LAKE HARMONY STORMWATER CONCEPT STUDY AND RECOMMENDATIONS FOR IMPROVEMENTS

LAKE HARMONY
KIDDER TOWNSHIP
CARBON COUNTY, PENNSYLVANIA

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Prepared for:

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I. INTRODUCTION AND BACKGROUND INFORMATION

Hanover Engineering Associates, Inc. (HEA) has been retained by the Lake Harmony Watershed Preservation Group (LHWPG) to analyze the existing stormwater conditions of the watershed surrounding Lake Harmony and to identify specific areas that may be contributing to the increasing sediment and nutrient accumulation within the lake.

Lake Harmony is a 118-acre glacial lake receiving water within a watershed area draining of approximately 491 acres located in Kidder Township, Carbon County, Pennsylvania. The average normal pool elevation of Lake Harmony is 1,856 feet above sea mean level. The elevation of the watershed ranges between approximately 1,856 to 2,071 feet above mean sea level. The lake body is supplied primarily by groundwater sources within the lake bed and surface runoff from rainfall events. Water exits the lake via an outlet structure located at the east end of the lake. There is no man-made dam or berm to impound the lake reservoir, as the lake was formed by natural conditions.

Lake Harmony is used by local residents, resorts, and visitors for a variety of activities including fishing, boating, swimming, and ice skating. Historically, the lake was used for ice harvesting during the winter months. As a valued recreational and vacation destination area, Lake Harmony currently promotes the local economy.

Over the last several decades, the quality of water in Lake Harmony has deteriorated to a eutrophic state, with high algae and plant growth occurring as the result of excessive nutrients, organics, and sediments entering the lake. The lake is estimated to have an average mean depth of approximately 8.5 feet and a maximum depth of 18 feet. Historical data indicate that the maximum depth in the lake was 31 feet. Sediment thickness measurements collected as part of various recent studies indicate maximum sediment thicknesses of approximately 9 to 13 feet, much of which is believed to be associated with human impacts and watershed development and land-uses.

The issue of Lake Harmony's integrity to continue to function as a natural kettle lake with the ability to support a recreational lake community has been a topic of concern among the community for several years.

The goal of this study is to promote awareness to the various groups, business owners, residents, and public officials in the Lake Harmony community and provide general guidance for taking action to maintain and improve the lake's intended function. This report is intended to function as a stand-alone document, but may also supplement the report prepared by HEA titled "Lake Harmony Data Review Summary and Interim Recommendations for Lake and Watershed Restoration Projects" dated April, 2014. Specific background information and discussion of historic studies, mostly pertaining to the lake itself, may be found in that report. This report will focus on the contributing drainage area of the lake and actions that may be taken to reduce continued and future accumulation of sediment and nutrient loading into the lake.

A large portion of the watershed has been developed with single family dwellings and related access roads, driveways, and accessory buildings. Many of the roads and building sites have been developed with little consideration of stormwater management or erosion and sediment pollution control. The existence of steep slopes exacerbates this problem. Poor maintenance of existing facilities and detached improvements projects also result in a significant increase in concentrated flows which carry sediment and nutrients directly into the lake.

The general strategy in developing and maintaining functional stormwater conveyance within the developed areas of the watershed is to:

1. Properly maintain existing systems
2. Identify areas where erosion and concentrated flows most commonly occur
3. Improve existing facilities and/or construct new facilities in those areas that help reduce flow velocity, remove sediment, and infiltrate.
4. Develop and implement policies and regulations that prevent future conditions which promote poor water quality.

It is important to address each area of concern from an area-wide perspective. The flow path of runoff must be followed from the very high point of the watershed to the bottom, considering how each lawn, road, driveway, swale, berm, culvert, or other facility may affect the concentration of flow, velocity, and ability to transport sediment and nutrients. Addressing an issue in one specific area will not necessarily alleviate the issue or improve conditions downstream.

For example, a property owner might be experiencing erosion problems on his/her driveway. To solve the problem, he/she builds a berm to deflect flow away from the driveway and onto the intersecting road. While the driveway is now safe from high flows, the redirected flow may now cause problems to the neighboring property due to the increase in concentrated flow and discharge of the berm to a different location.

Achieving these goals in not unattainable. While the scope of major projects requires professional design and construction, many small projects can be executed through community volunteers with the guidance of a few experienced individuals. Stormwater systems along Township and State roads and be improved as part of the regular improvements and maintenance program. Even efforts on individual properties can make a huge impact if the entire community participates.

II. METHODOLOGY AND OVERALL WATERSHED CHARACTERISTICS

There were two major components to the analysis of the Lake Harmony watershed and existing facilities. First, base mapping was developed in AutoCAD software using available topography data, aerial photography, and other mapping information such as tax parcels, roads, and soils. Next, a field investigation was conducted to inventory the existing stormwater facilities within the watershed, and note any specific areas of interest and flow patterns which cannot be determined using mapping alone. The field notes were then incorporated into the base mapping. Areas of interest were identified and the contributing drainage areas and conveyance facilities within the watershed were evaluated.

Data Sources

Available contour information and aerial photography is published by the Pennsylvania Department of Conservation of Natural Resources (DCNR) and was obtained from Pennsylvania Spatial Data Access (PASD). Contours data is derived from LIDAR (Light Detection and Ranging) and is accurate to one meter, which is sufficient to map the general drainage areas, but may not account for smaller features such as rows of roads, curbs, or swales. The aerial photographs were taken in 2008.

Tax parcel information, soil boundaries, roads, and other pertinent information was obtained from the Carbon County GIS (Geographical Information System). Parcel information was updated as of July, 2014. Mapping data was also supplemented by available mapping from the Pennsylvania Department of Transportation (PennDOT) and Google Earth.

Soil information was obtained from the United States Department of Agriculture Natural Resources Conservation Service (USDA- NRCS). Precipitation rates were obtained from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14, Volume 2, Version 3.

All data on the AutoCAD drawing is referenced to North American Datum 1983, Pennsylvania North Zone (feet).

