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July 17, 2013

Mr. Michael Kissinger, P.E.
Pennoni Associates, Inc.
One South Church Street, 2nd Floor
West Chester, PA 19382

RE: Wayne Glen (formerly Richter Tract)
Conditional Use Stormwater Management Review
Stormwater Management Review Letter No. 1

Dear Mr. Kissinger:

Enclosed you will find the Township Review Letter No. 1, generated by Princeton Hydro, LLC on behalf of Tredyffrin Township, for the Stormwater Management portion of the Conditional Use Application for the Wayne Glen Project. The attached Review Letter No. 1 provides comments on the proposed stormwater management design and management facilities for the Wayne Glen proposed development submitted by Pennoni Associates, Inc. for compliance with HR-375, Chapter 174 – the Tredyffrin Township Stormwater Management Ordinance, the Trout Creek Stormwater Overlay Ordinance, and the 2010 Trout Creek Study.

As stated in our call earlier today, Tredyffrin Township, along with our Princeton Hydro review staff would like to sit down and review these comments with Pennoni Associates, Inc. design staff within the next two weeks. Please contact me once you have had an opportunity to review the letter, and to schedule a review meeting. I can be reached at (610)-408-3616 or at EngineeringDept@tredyffrin.org with any questions or comments on the attached review letter.

Sincerely,

Stephen Burgo, P.E.
Township Engineer

cc: Mr. Burgo, P.E. – Township Engineer
Mr. Martin – Township Manager
Mr. Baumann – Director of Planning and Zoning
PC & BOS – Tredyffrin Township
Mr. Duckworth – Arcadia Land
Mr. Rich Wilson – Arcadia Land
Mr. Emerson, P.E., PhD. – Princeton Hydro, LLC
Mrs. Damerau – PADEP

Scientists, Engineers &
Environmental Planners
Designing Innovative
Solutions for Water,
Wetland and Soil
Resource Management

July 15, 2013

Tredyffrin Township
Attn: Stephen Burgo, PE
Township Engineer
1100 Duportail Road
Berwyn, PA 19312-1079

Re: Wayne Glen Independent Stormwater Review
Tredyffrin Township, Chester County, Pennsylvania
pH No. 1380.001

Dear Steve,

Princeton Hydro is pleased to provide Tredyffrin Township with this letter report which summarizes our review of the proposed stormwater management for the Wayne Glen development. We have reviewed the conditional use application in the context of its compliance with the Township Ordinance and the Trout Creek Overlay District Ordinance. We have made an attempt to directly compare and assess the project's compliance with these ordinances with the proposed design plans. This process ensures that there is consistency between the design plans and the calculations that are used to directly evaluate whether or not a project meets the requirements. At this stage we have made an attempt to focus on the general regulatory compliance of the project rather than comment on specific details of the proposed stormwater management features.

Based on our review of the provided documentation we do not believe that the engineer has demonstrated that the current design will be in compliance with the Township requirements including peak flow rate and volume control.

Documents Reviewed

The following documents were provided to us by the applicant's engineer for the purpose of our review.

- Wayne Glen (aka Richter Property) Conditional use application under the Trout Creek Stormwater (TCS) Overlay Ordinance (HR-396), prepared by Arcadia Tredyffrin, LLC, dated April 22, 2013.
- Post-Construction Stormwater Management Report, Wayne Glen Tredyffrin Township, Chester County, PA, prepared by Pennoni, dated April 22, 2013.

- Wayne Glen Conditional Use Submission, Tredyffrin Township, Chester County, Pennsylvania, 50 Sheets, prepared for Arcadia Tredyffrin, LLC, prepared by Pennoni, dated April 22, 2013.

We have not reviewed the Post-Construction Stormwater Management Operations & Maintenance Document in detail due to the current stage of the application process.

Introduction

The applicant is proposing to develop the property located at Walker Road and Old Eagle School Road; known as the Richter Property. Currently the property consists of two parcels totaling approximately 37 acres. The applicant is proposing the creation of the Wayne Glen development which includes a residential section with 113 new residential units as well as a professional parcel with two new buildings totaling 60,000 square feet.

