Total Maximum Daily Load (TMDL) for Phosphorus in Port Bay

Wayne County, New York

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Prepared for:

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1.0 INTRODUCTION

1.1. Background

In April of 1991, the United States Environmental Protection Agency (EPA) Office of Water's Assessment and Protection Division published "Guidance for Water Quality-based Decisions: The Total Maximum Daily Load (TMDL) Process" (USEPA 1991b). In July 1992, EPA published the final "Water Quality Planning and Management Regulation" (40 CFR Part 130). Together, these documents describe the roles and responsibilities of EPA and the states in meeting the requirements of Section 303(d) of the Federal Clean Water Act (CWA) as amended by the Water Quality Act of 1987, Public Law 100-4. Section 303(d) of the CWA requires each state to identify those waters within its boundaries not meeting water quality standards for any given pollutant applicable to the water's designated uses.

Further, Section 303(d) requires EPA and states to develop TMDLs for all pollutants violating or causing violation of applicable water quality standards for each impaired waterbody. A TMDL determines the maximum amount of pollutant that a waterbody is capable of assimilating while continuing to meet the existing water quality standards. Such loads are established for all the point and nonpoint sources of pollution that cause the impairment at levels necessary to meet the applicable standards with consideration given to seasonal variations and margin of safety. TMDLs provide the framework that allows states to establish and implement pollution control and management plans with the ultimate goal indicated in Section 101(a)(2) of the CWA: "water quality which provides for the protection and propagation of fish, shellfish, and wildlife, and recreation in and on the water, wherever attainable" (USEPA, 1991a).

1.2. Problem Statement

Port Bay (WI/PWL ID 0302-0012) is situated in the Town of Wolcott and Town of Huron, within Wayne County, New York. Over the past couple of decades, the bay has experienced degraded water quality that has reduced the bay's recreational and aesthetic value. Recreational suitability has become less favorable due to "excessive weed growth" in the bay. The "excessive weed growth" is thought to be caused by high levels of nutrients entering the bay from the surrounding watershed, lake-shore septic systems, and a municipal wastewater treatment plant (Wayne County, 2007). Port Bay is presently among the lakes listed on the Lake Ontario Basin PWL (NYS DEC, 2008).

A variety of sources of phosphorus are contributing to the poor water quality in Port Bay. The water quality of the bay is influenced by runoff events from the drainage basin, point source discharges, and loading from nearby residential septic systems. In response to precipitation, nutrients, such as phosphorus – naturally found in New York soils – drain into the bay from the surrounding drainage basin by way of streams, overland flow, and subsurface flow. Nutrients are then deposited and stored in the bay bottom sediments. Phosphorus is often the limiting nutrient in temperate lakes and ponds and can be thought of as a fertilizer; a primary food for plants, including algae. When lakes receive excess phosphorus, it "fertilizes" the lake by feeding the algae. Too much phosphorus can result in algae blooms, which can damage the ecology/aesthetics of a lake, as well as the economic well-being of the surrounding drainage basin community.

The results from state sampling efforts confirm eutrophic conditions in Port Bay, with the concentration of phosphorus in the bay exceeding the state's current guidance value for phosphorus (20 μg/L or 0.020 mg/L, applied as the mean summer, epilimnetic total phosphorus concentration), which increases the potential for nuisance summertime algae blooms. In 2002, Port Bay was added to the New York State Department of Environmental Conservation (NYS DEC) CWA Section 303(d) list of impaired waterbodies that do not meet water quality standards due to phosphorus impairments and was ranked as a high priority for TMDL development (NYS DEC, 2008). Based on this listing, a TMDL for phosphorus is being developed for the bay to address the impairment.

2.0 WATERSHED AND LAKE CHARACTERIZATION

2.1. Watershed Characterization

Port Bay has a direct drainage basin area of 21,068 acres excluding the surface area of the bay (Figure 1). Elevations in the bay's basin range from approximately 604 feet above mean sea level (AMSL) to as low as 246 feet AMSL at the surface of Port Bay.

Existing land use and land cover in the Port Bay drainage basin was determined from digital aerial photography and geographic information system (GIS) datasets. Digital land use/land cover data were obtained from the 2001 National Land Cover Dataset (NLCD, Homer, 2004). The NLCD is a consistent representation of land cover for the conterminous United States generated from classified 30-meter resolution Landsat thematic mapper satellite imagery data. High-resolution color orthophotos were used to manually update and refine land use categories for portions of the drainage basin to reflect current conditions in the drainage basin (Figure 2). Appendix A provides additional detail about the refinement of land use for the drainage basin. Land use categories (including individual category acres and percent of total) in Port Bay's drainage basin are listed in Table 1 and presented in Figures 3 and 4.