Property boundaries were not determined as part of this study, nor was any research performed for recorded deeds or mapping at the Carbon County Courthouse. Such a task would require considerable time and resources beyond the scope of this study, and would have an insignificant impact on the analysis. PennDOT records show no recorded right-of-way for South Lake Drive (S.R. 1003) and therefore by default it is 16.5 feet from the center of road. It should be noted that the tax parcel boundaries which are shown on the maps are not a guarantee of actual property boundaries, and are commonly inaccurate by several feet. They are shown only for reference.

Hydrologic Methods

An initial watershed delineation was developed using Steam Stats, which is a web-based software developed by the United States Geological Survey (USGS). Stream stats use existing stream gage data and a series of regression equations to determine stream flows for a given geographic location along a watercourse. The equations compare a variety of watershed basin characteristics, which include total, area elevation, basin slope, land coverage, depth to rock, annual precipitation, temperature and other factors. A report of the Stream Stats analysis can be found at Appendix A. This method does have limits and utilizes 20-foot contour data, so the results were only used for cursory investigation and comparison. Stream Stats determined the drainage area of the Lake Harmony to be 0.66 square miles (422 acres). The peak flow results were not considered since the minimum valid rage of drainage area for Stream stats is 1.72 square miles.

Using the LIDAR contour data, the total watershed was delineated and individual drainage areas were determined throughout the watershed. Drainage area boundaries were then adjusted according to observations made in the field. The final contributing drainage area to the lake was determined to be 491 acres.

Based on the Subdivision and Land Development Ordinance (SALDO) and Stormwater Management Ordinance for Kidder Township, the 10-year and 50-year peak flow rates were calculated.

Individual drainage area peak stormwater flows were calculated using the Rational Method. Generalized runoff coefficients were used based on the land cover and use surrounding Lake Harmony. These coefficients were taken from Act 167 studies of nearby counties (i.e. Monroe County, Brodhead/McMichaels Creek), since Carbon County does not have an adopted Act 167 study. Rainfall intensity for the 10-year and 50-year storm events were determined from NOAA Atlas 14 data using the time of concentration as the storm duration. Results of the hydrologic analysis can be found in Appendix B.

General Watershed Characteristics

The Lake Harmony watershed is generally confined to the surrounding slopes that surround the lake. Since there is no surface watercourse that contributes to the lake, there is no contributing watershed basin that would be associated with a stream. All flow that exits the lake is derived from surface runoff and groundwater.

A majority of the watershed area is wooded, with high concentration of development around the lake. Residential lots range in size from 1/8 acre to ½ acre, with a high percentage of impervious coverage from driveways, parking areas, and rooftops. Ground cover is bare in many of the developed areas, containing little vegetation.

Flow originates at the highest points of the watershed. Most of this surface runoff likely infiltrates into the ground or travels via shallow concentrated flow across natural ground cover. Many areas contain small depressions due to the rocky soils, which promote detention of flow and infiltration. Within 500 to 1,000 feet of the lake, developed areas become prominent. Here impervious areas and lot layouts promote concentrated flow along driveways, roads, and buildings. As the runoff travels downhill, it increases in velocity and volume. This flow makes its way to the primary roads that parallel the lake shore: North Lake Drive, South Lake Drive, and Lake Drive. Here it may be directed laterally along the road gutter to a culvert, or bypass at a blockage. The accumulation of flow concentrates to one point, and discharges at a point source on the downstream side of the road. From this point, the flow either makes a speedy route directly into the lake, finds its way through other culverts and swales, or is redirected or intercepted by some kind of individual management facility intended to reduce energy and filter out sediment. Some appear to function well and others not as much

While the drainage area to the lake is relatively small, steep slopes and development in the immediate vicinity of the lake shore contribute to concentrated, high-velocity flows. Surface water takes a short amount of time to flow from the high point of the watershed to the lake, thus increasing the potential to erode soils and transport sediment into the lake. Use of fertilizers and other chemicals on developed lawns and paving surfaces makes for easy transport into the lake with no pre-treatment or vegetated buffer at the shoreline.

Most of the roadways are dirt or gravel with insufficient or no roadside development to handle stormwater. Existing conveyance systems are blocked with leaves and sediment (mostly eroded road material and winter materials). Pipes are separated at joints or otherwise damaged. Swales and ditches have poor stability and show evidence of erosion. Outlets have little to no energy dissipation and show signs of erosion.

Based on the observations made during the field visits, the main contributor of sediment to the lake is clearly from the dirt and gravel roads, as well as un-stabilized ditches and gutters along the roads. It is evident that material is continuously eroding from these features and often improperly repaired or replaced, only to allow further accumulation of sediments.

Another source noted during the field visits was leaf disposal. Many properties appear to be collecting leaves from their lawns and disposing in vacant areas. These piles of leaves have a clear route to be carried by wind and water into the lake.

Another contributor to the sediment accumulation is from wave erosion at the shoreline. This occurs naturally by wind, but use of motor boats for recreation on the lake accelerate this occurrence many times. Lake of shoreline and emergent vegetation along the edge of the lake also increases the effects of wave action. When waves wash up against the shoreline, erosive action causes the soils along the shore to wash into the lake. Over time, the lake fills in with these deposits, causing flatter slopes within the lake sides, and increases the surface area of the lake.

III. GENERAL/AREA-WIDE AND MAINTENANCE RECOMMENDATIONS

General Approach

The principle concept in reducing sediment and nutrient runoff is to control the stormwater in a stable manner. There is no feasible way to significantly reduce the amount of rainfall entering the watershed, but the manner in which it is conveyed can be controlled through stabilized conveyance and facilities which detain and clean the water.

Runoff picks up the most sediment and nutrients when it is flowing as "shallow concentrated flow" over land, such as lawns, roads, parking lots, and open spaces. Conditions worsen when soil is on steep slopes and poorly stabilized by means of vegetation, armoring, or compaction. As the length of this type of flow increases, the velocity and depth of flow also increases. These conditions create more turbulence and shear forces against the ground surface, which in turn suspends the sediment into the water. If the sediment is laden with nutrients and other pollutants, they will be carried as well. The less length that runoff travels in this state will limit the amount of sediment and nutrient transport. The goal is to limit the amount of contact time with open surface runoff and contain the flows in a controlled conveyance facility, such as a swale or conduit.