The property is located in a headwater section of Trout Creek and contains an unnamed tributary (aka Weadley Branch) of Trout Creek which is described as an ephemeral stream which typically only has observable flow during periods of and immediately following rainfall. The contributory drainage area of the tributary in the area of the property is reported to be on the order of one square mile, all of which is located upstream (south) of the property in question. The tributary on the property is located just below the confluence of the "Weadley Road" and "Avonwood Drive" tributaries identified in the Trout Creek Study. The tributary flows under Walker Road at the northern side of the property.

The application seeks to use the bonuses offered in the TCS Overlay Ordinance. In an effort to meet these criteria, the application includes a variety of stormwater control measures (SCMs) to address runoff peak flow rate and volume. The application also incorporates a large regional detention basin which is proposed in the center of the residential section in the location of the stream channel.

General Comments

The proposed stormwater management approach uses a combination of various types of distributed SCMs. The general approach to stormwater management in the Wayne Glen submission is commendable.

In general, the stormwater documentation is well organized, clear, and concise. The proposed site stormwater management approach and supporting calculations are complex and the engineer should be commended for their ability to convey the necessary information in a manner that can be readily interpreted.

Only a few minor discrepancies were noted. The calculations imply that the engineer delineated the contributory drainage areas to all SCMs, however these delineations were not provided. We discussed this with Pennoni and they stated this was not provided in an effort to simply the submission. This is reasonable, however we would suggest that this information be provided in any future submissions.

Drainage area names and acreage totals are not consistent between the Drainage Area Map (DA-2) and the post development calculation output (Appendix B). The totals listed on the Drainage Area Map are also not consistent with our own independent measurements taken from the design plans. This issue was also discussed and confirmed with Pennoni. We suggest that this be rectified in any future submissions.

Rainfall Data

The engineer provides a summary table of the various sources of rainfall data relevant to Tredyffrin Township. In the routing calculations, the engineer uses rainfall data which is consistent with the Trout Creek Study which includes a two-year storm of 3.16 inches. In the volume control calculations (Worksheet 4) the engineer uses a rainfall depth of 3.21 inches. It is suggested that the engineer should use a consistent rainfall depth to represent the two-year storm in both the volume calculations and the routings (peak flow compliance).

Curve Number Methodology

The applicant uses composite Curve Numbers (CNs) to calculate runoff from the property under both pre and post-development conditions in the peak flow rate routings. This can drastically under predict runoff under post-development conditions especially for small drainage areas with significant impervious cover; like the ones considered in this analysis. The effect is magnified in the smaller storms (1 one- and two-year) and becomes less critical in the larger storms (100-year). For this reason Section 23, B.4. of the Township Ordinance states that "Weighted averaging of ground cover for calculation purposes is not permitted." It should be noted that the volume control calculations appropriately use a separate CN calculation instead of the composite CN calculation.

The drainage area "PDRA-4A" is the direct contributory drainage area to Subsurface Infiltration Basin 1 it contains two smaller drainage areas. Based on the Runoff Volume Control Calculations (Appendix C), this SCM has a total drainage area of 2.82 acres which was determined to produce 15,665 cubic feet of runoff during the two-year storm (3.21 inches) using a non-composite CN analysis. Bioretention Basin 12 is located within the drainage area for Subsurface Infiltration Basin 1. This SCM has a drainage area of 0.42 ac and was determined to produce 1,921 cubic feet of runoff from a non-composite or separate CN analysis. Therefore the total drainage area to

Subsurface Infiltration Basin 1 consists of a total of 3.24 acres and is correctly calculated in Appendix C with separate CN values to produce a total of 17,586 cubic feet of runoff in the two-year storm.

In order to determine the relative impact of the use of a composite CN value, this non-composite CN result is compared to the composite CN method used in the post-development calculations. The post-development calculations and routings contained in Appendix B indicate that for the two-year storm (3.16 inches) this same 3.24 acre drainage area with a composite CN of 78 will produce only 14,600 cubic feet of runoff (see page 153 of Appendix B). The use of different rainfall amounts for the two-year storm make direct comparisons difficult, however, our independent calculations indicate that if 3.21 inches of rainfall were used the runoff would only increase to 15,100 cubic feet; which still under predicts the runoff by approximately 14%.

As another example, drainage area "PDRA-3B" is the only drainage area to Bioretention Basin 4. Analysis of the composite versus non composite CN calculation for this area indicates that the use of a composite CN underestimates the runoff volume by approximately 16%.

