REGENCY AT PROVIDENCE – STORMWATER SYSTEM DESCRIPTION

This is a description of the stormwater control system for the Regency at Providence community (RAP) in Upper Providence Township, PA. The system was designed by Eastern States Engineering (now ESE Consultants of Fort Washington, PA, a wholly owned subsidiary of Toll Brothers). The system consists of stormwater inlets, flared end sections, manholes, subsurface pipe, subsurface infiltration chambers, numerous swales, a rain garden, and various other control structures.

Rainwater and snowmelt from paved areas (roadways, parking lots, driveways and sidewalks) and runoff from unpaved areas of the community flows through the stormwater system to two retention (wet) ponds, one detention (dry) pond or to adjacent wetlands. A separate document posted to the RAP website describes those pond facilities, as well as a fourth pond, near the Fairmount entrance, which is not integral to the stormwater system. Beginning in October 2023 the stormwater system has been overseen by a committee of volunteer residents and maintained, as needed, by local contractors directed by the Community Association Executive Board through its management company.

Entries to the Stormwater System

Most of the rainfall and snow melt enters the system through inlets situated in the gutters of RAP's streets, in turf areas behind homes or in turf areas of HOA common property. Each inlet consists of a bicycle-safe structural steel grate set in a concrete cap that sits atop a precast rectangular reinforced concrete collection box which, in turn, is connected to subsurface stormwater piping. The bases of these structures are of various depths, depending on the topography and the depths of the pipe connected to them. Deeper collection structures are created by stacking sections atop one another - sealed by non-shrink mortar - and have aluminum access rungs embedded in one of the interior walls.

Type C (**c**ombination) inlets are located in the gutters of our paved roadways and have both a grate and a rectangular opening in the face of the curb for enhanced drainage flow. At eight locations in Phase IV's gutters, type C dual inlets are located side-by-side in order to achieve more efficient collection of stormwater. Type M (highway **m**edian or **m**ountable curb) inlets have only a grate and are located in turf areas or in roadway gutters where no curb exists. The number of each type of inlet in the community's stormwater network is as follows:

	Type C	Type M	Total
Phase I	41	17	58
Egypt Rd.*	5*	0	5
Phase II	26	18	44
Phase III	30	12	42
Phase IV	40	8	48
Total	142	55	197

*The Egypt Road inlets east of the Fairmount/Eden intersection take stormwater from Phase I areas and Egypt Road and direct them into Phase II; as a result, they are considered part of our system. Egypt Road stormwater inlets west of that intersection do not discharge into our system.

Type C inlet has both a grate and an opening in the face of the curb.

The RAP system contains one catch basin which is located in the Sloan clubhouse parking lot at the southeast corner of the parking island. In addition to pavement runoff, the basin takes water from the underdrains of the landscaped parking island and discharges it to the inlet at the southeast corner of the parking lot. The bottom of this basin is a 3" deep sump for capturing sediment, thus improving water quality in the downstream system.

Type M inlet usually found in turf areas of the community.

In some turf or unpaved areas stormwater enters the system via flared end sections (FESs). These structures are utilized in locations where floating debris such as leaves or twigs in surface water run-off could potentially plug the grate of an M type inlet, causing localized flooding during heavy rain events. Use of an FES will also reduce erosion and scouring when installed on the upstream side of an earthen embankment. Our community utilizes FESs made of both precast concrete and high strength plastic such as high density polyethylene (HDPE). Most of the flared end sections in Phase IV have aluminum child-proof grates bolted to the structure.

This concrete FES is in the embankment near the southwest corner of the tennis courts.

This flared end section directs runoff from the turf near Black Rock Rd. into the Phase IV system. Note the child-proof grate.

Manholes

RAP's stormwater system piping is also connected in several areas to access manholes that have circular cast iron solid covers, rather than grates. The cylindrical precast concrete manholes are four feet in diameter with built-in aluminum access rungs and sit atop a steel reinforced concrete base. A precast eccentric cone connects the cylindrical portion of the manhole structure to the cover's frame at ground level. The horizontal joints between stacked sections are sealed with non-shrink mortar. Usually located where drainage lines converge or change direction, these structures provide access to the system for maintenance, inspection and cleaning. The fourteen manholes are located in the following locations:

- Two near the Phase I northern site boundary behind 141 and 143 Sloan Road
- One in the roadway at the Sloan/Fairmount intersection
- Two in the roadway at the Eden/Hanover/Copley intersection
- One in the landscaped parking island across from 244 Hanover Road
- One near the Pond 2 inflow structure in the grass between 261 Hanover and the walking trail (with a cover incorrectly stamped "Sanitary Sewer")
- One in the roadway at the Copley/Peters intersection
- One near the Pond 3 inflow structure behind 416 and 418 Peters Way
- Two near the southwest shore of Pond 4

An eccentric cone connects the cylindrical manhole to the access point at ground level.