It is unavoidable, however, to prevent all forms of sediment and nutrients from being transported by surface runoff. Measures may also be taken to help remove these pollutants from concentrated flows as it approaches the lower regions of the watershed before discharging into the water body. Various best management practices (BMPs) exist which can settle out soil particles and filter out nutrients and pollutants. Often a combination of two or more can increase the effectiveness.

One method of removal is by reducing the velocity of the flow, allowing the soil particles to settle out of suspension. This can be done by increasing the contact area or creating a detention area. Examples include rock aprons, energy dissipaters, and detention basins. These facilities are effective at removing larger soil particles, but do not aid much for dissolved particles or microscopic particles held in suspension chemically. Fortunately, these suspended particles will likely also remain suspended in the lake and not settle to the lake bottom. However, the issue still remains with nutrient and pollutant loading which affects the health of the lake.

To effectively remove nutrients and pollutants, again, contact time is required against some kind of medium that will remove the pollutants. The medium can be infiltration into the soil, vegetation, or through man-made materials. Some approaches include vegetated filter strips, bio-retention areas and rain gardens, infiltration trenches and swales, shoreline buffers, and constructed filter mediums such as sand/compost/mulch or commercially available manufactured BMPs such as hydrodynamic devices (separation chambers) or filter inserts for inlets.

All of these BMPs have their benefits and setbacks. Most of the setbacks include installation cost and on-going maintenance and upkeep. The facilities cannot be installed and forgotten about. Remember, if the sediment and pollutants are not going into the lake, where are they going? They must periodically be collected and removed to another location. It is important to develop and implement a maintenance plan and identify responsible parties to execute such maintenance.

Of course, a passive approach is to do as much as possible to prevent the generation of pollutants in the first place. Many of these ideas can be applied in planning stages of development before and area is improved with roads and structures. Unfortunately, Lake Harmony is well beyond the stages on planning, so the community must work with the conditions that already exist. Future redevelopment and improvements can use these practices however, to prevent future potential for increased pollution in the lake. Some of these concepts include cluster development, minimizing disturbance, re-vegetation with native species, reducing impervious area, and street sweeping.

Typically, one the goals stressed in stormwater best management practices is to create as much potential for infiltration as possible. This is good practice for planning purposes, but we do not recommend encouraging infiltration through pavement techniques around Lake Harmony, such as pervious paving or gravel roads. If gravel roads must be used, the surface material should be clean stone (i.e. AASHTO #57/2B) with little or no fines. Due to the steep slopes and development of the lake perimeter, the best solution is to reduce contact time with surface runoff and convey stormwater in an efficient manner. Since there are no real concerns for peak flow rates into the lake, we recommend that roads be surfaced with impervious material with sufficient collection of drainage along gutters through curbing, berms, and swales. Since most of the sediment is generated from the unpaved roads, this will greatly reduce the amount of sediment transported into the lake. Elevating the roads above the surrounding ground surface and establishing a good road cross section (crown) will also direct runoff to the appropriate facilities and limit the amount of overland flow.

Road crews and property owners should also be mindful of using certain techniques for operation and maintenance of roads, driveways, and lawns. Consider the following:

- Use of salt, cinders, and anti-skid materials during winter weather. We observed during our site visits that numerous property owners use coal ash and other similar materials for anti-skid material. Where does this material go after the snow and ice melt? Is there a way to prevent these materials from being washed downstream, or limit their use?

- How many truckloads of stone have been spread on individual roads/driveways over the last several years? Is there something that can be done to prevent the road/driveway from eroding that would prevent constant replacement and re-grading of stone?

- Undeveloped/underdeveloped roads: Many of the outlying road networks surrounding the lake are a mess. Some of them have no defined cross section or alignment. Some wind around trees or boulders, while others spread out to large open "parking lots". Builders appear to have haphazardly wound their equipment to their building sites with no consideration of the big picture. What can be done to reduce the impacts of these roads? Getting these areas under control will go a long way towards improving the lake health, even if the process requires removal of some trees or substantial earthwork. Re-align these roads, develop a consistent cross section with proper roadside drainage, and re-establish vegetation on un-used areas.

- Individual on-lot improvements: Some property owners have made a valiant effort to contain stormwater and reduce its impacts. However, many have missed the mark. There are several examples of areas that have what seems to be a good project, but what happens downstream? Often times this "good idea" only causes increased problems to the properties down the line. Improvement projects should be well thought out and designed or reviewed by an experienced individual. Contractors are often very skilled and experienced at building site improvements, but are not necessarily reliable for a sound design. The best approach is to consult with a designer who can work with a contractor to develop the most cost-effective design that will have the best outcome for the entire area, not just the individual lot.

- Leaf cleanup and yard waste is also an issue. These materials should be collected and disposed or composed in an appropriate area that will not generate contamination of surface runoff. Leaf pick-up programs should be developed and implemented to prevent careless dumping. This is not to be confused with natural organic cover in unimproved areas, which helps to improve water quality.

- Maintenance of existing facilities: This is a significant problem around the entire lake. Who is responsible for inspecting and maintaining inlets and culverts? Who maintains and stabilizes roadsides when disturbed or eroded? It appears the answer at this moment in time is no-one. PennDOT and Township crews should be held accountable for their roadways and drainage, and private owners should establish procedures and funding to maintain the private roads and facilities. The entire community must cooperate and work together, as the longevity of Lake Harmony is in the best interest of all who are part of the community.

IV. SPECIFIC AREAS OF INTEREST

See the overall drainage map and blow-up drawings for each area of interest. Drawings show existing facilities, flow patterns, and recommended improvements. These recommendations are preliminary suggestions and not a final design. Detailed survey, analysis, and design as well as permits may be required to properly install the recommended improvements.