Figure 1. Port Bay Direct Drainage Basin

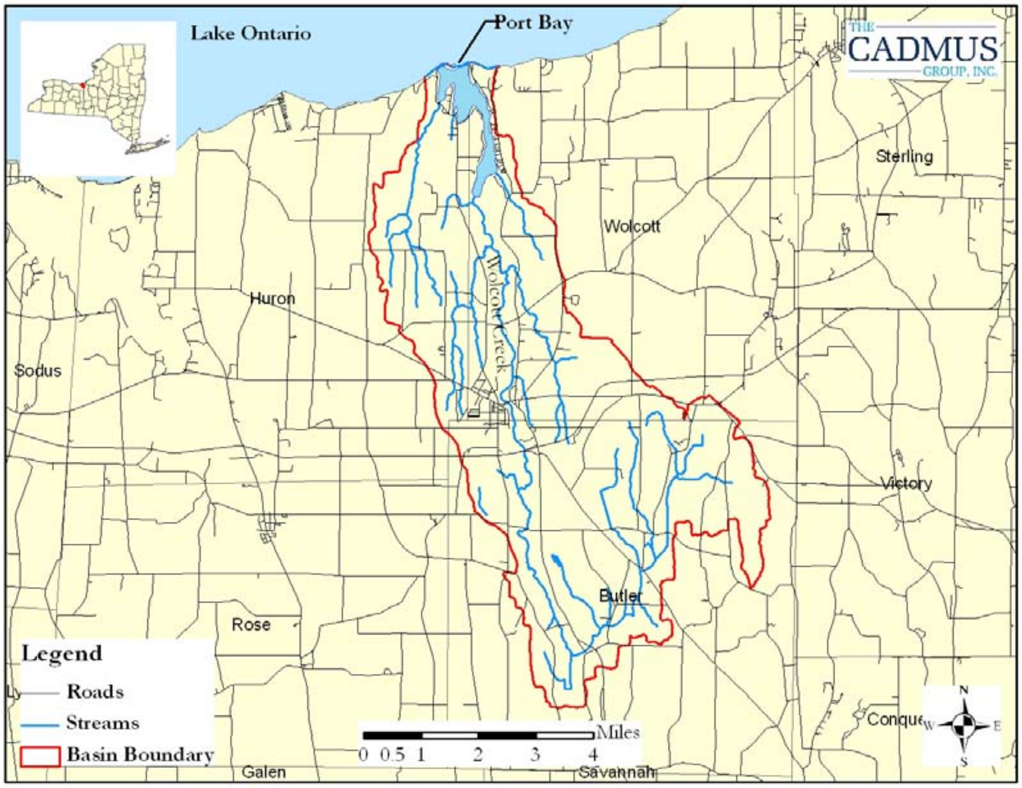


Figure 2. Aerial Image of Port Bay

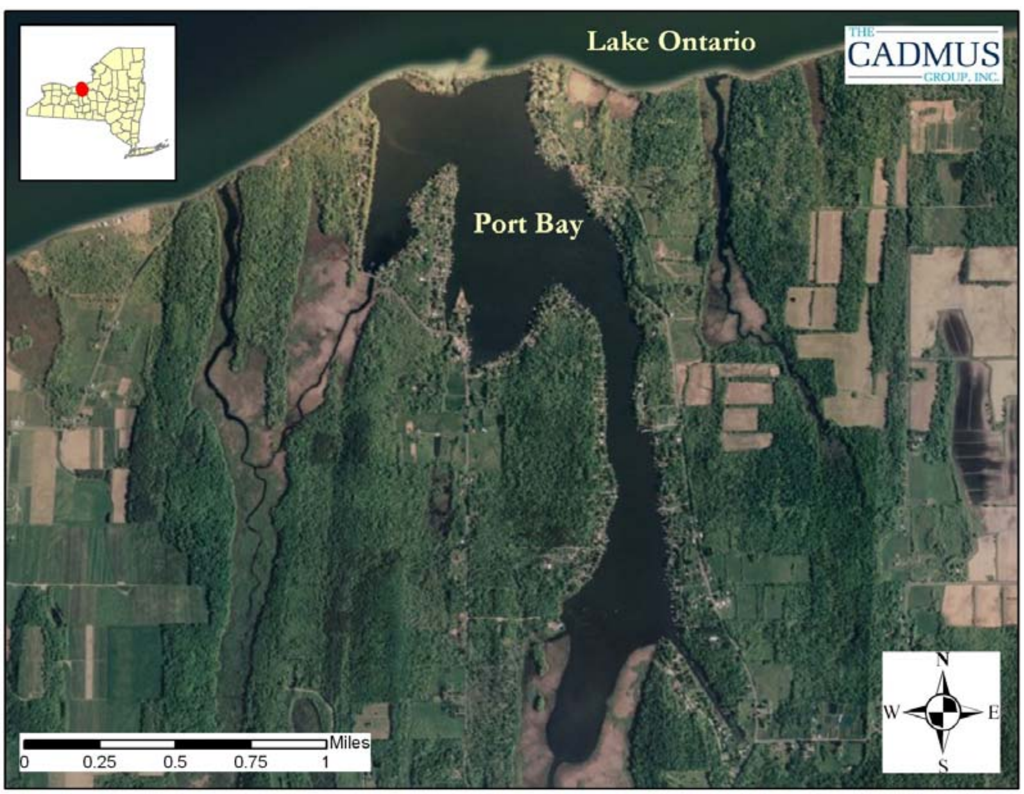


Table 1. Land Use Acres and Percent in Port Bay Drainage Basin

Land Use Category	Acres	% of Drainage Basin
Open Water	98	0.47%
Agriculture	8,437	40.0%
Hay & Pasture	4,698	22.3%
Cropland	3,739	17.7%
Developed Land	1,333	6.33%
Low Intensity	1,277	6.06%
High Intensity	56	0.27%
Forest	10,022	47.6%
Wetlands	1,178	5.6%
TOTAL	**21,068**	**100%**