In summary, the use of composite CN values likely underestimates the runoff for the two-year storm by between 10 and 20%. This will have a direct result on the ability of the site to meet the peak flow rate requirements since the low estimates for runoff will translate into lower predicted peak flow rates. The calculations should be revised using a non-composite method to be more accurate and consistent with the Township Ordinance.

Peak Flow Rate Control Compliance

In order to qualify for bonuses outlined in the TCS Overlay Ordinance the engineer must demonstrate substantial peak flow rate reductions including reducing the one-, two- and five-year post-development peak flow rates down to 50% of the predevelopment one-year peak flow. They must also demonstrate a 50% reduction below the predevelopment peak flow rates for the 10- through 100-year storms.

Based on our review of the plans and supporting calculations, it is our opinion that the applicant has not demonstrated compliance with these requirements. The primary reasons for this conclusion include the use of composite CNs and discrepancies in the modeled storage in numerous proposed SCMs.

As was discussed in the previous section, the calculations/routings underestimate the peak flow rates due to an underestimate of the runoff volume. This is a result of the use of composite CN values.

Review of the calculations indicates that the Bioretention Basins are assumed to infiltrate at 0.5 in/hr and the Infiltration Basins are assumed to empty at 0.75 in/hr. These rates do not appear to be conservative in our opinion as is discussed in a later section of this report. However, we expect that this assumed infiltration rate will have limited influence on the results of the routings which assume the SCMs are fully drained prior to the storm. However, it will have a major influence on the peak flow compliance if the infiltration SCMs cannot fully dewater in 72 hours.

The post development calculations for each of the proposed SCMs were not reviewed to the full level of detail and no attempt was made to fully duplicate the calculations. However, a select few calculations that were reviewed in detail were found to have inconsistencies that cause us to question the purported compliance with the peak flow rate requirements.

For example, the post development calculations for Infiltration Basin 2 indicate that the basin area at an elevation of 150 feet will have a surface area of 4.78 acres (see page 523 of Appendix B). However, the Stormwater Management Report indicates that the basin will have an area of only 0.54 acres at this elevation. Our own independent measurements in the design plans indicate an area similar to the smaller value which is reported in the Stormwater Management Report. The total storage in the basin is represented by a value of 2.28 acre-feet (elevation 150 feet) in the calculations while the design plans and Stormwater Management Report state that the total storage at 150 feet is only 1.22 acre-feet. Therefore, these discrepancies suggest that the post development calculations substantially overestimate the storage and peak flow reduction potential of the basin. Similar overestimates of size and anticipated performance were also noted for the multiple proposed Bioretention Basins throughout the project.

Volume Control Compliance

Section 208-161.A(3) of the Township Ordinance states that developments within the TCS overlay district shall construct SCMs that "Recharge, evapotranspirate, and/or provide on-site capture and reuse of the total volume of stormwater generated by the proposed development during the 2-year/24-bour storm." In an effort to comply with the requirement the application includes numerous SCMs including Bioretention Basins, Permeable Pavers, and Subsurface Infiltration Basins. It is our opinion that the proposed design does not comply with the volume control requirements.

To demonstrate compliance the Stormwater Management Report includes "Worksheet 4" calculations which calculate the post-development runoff for the two-year storm, as well as the difference in runoff from pre- to post-development to demonstrate compliance with both the Township Ordinance and State regulations. In this situation the Township requirement is more stringent and therefore controls.

In the "Worksheet 4" analysis included in Appendix C of the Stormwater Management Report, the calculations for the three POI locations indicates a total of 566,595 square feet of impervious cover. However, Sheet 8 of the design plans indicates that between the residential and professional parcels there is a total of 587,039 square feet, not including the 42,000 square feet of proposed green roof. The reason for this apparent discrepancy could not be determined. These different totals suggest that there could be an additional 20,444 square feet of proposed impervious cover not accounted for in the volume control compliance calculations and design.