In many areas it is uncertain where property corners are located. Survey monuments do not appear to be reliable or are non-existent. Effort will be required to determine if proposed improvement areas are within private property or areas of paper streets that may or may not already be improved. In some cases, the improved street is not within the designated right-of-way. Work performed in Township or PennDOT right-of-way will require the appropriate highway occupancy permit if performed by outside parties.

Areas of interest are numbered chronologically on the map starting at the west end of North Lake Drive and progressing clockwise around the lake, ending at the northeast side of the cove. Sub-areas, which drain to existing collection facilities, or areas of concern, are labelled with lower-case letters. Generally, the letters will increase from downstream to upstream along the flow path (for example, 2a would be closest to the lake with 2b, 2c, etc. progressing upstream).

AREA 1
WEST SIDE OF LABARRE DRIVE – LOW POINT ON CURVE

This area consists of the western portion of Labarre Drive. Although small in size, the horizontal curve as Labarre Drive travels downhill poses a problem due to unstable road surface and a sump area on the north side of the curve. This issue can be resolved by installing an inlet and culvert across Labarre Drive. Additional flow reduction and infiltration can be achieved with a small rock lined basin at the outlet. To avoid damage to the southern properties, the flow should be directed to the west across the existing driveway

AREA 2
LABARRE DRIVE & NORTH LAKE DRIVE - INLET

Area 2 is the existing 18” corrugated metal pipe, underdrain, and conveyance swale in the middle portion of Labarre Drive. While the pipe size appears adequate, storm water is bypassing the system. Gutter flow along the north side of Labarre Drive is causing erosion and is inadequate to handle high flows. The corrugated metal pipe (CMP) and concrete swale discharging to the lake appear to be functioning well.

Improvements in this area include re-grading and paving Labarre Drive, installing swales along the north side of the road and ensure that runoff is entering the existing storm sewer system. A series of swales, inlets, and culverts can be installed at the east side of Labarre Drive to handle flow from the east along North Lake Drive and relieve some of the volume flowing westward.

AREA 3 & 4
TOBYHANNA STREET AND HARTUNG STREET - INTERSECTIONS

Area 3 is the drainage area to the existing 18" reinforced concrete pipe (RCP) on North Lake Drive between Labarre Drive and Tobyhanna Street. The pipe size appears adequate.

Area 4 is the drainage area to the existing 18" RCP on North Lake Drive at the intersection of Harting Street. The pipe size appears adequate.

AREAS 5 & 6
TUNKHANNA STREET AND HARMONY AVE – INTERSECTIONS

Area 5b drains to the west side of the intersection of North Lake Drive and Tunkhanna Street. It is proposed to add swales along North Lake Drive and Tunkhanna Street that will be collected in a new inlet that connects to the existing inlet east of Tunkhanna Street. Area 5a is the area to the existing inlet on the east side that discharges through the property owned by Lake Harmony Estates.

The existing inlet for area 6c is at the intersection of North Lake Shore Drive, Harmony Avenue, and South Lake Drive. The northern drainage way from Tobyhanna Street appears to drain into an existing depression that would clean stormwater before it enters the inlet at Area 6c. The pipe size appears adequate. What appears to have originally been a twenty five foot drainage easement from Tobyhanna Street to North Lake Drive appears to be occupied by the neighboring land owner.

6b is the existing inlet at the intersection of the paper street and South Lake Drive. This inlet connects to the inlet at 6c uphill and discharges to area 6a through the property owned by Lake Harmony Estates. A swale can be added south of this inlet along the east side of South Lake Drive to clean storm water before it enters inlet 6b.

Area 6a collects areas 5 and 6. A rain garden/infiltration basin can be added to clean storm water before it discharges to the lake.

AREA 7

Area 7 is the portion of drainage that flows to the south gutter of SR 1003 and follows the gutter east away from the lake. Therefore, this drainage is not part of the Lake Harmony watershed and was not evaluated.

AREA 8
EAST OF LAKEVIEW DRIVE STREET

The last system is the 24" pipe that crosses SR 1003 uphill and east of Lakeview Drive Street. The area to this pipe is the 6.3 acre area 8c. This system then picks up area 8b from the SR1003 northern gutter and area 8a between SR 1003 and the lake. This pipe could nominally be 18 inches. It is likely the gutters are undersized. Erosion problems were noted on the north side of SR1003 and in the swale between SR1003 and the lake. Water bars should be added to channel stormwater across the driveway and into the rock swale.

AREA 9
LAKEVIEW DRIVE SYSTEM – EXISTING INFILTRATION BED

The Lakeview Drive intersection is a low point along SR 1003 capturing any bypass from the nearby systems. The street itself is a long sliver up the road (9c) and the two gutter systems 9a from the west and 9d from the east. It would also include the area 9b. Area 9b currently continues down from Lakeview Drive to the SR 1003 gutter, but it could be channeled roadside down Lakeview Drive entirely. The lots uphill along Skye Drive could be encouraged to add rain gardens to reduce the storm water flow to this cross pipe. Other previously cleared open spaces uphill could also be utilized. With no uphill reductions, this pipe should be a 24" pipe rather than the existing 15".

AREA 10
PIPE BETWEEN CHURCH STREET AND LAKEVIEW DRIVE

Stormwater bypassing the above system will continue on the 12" pipe between these two streets. If no stormwater bypasses and the uphill systems 9b and 10b are constructed, the 12 inch pipe is an adequate size. Otherwise it is probable areas 9b & 10b continue across Lakeview Drive to this pipe, thereby overloading it.

A potential BMP uphill of Lakeview Drive east of Church Street. Basin 10b would catch and control the outfall from pipes 10d and 10c above combined with an additional 0.5 acre between. (191 Lakeview Drive – Branda) At a minimum, the street just west of this lot needs to be re-graded and paved and the storm water could be collected and conveyed down the street R.O.W.

The Basin east of 10a is 9b. The contours show the area between these basins to be flat. Additional survey would be needed in the field to determine if 10b would flow to 9b for maximum cleaning or if it will be necessary to discharge 10b down the street R.O.W. Basin 9b would discharge down Lakeview Drive to 9a.

