# Prioritization of BMPs and Implementation of Watershed Projects for Harveys Lake

## Borough of Harveys Lake, Luzerne County, Pennsylvania

**(Project Number #2536; Funded by PA Department of Environmental Protection, under the 319(h) NPS Program)**

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***March 2010***

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APPENDICES

## Section 1 - Introduction

Harveys Lake is a 256 ha (632.8 acres) waterbody located in Luzerne County, Pennsylvania, just northeast of Wilkes-Barre. Harveys Lake is the largest natural lake, by volume, within the Commonwealth of Pennsylvania. The outflow of Harveys Lake forms the headwaters of Harveys Creek, which eventually discharges into the Susquehanna River at West Naticoke. Based on Title 25, Chapter 93 classification, from the outlet of Pikes Creek Pond to the Susquehanna River, Harveys Creek is classified as a cold water fishery (CWF) for water quality protection. In addition, the section of Harveys Creek from the outlet of Harveys Lake down to, and including, Pikes Creek Pond is classified as a high quality - cold water fishery habitat (HQ-CWF). Thus, Harveys Lake is also designated as a HQ-CWF waterbody.

The Harveys Lake watershed is 1,469 ha (3,629 acres) in size and is located in the Upper Susquehanna - Lackawanna watershed. Most of the watershed is located in Luzerne County, but a small portion extends into the northeastern corner of Wyoming County (Figure 1 in Appendix A). Harveys Lake, its surrounding watershed and the downstream environments, are located in the State Water Plan Watershed of Toby-Wapwallopen Creeks (5B) and the approximate coordinates of the lake's centroid are $41^{o}21^{'}26^{"}$ north latitude and $76^{o}0^{'}50^{"}$ west longitude.

Harveys Lake has been the subject of a number of studies and investigations over the past 50 years, the last major study being a Phase I USEPA Diagnostic / Feasibility Study conducted in 1993-94 by Coastal Environmental Services, Inc. The executive summary of this Phase I Study is provided in Appendix B. Prior to the Phase I Study, limnological studies on Harveys Lake were conducted by Dr. C. B. Reif of Wilkes University since the late 1940's. The data Dr. Reif collected through the years have been critical in documenting the earlier ecological conditions of the lake. For example, this historical data set was used to identify the importance of the fish and zooplankton communities in controlling algal growth in Harveys Lake. A summary of these, as well as other studies on Harveys Lake, are provided in the Phase I report (Coastal Environmental Services, 1994).

The Phase I Study was used to generate a limnoloigcal and watershed-based database on Harveys Lake, in an effort to develop a Restoration and Management Plan. The primary objective of the Restoration and Management Plan was to identify a series of cost effective in-lake and watershed-based techniques to improve the water quality of Harveys Lake. For convenience, a copy of the Restoration and Management Plan is provided in Appendix B.

## Section 2 - Summary of the Phase I Diagnostic / Feasibility Study of Harveys Lake

Algal blooms have periodically plagued Harveys Lake throughout the 20th century. In response to these blooms and their accompanying declines in water quality, a sewage system was designed and constructed to cover the entire area immediately surrounding the lake and most of the Borough of Harveys Lake. This sewage system was put on line in the summer of 1976 (Reif, 1986). While the sewage system substantially improved the water quality of the lake, periodic blooms were still a major problem due to non-point source (NPS) pollutant loading. These blooms, in spite of the sewage system, prompted the funding of the Phase I Diagnostic / Feasibility Study of Harveys Lake and its watershed under the US EPA Clean Lakes Program.

As mentioned above, funding was awarded to the Borough of Harveys Lake and the Harveys Lake Environmental Advisory Council (EAC) to conduct a Phase I Study of Harveys Lake and its watershed. This funding originated from the US EPA Clean Lakes Program (314), which provided the funding to the PA Department of Environmental Protection (PADEP) for distribution. The Study was conducted in 1993 – 1994.

A Harveys Lake Phase I Clean Lakes Study had three major objectives. First, collect a variety of physical, chemical and biological data on the lake and watershed to quantitatively describe the system. Second, develop an annual "pollutant" budget for the lake. A large part of this pollutant budget involved quantifying the pollutant loads associated with each particular land use within the watershed. For the water quality problems experienced in Harveys Lake, the term pollutant specifically refers to phosphorus, nitrogen and suspended solids. Third, all of the information complied for the Phase I Study was used to develop a holistic, long-term Restoration and Management Plan for the lake and its watershed. Again, the Executive Summary and Restoration and Management Plan are included in Appendix B.