In order to meet the volume control requirements SCMs should be designed so they provide enough storage to contain the two-year runoff volume from their respective individual drainage areas. Any storage in excess of this volume will only be useful in storms greater than the two-year storm and therefore should not be counted towards compliance with the two-year requirement. A hypothetical and extreme example of this would be a large SCM located at the high point of the property will little to no contributory drainage area. The example SCM may have been sized to contain the property's entire two-year runoff volume, but if due to its small drainage area, the storage is not used, the design would not meet the Township requirement. Therefore any storage in excess of the two-year runoff volume to an SCM should not be counted towards the entire site's compliance.

In practical design applications it is difficult to perfectly evenly distribute storage throughout the project. However, efforts should be made to, on average, provide at least enough storage for the runoff from two-year storm for each SCM's drainage area. Furthermore, any excess storage that will not be used in the two-year storm should not be accounted for when demonstrating compliance.

For example, Subsurface Infiltration Basin 2 provides approximately twice the storage than would be useful in the two-year storm. However, this additional 24,568 cubic feet of storage is included in the net volume control compliance calculations for this POI.

A summary table of the reported volume control compliance summations (Pennoni) along with our own independent assessment and quantification of the volumes (pH) is provided below in Table 1. As the table shows, our independent calculations suggest that the proposed SCMs provide only 68% of the required storage. Explanations for the discrepancies are explained in the following three sub sections which focus on each of the SCMs used by Pennoni to demonstrate compliance with the volume control requirements.

Table 1. Summary of volume control compliance.

	POI #1		POI #2		POI #3	
	Pennoni	pH	Pennoni	pH	Pennoni	pH
Bioretention Basins	29,234	21,478	17,484	16,250	30,540	23,126
Permeable Pavers	31,409	10,641	42,746	12,996	0	0
Subsurface Infiltration Basins	0	0	8,429	8,175	58,669	30,533
Total Storage	60,643	32,119	68,659	37,421	89,209	53,659
Required	46,930		68,419		64,509	
Deficit	**14,811**		**30,998**		**10,850**	

Bioretention Basins

The plans include 15 Bioretention Basins which are designed with a three foot soil replacement and underlying stone bed. Most of the Bioretention Basins have an elevated outflow standpipe which is elevated one foot or less above the proposed basin bottom. The volume control calculations account for the surface storage below the outlet standpipe as well as the subsurface storage. A review of the storage calculations (stage vs. storage relationships) indicates that the surface storages are accurately represented. The subsurface storage calculations assume a 40% void space in the proposed stone beds and 10% in the amended soil. The 40% estimate is typical but likely high, while the 10% estimate in the amended soil is, in our opinion, reasonable.

As discussed in the previous section, a review of Appendix C of the Stormwater Management Report indicates that seven (7) of the 15 Bioretention Basins provide excess storage. The remaining eight (8) Bioretention Basins provide *less* than the required storage. The engineer arrives at a total storage in the Bioretention Basins of 77,258 cubic feet in between the three POIs. Our own calculations, which do not include excess storage beyond the two-year runoff volume, result in a total of only 60,854 cubic feet. Therefore, based on our assessment, the Pennoni calculations overestimate the storage provided in the Bioretention Basins by approximately 27%.

It should be noted that the storage calculations do not account for infiltration during the storm. However, the Appendix C calculations which are summarized on page C.6 display these calculations even though they are not explicitly used. The calculations for "Infiltration Volume" are intended to represent the volume of infiltration expected over a period of six hours over the area of the basin at a rate of 0.5 in/hr. However, the calculations fail to convert 0.5 in/hr into ft/hr and therefore overestimate this volume by a factor of twelve (12). Furthermore, the "Total Volume Abstraction" summation on page C.6 incorrectly sums the storage components by double accounting for "Total Storage Volume". As a result of these two errors the suggested volume abstractions grossly overestimate the performance of the SCMs. These values should either be corrected or be removed from the reporting as they do not accurately reflect the anticipated SCMs' volume control performance.

It should be reiterated that the volume control performance assumptions of the Bioretention Basins are contingent on the site having underlying soil which is capable of adequately dewatering the basins between storm events. More discussion on the anticipated infiltration capability of the site is provided in a later section of this report.

Permeable Pavers

The application proposes the widespread use of Permeable Pavers in an effort to comply with the volume control requirements. A total of over 88,000 square feet of Permeable Pavers are proposed. This SCM is an ideal tool which is frequently used to distribute infiltration across a site and manage rainfall/runoff close to its source. The incorporation of the Permeable Pavers on the proposed residential parcel is commendable and will undoubtedly have positive impacts on the stormwater management of the proposed development. An example screen shot from the Overall Stormwater Plan is provided below in Figure 1 to illustrate the density and amount of Permeable Pavers used in the design. The Permeable Paver areas are shown in dark blue.