AREA 11
CHURCH STREET BETWEEN CHESTNUT STREET AND LAKEVIEW DRIVE

Between Chestnut Street and Church Street intersection is the high point along SR 1003. The area flowing to this next intersection starts back up the hill from Crest Lane in the Skye Drive region. Area 11a flows from the low point of Skye Drive down through all the internal areas to a low point between these streets on the south side of SR 1003. Individual rain gardens on the downhill side of the developed areas of these lots would reduce the flow to the lower levels and provide water quality benefits.

A basin at the low area east of Skye Drive would reduce the amount of storm water flowing over the roadway. A cross pipe and downhill conveyance would provide additional control.

AREA 12
CHESTNUT STREET – INTERSECTION

A narrow strip of area flow to the south gutter of SR 1003. This flow could be captured with an inlet and culvert network and discharged on the north side of S.R. 1003 to the paper street. a rain garden/infiltration basin could be added here as well.

The high point of this system is area 12b. 13f, 13e, and 13d flow down Chestnut Street between New Birch Street and Lakeview Drive. Flow travels to the west side of Chestnut Street into two rock-lined plunge pools, and then drains to the south gutter of SR 1003. These flows combine with Area 13d to the existing plunge pools on the west side of Chestnut Street. (15" pipe minimum) This stormwater could be further treated by a basin at the southwest corner of the intersection with Chestnut Street and SR 1003.

It could then be piped across SR 1003 for further treatment in Basin 12a on the public access to the lake. The steepness of this access could prove challenging. This system would require a 15" pipe.

AREA 13
SPRUCE STREET - INTERSECTION

Heading up the hill to the tennis court off of Park Lane is the uphill edge of the area draining to this system with area 13g. 13g flows from the tennis court across New Birch Street and the unimproved part of Lakeview Drive to the east edge of Spruce Street. The west edge of this street would be Swale 13h. These two swales would then combine with the gutter flow from the east (Area 13b) to cross SR 1003 to a potential basin 13a on the access to the lake. The final pipe size would be 18" or an equivalent swale.

Currently this system drains either across SR1003 at this point or continues in the gutter to the next downstream outfall.

AREA 14
SOUTH LAKE DRIVE – BEACH AREA

Lakeview Drive has the potential to control some of the flow to the low point inlet on SR 1003 with swales to a storm water facility on the north side of Lakeview Drive. This facility would capture flow from areas 14i, 14j, and 14k. Further facilities could be constructed at the tennis court off of Park Lane to intercept the flow from the impervious area.

These areas then continue downhill to the 14g and 14h areas along the south portion of SR 1003. Flow collects along the gutter of SR 1003 and collects in the low point inlet mentioned above. It is uncertain where the culverts connect or discharge, but there is a nearby inlet on the opposite side of SR 1003 which collects a small area, like functioning as a junction box for the storm sewers. Just upstream of the beach, a small infiltration basin has been constructed which has a 4-in inlet pipe coming from the road. That basin outlets via an 8-inch pipe which connects with an M-inlet.

Further west on SR 1003, another open ended culvert conveys flow from Area 14d to the north side, just west of the beach area. This pipe ties into the same M-inlet as the infiltration basin.

The outlet pipe heads into the beach area, turns to the left and discharges into a rock apron approximately 50 feet from the lake.

AREA 15
LAKE HARMONY ESTATES POA BOAT LAUNCH AREA

This area is a very large portion of the watershed and has many issues. First, the CMP discharge culvert that runs from SR 1003 to the direct outfall into the lake is extremely corroded and separated at the joints in many places. The M-inlet on the south side of SR 1003 is collecting runoff from over 800 feet of gutter. Maximum inlet spacing should be no more than 300 feet along a street. This area captures Area 15a which has a total area of three acres. One inlet is extremely undersized to handle even small rainfall events.

This inlet also collects runoff along the entire corridor of Wood Street. A headwall and storm sewer are located on the west side of Wood Street at the intersection of Wood and Lakeview, which collects flow from Area 15e, 15f, 15g, 15h, and 15i. A more serious issue exists when runoff is collected from Area 15i at the cul-de-sac of New Birch Street. This concentrated flow travels via an earthen swale towards Wood Street, turns between two houses, and simply discharges onto the dirt surface of Lakeview Drive just west of Wood Street. The flow then meanders over Lakeview Drive and approaches the inlet for Area 15b. Flow does not enter here however, because the inlet in entire blocked with leaves and debris. So, the flow bypasses and travels down the edge of Wood Street to the already undersized inlet at the intersection of Wood Street and SR 1003.

There are some opportunities available for infiltration facilities farther upstream of these areas, mainly Areas 15d and 15i along Wood Street. Flow could be handled through infiltration swales on the upslope side along Estates Drive as well.

AREA 16
SOUTH LAKE DRIVE (S.R. 1003)

Area 16 is a small area that runs across SR 1003 to a small rock swale at the bend east of Pocono Street, which is unimproved at SR 1003. The homeowners along the north side of SR 1003 have constructed diversion berm along their driveways and road shoulder to direct flow away from the road and bypass their driveways. One home has constructed a small infiltration basin that appears to receive flow from a pavement base drain under SR 1003.

AREA 17
SPRING STREET SYSTEM

Spring Street is a high point along SR 1003, with Area 16 to the east and Area 17 to the west.

The drainage areas then move to the top of the hill for system 17k and 17j. In order to reduce the load on the downstream culverts and prevent storm water from running over other streets, a series of swales and basins could be added at the intersection of Estates Drive and Spring Street. A swale could be added up to 300 feet from Wood Street along Estates Drive. Combined with road re-profiling, this would prevent runoff from travelling across the roadway.

17k at the south east corner of the intersection could provide treatment and control for 4 to 5 lots and Estates Drive. 18f essentially treats the flow from the lot at the south west corner of the intersection. 18e at the uphill north west corner of the lot would capture flow from the intersection. Detailed survey would be needed to determine if these basins can only function in parallel or if they can be chained together in series.