Figure 3. Percent Land Use in Port Bay Drainage Basin

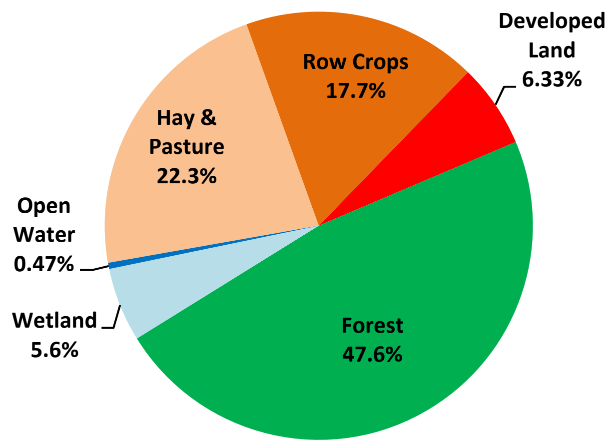
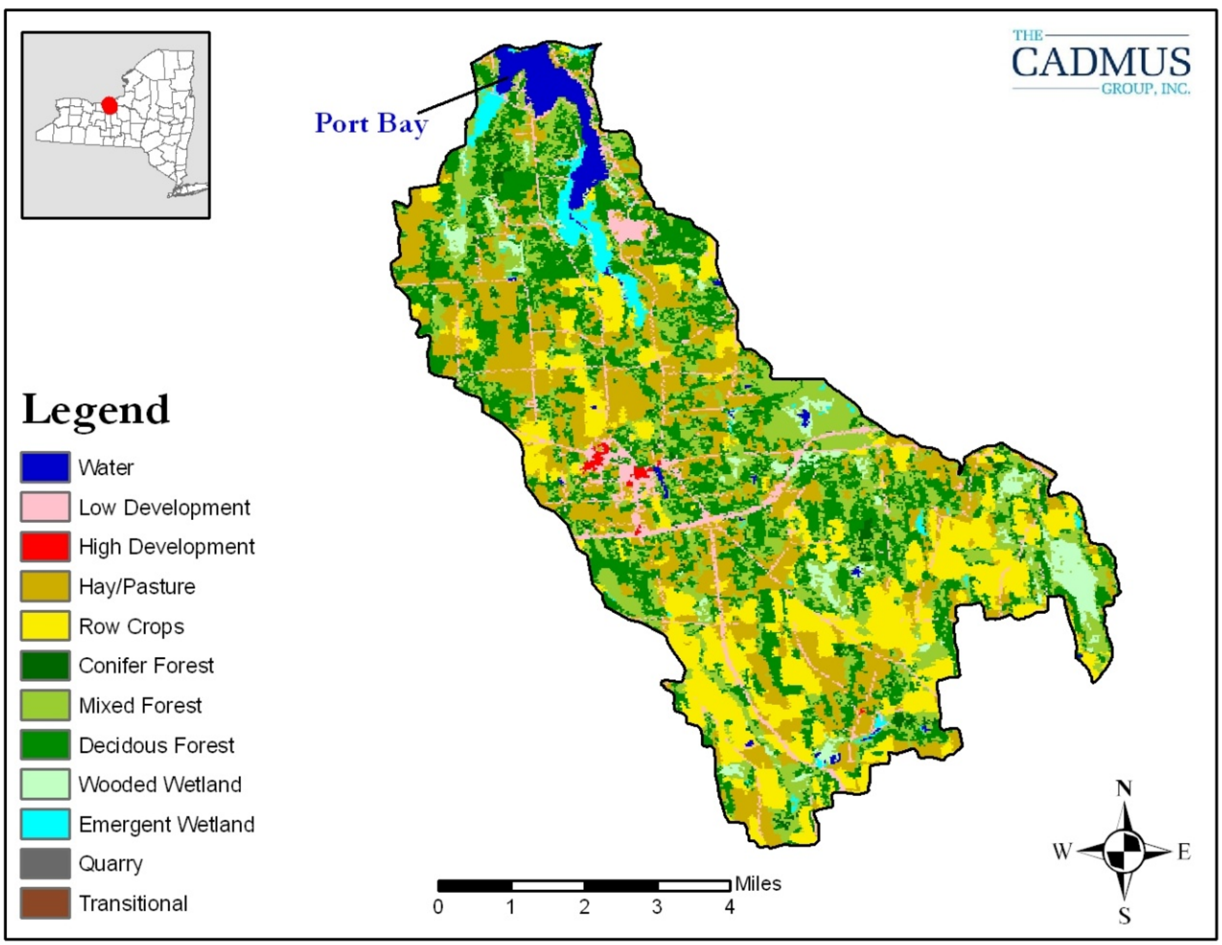


Figure 4. Land Use in Port Bay Drainage Basin



2.2. Lake Morphometry

Port Bay is a 461 acre waterbody at an elevation of about 246 feet AMSL. Figure 5 shows a bathymetric map developed by The Cadmus Group, Inc. for Port Bay based on data collected by the Upstate Freshwater Institute during the summer of 2007. Table 2 summarizes key morphometric characteristics for Port Bay.

Figure 5. Bathymetric Map of Port Bay

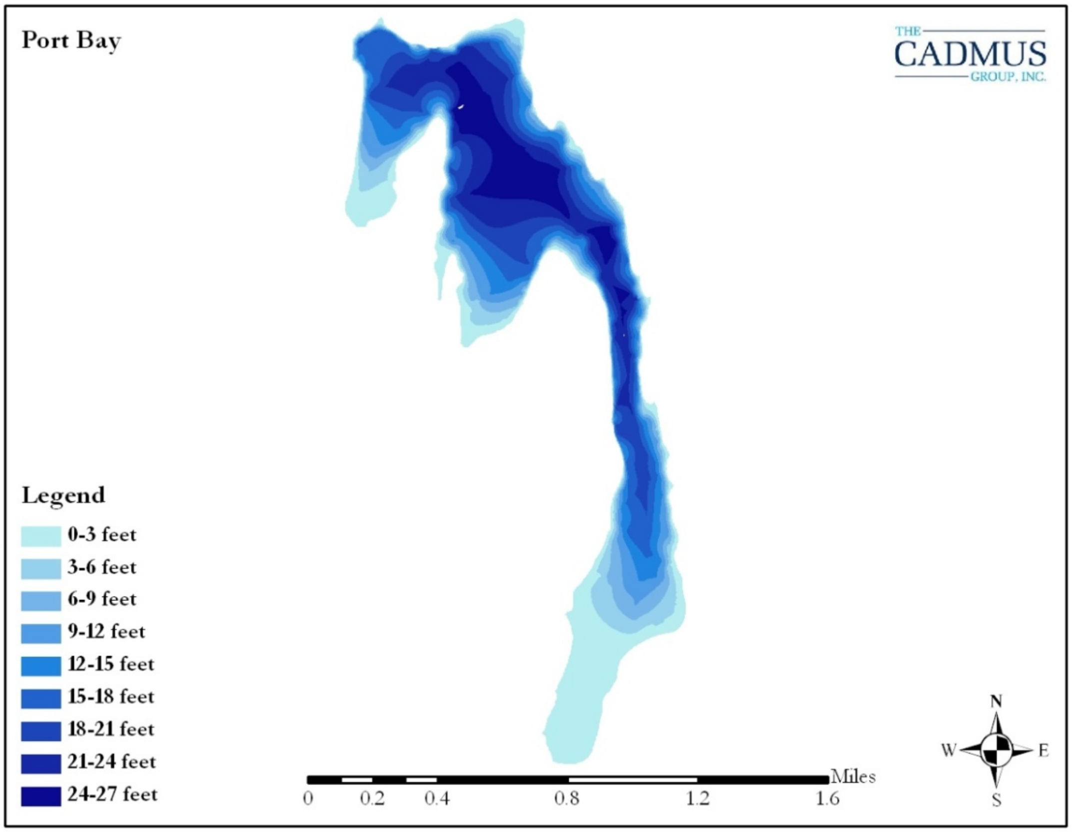


Table 2. Port Bay Characteristics

Surface Area (acres)	461
Elevation (ft AMSL)	246
Maximum Depth (ft)	27
Mean Depth (ft)	13
Length (ft)	8,014
Width at widest point (ft)	2,999
Shoreline perimeter (ft)	41,448
Direct Drainage Area (acres)	21,068
Watershed: Lake Ratio	46:1
Mass Residence Time (years)	0.2
Hydraulic Residence Time (years)	0.2

