Basin Inspection Summary
SEA #: 6431-SAYB
June 28, 2018

Introduction

On May 18, 2017, Sweetland Engineering & Associates, Inc. (Sweetland) was retained by the Saybrook Homeowners Association (HOA) to conduct an inspection and investigation of stormwater management Basins 2, 3, and 4, before accepting ownership and responsibility for the Basins. See Figure 1 for a location of the Basins within the development.

Figure 1. Locations of stormwater management basins within the Saybrook development. Basins 1 and 5 to be maintained by others.

On Tuesday, May 1 and Wednesday, May 2, 2018, Dr. Katie Blansett, P.E. and Mr. John Fisher, E.I.T. of Sweetland conducted double ring infiltration testing according to the Pennsylvania Stormwater Best Management Practices Manual, Appendix C – Site Evaluation and Soil Testing Protocol. The testing was intended to determine the existing infiltration of the basins so the rings were inserted at the surface of the basin bottom without removing vegetation. The most recent measurable precipitation to the

testing was 0.02 inches of rain on 4/27/2018 (The PA State Climatologist). The most recent significant rainfall was 0.71 inches on 4/16/2018. Table 1 summarizes the results of the infiltration tests for all test locations and Table 2 summaries rates by Basin.

Photo 1
Ring diameters of 12 inches and 6 inches were used for the double ring infiltration tests. The rings were driven into the ground at least 4 inches.

Table 1. Infiltration test results for 10 test pit locations.

Test Pit #	Basin #	Time Interval (min)	Average Drop in Water Level (in)	Infiltration rate (inches per hour)
1	2	30 min	0.23	**0.47**
2	2	30 min	0.23	**0.47**
3	2	30 min	0.20	**0.40**
4	2	30 min	0.80	**1.60**
5	2	30 min	0.06	**0.12**
6*	2	30 min	0.47	**0.93**
7	3	30 min	0.06	**0.12**
8	3	30 min	0.06	**0.12**
9	4	10 min	1.54	**9.24**
10	4	10 min	1.57	**9.40**

*A perc test rather than a double ring infiltration rate was conducted at TP 6.

Table 2. Average infiltration rate for each basin.

Basin #	Average Infiltration rate (inches per hour)
2*	0.61
3	0.12
4	9.32

*The average value for Basin 2 does not include TP 6 because that was a perc test rather than an infiltration test.

Basin 2

Infiltration testing in Basin 2 was conducted on 5/2/18. According to the design plans for this basin, the basin bottom is at two different elevations. The eastern portion is at a slightly lower elevation holding

runoff during small events. The western portion of the basin is slighter higher and provides storage during larger events, but not infiltration for smaller, more frequent events. There is no outlet structure to this basin. If the volume of runoff exceeds the storage and ability to infiltrate, Basin 2 will overflow over land through a drainage easement to Basin 3.

Test pits and infiltration tests were confined to the eastern part of the basin where infiltration is a primary function. Figure 2 shows the locations of the test pits within the infiltration area of Basin 2. Photos 2-13 document the basin condition and testing observations. The average infiltration rate for Basin 2 was 0.61 in/hr.

Figure 2. Test pit/infiltration test locations within the eastern, infiltration area of Basin 2.

Photo 2
There is little to no topsoil at test pit 1. The soil is very clayey and breaks apart into large, angular chunks.

Photo 3
Infiltration test 1 was conducted in an area that had been disturbed during a basin repair conducted in the summer of 2017.

Photo 4
The soil profile shows nearly no top soil and clay smear from the shovel.

Photo 5
Based on the rate of fall during the pre-soak, an infiltration testing time interval of 30-minutes was used for all test pits in Basin 2. The average drop in water level at TP 2 over the 30-minute interval was 0.23 in.

Photo 6
The soil profile at TP 2 shows nearly no top soil.

Photo 7
A soil clod from the ground surface at TP 2 shows no top soil.

Photo 8
More than 15 minutes after the rings were removed from the ground at TP 3, water continued to lay at the surface and runoff rather than infiltrate.

Photo 9
There is a higher density of grass at TP 4 than there is in other areas within the infiltration area of Basin 2. Although there is still little topsoil, the soil is less compacted and there is a looser soil structure as compared to TP 1, 2, and 3. The average drop in water level over 30-minutes was 0.8 inches.