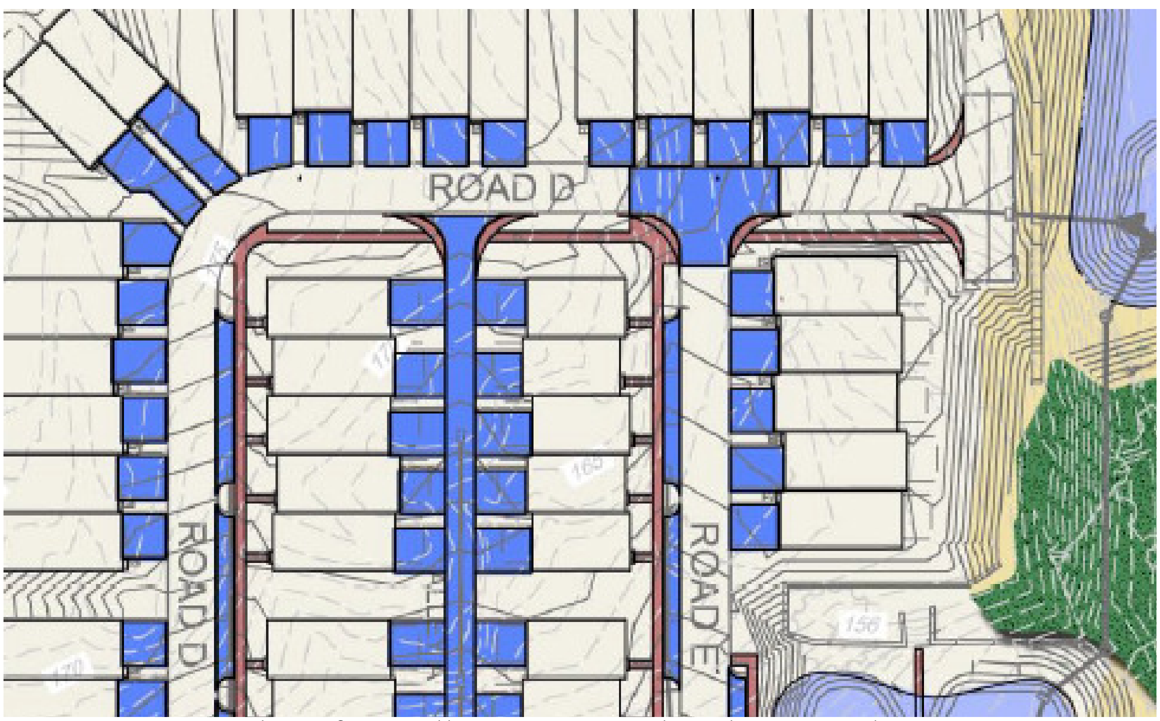

Figure 1. Screen shot of Overall Stormwater Plan showing reliance on Permeable Pavers.

Since the application relies heavily on Permeable Pavers, the method used to account for the volume control capabilities should be as accurate as possible. However, in our independent assessment of the anticipated two-year storage volume provided by the Permeable Pavers, we determined that the storage is likely over estimated by over a factor more than three (3); or 310%. To understand this discrepancy it is necessary to explain how Pennoni accounted for storage in the Permeable Pavers and how we suggest it should be accounted.

The Permeable Pavers are proposed to be constructed over a crushed stone storage bed. The thickness of the bed is typically two (2) feet for the majority of the area but is over six (6) feet in some areas in order to extend down to existing grade. The volume/storage calculations for these SCMs account for the entire storage in the bed. As discussed previously, it is our opinion that storage in excess of the two-year runoff volume should not be counted towards compliance with the requirement. Furthermore, most of the Permeable Paver areas have little to no contributory drainage area; that is to say that they only manage rainfall that fall directly on them. For a stone storage bed of 40% void space (standard but likely high) the entire volume of the two-year storm (3.21 inches) would be contained in a stone bed depth that was approximately eight (8) inches thick. Therefore any storage in excess of this thickness should not be counted towards compliance with the two-year volume control requirement. Review of the proposed total area and storage of the Permeable Pavers indicates that the average thickness is 2.1 feet, which is roughly a factor of three times larger than what should more accurately be counted.