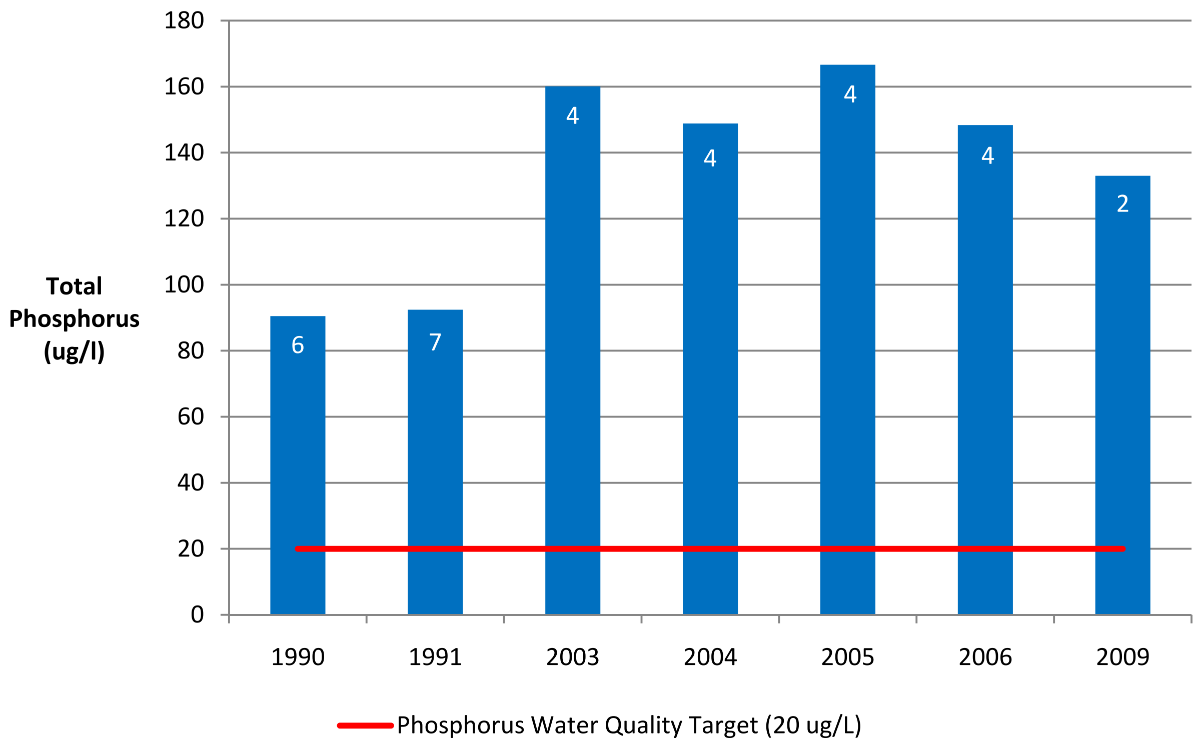
2.3. Water Quality

NYS DEC's Citizens Statewide Lake Assessment Program (CSLAP) is a cooperative volunteer monitoring effort between NYS DEC and the New York Federation of Lake Associations (FOLA). The goal of the program is to establish a volunteer lake monitoring program that provides data for a variety of purposes, including establishment of a long-term database for NYS lakes, identification of water quality problems on individual lakes, geographic and ecological groupings of lakes, and education for data collectors and users. The data collected in CSLAP are fully integrated into the state database for lakes, have been used to assist in local lake management and evaluation of trophic status, spread of invasive species, and other problems seen in the state's lakes.

Volunteers undergo on-site initial training and follow-up quality assurance and quality control sessions are conducted by NYS DEC and trained NYS FOLA staff. After training, equipment, supplies, and preserved bottles are provided to the volunteers by NYS DEC for bi-weekly sampling for a 15 week period between May and October. Water samples are analyzed for standard lake water quality indicators, with a focus on evaluating eutrophication status-total phosphorus, nitrogen (nitrate, ammonia, and total), chlorophyll *a,* pH, conductivity, color, and calcium. Field measurements include water depth, water temperature, and Secchi disk transparency. Volunteers also evaluate use impairments through the use of field observation forms, utilizing a methodology developed in Minnesota and Vermont. Aquatic vegetation samples, deepwater samples, and occasional tributary samples are also collected by sampling volunteers at some lakes. Data are sent from the laboratory to NYS DEC and annual interpretive summary reports are developed and provided to the participating lake associations and other interested parties.

As part of CSLAP, a limited number of water quality samples were collected in Port Bay during the summers of 1990-1991. SUNY Brockport collected water samples in Port Bay during the summers of 2003-2006 and NYS DEC collected additional samples in the summer of 2009. The results from these sampling efforts show eutrophic conditions in Port Bay, with the concentration of phosphorus in the bay exceeding the state guidance value for phosphorus (20 μg/L or 0.020 mg/L, applied as the mean summer, epilimnetic total phosphorus concentration), which increases the potential for nuisance summertime algae blooms. Figure 6 shows the summer mean epilimnetic phosphorus concentrations for phosphorus data collected during all sampling seasons and years in which Port Bay was sampled; the number annotations on the bars indicate the number of data points included in each summer mean.