- One behind 734 and 736 Hillview Drive
- One behind 632 and 634 Regency Hills Drive
- One behind 633 Regency Hills Drive

Manhole access cover in the pavement of the Copley/Peters intersection

Manhole access cover near Pond 3 inflow structure

The community's paved streets also contain many manholes for the sanitary sewer system which is owned and maintained by the Upper Providence Township Municipal Authority. These manholes are connected by subsurface PVC and ductile iron pipe. The waste material in this system flows to the Lower Perkiomen Valley Regional Sewer Authority treatment plant located on Station Avenue in Oaks. The sanitary sewer system and our stormwater system are neither physically nor operationally connected.

Subsurface Piping

Directing the flow of stormwater from one point to the next is steel-reinforced concrete pipe (RCP). It consists of a welded steel cage imbedded in high strength concrete and is manufactured in various lengths and diameters. The steel cage is comprised of a circular steel wire spiral with steel bars running the length of the pipe, spot welded at the contact points. A video of the pipe manufacturing process can be viewed here. The pipe sections are set on compacted type 2A modified crushed stone material to form a dense, uniform base. The lengths of pipe are connected by either bell and spigot joints or by tongue and groove joints, sealed by rubber O-rings or gaskets. The Army Corp of Engineers rates the nominal expected life of RCP for stormwater service at 100 years when properly installed.

Spigot end of RCP (left), with rubber gasket, is being inserted into bell end of an adjoining section

Beginning at the upper elevations of our system the pipe diameters are small and become progressively larger to accommodate greater water flow in the downstream portions of the network. The RAP system consists of the following linear feet of the various sizes of RCP. These lengths were derived from ESE design drawings and, where available, ESE as-built drawings.

Lengths of RCP (feet) by Pipe Diameter (inches)

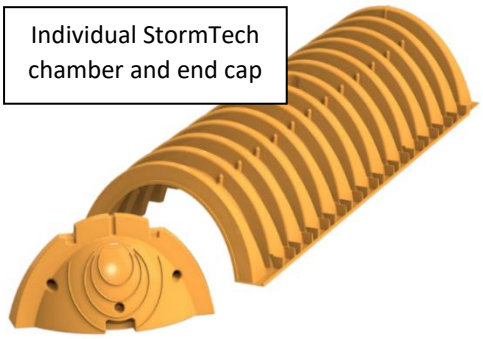
	15”	18”	21”	24”	27”	30”	36”	42”	48”	54”	Total
Phase I	1,952	1,812	572	686	921	52	1,143	0	37	0	7,175
Egypt Rd.*	0	58	0	191	0	0	0	0	126	0	375
Phase II	969	182	345	822	83	0	0	0	667	169	3,237
Phase III	1,989	120	158	88	0	0	646	27	0	0	3,028
Phase IV	2,582	1,712	0	430	0	313	758	0	0	0	5,795
Total	7,492	3,884	1,075	2,217	1,004	365	2,547	27	830	169	19,610

*See note in previous table

The RAP stormwater system also utilizes 25 feet of 34”x53” elliptical RCP exiting the last manhole prior to entering Pond 4. Using elliptical pipe with a large horizontal diameter allows for greater flow capacity in applications where the depth of buried pipe is restricted.

Infiltration Chambers

Infiltration chambers are installed below ground for the purpose of allowing stormwater flowing into them to accumulate and then percolate back into the underlying aquifer rather than be discharged into local streams, lakes, rivers or bays. This helps to recharge groundwater supplies, mitigate flooding and decrease the risk of erosion. RAP Phases I and II contain infiltration chambers that capture stormwater from certain inlets for this purpose; during very heavy precipitation events these chambers may overflow into the stormwater system and then, ultimately, to Pond 2.