17j is a potential basin or swale at the north east corner of the intersection with the potential to clean and control the storm water from Estates Drive and three lots.

Continuing downhill, the next intersection with New Birch Street was examined with areas17h, 17i, and 17j. From the contours, it is again assumed that New Birch Street is not sufficiently crowned and storm water over tops it. It differs from Estates Drive in that the high point of the road is 250 feet east of the intersection.

The HOA will need to determine if the unopened portion of New Birch Street west of Spring Street could be utilized for storm water control. Any further development in this area will need to incorporate a correctly designed and constructed roadway with storm water management controls.

The flat area 17i could be utilized for bio retention swales east of Spring Street before continuing on to additional basins at the intersection with New Birch Street. 17h is the potential for a swale along the south east edge of New Birch Street to a basin at the south east corner.

17g has potential for a swale on the north edge of New Birch Street. The topography then goes uphill on the lots between New Birch Street and Lakeview Drive resulting in the potential for a basin along the east side of Spring Street. (17f)

Outfalls from all of these basins will need to be determined, but it is assumed the decision will be to continue the storm water along Spring Street to Lakeview Drive to Basin 17e. The high point moves west to within 150 feet of Spring Street. 17e could provide additional treatment for the storm water from the upper levels.

The HOA will need to determine if the unopened portion of Lakeview Drive west of Spring Street could be utilized for storm water control. It is best to use previously cleared area rather than removing additional trees. This area also has little existing development uphill, further limiting storm water quality benefit.

Swales 17c and 17d would then convey storm water the remaining distance down to SR 1003. It is assumed the majority of the storm water would be combined on the west side of Spring Street in Swale 17c with Swale 17d conveying only the small area on the east side between Lakeview Drive and SR 1003. The area from 17b would then combine in a swale in the relatively flat area of SR 1003 west of Spring Street.

Note that this area of SR 1003 is in very bad condition and needs to be completely re-graded and updated to new highway design standards. The paper street continuation to the lake is very steep and conveyance in this area would be difficult as is the next paper street access downhill to the west. Continuing the flow path to the system at the unnamed street access and expanding this system is the most practical solution.

AREA 18
UN-NAMED STREET AT 350 SOUTH LAKE DRIVE

This area is unique in that it has two parallel discharge points right next to each other. Areas 18h and 18g collect the lower portion of the area along SR 1003. Flow overtops the road and makes its way toward the wake. Flow is collected at the base of a driveway near the shoreline and discharged through a 6-inch pipe into the lake.

The other portion of Area 18 drains to a private driveway and discharges to an 18-inch RCP culvert which empties on the north side of SR 1003. The flow travels through some parking and driveway areas through a series of swales and culverts, before collection into the same outlet pipe at Area 18g

Residents along Estates drive should be encouraged to construct small BMP’s (rain gardens) along the downhill edge of developed areas. Development along New Birch Street should incorporate BMP’s on both sides of the R.O.W. By the time this large area flows uncontrolled to the storm pipe, a nominal 24” pipe would be required. The existing pipe is sized as an 18”. The swales uphill along the unnamed street are eroded and need to be stabilized.

As SR 1003 is uncrowned in this area any storm water not caught in storm systems runs directly over the highway.

17a is the swale cut by the flow from Spring Street across SR 1003. This area should be combined with area 18h in a new swale to the location of the previously noted cross pipe. This would upsize the pipe to approximately a 30" pipe, but would greatly reduce the amount of stormwater running over the state highway

AREA 19
NEW BIRCH STREET

The first potential stormwater management area along SR 1003 is Area 19 with a potential basin at the bend east of Estates Drive. This area is lower than the paper street to the east. A drainage swale should be constructed on the south side of SR 1003 to channel storm water in a controlled manner to a collection point rather than it running across the highway. Further BMP could be installed uphill in this drainage shed along Lakeview Drive, New Birch Street, and the lower areas of the developed lots on Estates Drive. Estates Drive is the top of the ridge with areas south drainage away from the lake. Area 19 is a large 12.8 acre area and by the time it is concentrated at the state highway, a 24" nominal pipe would be needed for conveyance. This system could further discharge down the flat paper street continuation or along a swale to the Boulder Pit west of Estates Drive.

AREA 20
MAPLEWOOD ROAD & ESTATES DRIVE

The next areas of interest are on Maplewood Road. The subareas start uphill with the area to the existing 12" CMP culvert at the intersection of Beechwood Road and Maplewood Road. (20c) This pipe should be a minimum of 18" to convey the 4 acres flowing to it. The stormwater then continues downhill in swale 20b to the next paper street then through area 20a to the channel to the Boulder pit. The low point of Lake Drive is approximate 125 feet west of the intersection with Maplewood Road through the parking lot on lands of Vacation Charters, LTD. Storm water from both Maplewood Road and Estates Drive flow to this low point.

The unopened paper street between areas 20b and 20a could be utilized as a storm water management area. It will be necessary to determine if the original design concept for this street is still valid, separation distances to structures with basements, if the topography will allow berms with a minimal ponding depth of 1 foot or swales at less than 6% grade. The suitability of the soil will then need to be determined.

Any other unopened paper streets also would present the opportunity for storm water management areas if planning and physical constraints allow. The maximum benefit would be in areas downhill of existing or proposed development with minimal benefit for areas downhill of currently wooded areas. The DEP guidelines are to have 1 acre of BMP for every 5 acres of impervious area and 8 acres of total area.

The design along the south side of the lake is complicated by the longer flow paths from the top of the ridge to the lake with multiple rows of lots. Crowning of roadways and parallel swales can channel stormwater along drainage ways that are not identifiable from one meter accuracy contours. In general, it appears that the uneven terrain and existence of small depressions is doing an effective job of infiltrating and slowing storm water. The only evidence of concentrated flow is along Maplewood Road.

AREA 21
SPLIT ROCK LODGE AREA

The area surrounding the Split Rock Lodge resort area and residential lots is fairly contained. The surface drainage near the resort area essentially drains to the large parking area located northwest of the clubhouse. Here the drainage enters a series of M-inlets that do not appear to discharge to any surface. Underground detention must exist to infiltrate water into the ground. It is uncertain if the inlets or underground area becomes surcharged during large rainfall events.