Figure 6. Summer Mean Epilimnetic Total Phosphorus Levels in Port Bay



3.0 NUMERIC WATER QUALITY TARGET

The TMDL target is a numeric endpoint specified to represent the level of acceptable water quality that is to be achieved by implementing the TMDL. The water quality classification for Port Bay is *B*, which means that the best usages of the lake are primary and secondary contact recreation and fishing. The lake must also be suitable for fish propagation and survival. New York State has a narrative standard for nutrients: "none in amounts that will result in growths of algae, weeds and slimes that will impair the waters for their best usages" (6 NYSCRR Part 703.2). As part of its Technical and Operational Guidance Series (TOGS 1.1.1 and accompanying fact sheet, NYS, 1993), NYS DEC has suggested that for waters classified as ponded (i.e., lakes, reservoirs and ponds, excluding Lakes Erie, Ontario, and Champlain), the epilimnetic summer mean total phosphorus level shall not exceed 20 µg/L (or 0.02 mg/L), based on biweekly sampling, conducted from June 1 to September 30. This guidance value of 20 µg/L is the TMDL target for Port Bay.

4.0 SOURCE ASSESSMENT

4.1. Analysis of Phosphorus Contributions

The MapShed watershed model was used in combination with the BATHTUB lake response model to develop the Port Bay TMDL. This approach consists of using MapShed to determine mean annual phosphorus loading to the bay, and BATHTUB to define the extent to which this load must be reduced to meet the water quality target. MapShed incorporates an enhanced version of the

Generalized Watershed Loading Function (GWLF) model developed by Haith and Shoemaker (1987) and the RUNQUAL model also developed by Haith (1993). GWLF and RUNQUAL simulate runoff and stream flow by a water-balance method based on measurements of daily precipitation and average temperature. The complexity of the two models falls between that of detailed, process-based simulation models and simple export coefficient models that do not represent temporal variability. The GWLF and RUNQUAL models were determined to be appropriate for this TMDL analysis because they simulate the important processes of concern, but do not have onerous data requirements for calibration. MapShed was developed to facilitate the use of the GWLF and RUNQUAL models via a MapWindow interface (Evans, 2009). Appendix A discusses the setup, calibration, and use of the MapShed model for lake TMDL assessments in New York.

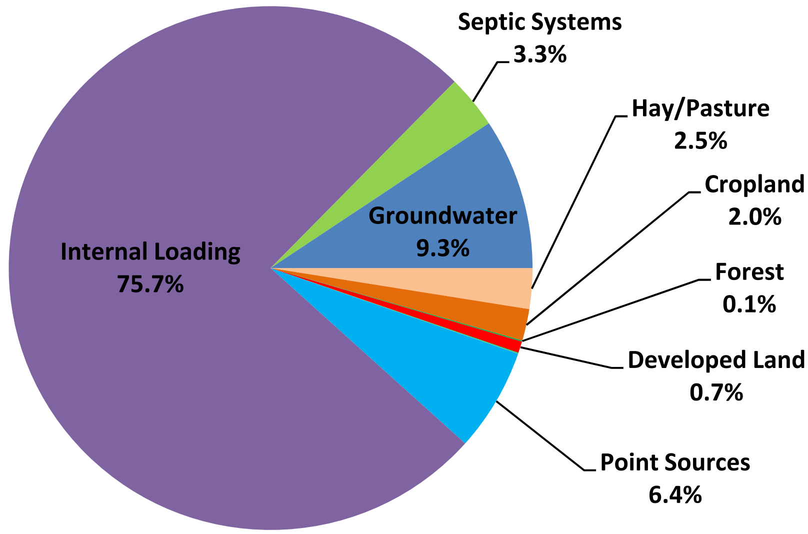
4.2. Sources of Phosphorus Loading

MapShed was used to estimate long-term (1990-2007) mean annual phosphorus (external) loading to Port Bay. Additionally, estimates for internal loading were calculated (see Section 4.2.7). The estimated mean annual external load of 41,899 lbs/yr of total phosphorus that enters Port Bay comes from the sources listed in Table 3 and shown in Figure 7. Appendix A provides the detailed simulation results from MapShed.

Table 3. Estimated Sources of Phosphorus Loading to Port Bay

Source	Total Phosphorus (lbs/yr)
Hay/Pasture	1,052
Cropland	817
Forest	30
Wetlands	6
Developed Land	295
Stream Bank	19
Septic Systems	1,376
Groundwater	3,906
Village of Wolcott WWTP (NY0020303)	1,902
Reckitt Benckiser, Inc. (NY0078531)	772
Merrell Farms Inc. (NYA000120)	0
Internal Loading	31,724
TOTAL	**41,899**

Figure 7. Estimated Sources of Total Phosphorus Loading to Port Bay



4.2.1. *Wastewater Treatment Plants*

The following two wastewater treatment plants are located in the Port Bay drainage basin: 1) Wolcott Wastewater Treatment Facility (SPDES ID: NY0020303); and 2) Reckitt Benckiser, Inc. (SPDES ID: NY0078531). Estimated monthly total phosphorus concentrations and flows were calculated by NYS DEC for these facilities; these estimates are provided in Appendix D. This information is used in MapShed to calculate phosphorus loading from the point sources. Estimated total phosphorus loading from the point sources (combined) is 2,674 lbs/yr (6.4% of the total external loading to Port Bay). Reckitt Benckiser, Inc. is no longer operating and the permit has been discontinued. Therefore, this facility will not be a future source of phosphorus.

4.2.2. *Residential On-Site Septic Systems*

Residential on-site septic systems contribute an estimated 1,376 lbs/yr of phosphorus to Port Bay, which is about 3.3% of the total loading to the bay. Residential septic systems contribute dissolved phosphorus to nearby waterbodies due to system malfunctions. Septic systems treat human waste using a collection system that discharges liquid waste into the soil through a series of distribution lines that comprise the drain field. In properly functioning (normal) systems, phosphates are adsorbed and retained by the soil as the effluent percolates through the soil to the shallow saturated zone. Therefore, normal systems contribute very little phosphorus loads to nearby waterbodies. A ponding septic system malfunction occurs when there is a discharge of waste to the soil surface (where it is available for runoff); as a result, malfunctioning septic systems can contribute high phosphorus loads to nearby waterbodies. Short-circuited systems (those systems in close proximity to surface waters where there is limited opportunity for phosphorus adsorption to take place) also contribute significant phosphorus loads; septic systems within 250 feet of the lake are subject to potential short-circuiting, with those closer to the lake more likely to contribute greater loads. Additional details about the process for estimating the population served by normal and malfunctioning systems within the lake drainage basin is provided in Appendix A.