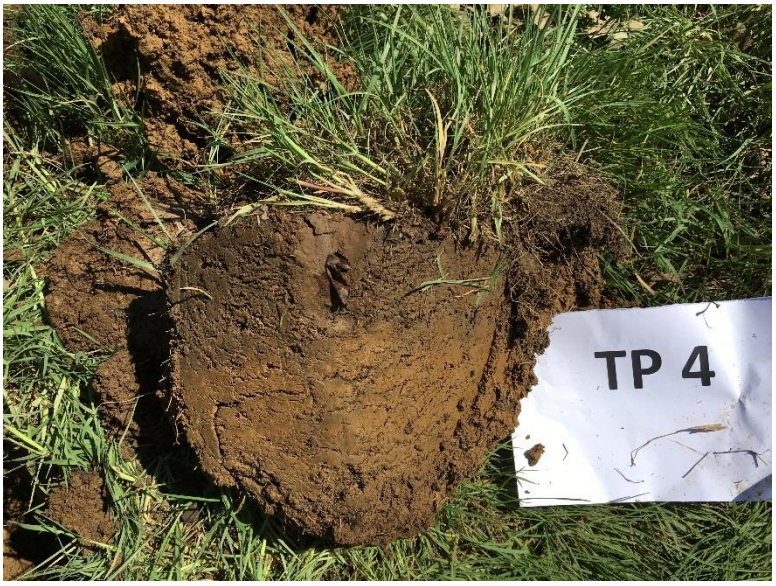

Photo 10
A soil clod from the surface at TP 4 shows a darker top layer, which indicates a higher content of organic material.

Photo 11
TP 5 is in the general vicinity of basin work completed in the summer of 2017. This location had the lowest infiltration rate in Basin 2. The average drop in water level of the 30-minute test interval was 0.06 inches

Photo 12
After the test was completed at TP 5 and the rings were removed from the ground, the rings remained clogged with a chunk of clay that was pulled out with the testing equipment.

Photo 13
Following the testing at TP 5, water continued to sit in the depression created by the rings and did not infiltrate.

Basin 2 Modifications

As can be seen in the photos and reflected in the infiltration data, there has been some compaction of the soil in Basin 2. Some of the surface area of the Basin bottom are bare, without vegetation. During the summer of 2017, Sweetland twice observed modifications to the Basin 2 made within the lower portion of the basin. Construction equipment was in the basin bottom and material was stock piled which would have compacted soil and removed or killed vegetation. Photos 14 – 22 document observations of basin modifications

Photo 14
Modifications to Basin 2 were observed on 5/22/17. An area was excavated with soil stock piled in the Basin while aggerate was placed in the hole.

Photo 15
During the 5/22/17 modifications, the placed aggregate was covered with a fabric and then the soil was replaced.

Photo 16
There was a light rain on 5/22/17. Equipment rutted the basin embankment and floor.

Photo 17
During the 5/22/17 modifications, stone was placed at the southeast inflow pipe. Equipment left rutting in the vicinity of the work.

Photo 18
During the 5/22/17 modifications, rutting from equipment can be seen in the Basin embankment and bottom in the area of the basin that is designed for infiltration.

Photo 19
At the end of work day on 5/22/17, the disturbed areas were covered with straw. It is not known if the areas were also seeded.

Photo 20
Three days after the Basin 2 modification, a rain storm washed away straw (5/25/17).

Photo 21
Three days after the Basin 2 modification, a rain storm washed away straw (5/25/17).

Photo 22
Additional basin modification were completed on 6/7/17

Photo 23
The embankment area that had already been disturbed on 5/22 was further disturbed 6/7/17. There was a light rain which would have increased soil compaction

Photo 24
During the 6/7/17 modifications, the excavated area filled with water. Excavated material was stock piled in the basin, which would increase the likelihood on compaction of the soil below.

Information about the basin modifications was not provided to the Saybrook HOA.

Basin 2 infiltration rate analysis

Since there is no outlet structure to Basin 2, it is important that soil in the basin bottom allow water to infiltrate at a rate that prevents stagnate ponding and conditions that support mosquito breeding.

The report "Soil Infiltration Capacity in Two Stormwater Detention Basins at the Saybrook Farms Development," prepared by Todd Giddings and Associates, Inc (TGAI) and dated February 8, 1993 states that two double ring infiltration tests (Tests 2 and 3) were conducted in Basin 2 yielding rates of 0.024 ft/min (17.3 in/hr) and 0.009 ft/min (6.48 in/hr), respectively. Based on a spillway elevation of 1222.0 ft, the maximum water depth at the location of Test 2 is 8.60 feet and the maximum water depth at the location of Test 3 is 4.5 feet. According to the TGAI report, "this location could accommodate the infiltration of the maximum water depth of 8.60 feet in 5.97 hours" at Test Location 2. At Test Location 3, "the time required for this maximum water depth of 4.5 feet to infiltrate the subsurface would be 8.33 hours.