Based on the findings of the Phase I Study, the trophic state (level of biological productivity) of Harveys Lake was in the meso-eutrophic range (moderately to highly productive) for total phosphorus (TP) and chlorophyll *a*, and considered oligotrophic (relatively low in productivity) for water clarity as measured with a Secchi disk. While in-lake TP concentrations ranged from low to moderately high (0.015 and 0.040 mg/L), it was determined that an increase in the annual phosphorus load entering Harveys Lake of as little as 10% would result in a greater than 50% probability that Harveys lake would become eutrophic (highly productive, experiencing large and frequent algal blooms).

Since phosphorus was determined to be the primary limiting nutrient for Harveys Lake, the majority of the long-term management recommendations focus on this nutrient. It takes very little phosphorus to stimulate a large amount of algal growth. For example, it has been determined that one pound of phosphorus has the potential to generate

approximately 1,100 lbs of wet algae. Thus, reductions in the range of tens to hundreds of pounds in the phosphorus loads can result in substantial improvements in water quality.

An annual phosphorus budget, as well as for nitrogen and total suspended solids, was calculated for Harveys Lake. It should be noted these pollutant budgets are based on in-lake and watershed data collected in the late 1980's to early-1990s. Based on the Phase I Study, surface runoff during storm events accounted for almost 60% of the annual TP load entering Harveys Lake. The second largest source of TP was internal regeneration from the sediments (Appendix B).

Based on Unit Areal Loading (UAL) modeling efforts, forested land accounts for almost 60% of the total land within the Harveys Lake watershed and approximately 40% of TP load originating from surface runoff. In contrast, developed land, which includes residential, commercial, industrial and transportation, accounted for less than 15% of the land within the watershed, but 44% of the TP load originating from surface runoff (Appendix B). The results of this analysis clearly demonstrate that developed land, and their associated impervious surfaces, produces a substantial increase in the lake's annual TP load. This also holds true for other NPS pollutants, including nitrogen and total suspended solids.

The impact of NPS pollution, particularly TP, on the ecological and economic value of Harveys Lake, has raised concern over how to minimize and manage both current and future pollutant loads. During the later half of the 1990s the Borough of Harveys Lake and the Harveys Lake EAC distributed educational material to residents and developed and passed a local ordinance banning the use of phosphorus fertilizers for lawns. In late 1990's the Borough and the EAC, with technical assistance from Princeton Hydro, submitted a proposal for funding under the 319 program.

## Section 3 – Summary of the First Non-Point Source (319) Implementation Grant and the two Growing Greener Grants

In 1999 a Non-Point Source (NPS) grant was awarded to the Borough of Harveys Lake and the Harveys Lake EAC to initiate watershed control measures that would reduce the existing NPS pollutant loads, particularly phosphorus, entering the lake and creek. The long-term objective of implementing these measures is to control the frequency and magnitude of blue-green algal blooms, reduce excessive rates of sedimentation and reduce incidences of elevated fecal coliform counts along some of the local beaches.

As detailed in Appendix C, the projects that were completed under the first NPS (319) Implementation grant included:

1. The completion of two streambank stabilization projects within the Harveys Lake watershed,
2. The removal of a 400 cubic yard gravel bar where a small, unnamed stream enters the lake from the northwest, between the Harveys Lake Beach Club and the Fish & Boat Commission's public boat launch,
3. The development and distribution of four educational brochures on non-point source pollution,
4. The development of a GIS database on the Harveys Lake watershed,
5. And the collection and synthesis of two years of in-lake and stormwater water quality monitoring.

In addition, since the stabilization projects were under budget, the remaining funds were used to assist in the completion of a watershed-based project located in the Hemlock Gardens section of the watershed. In addition to the 319 Implementation grant, two Growing Greener grants were awarded to the Borough and the EAC. The first was to supplement the purchase of plants for the streambank stabilization projects under the first 319 grant, while the second was to design and install a large, regional, structural Best Management Practice (BMP) for a 28.4 acre section of the watershed known locally as Hemlock Gardens.

Originally, the large structural BMP proposed for Hemlock Garden was an infiltration basin, however, once the field survey work and testing was complete, it was determined that such a BMP was not feasible for the site. Therefore, an alternative structure, the Manufactured Treatment Device (MTD) Nutrient Separating Baffle Box in series with a Water Polishing Unit, was proposed for Hemlock Gardens (Appendix D). The installation of the Baffle Box – Polishing Unit, coupled with the associated road swale stabilization work required at Hemlock Gardens was more expensive that the original Growing Greener budget. However, since the 319 grant was under budget, the remaining funds and the funds associated with the first Growing Greener grant, were used to complete the Hemlock Gardens project, as described in its final report (for the Executive Summary see Appendix D).