Additionally the proposed Permeable Paver areas are generally not level. Notable areas include the driveways for all residential units and Alley A between the proposed Townhomes. Alley A varies in elevation by approximately 14 feet from the north end to the south end. The stone storage bed beneath the Permeable Pavers is only proposed to be one (1) foot thick. The storage calculations assume the bed will provide an even depth of storage throughout the entire length and 14 foot vertical elevation differential. In reality rainfall that infiltrates the upgradient pavers will flow up and out of the pavers at the lower end of the alley. Based on the proposed slope of the alley, only approximately the bottommost 50 feet of the 600 foot long alley will likely provide appreciable storage. An analogy for this concept is a cookie sheet tray. It can store the full volume of water when flat, but a slight slope will eliminate most of its storage.

For this reason Appendix B of the Township Ordinance (Section 2. Design Considerations b.) states that "infiltration BMP bottom areas shall be level and in no case shall have a slope greater than 0.5%." The slope in the proposed ally is greater than 2%. Our estimates for the Permeable Paver storage do not account for lost storage due to slope.

Subsurface Infiltration Basins

A total of three Subsurface Infiltration Basins are proposed for the Wayne Glen development. All three of these SCMs are located in the professional parcel. These SCMs consist of perforated pipe encased in a crushed stone bed. Similar to the previous two SCM sections in this report, the volume control calculations overestimate the two-year storage provided by the basins by accounting for storage in excess of the two-year runoff volume for the individual drainage areas.

Most notably, Subsurface Infiltration Basin 2 provides approximately twice the storage than would be utilized in the two-year storm. However, this additional 24,568 cubic feet of storage is included in the net volume control compliance calculations. The calculations for all three of the proposed Subsurface Infiltration Basins over account for the two-year storage in the same fashion.

SCM Loading Ratio Compliance

In Appendix B A.2. of the Township Ordinance, it is suggested that the a maximum loading ratio of 8:1 relating total drainage area to infiltration area be followed and that a maximum loading ratio of 3:1 relating impervious drainage area to infiltration area in karst areas be followed.

The Stormwater Management Report summarizes the reported loading ratio values for all the SCMs in Appendix C. For the Bioretention Basins reported loading ratios range from 3 to 13:1 for total area and 1 to 8:1 for impervious area. The Subsurface Infiltration Basin reported values range from 4 to 5:1 for total area and 2 to 3:1 for impervious area. The two surface Infiltration Basins have loading ratios of 7:1 (total area) and 2:1 (impervious area) for Infiltration Basin 1 and 8:1 (total area) and 4:1 (impervious area) for Infiltration Basin 2. However, it is our opinion that these reported loading ratio values are misleading and generally underestimated.

For example, Infiltration Basin 2 is listed to have a total drainage area loading ratio of 8:1. This assumes an infiltration surface area of 28,466 square feet for the basin and a drainage area of 5.35 acres. However, the basin's bottom contour is at an elevation of 144 feet and has a total area of only 7,405 square feet; which would imply a loading ratio of 31:1. The basin has a six (6) inch orifice at an elevation of 145.5 and the top of the riser is proposed at 148.50 feet. At an elevation of 145.5 feet direct outflow begins and at this elevation the basin still only has a wetted area of 12,632 square feet; this area would result in a loading ratio of 18:1. It is not clear why an infiltration surface area of 28,466 square feet was used in the reported calculation. At an elevation of 150 feet, the highest reported in the surface storage table in Appendix C, the basin still only has a surface area of 22,259 square feet which would imply a total loading ratio of 10:1, instead of the reported 8:1. Similar underestimates are expected in relating to the 3:1 ratio desired in karst areas. Similar discrepancies in reported loading ratios are expected for SCMs throughout the project.

Furthermore, the total drainage area to Infiltration Basin 2 is somewhat underestimated at 5.35 acres. The Stormwater Management Report states "that since many of these SCMs are in series, the loading ratio calculations are based on the area to the facility, excluding an upstream previously treated area." The total drainage area to Infiltration Basin 2 including upstream SCMs is reported in Appendix B to be 8.31 acres. This estimate for drainage area would result in a loading ratio of 49:1 if the basin bottom contour area of 7,405 square feet is used, or 29:1 if the wetted area at the point of discharge is used to represent the infiltration area (elevation 145.5).