GIS analysis of orthoimagery for the basin shows approximately 101 houses within 50 feet of the shoreline and 302 houses between 50 and 250 feet of the shoreline; all of the houses are assumed to have septic systems. Additionally, 85 houses were identified as directly abutting stream banks in the watershed. Within 50 feet of the shorelines and on stream banks, 100% of septic systems were categorized as short-circuiting. Between 50 and 250 feet of the shoreline, 80% of septic systems were categorized as short-circuiting, 5% were categorized as ponding systems, and 15% were categorized as normal systems. To convert the estimated number of septic systems to population served, an average household size of 2.61 people per dwelling was used based on the circa 2000 USCB census estimate for number of persons per household in New York State. To account for seasonal variations in population, data from the 2000 census were used to estimate the percentage of seasonal homes for the town(s) surrounding the bay. Approximately 78% of the homes around the bay are assumed to be year-round residences, while 22% are seasonally occupied (i.e., June through August only). The estimated population in the Port Bay drainage basin served by normal and malfunctioning systems is summarized in Table 4.

Table 4. Population Served by Septic Systems in the Port Bay Drainage Basin

	Normally Functioning	Ponding	Short Circuiting	Total
September – May	92	31	871	994
June – August (Summer)	118	39	1116	1273

4.2.3. *Agricultural Runoff*

Agricultural land encompasses 8,437 acres (40.0%) of the bay's drainage basin and includes hay and pasture land (22.3%) and row crops (17.7%). Overland runoff from agricultural land is estimated to contribute 1,869 lbs/yr of phosphorus loading to Port Bay, which is 4.5% of the total phosphorus loading to the bay.

In addition to the contribution of phosphorus to the bay from overland agriculture runoff, additional phosphorus originating from agricultural lands is leached in dissolved form from the surface and transported to the bay through subsurface movement via groundwater. The process for estimating subsurface delivery of phosphorus originating from agricultural land is discussed in the Groundwater Seepage section (below). Phosphorus loading from agricultural land originates primarily from soil erosion and the application of manure and fertilizers. Implementation plans for agricultural sources will require voluntary controls applied on an incremental basis.

4.2.4. *Urban and Residential Development Runoff*

Developed land comprises 1,333 acres (6.3%) of the bay's drainage basin. Stormwater runoff from developed land contributes 295 lb/yr of phosphorus to Port Bay, which is about 0.7% of the total phosphorus loading to the bay. This load does not account for contributions from malfunctioning septic systems.

In addition to the contribution of phosphorus to the bay from overland urban runoff, additional phosphorus originating from developed lands is leached in dissolved form from the surface and transported to the bay through subsurface movement via groundwater. The process for estimating subsurface delivery of phosphorus originating from developed land is discussed in the Groundwater Seepage section (below).

Phosphorus runoff from developed areas originates primarily from human activities, such as fertilizer applications to lawns. Shoreline development, in particular, can have a large phosphorus loading impact to nearby waterbodies in comparison to its relatively small percentage of the total land area in the drainage basin.

4.2.5. *Forest Land Runoff*

Forested land comprises 10,022 acres (47.6%) of the bay's drainage basin. Runoff from forested land is estimated to contribute about 30 lbs/yr of phosphorus loading to Port Bay, which is about 0.1% of the total phosphorus loading to the bay. Phosphorus contribution from forested land is considered a component of background loading.

4.2.6. *Groundwater Seepage*

In addition to nonpoint sources of phosphorus delivered to the bay by surface runoff, a portion of the phosphorus loading from nonpoint sources seeps into the ground and is transported to the bay via groundwater. Groundwater is estimated to transport 3,906 lbs/yr (9.3%) of the total phosphorus load to Port Bay. With respect to groundwater, there is typically a small background concentration owing to various natural sources. In the Port Bay drainage basin, the model-estimated groundwater phosphorus concentration is 0.058 mg/L. The GWLF manual provides estimated background groundwater phosphorus concentrations for ≥90% forested land in the eastern United States, which is 0.006 mg/L. Consequently, about 10% of the groundwater load (404 lbs/yr) can be attributed to natural sources, including forested land and soils.

The remaining amount of the groundwater phosphorus load likely originates from agricultural or developed land sources (i.e., leached in dissolved form from the surface). It is estimated that the remaining 3,501.5 lbs/yr of phosphorus transported to the bay through groundwater originates from developed land (477.4 lbs/yr) and agricultural sources (3,024.1 lbs/yr), proportional to their respective surface runoff loads. Table 5 summarizes this information.

Table 5. Sources of Phosphorus Transported in the Subsurface via Groundwater

	Total Phosphorus (lbs/yr)	% of Total Groundwater Load
Natural Sources	404.0	10.35%
Agricultural Land	3,024.1	77.43%
Developed Land	477.4	12.22%
TOTAL	**3,905.5**	**100.00%**

4.2.7. *Internal Loading*

Port Bay has been exposed to nutrient loading that is much higher than its assimilative capacity. Over time, much of this excess phosphorus has been deposited into the bottom sediments. Internal phosphorus loading from lake sediments can be an important component of the phosphorus budget for lakes, especially shallow lakes. Excess phosphorus in a lake's bottom sediments is available for release back into the water column when conditions are favorable for nutrient release. Such conditions can include re-suspension of sediments by wind mixing or rough fish activity (e.g., feeding off bottom of lake), sediment anoxia (i.e., low dissolved oxygen levels near the sediment water interface), high pH levels, die-offs of heavy growths of curly-leaf pond weeds, and other mechanisms that result in the release of poorly bound phosphorus.