## Section 4 – Summary of the Second Non-Point Source (319) Implementation Grant

While a NPS, 319(h) grant and the two Growing Greener grant projects were completed by 2003 and a second NPS grant (ME# 3511108) was subsequently awarded to the Borough and the EAC that same year. This second NPS grant focused on demonstration projects of various small-scale retrofits that can be easily integrated into the existing stormwater infrastructure. The goal of the grant was to determine which of a number of smaller-scale, selected technologies / retrofits are best suited for installation on a watershed scale to reduce TP and TSS loads. The primary focus area of the project is the land immediately surrounding the lake, along Route 415.

Less than 15% of the Harveys Lake watershed is developed, however, almost all of this development is within 0.5 miles of the lake shoreline. In addition, the majority of this development is privately held residential and commercial use, some of which have no stormwater infrastructure. This makes the installation of large, conventional structural BMPs (i.e. wet retention ponds, vegetative filter strips and artificial wetland) extremely difficult. These existing conditions are why this second NPS (319) grant focused on assessing the potential feasibility of retrofitting small, manufactured treatment devices into existing stormwater infrastructure.

For convenience, all of the project activities conducted under this second NPS (319) grant are summarized below:

1. Installation of six (6) Grate Inlet Skimmer Boxes (GISBs) in selected catch basins along Route 415. These small-scale retrofits were designed to be installed into existing stormwater infrastructure with minimal costs and no permitting.
2. Installation of a Continuous Deflective Separation (CDS) unit at the Harveys Lake Beach Club, located in the northeast corner of the lake just off Route 415 and across from where Baird and Maple Street both intersect with Route 415.
3. Conducting a fishery survey to develop a biomanipulation program for Harveys Lake.
4. A series of public presentations and field tours of Harveys Lake and the associated watershed projects.
5. The collection and synthesis of two years of in-lake and stormwater water quality monitoring.

While the stormwater projects installed as part of this grant required a minimal amount of excavation and were relatively easy to implement, their small size limited the amount of pollutants they removed. However, the amount of TP removed by these smaller-scale retrofits on an annual basis was still quantified for the sake of the long-term management of the watershed and documenting compliance with the TMDL (for details see below).

## Section 5 - Quantification of Pollutant Reductions in the Harveys Lake Watershed, Relative to its TMDL

The PA DEP completed a phosphorus TMDL for the Harveys Lake watershed in 2002. A summary of the TMDL is provided in Appendix E. One of the primary objectives of the phosphorus TMDL was to quantify the existing phosphorus load entering Harveys Lake and determine its targeted or desired phosphorus load. The desired TP load is based on the lake's favorable response to the phosphorus load at that particular targeted level. The State's TMDL analysis of Harveys Lake quantified the existing phosphorus load to be 1,019 lbs, while the targeted phosphorus load was quantified to be 789 lbs (Appendix E). This means that the phosphorus load for Harveys Lake must be reduced by 230 lbs in order to achieve the targeted load.

As described in this final project report for the Harveys Lake Non-Point Source (319) Implementation grant, the watershed projects completed as of the end of 2009 removed approximately 31% of the TMDL's required reduction of 230 lbs to attain the targeted phosphorus load. For convenience, the summary table that was used to document this reduction in the first report is provided here (Table 1).

## Table 1

## Revised Summary of the BMP Impacts on the Harveys Lake Phosphorus TMDL (as of 2009)

| Loading Scenario | Pounds (lbs) per yr | Kilograms (kg) per yr |
|---|---|---|
| Current Load | 1,019 | 462 |
| Targeted Annual Load | 789 | 358 |
| Identified Load Reduction | 230 | 104 |
| | | |
| Two Streambank / Shoreline Stabilization Projects (1st NPS (319) grant) | 22 | 10 |
| Amount of Phosphorus Removed by Hemlock Garden BMP* (Growing Greener grant) | 30 | 13.6 |
| CDS Unit and Six GISB Retrofits (2nd NPS (319) grant) | 5 | 2.3 |
| StormBasin Retrofits (3rd NPS (319) grant) | 14 | 6.1 |
| | | |
| Total Phosphorus Load Removed by BMPs / Retrofits to Date | 71 | 31.9 |
| Remaining TP Load Requiring Reduction | 155 | 70.5 |

* revised to include stormwater data collected during the 2006 monitoring year

# Section 6 - Identified Scope of Work for the Third Non-Point Source (319) Project for Harveys Lake, the Demonstration Project