As was previously mentioned, the Stormwater Management Report states that the loading ratio calculations do not account for drainage area to the SCM that has previously been treated by an upstream SCM. This primarily relates to areas that flow into a Bioretention Basin prior to flowing into one of the Infiltration Basins. Many of the SCMs are arranged in series as described above. This is usually advantageous from a water quality and volume standpoint. However, it should be clear that this practice of arranging SCMs in series further concentrates flow. Based on the site geology this may not be the best option for the development. As illustrated above, it also has a major impact on the reported loading ratios which should be clearly understood.

Infiltration Testing and Anticipated SCM Performance

The proposed stormwater management system relies heavily on infiltration. The proposed SCMs include Bioretention Basins, Infiltration Basins, Permeable Pavers, and Subsurface Infiltration Basins all rely on infiltration to properly function. If the SCMs do not empty within a reasonable time, full design storage will not be available for use. If this occurs, the volume control and peak flow rate reduction capabilities of the SCMs can be drastically reduced or eliminated in their entirety. It is understood that the infiltration testing completed to date is preliminary and a much more thorough and detailed investigation would need to be completed in the future.

In support of the design the Stormwater Management Report includes two reports which summarize in-field infiltration testing and soil explorations. These reports include the original GAI report dated November 3, 2010 and a Pennoni memorandum dated April 9, 2013.

It should be noted that neither of the investigations use USDA soil textural descriptions as is required in Appendix C of the PA BMP Manual. Both efforts used double-ring infiltrometer in general compliance with the PA BMP Manual, although neither appeared to follow the ASTM standard for this method (ASTM D-D3385

Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer).

The GAI report summarizes a series of infiltration tests which were conducted in test pits and boreholes. Specifically double-ring infiltration tests were conducted in the three test pits. The report does not further describe the test with respect to actual test conditions, ring sizes, depth driven, presoak etc. These tests were clustered towards the northern portion of the site since the purpose and scope of the testing was not for the current scope of the Wayne Glen development.

Only one of the three tests pits encountered soil which would generally be considered to be highly conducive to infiltration. Soil encountered and tested in test pits TP21-2 and TP21-4 are described in USCS terminology as Lean Clay with Sand (CL) and Lean Clay (CL). Grain size analyses were conducted and demonstrated that some soil sample contained more than 90% fines and less than ten percent sand.

The results of the tests ranged from0.12 in/hr in a “Lean Clay with Sand” to 4.3 in/hr in a Silty Sand. Some of the results are unexpected, especially the 2.7 and 2.2 in/hr reported for a Lean Clay, these values are at least an order of magnitude higher that would normally be expected. In general the tests indicate that the finer grained native material is likely not highly conducive to infiltration.

The Pennoni memorandum summarizes the completion of six (6) test pits distributed throughout the property. The logs report that across the entire site the soils encountered were described as Silty Clay and Clayey Silt. These soils are not ideal for infiltration. However, the test results range from 0.38 to 1.9 in/hr; which in our experience seems high for the fine grained soils (>50% passing the No. 200) that are described. The routing calculations in Appendix B assume 0.5 in/hr for the Bioretention Basins and 0.75 in/hr for the Infiltration Basins. In our opinion these estimates are not conservative.

In summary, the preliminary soil testing results are marginal at best for infiltration. The proposed stormwater management system relies heavily on infiltration. Therefore the importance of thorough and proper infiltration testing cannot be overstated. In the case were marginal soils are encountered, the best approach is to spread the infiltration out across the site to mimic natural conditions as much as possible. To some extent the current project has attempted to accomplish that. However, due to the size and scope of the project, it is our opinion that additional infiltration testing should be conducted. We would also suggest that testing be completed by a professional soil scientist or a professional engineer with experience in soil classification and infiltration testing.