The flows generated from the residential areas in Areas 21g, 21f, 21e, and 21d travel along the roadside ditches of Forrest Drive and Crest Drive. Where the two roads intersect, there is a series of inlets and storm sewers that discharge the water to the south towards the large parking area. The roadside ditches show signs of erosion and could use some upgrading for stability, but seem to be handling the volume of flow during storms. The concentrated flow then passes through a culvert under Lodge Hill Road and discharges into the parking area, where it ultimately seeks the inlet at the entrance from Birchwood Road.

Similar conditions exist on the southern portion of Area 21. Flows collect along Greenwood and Birchwood Drive (Areas 21j and 21i) and flow down a steep section of Birchwood Road to the parking lot. Portions of Birchwood are heavily eroded on the steep slopes.

Other contributing areas come from a small portion of Split Rock Road, where there is an inlet and storm sewer network of unknown destination that run in the direction of the parking lot.

Another M-inlet exists within the parking area which collects Area 21a. Again, it is uncertain where this water goes once underground.

Aside from stabilizing the roadside swales, there is little to be concerned with in this area since it appears that runoff does not flow directly into the lake. The parking area is curbed and can act as a detention/retention basin in the event that the inlets surcharge.

AREA 22
SPLIT ROCK LODGE PAVILLION AREA & LAKE DRIVE

Flows from Area 22b originate from the south side of Crest Drive and flow towards the west portion of the lake. Flows begin to concentrate along Lodge Hill Road and enter the 4’ by 4’ inlet along Lake Drive, near the pavilion. And 18-inch CMP storm sewer carries the flow along Lake Drive and then across lawn area before it discharges directly into the lake near the beach area. The pipe is exposed at the surface in many areas and shows signs of wear. Water quality could be improved by detaching the direct outlet to the lake and installing a rain garden in the lawn area.

AREA 23
MOSEYWOOD ROAD – LOW POINT ON LAKE DRIVE

Most of the residential areas around Lake Drive on the western side of the lake seem to have low impact to water quality. The lots are large enough to support a high percentage of natural ground cover, and the roads are well maintained and properly graded. The soils and terrain seem to be more conducive to infiltration and slowing surface flow. The only obvious issue noted was the disposal of yard waste (leaves) along the east side of Lake Drive. It appears that property owners fronting Lake Drive just clean up their yards and dump the waste on the other side of the road. All of that organic waste is ending up in the lake, increasing both sediment and nutrient loading.

Area 23 has potential to support infiltration and rate control. The corner lot at Moseywood Road and Lake Drive has a large stone driveway and steep front yard. An infiltration basin could be constructed here to handle that water and discharge it to the lake via a culvert instead of overtopping the road.

AREA 24
CREST DRIVE AND LAKE DRIVE – NORTHEST OF COVE

Similar to Area 23, there are no real problem areas identified here. A 2' by 2' inlet collect water from Crest Drive and conveys it towards the lake through a storm sewer. Some minor restoration and improvements could be made here, but as a whole, this area does not require attention like most other parts of the lake.

V. PRIORITY & COST ESTIMATES FOR RECOMMENDED IMPROVEMENTS

For this section, we have developed a list of various project areas that can be further investigated and developed into a workable improvement project. These areas can be combined, reduced, or expanded to meet the specific needs of the LHWPG based on timing, budget, and available resources.

Each project area was subjectively evaluated on the basis of the following criteria:

1. Contributing drainage area and peak flow rates
2. Inadequacy of existing facilities
3. Potential for reduction of surface runoff pollution

Each project area will vary in size (area) and cost dependent on the site-specific conditions. Some areas will require extensive improvements and replacement of existing facilities, while other areas can be improved by simple means.

In general, all developed areas within the Lake Harmony Watershed can benefit from the follow improvements:

- Establish a road cross section of minimum two percent. Preferably, the road section should be crowned in the middle. Curb or swale should be provided to capture runoff from the road and areas above. A simple bituminous curb or roadside berm or swale will handle most flows.

  If possible, roads can also be sloped into the uphill side. This would require drainage on only one side to capture runoff from the road.

- Elevate road surfaces wherever practical to prevent outside runoff from entering the roadway.

- Pave roadways with asphalt paving or clean graded stone, which will result in runoff with less sediment load.

- Collect roadside drainage at a minimum of 300 feet into a conveyance facility such as a defined swale or storm sewer. These facilities should continue downstream until they are discharged into an infiltration/detention facility, or energy dissipater prior to entering the lake. Facilities should be designed and sized based on the hydrologic and hydraulic conditions.

- Swales and pipes can increase pollutant removal with infiltration components (vegetated swale, infiltration trench).

Labarre Drive & North Lake Drive (Areas 1 & 2)

Priority – High

Existing facilities in this area can be improved to provide better handling of runoff along Labarre Drive and upstream areas. The existing channel and culvert can be retained between the Raphaelson and Andrews properties. Adding a second discharge point and improving the roadway to the east would also relieve erosion and flows to the previous point. Runoff can be collected along North Lake Drive to enter this system as well. On the west end of Labarre Drive, the low area on the turn needs to be addressed and discharged to the west of Labarre Drive.

Improvements

- Reset/replace inlet on Labarre Dr.
- Re-grade and pave Labarre Dr.
- Swale along north side of Labarre Dr.
- Swale along north side of N. Lake Dr. at intersection
- Storm Sewer at east end
- Discharge swale to lake
- Storm sewer at west end, rock basin

Estimated Construction Cost: $174,650

Tunkhanna Street & North Lake Drive (Area 5)

Priority – Low

Runoff along Tunkhanna Street can be captured with roadside swales and piped into the existing inlet at the northeast corner of the intersection of Tunkhanna and N. Lake Dr. There is an existing stone driveway that accesses the lot at the northwest corner of the intersection. There is also a driveway along Tunkhanna Street. The lower driveway can be eliminated and restored with native vegetation.