Individual StormTech chamber and end cap

RAP’s individual chambers are StormTech SC-740 units that are each 30” high, 51” wide and 90.7” long. The open-bottom polypropylene chambers are stacked end-to-end (secured by overlapping the corrugations) and arrayed in side-by-side rows, four abreast (with the exception of a three-row section behind 264 Hanover Road), are surrounded by crushed stone wrapped in non-woven geotextile and then backfilled to grade level. Each individual chamber has 48 orifices in the sidewalls to allow any excess water that does not percolate out the bottom to flow into the surrounding crushed stone.

Outlets of these rows of chambers (which are similar to those at RAP) will be connected to the next inlet structure via a manifold of corrugated HDPE pipe.

Stormwater flows to an M type inlet structure which discharges into a high density polyethylene (HDPE) manifold which then distributes the water to each of the parallel rows of chambers; the final chamber in each row is connected to an HDPE outlet manifold and then into the next M type inlet. Inspection ports in the top of the first and last chambers of each row are accessed by vertical PVC pipe rising up to ground level; these allow for fiber optic camera inspections and/or measuring the depth of any sediment build-up on the chambers’ crushed stone base directly under the inspection port.

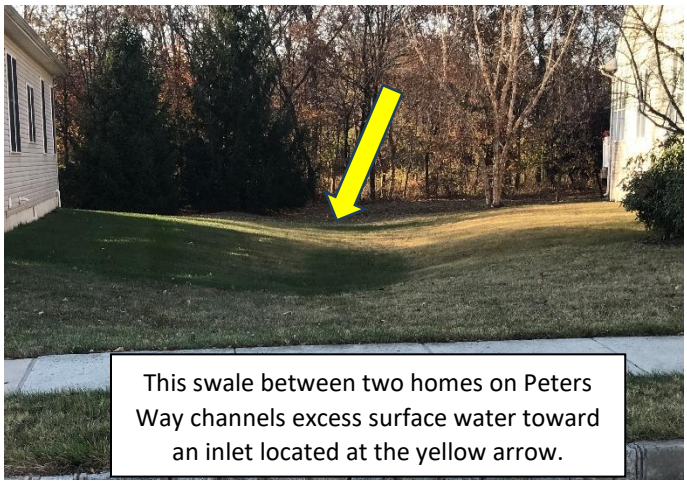
The twelve sections of RAP’s infiltration chambers in phases I and II are depicted in the Subsurface Network Layout section later in this document; they provide a total of 492,500 gallons of stormwater storage.

The design notes of the ESE Consultants drawings for RAP make reference to StormTech "Isolator Rows" that take all initial flow from the upstream inlets; wrapped in woven geotextile these chambers are intended to capture any sediment in the stormwater. Despite these design notes, it has been confirmed by visual inspection of the upstream inlet of each StormTech section that the RAP system contains no such isolator rows. This means that all the open bottom chambers sit directly on the gravel base of the trenches and that stormwater from upstream inlets flows equally into all the parallel rows of chambers. The ramification of the actual RAP installation can be seen in the following statement from the manufacturer, Advanced Drainage Systems:

> "A StormTech chamber system can only be cleaned when Isolator Rows are in use. Isolator Rows must be directly connected to a manhole, catch basin or other access structure. The Isolator Rows can be cleaned with Jet-Vac equipment."

Swales and Slopes

Throughout the community's turf areas numerous vegetated swales are used to capture and channel surface water away from certain areas (such as home foundations) and toward other areas (such as inlets and flared end sections). Using grass and natural vegetation, swales enhance water quality by filtering sediments, nutrients and pollutants before excess stormwater runoff enters the stormwater piping network on its way to the community's ponds. Swales also enhance surface water infiltration, thereby helping recharge ground water supplies.



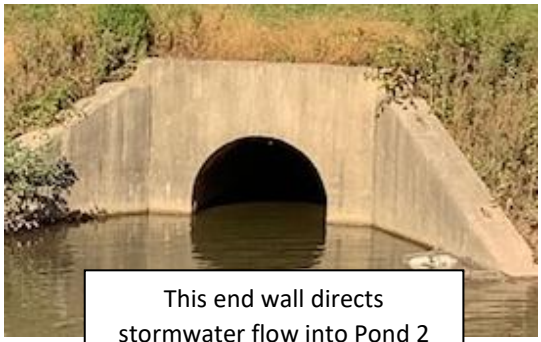
This swale between two homes on Peters Way channels excess surface water toward an inlet located at the yellow arrow.