Regional Detention Basin

The applicant is proposing to provide a large regional detention basin in the center of the residential parcel. As the Stormwater Management Report mentions, this property was identified in the original Trout Creek Study as a good location for a regional stormwater management facility. The plans indicate that the existing 4x6 foot culvert under Walker Road will be replaced with one of equal dimensions. The plans also indicate that two three-foot diameter culverts will be added at an elevation above the invert of the 4x6 foot culvert. Additionally the Stormwater Management Report states that additional area for water ponding will be provided by “flattening the overbank areas” of the tributary. Due to the site’s complex existing topography it is difficult to determine the scope of the proposed earthwork in the area of the proposed regional basin. It would be helpful to have a color rendering of this area illustrating areas and depths of cut and fill. The design also proposes the creation of a berm on the upstream side of Walker Road. This will provide additional storage during larger storms.

The basin will only provide minimal peak flow reduction in the smaller more frequent storms. For example, 2 and 6% reductions are reported for the one- and two-year storms. This is due to the fact that the size of the culvert will not be changed and there appears to only be minimal additional storage proposed at low lower elevations. A more thorough comparison of the proposed earthwork in this area may better determine if the widespread grading in this area is worthwhile.

Furthermore, the small storm performance of the proposed regional basin should be better defined for comparison purposes. An examination of Appendix F and Appendix G of the Stormwater Management Report indicates that the proposed Walker Road culvert was modeled under post-development conditions along with the proposed topography of the regional basin. The culvert and the topography are used to define the “Reg Basin” element in the post-development conditions. The pre-development calculations do not simulate the Walker Road culvert and instead use a single node, or junction to define this point. However, based on descriptions of the area and the original Trout Creek Study, it is apparent that the area of the proposed regional detention basin likely already provides some peak flow reduction capabilities. These impacts would be greatest in the smaller more frequent storms which come close to or barely overtop Walker Road and would likely be minimal during larger events similar to the 100-year storm. In fact, the original Trout Creek Study stated that any potential development in this area should “ensure that any modification of the existing Walker Road Culvert maintains, at a minimum, the same amount of storage or ponding upstream of the culvert as presently occurs so as to not reduce any attenuation that the existing culvert provides.”

The post-development calculations presented in the Stormwater Management Report do not account for any flow attenuation properties that currently exist at the site.

Therefore the peak flow rate reduction characteristics for the regional basin are likely smaller than reported with a greater difference for the smaller more frequent storms.

The Stormwater Management Report states that Walker Road currently over tops at flow rates in the range of the two-year storm. By constructing the proposed berm the basin will decrease the frequency of this current hazard. However, this introduces other potential hazards which currently do not exist. This includes the potential for a dam breach and the potential development of sinkholes due to the soluble bedrock identified at the site. These two conditions are not necessarily independent of one another.

The additional hydraulic load created by the temporarily impounded water in the proposed basin will increase the risk of sinkhole formation. We will provide more comment on geotechnical related aspects of the project once the more recent field data is collect and reported.

We understand that a dam breach analysis will be completed for the project. We believe that it is necessary that the Township fully understand the potential impact of a dam breach.

As was previously discussed with the Township, we suggest that the existing floodplain through this reach be mapped as this will likely have an impact on the by right plan. We have received a preliminary floodplain map for the northern portion of the property which was completed on behalf of the Turnpike. We have not reviewed the mapping methods or any supporting data, however, this information further confirms that the floodplain will likely have an influence on the by right plan. Having an updated and full floodplain map of the property will also enable a better comparison between the existing and proposed flow attenuation characteristics of the area upstream of Walker Road.

In summary, we believe that the incorporation of a large regional basin in the residential parcel of the property, if properly designed, can minimize the frequency and severity of the overtopping of Walker Road. However, as is detailed above, we believe that additional data should be provided by the applicant before we can ensure that the currently proposed regional basin will provide the intended benefits currently reported in the Stormwater Management Plan.

Summary and Conclusions

This concludes our initial review of the proposed Wayne Glen development. We would like to reserve the right to make additional comments in the future as it becomes necessary. I look forward to meeting with you to discuss this report in detail and answer any questions you may have. Please do not hesitate to contact me with any questions. We appreciate the opportunity to provide Tredyffrin Township with these services.

Sincerely,

Clay Emerson, Ph.D. PE CFM
Princeton Hydro, LLC

Cc: Keithe Merl, PE CPESC, Princeton Hydro
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Steve Souza PhD, President
Encl: (0)