An application for funding under the State's NPS (319) Program was submitted for the Harveys Lake watershed in 2005 to continue the Borough's long-term efforts to preserve and protect the natural resources of Harveys Lake. While a number of watershed-based restoration projects such structural Best Management Practices (BMPs) or the installation of Manufactured Treatment Devices (MTDs) have been implemented up to this point, an approved Management Plan was not developed for the lake and watershed. Thus, a large part of this third NPS grant was to develop a Stormwater Implementation Plan. In addition to the Plan, a series of small-scale retrofits were installed and some in-lake and stormwater monitoring was conducted. These project Work Elements are outlined below and associated Work Products are provided in Appendices F through H.

1. Update and expand existing GIS database on the Harveys Lake watershed for a Prioritization Analysis of potential BMP projects.
2. Conducting a watershed-wide prioritization analysis, resulting in the development of an approved Stormwater Implementation Plan for the Harveys Lake watershed.
3. Implementation of a number of small-scale, stormwater retrofit projects.
4. In-lake and stormwater monitoring.
5. Project documentation and data analysis, including a long-term assessment of the lake's trophic state indices.

***Update the existing GIS database and develop the Stormwater Implementation Plan***

Since the first NPS (319) grant was awarded to the Borough of Harveys Lake and the Borough's EAC in 1999, a number of watershed-based projects have been implemented to reduce TP and other pollutants that enter and impact Harveys Lake and Creek (see Sections 2-5; Table 1). In spite of the documented success of these projects, the Borough did not have a watershed-based plan for Harveys Lake to objectively prioritize, schedule and implement projects in the future. In addition, the development of a TP TMDL by PA DEP in 2002 amplified the need for such a plan. Thus, the first two Work Elements of 2005 NPS (319) grant was to develop such a Plan using a GIS-based approach.

Since the majority of the water quality problems associated with Harveys Lake, particularly with the pollutants TP and TSS, originate from surface runoff, the Plan's focus is primarily on stormwater. Using GIS and State-based land use / land cover data; a prioritized analysis was conducted to rank the magnitude of the "developed" land source of phosphorus from highest to lowest. The term developed land source refers to any land use / land cover that is associated with human activities or use (i.e. residential, commercial, agricultural, transportation, etc.). This ranked analysis was used to identify site-specific locations for potential watershed restoration projects. Estimates of each project's contributing reduction to the lake's annual TP load were provided to document how such projects can be used to attain the targeted TP load as identified in the TMDL.

Thus, the Stormwater Implementation Plan is essentially a "blueprint" for the Borough and the EAC to use in scheduling and implementing watershed-based projects to comply with the State's TMDL.

The GIS-based analysis, the associated description and ranking of proposed projects, their estimated costs and pollutant removal rates, and a proposed schedule for implementation are provided in detail in the Harveys Lake Watershed Stormwater Implementation Plan (Appendix F). Field reconnaissance for the development of the plan occurred in 2006 and 2007, while a first draft of the Plan was submitted to participating stakeholders by February 2008. Based on input from the Borough, the Borough EAC and PA DEP, a second draft was submitted in April 2008, while a final draft was submitted in December 2008. In early 2009 PA DEP submitted the final draft to US EPA, whose comments were integrated into the draft for the development and approval of the final version of the Plan in May 2009. Some of the projects identified in the approved plan were used to submit an application for a fourth NPS (319) grant funding request. This fourth NPS grant project is being initiated in April 2010.

***Implementation of a number of small-scale, stormwater retrofit projects***

As identified in the approved Stormwater Implementation Plan the Baird Street – Maple Street – Green Street – Route 415 "loop" was identified as a medium level of prioritization for implementation.

A total of 23 catch basin retrofits from Stormwaterworks.com, LLC were manufactured and delivered to the Harveys Lake Borough to be installed along Baird and Maple Streets and Lakeside Drive. Of the existing catch basins, 27 were identified for this project. See Appendix G for more details on the Stormwaterworks retrofits and their installation at Harveys Lake.