In order to minimize standing water during rain events, both turf and paved areas are sloped to direct surface water toward collection points. Driveways and driveway aprons are sloped toward street gutters; sidewalks are slightly tilted toward the street; our 32 foot wide streets are sloped 1/4 inch per foot from the center toward the Belgian block curbing, making the gutters 4 inches lower than the crown of the street; and the gutters themselves are sloped at least the PennDOT minimum of 1/16 inch per foot along the length of the street to ensure proper flow to the next stormwater inlet.

Other Control Elements

The RAP stormwater system includes a number of other structures and features to reduce erosion, ensure effective drainage, enhance infiltration and minimize environmental impacts.

Head walls are precast concrete structures placed at the entrance to a culvert or subsurface piping. They stabilize the embankment, prevent erosion and help manage water flow. Their design (often with wing walls) helps reduce turbulence and scouring at the pipe inlet. They are located ahead of some earthen embankments as well as at the entrance to the culverts carrying the wetland stream under Egypt Road and Copley Road.



This end wall directs stormwater flow into Pond 2

End walls are precast concrete structures that are located at the outlet of culverts or piping; they are similar in appearance to head walls, but are typically more structurally robust in order to withstand the forces of both the embankment and water

pressure. They can be found at the inflow points of our ponds and in areas where our system discharges into adjacent wetlands and streams.

In order to enhance surface water infiltration, "**b**est **m**anagement **p**ractices" trenches are installed on HOA common property in Phase III behind 487 - 491 Peters Way and in Phase IV behind 732 - 738 Hillview Drive. The two Phase III BMP trenches are lined/covered with filter fabric and filled with ¾ inch crushed stone. By design, grates at ground level lead to perforated plastic pipe buried in each bed of stone [*despite several attempts these grates cannot, at this writing, be located at the Phase III site - it is believed the vertical plastic pipes were capped until completion of construction, then mistakenly left in place and buried during final site grading*]. The voids in the stone provide a total of 18,800 gallons of stormwater storage for percolation into the surrounding soil. The two Phase IV trenches each utilize 126 subsurface rain tank modules rather than crushed stone. These modules each measure 27"x16"x34½", are comprised of 85% recycled polypropylene and are wrapped in non-woven geotextile. A 12"x12" grate at grade level delivers surface water to each trench's modules. The voids in these modules provide a total of 16,400 gallons of water storage for infiltration to the surrounding soil.