Accurate simulation of internal phosphorus loading is an uncertain science and a generally applicable method has yet to be identified. Several existing methods were considered for estimating internal loading in Port Bay. However, a lack of sufficient data hindered the ability to verify the ability of these methods to accurately simulate the internal loading process. Therefore, once all external sources of phosphorus loading were identified, the remaining load was assumed to be originating from internal sources (i.e., lake bottom sediments). Based on this determination, internal loading is currently estimated to contribute about 31,724 lbs/yr (75.7%) of phosphorus to Port Bay.

4.2.8. *Other Sources*

Atmospheric deposition, wildlife, waterfowl, and domestic pets are also potential sources of phosphorus loading to the bay. All of these small sources of phosphorus are incorporated into the land use loadings as identified in the TMDL analysis (and therefore accounted for). Further, the deposition of phosphorus from the atmosphere over the surface of the bay is accounted for in the bay model, though it is small in comparison to the external loading to the bay.

5.0 DETERMINATION OF LOAD CAPACITY

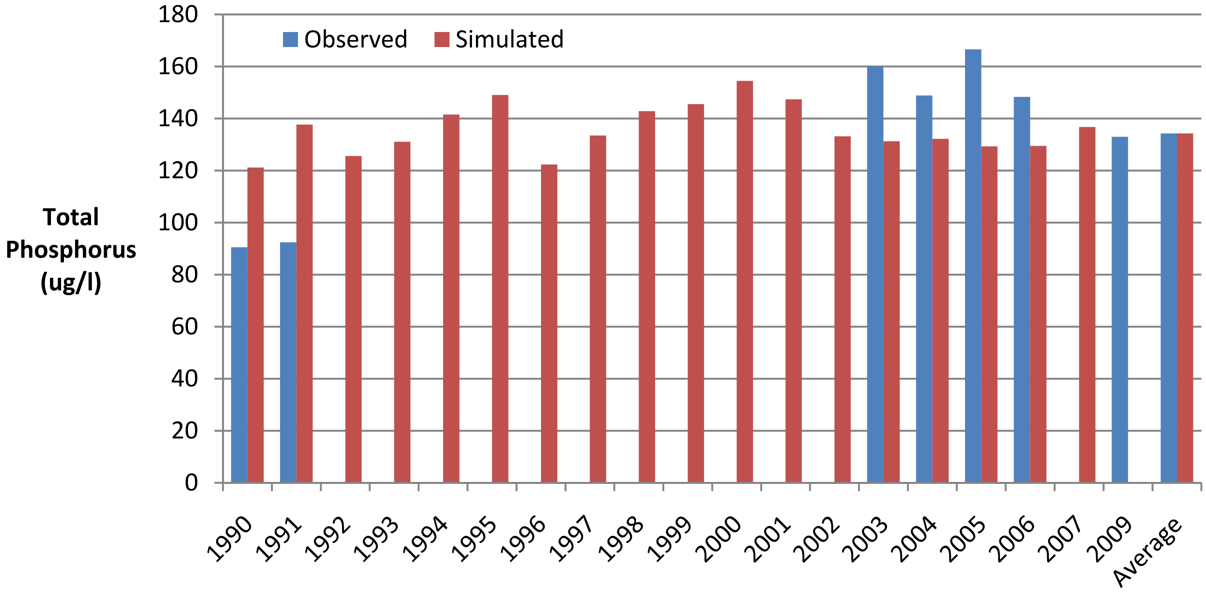
5.1. Lake Modeling Using the BATHTUB Model

BATHTUB was used to define the relationship between phosphorus loading to the bay and the resulting concentrations of total phosphorus in the bay. The U.S. Army Corps of Engineers' BATHTUB model predicts eutrophication-related water quality conditions (e.g., phosphorus, nitrogen, chlorophyll a, and transparency) using empirical relationships previously developed and tested for reservoir applications (Walker, 1987). BATHTUB performs steady-state water and nutrient balance calculations in a spatially segmented hydraulic network. Appendix B discusses the setup, calibration, and use of the BATHTUB model.

5.2. Linking Total Phosphorus Loading to the Numeric Water Quality Target

In order to estimate the loading capacity of the bay, simulated phosphorus loads from MapShed and calculated internal loads were input to the BATHTUB model, which was then used to simulate water quality in Port Bay. MapShed was used to derive a mean annual phosphorus loading to the bay for the period 1990-2007. Using this external load and the calculated internal load as input, BATHTUB was used to simulate water quality in the bay. The results of the BATHTUB simulation were compared against the average of the bay's observed summer mean phosphorus concentrations for the years 1990-1991 and 2003-2006. Year-specific loading was also simulated with MapShed for external loading and calculated for internal loading, run through BATHTUB, and compared against the observed summer mean phosphorus concentration for years with observed in-lake data. The combined use of MapShed, BATHTUB, and internal loading estimates provides a decent fit to the observed data for Port Bay (Figure 8).

Figure 8. Observed vs. Simulated Summer Mean Epilimnetic Total Phosphorus Concentrations (μg/L) in Port Bay



The BATHTUB model was used as a "diagnostic" tool to derive the total phosphorus load reduction required to achieve the current phosphorus target of 20 μg/L. The loading capacity of Port Bay was determined by running BATHTUB iteratively, reducing the concentration of the drainage basin phosphorus load (which in turn reduced the internal load) until model results demonstrated attainment of the water quality target. As external loading is reduced, internal loading is also reduced; thus the percent reduction in internal loading is estimated to be proportional to the percent reduction in external loading. The maximum concentration that results in compliance with the TMDL target for phosphorus is used as the basis for determining the bay's loading capacity. This concentration is converted into a loading rate using simulated flow from MapShed.