A total of 22 StormBasins and 1 StormSack were manufactured and delivered to the Borough in early December 2009. Installation of these structures commenced on 10 December 2009 with the aid of Chris Zimmerman from Stormwaterworks.com, LLC, two employees of the Harveys Lake Borough DPW, and Princeton Hydro, LLC. A summary of these activities are provided below:

- A total of 12 catch basins were retrofitted with StormBasin structures on 10 December 2009
- Three of these structures were fitted with sampling tubes on 10 December 2009
- Five additional catch basins were retrofitted on 27 December 2009

In addition, six of the retrofits were delivered but not included due to various logistical or structural reasons which included:

- Requiring a new grate or adjustment to frame prior to StormBasin installation
- Requiring re-sizing or similar adjustments
- Requiring additional structure (i.e. flat flanges) for proper installation
- Shallow depth preventing proper installation

Once the heavy snow storms hit the area in January 2010, these projects were postponed; however, these six individual catch basin projects will be completed in the spring of 2010. There were also four additional catch basins that did not receive any retrofits due to their poor condition. These catch basins need to be either re-built or completely replaced prior to the installation of the StormBasins.

***In-lake and stormwater monitoring and trophic state analysis***

As previously described two years of in-lake water quality monitoring was conducted in Harveys Lake as part of this grant. Specifically, the monitoring focused on the growing seasons of 2006 and 2007, with three monitoring events conducted during each year for a total of six in-lake events. Details on the sampling methodology and protocol, the resulting data, and the associated analyses are included in a separate report, provided here as Appendix H. The report also includes an inter-annual assessment of the trophic state of Harveys Lake from the original Phase I study (1993) to 2007.

Two detailed stormwater monitoring events were conducted in the summer of 2006. These stormwater monitoring events focused on monitoring the lake's inlets, existing BMPs or sites of future BMP installation. For example, the stormwater data collected at the stations SS-1 through SS-3 were used to provide updated information on the pollutant removal efficiency of the three chambered baffle box treatment system, which was installed in Hemlock Gardens in 2003 (Figure 3). Based on the results of these two storm events, the TP load removal efficiency of the Hemlock Gardens stormwater structure varied between 22 and 36%, while the TSS load removal efficiency was between 38 and 50%. The load removal data were integrated into the long-term pollutant removal database for the Hemlock Gardens BMP to revise the long-term estimated annual pollutant removal rate. As shown in Table 1, based on the stormwater data collected from 2004 to 2007, the three chambered baffle box treatment system in the Hemlock Gardens section of the watershed is estimated to remove approximately 30 lbs of TP per year.

In addition to further assessing the efficiency of an existing BMP, stormwater samples were also collected to provide pre-installation pollutant loading data. Specifically, two sampling stations were established along Maple Street (SS-5 and SS-6 on Figure 6) to quantify the pollutant loads generated from this section of the watershed, prior to the installation of the small-scale StormBasin retrofits. Since no stormwater samples were collected after the 23 StormBasins were installed along Maple and Baird Streets (Figure 2), the pre-installation stormwater data were used to estimate the annual amount of TP

that would be removed through the StormBasin retrofits. Based on the 2006 monitoring program, the mean TP concentration from the Maple Street part of the watershed is 0.117 mg/L. The estimated amount of TP removed from the Maple Street – Baird Street drainage area was calculated by using the mean TP concentration, estimating the Maple Street – Baird Street drainage area, and using local precipitation records. Based on the manufacturer, the cartridges in the StormBasins can remove as much as 80% of the phosphorus entering as stormwater. However, based on field studies, the estimated TP removal rates of these retrofits is approximately 64%. Thus, the field removal rate was used for this analysis. As shown in Table 1, it is estimated that the 23 StormBasins installed in the Maple Street – Baird Street section of the watershed removes approximately 14 lbs of TP per year. This estimated removal rate will be verified by conducting some stormwater samples in this section of the watershed, part of the upcoming 319 grant.

Finally, it should be mentioned that funds from this 319 grant were used to purchase 50 soil testing kits for residents of Harveys Lake. The test kits provided information to residents on the condition of their lawns and whether phosphorus-based fertilizers or another alternative lawn management action (i.e. liming) is required. To date, results for 25 of the 50 soil analysis data reports have been received and are provided in Appendix I. As of April 2010, 15 more have been completed but the reports have not been submitted and 10 remain to be conducted this spring. However, provided below is a summary of the 25 analyses conducted to date:

- All 25 lawns had sub-optimal pH (too acidic) so all received the recommendation to apply limestone to raise the pH. Having sub-optimal soil pH does not allow the grasses to utilize available phosphorus. Thus, any phosphorus applied to lawns with a sub-optimal soil pH, is not utilized and is subsequently washed into receiving waterways through stormwater.
- Approximately 66% of the 25 tested lawns (10 of the 25) have optimal or above optimal amounts of phosphorus, where no P-fertilizers were required. While, these results emphasize the importance of testing one's lawn soil, there are an additional 25 soil samples that need to be evaluated. The additional information will be submitted as an addendum to this report.