Improvements

- Reset/replace existing inlet
- Swale along both sides of Tunkhanna Street
- Swale at northwest corner of intersection
- Inlet and culvert under north side of intersection
- Eliminate driveway at northwest corner of intersection

Estimated Construction Cost: $21,300

Marina at Northeast Corner of Lake Harmony (Area 6)

Priority – Medium

The existing system here is functional but could use some upgrades and maintenance. This drainage area is a good opportunity to construct a downstream infiltration basin/rain garden prior to discharge into the lake. The southern portion of the property at 124 North Lake Drive is ideal. Existing swales and piping can be routed into the basin.

Improvements
- Swale along North Lake Drive to existing inlet at corner of N. Lake Dr. and Harmony Ave.
- Infiltration Basin/Rain Garden

Estimated Construction Cost: $16,925

South Lake Drive – East of Lakeview Drive (Area 8)

Priority - Low

This is the paper street or easement area between 154 South Lake Drive and 160 South Lake Drive, with an extremely steep driveway and large drainage area. The existing culvert appears adequate, but improvements can be made to direct flows to the inlets and stabilize gutter flow. Waterbars should be constructed on the driveway to control runoff and the discharge swale should be improved.

Improvements
- Swale along driveway to lake
- Waterbars along Driveway
- Improve gutters

Estimated Construction Cost: $7,540

Lakeview Drive & South Lake Drive (Area 9)

Priority - Medium

This is the large rain garden that was constructed a few years ago. The rain garden needs to be re-worked to have proper detention and vegetation. Currently, the outlet pipe is immediately draining the basin area and the only contact is with rock ballast. Upstream along Lakeview Drive, roadside swales can collect water to the existing inlet and culvert on South Lake Drive, which may be undersized. The north-south portion of Lakeview Drive should be re-graded and paved. Further treatment can be obtained along the south side of Lakeview Drive, east of Church Street, with some potential infiltration areas and more roadside swales.

Improvements

- Re-construct rain garden/infiltration basin
- Swale along west side of Lakeview Dr.
- Re-grade and pave north-south portion of Lakeview Dr.
- Swale along south of Lakeview Dr., east of Church St.
- Infiltration basin/rain garden along south of Lakeview Dr
- Culverts under Lakeview Dr. at southeast corner and S. Lake Dr.

Estimated Construction Cost: $63,675

Church Street and South Lake Drive (Areas 10 & 11)

Priority - Medium

This area takes a large portion of drainage area from the Skyetop development. Church Street needs to be re-aligned and re-constructed to adequately handle the water from this drainage area. Some facilities are in place, but the road itself poses a great risk to erosion and uncontrolled runoff. Some of this flow could be redirected to Lakeview Drive and handled by the facilities described above under "Lakeview Drive and South Lake Drive".

Improvements

- Re-align and re-construct Church Street
- Swale along east side of Church Street.

Estimated Construction Cost: $50,780

Chestnut Street & South Lake Drive (Area 12)

Priority - Low

There is potential to construct an infiltration basin/rain garden on the north side of South Lake Drive. Proposed storm sewer can catch runoff that would normally flow along South Lake Drive towards Spruce Street.

Runoff can also be collected at the Lakeview Drive intersection and directed into the existing rock basins along Chestnut Street.

Improvements

- Infiltration basin/rain garden on north side of intersection

- Two inlets and culverts at south side of intersection
- Swales at Lakeview Dr. intersection
- Two inlets and cuverts at Lakeview Dr. intersection

Estimated Construction Cost: $41,500

Spruce Street & South Lake Drive (Area 13)

Priority - Low

This intersection takes gutter flow along South Lake Drive and a small area along Spruce Street. Improvements to this intersection would relive some of the flow at the beach area to the west. There is available area for an infiltration basin/rain garden. Runoff would be collected via inlets and storm sewer at the intersection. Re-grading Spruce Street would be necessary, with a swale along the western side.

Improvements
- Discharge swale to lake
- Infiltration basin/rain garden on north side of intersection
- Two inlets and culverts at south side of intersection
- Re-grade Spruce St.
- Swale along west side of Spruce St.

Estimated Construction Cost: $56,125

South Lake Drive – Beach Area (Area 14)

Priority - Low

This area has many existing facilities. However, South Lake Drive could benefit from the development of roadside swales and proper function of the existing storm sewer system.

Improvements
- Swale along south side of South Lake Drive to existing inlet
- Potential for infiltration basin along Lakeview Dr.
- Swales along Lakeview Dr. to direct flow to proposed basin

Estimated Construction Cost: $56,125

Wood Street & South Lake Drive (Area 15)

Priority – Very High

Wood Street required extensive improvements, due to the large drainage area and high concentrated flows that originate upstream. Existing storm sewers are in poor condition and need to be replaced and upgraded. The channel discharge that flows from New Birch Street to the southwest must be addressed. Facilities at Park Lane and above the Estates Drive intersection can also reduce some of the peak flow downstream at the problem areas.

Improvements

- Replace CMP storm sewer at S. Lake Dr. intersection and through boat launch
- Swale along south side of S. Lake Dr.
- Replace storm sewer along west side of Wood St.
- Re-route existing swale along New Birch Street R.O.W. to Wood St. intersection.
- Infiltration basin/rain garden at Park Ln. intersection
- Swale along Park Ln
- Infiltration basin/rain garden along Wood St. above Estates Dr.

Estimated Construction Cost: $92,150

Spring Street (Area 17)

Priority – Low

This is not a critical area, but there are several locations to infiltrate and provide good stormwater management. The intersection at South Lake Drive has no stormwater facilities and flows along the gutter to the west. Reducing runoff upstream would greatly improve this condition.

Improvements

- Swale to handle gutter flow along S. Lake Dr.
- Infiltration basin at four locations between S. Lake Dr. and New Birch St.
- Swales along Spring Street between New Birch St. and Estates Dr.
- Infiltration basins at the Spring St. and Estates Dr. intersection
- Swale along Estates Dr. to catch runoff from steep driveways

Estimated Construction Cost: $88,600