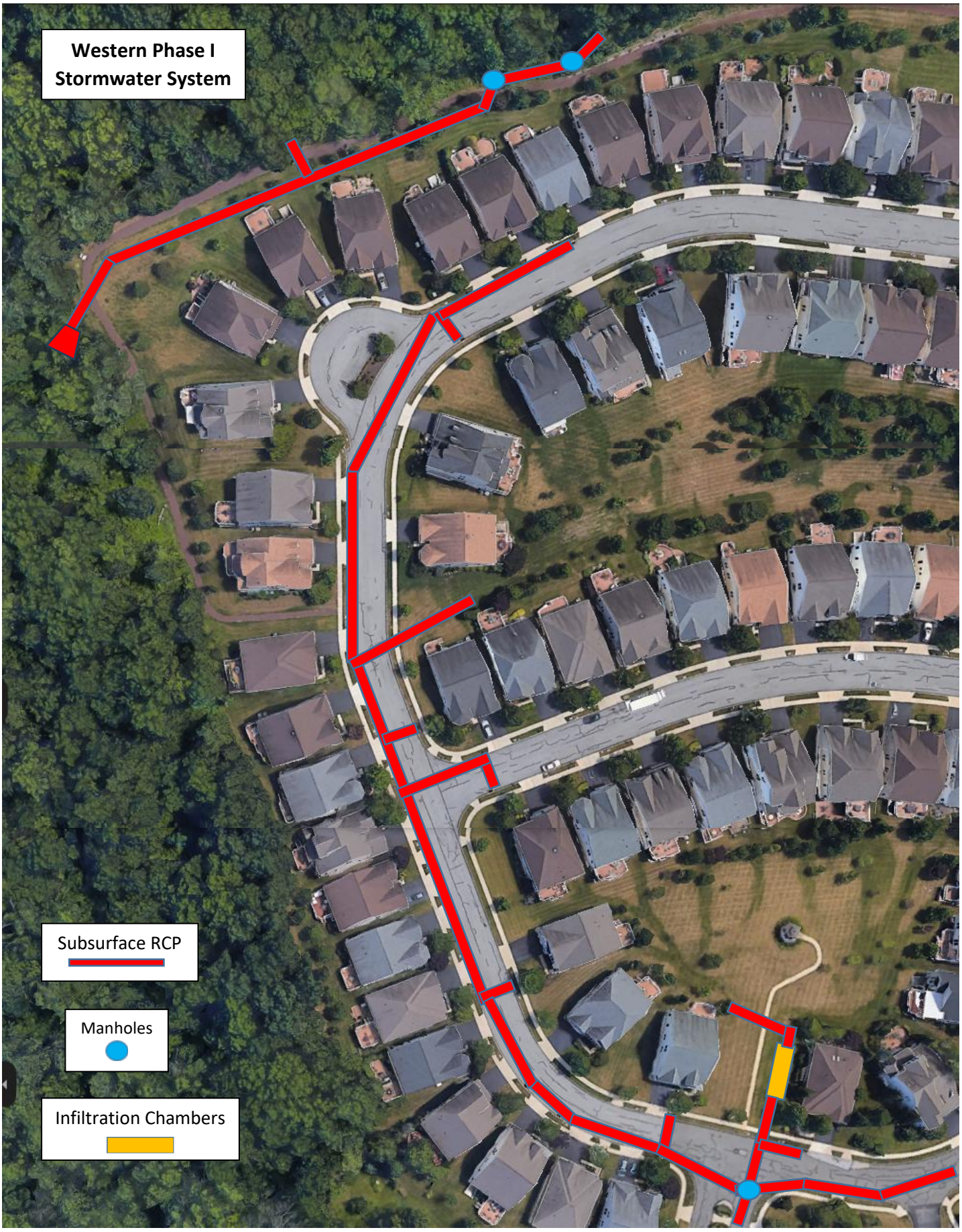
A rain garden is a shallow, planted depression intended to capture, absorb and filter stormwater runoff; it prevents flooding, reduces erosion and improves water quality. The single rain garden in our community is located on common property behind 832 and 834 Woods End Court. It is 41 feet long by 26 feet wide and contains a soil mixture of 50% sand, 30% planting soil and 20% shredded mulch at a minimum depth of 24 inches. The entrance and exit of the garden are protected from scour and erosion with rip rap, the water flow path through the center is comprised of river rock, while the remaining area is planted with moisture tolerant species. A flared end section at the garden's outfall carries any excess stormwater under the adjacent pedestrian path.

Phase IV's rain garden captures excess stormwater runoff from the surrounding area.