There was a Ferguson Township ordinance in place at the time that required stormwater management basins to dewater within 72 hours. If water were ponding at the maximum depths, an average minimum infiltration rate of 1.4 in/hr at Test Location 2 and 0.8 in/hr at Test Location 3 would be needed to dewater the basin within the required 72 hours. The average of six (6) infiltration tests conducted by Sweetland on May 1, 2018 was 0.66 in/hr. A comparison of the current soils infiltration condition to the design parameters, shows that the soils in the basin are not able to infiltrate at the necessary rates to dewater the basin within the required 72 hours. Table 3 summarizes the test location data from the TGIA 2/8/93 report and the measured current values.

Table 3.

	Values from TGIA 2/8/93 report					
	Max water depth (ft)	Infiltration rate (ft/min)	Infiltration rate (in/hr)	Time to drain (hr)	Avg minimum infiltration rate needed to drain max depth in 72 hours (in/hr)	5/1/18 Field measured average infiltration rate (in/hr)
TL 2	8.60	0.024	17.28	5.97	1.4	0.6
TL 3	4.50	0.009	6.48	8.33	0.8	

Basin 3

Infiltration testing in Basin 3 was conducted on 5/2/18. According to the design plans this basin was designed to have infiltration across the entire bottom. Figure 3 shows the locations of the test pits within the infiltration area of Basin 3. Photos 25-32 document the basin condition and testing observations. The average infiltration rate for Basin 3 was 0.12 in/hr.

Figure 3. Test pit/infiltration test locations within the Basin 3.

Photo 25
At permit termination basin should have 70% vegetation cover. Basin 3 does not meet this criteria.

Photo 26
Test pit 7 shows a clay soil with a very dry surface layer.

Photo 27
The lower portion of the basin bottom is caked with sediment and is not likely to grow vegetation without soil amendment and plantings.

Photo 28
Vegetation in the upper portion of the basin is patchy with bare areas.

Photo 29
Vegetation in the upper portion of the basin is patchy with bare areas.

Photo 30
There are bare spots of soil around the embankment and outlet structure. Erosion of soil is likely here.

Photo 31
The outlet channel is not stabilized with vegetation and further erosion is likely to occur.

Photo 32
The inflow pipe toward the northeast shows channelization and further erosion is likely.

Basin 4

Infiltration testing in Basin 4 was conducted on 5/3/18. According to the design plans, the basin has been designed for infiltration across the bottom. Figure 4 shows the locations of the test pits. Photos 33-36 document the basin condition and testing observations. The average infiltration rate for Basin 4 was 9.32 in/hr.