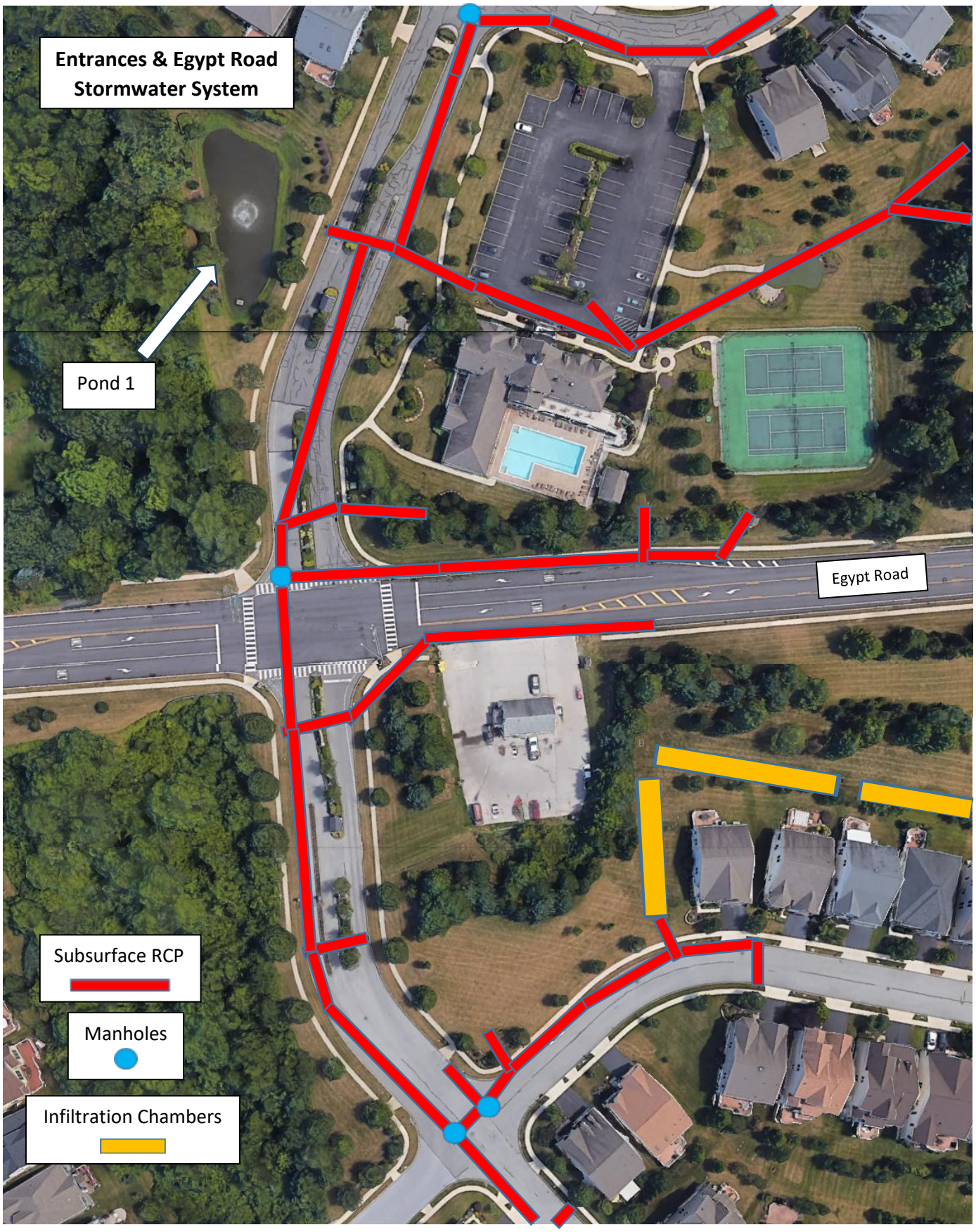
Subsurface Network Layout

The following six pages are Google Earth images of our community with subsurface piping, manholes, infiltration chambers and BMP trenches overlain on the aerial views. These depictions are not to scale and are intended to provide a sense of the network layout as captured from the ESE Consulting design drawings and the author's field observations.

Pipe, inlets and manholes in our roadways or parking lots are on HOA common property. Pipe, inlets, manholes, infiltration chambers and other control structures behind or between homes (on homeowner property) are located within drainage easements. Most of the drainage easements in our community are 25 feet wide while several are either 10 feet wide or "variable width".


Western Phase I
Stormwater System
Subsurface RCP
Manholes
Infiltration Chambers


Eastern Phase I
Stormwater System
Subsurface RCP
Manhole
Infiltration Chambers


Entrances & Egypt Road Stormwater System
Pond 1
Egypt Road
Subsurface RCP
Manholes
Infiltration Chambers


Phase II Stormwater System
Subsurface RCP
Manholes
Infiltration Chambers
Pond 2


Phase III
Stormwater System
Subsurface RCP
Manholes
BMP Trenches
Pond 3


Phase IV Stormwater System
Subsurface RCP
BMP Trenches
Rain Garden
Manholes
Black Rock Road
Pond 4

Periods of System Construction

As an indication of the year(s) each portion of the stormwater system was constructed, the initial sales dates of the first homes in each phase were utilized. This approach yielded the following approximate time periods:

Phase I	2004-05
Phase II	2006
Phase III	2007
Phase IV	2010-11

If a better source for these construction periods is subsequently discovered, this portion of the document will be updated.

Inspections, Maintenance & Repairs

With respect to the community's stormwater system, the October 19, 2021 *Reserve Fund Analysis Update* by Bustamante Engineers observed that:

> "This infrastructure should have at minimum a 50-year service life. Since it is unlikely these items would require complete replacement, we included an allowance for emergency repairs and/or partial replacement costs on failing sections of the stormsewer system."

Appendix page A-3 of the study recommends that a total of $2,812.50 be added to the reserve fund each year to account for such repairs and partial replacements.

In August 2023 Raintain LLC of Cinnaminson, NJ performed a partial visual inspection of RAP's inlets and infiltration chambers. Their report indicated that the fifty inlet structures observed were generally clear of sediment, trash and leaves. Eleven infiltration chambers were accessed through their inspection ports and found to have a moderate amount of sediment buildup. No inspection of the subsurface stormwater piping was performed by Raintain.

Prior to the 2024 repaving of Sloan Road, Fairmount Boulevard, Thayer Way and the Sloan clubhouse parking lot, an internal CCTV inspection was performed of the stormwater piping beneath those paved areas; this inspection was performed by Delco Storm & Sewer Services. Three defects were found in the 15" diameter pipe on the west side of Sloan Road and one in the 24" pipe on the east side of Sloan. These defects were repaired in May 2024 by Trinity Subsurface, LLC using 48 inch long resin-impregnated fiberglass sleeves pressed into the interior surface of the damaged piping. A report providing details of the inspection and the trenchless repairs can be found on the RAP website here.

As part of the aforementioned paving project, Delaware Valley Paving replaced 12 type C inlet caps in Phase I. The new concrete caps are located near:

- Sloan Road - #101, #110, #141, #156, #157, #167, #171, #193
- Thayer Way – west side of #21
- Fairmount Boulevard - entrance gate & exit gate (2)
- Sloan Clubhouse - southeast corner of parking lot (1)

Environmental and Regulatory Considerations

During snow or ice events RAP's snow removal contractor will often pre-treat roads, sidewalks, driveways and walkways with de-icing agents. The de-icing product used for our roads is rock salt (sodium chloride). The product for the other surfaces is a proprietary blend of calcium chloride, potassium acetate and sodium chloride granules, all coated with calcium magnesium acetate. Since both of these deicing materials contain compounds of chlorine, they are applied judiciously in order to minimize environmental impacts downstream of our stormwater system.

In a similar vein, the fertilizer used for lawn and turf areas in the community contains no phosphorous. This ensures that any runoff during heavy rain events does not carry phosphates into the stormwater system where they might otherwise contribute to algae blooms in our ponds and downstream waters.

In general, stormwater systems are regulated at the federal level by the Environmental Protection Agency under the Clean Water Act of 1972; the CWA was amended in 1987 to include stormwater discharges. The EPA generally delegates their oversight responsibilities to the individual states, in our case the Pennsylvania Department of Environmental Protection. In turn, the DEP looks to each of Pennsylvania's 67 counties to regulate stormwater runoff. Since all of Montgomery County is in the Chesapeake Bay watershed, discharges of sediment, phosphorous and compounds of nitrogen are of particular interest.

The EPA regulations establish a definition for a *municipal separate storm sewer system* (MS_4), an entity which is required to have a Pollutant Reduction Plan and employ certain Pollutant Control Measures. Upper Providence Township is such an MS_4 whose website provides information on their plans and activities. Our community and our ponds ("storm basins") can be seen on the lower portion of the Township's Pollutant Reduction Plan map, shown here. Since both the design and construction of our stormwater system was approved by the Township, the primary responsibility of the RAP Community Association is to monitor and properly maintain the existing system.

Bruce Sieving
Ponds, Stormwater & Irrigation Committee
April 2025

Information Sources

- ESE Consulting, Inc. Site Improvement and As Built Drawings for Regency at Providence community
- PennDOT design manual, chapter 10, *Drainage Design and Related Procedures*
- PennDOT design manual, chapter 13, *Storm Drainage Systems*
- Pennsylvania Stormwater Best Management Practices Manual https://www.stormwaterpa.org/assets/media/BMP_manual/07_Chapter_6.pdf
- StormTech product catalog - https://assets.adspipe.com/m/22a6c0bb6aaee742/original/StormTech-Product-Catalog.pdf
- Google Earth - Aerial views of the RAP community
- CAB member William Goldate – Phase I repaving details
- Pristine-Green Landscape Services LLC – deicing and fertilizer materials
- Bustamante Engineers Inc. - Reserve Fund Analysis Update
- Raintain, LLC – partial system inspection report
- Delco Storm & Sewer Services - inspection report on Phase I under-pavement stormwater facilities
- ChatGPT – information on various stormwater topics, standards and components
- YouTube - video of reinforced concrete pipe manufacture
- Upper Providence Township MS_4 webpage: https://www.uprov-montco.org/268/MS4-Pollutant-Reduction-Plan
- Author's site observations, measurements and photographs