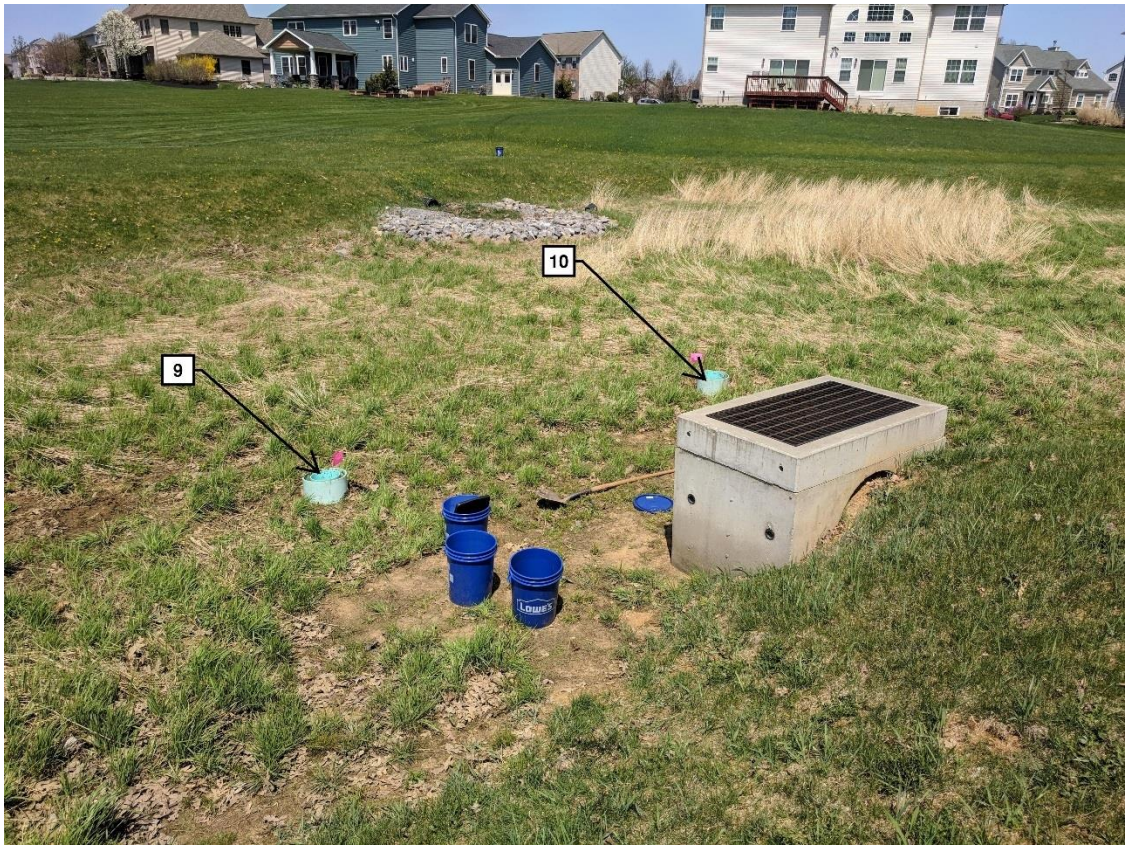

Figure 4. Test pit/infiltration test locations Basin 4.

Photo 33
Basin 4 is vegetated with a mix of different grasses but also has bare patches.

Photo 34
Test pit 9 shows more top soils and a looser soil structure than in the pits within Basins 2 and 3.

Photo 35
TP 9 ran dry during the pre-soak period so the 10-minute test interval was used.

Photo 36
Test pit 10 shows more top soils and a looser soil structure than in the pits within Basins 2 and 3.

Recommendations

The Saybrook Development is located in the Nittany Valley and underlain by Stonehenge Formation limestone bedrock. There is a risk of sinkhole formation over the fractured limestone bedrock in the valleys of Ridge and Valley Physiographic region. Although infiltration from stormwater management doesn't dissolve limestone at a rate to increase the risk of subsurface void creation, the excess weight of retained stormwater in a basin over an existing void can increase the risk of sinkhole formation.

It is our recommendation that the following site improvements be made to the basins to support long-term growth of grass, improve the uniformity of infiltration and to limit soil erosion. It is our opinion that these improvements are necessary to have the basins meet the standards of the previously approved design plans and standard infiltration basin construction practices. With the basins in their current state, there is an increased risk of sinkhole formation, soil erosion and excessive standing water. The excessive standing water can create conditions conducive to mosquito breeding and increases the risk of drowning with increased exposure to standing water. These factors create an unnecessary increase in liability for long term maintenance costs, regulatory agency enforcement and risk to public safety

Basin 2

- The HOA should be provided with all documentation for the modifications made during the summer of 2017, including the reason for conducting the repairs, the design methodology for the repairs and any documentation of the resulting condition from the repairs.
- Within the lower area of the basin, modification should be made to restore infiltration:
    - Remove approximately 7" of clayey soil,
    - Till basin bottom,
    - Place a minimum of 5" of topsoil (there is no depth of topsoil noted on the design plan, but a minimum of 4-6" is required/industry standard to support grass growth), and
    - Vegetate to achieve a uniform 70% perennial vegetative cover per PA Code Ch 102.22(a)(2)(ii).
- Do not run construction equipment across the basin bottom, except as shown in the original construction documents or per a revised construction plan sealed by a professional engineer.
- Do not preform work while soil is wet.

Basin 3

- Clean around outlet structures. Remove leaves and other dead vegetation
- Modification should be made to restore infiltration:
    - Remove approximately 8" of clayey soil,
    - Till basin bottom,
    - Place 6" of topsoil per Saybrook Final Subdivision Plan Phase 10, Post Construction Stormwater Management Plan, Sheet PSCM 2, dated 3/21/14.
    - Vegetate to achieve a uniform 70% perennial vegetative cover per PA Code Ch 102.22(a)(2)(ii).
- Place riprap at the outlet of the northeast inflow pipe as noted on Saybrook Final Subdivision Plan Phase 10, Post Construction Stormwater Management Plan, Sheet No PSCM 1, dated 3/31/14.
- Establish vegetation around the embankment of the basin
- Establish vegetation in the outflow channel. May need to include reinforcing if slopes are too steep for stabilization with vegetation alone. (Design for channel was not reviewed as part of this report.)
- Do not run construction equipment across the basin bottom, except as shown in the original construction documents or per a revised construction plan sealed by a professional engineer.
- Do not preform work while soil is wet.

Basin 4

- Clean around outlet structures. Remove leaves and other dead vegetation.
- Establish permanent vegetation in areas of bare soil to meet a uniform 70% vegetative cover per PA Code Ch 102.22(a)(2)(ii).