The maximum annual phosphorus load (i.e., the annual TMDL) that will maintain compliance with the phosphorus water quality goal of 20 μg/L in Port Bay is a mean annual load of 2,251 lbs/yr. The daily TMDL of 6.2 lbs/day was calculated by dividing the annual load by the number of days in a year. Lakes and reservoirs store phosphorus in the water column and sediment, therefore water quality responses are generally related to the total nutrient loading occurring over a year or season. For this reason, phosphorus TMDLs for lakes and reservoirs are generally calculated on an annual or seasonal basis. The use of annual loads, versus daily loads, is an accepted method for expressing nutrient loads in lakes and reservoirs. This is supported by EPA guidance such as *The Lake Restoration Guidance Manual* (USEPA 1990) and *Technical Guidance Manual for Performing Waste Load Allocations, Book IV, lakes and Impoundments, Chapter 2 Eutrophication* (USEPA 1986). While a daily load has been calculated, it is recommended that the annual loading target be used to guide implementation efforts since the annual load of total phosphorus as a TMDL target is more easily aligned with the design of best management practices (BMPs) used to implement nonpoint source and stormwater controls for lakes than daily loads. Ultimate compliance with water quality standards for the TMDL will be determined by measuring the lake's water quality to determine when the phosphorus guidance value is attained.

6.0 POLLUTANT LOAD ALLOCATIONS

The objective of a TMDL is to provide a basis for allocating acceptable loads among all of the known pollutant sources so that appropriate control measures can be implemented and water quality standards achieved. Individual waste load allocations (WLAs) are assigned to discharges regulated by State Pollutant Discharge Elimination System (SPDES) permits (commonly called point sources) and unregulated loads (commonly called nonpoint sources) are contained in load allocations (LAs). A TMDL is expressed as the sum of all individual WLAs for point source loads, LAs for nonpoint source loads, and an appropriate margin of safety (MOS), which takes into account uncertainty (Equation 1).

Equation 1. Calculation of the TMDL

$$TMDL = \sum WLA + \sum LA + MOS$$

6.1. Wasteload Allocation (WLA)

The WLA for Port Bay is currently set at 76 lbs/yr. There are no MS4s in the Port Bay basin. However, there is currently 1 permitted wastewater treatment plant discharger in the basin (Village of Wolcott Wastewater Treatment Facility). The Reckitt Benckiser, Inc. facility is no longer operating and the permit has been discontinued.

One regulated concentrated animal feeding operation (CAFO), Merrell Farms Inc., is located in the watershed. This CAFO is regulated via the federally-issued National Pollutant Discharge Elimination System (NPDES) General Permits for CAFOs. NPDES permits for CAFOs require that the facilities be designed, constructed and operated to have no discharge of pollutants to navigable waters, unless caused by a catastrophic storm (24-hour duration exceeding the 25-year recurrence interval). CAFOs must comply with their no-discharge permit requirements; therefore, loading from the Merrell Farms CAFO is assumed to be zero (0).

6.2. Load Allocation (LA)

The LA is currently set at 1,946.4 lbs/yr. Nonpoint sources that contribute total phosphorus to Port Bay on an annual basis include loads from developed land, agricultural land, and malfunctioning septic systems. Table 6 lists the current loading for each source and the load allocation needed to meet the TMDL; Figure 9 provides a graphical representation of this information. Phosphorus originating from natural sources (including forested land, wetlands, and stream banks) is assumed to be a minor source of loading that is unlikely to be reduced further and therefore the load allocation is set at current loading. Internal loads were allocated under the assumption that the internal load will decrease proportionally to decreases in external loads and eventually reach zero. The bulk of the reductions need to come from agricultural land and septic systems, which account for most of the external load in the watershed.

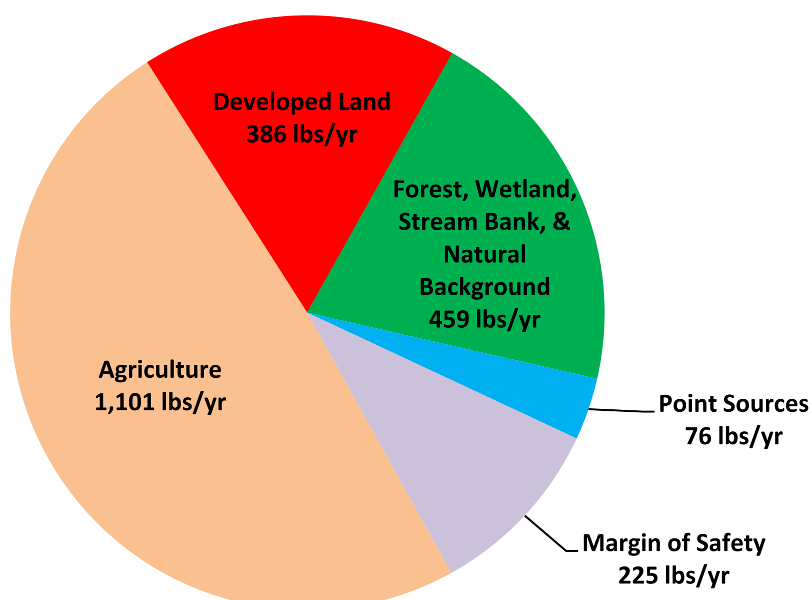
Table 6. Total Annual Phosphorus Load Allocations for Port Bay*

Source	Total Phosphorus Load (lbs/yr)			% Reduction
	Current	Allocated	Reduction	
Agriculture**	4,894	1,101	3,793	78%
Developed Land**	772	386	386	50%
Septic Systems	1,376	0	1,376	100%
Forest, Wetland, Stream Bank, and Natural Background**	459.4	459.4	0	0%
Internal Loading	31,724	0	31,724	100%
LOAD ALLOCATION	**39,225.4**	**1,946.4**	**37,279**	**95%**
Village of Wolcott WWTP (NY0020303)	1,902	76	1,826	96%
Reckitt Benckiser, Inc. (NY0078531)	772	0	772	100%
Merrell Farms Inc. (NYA000120)	0	0	0	0%
WASTELOAD ALLOCATION	**2,674**	**76**	**2,598**	**97%**
LA + WLA	**41,899.4**	**2,022.4**	**39,877.0**	**95.2%**
Margin of Safety	---	224.7	---	---
TOTAL	**41,899.4**	**2,247.1**	**---**	**---**

* The values reported in Table 6 are annually integrated. Daily equivalent values are provided in Appendix C.

** Includes phosphorus transported through surface runoff and subsurface (groundwater)

Figure 9. Total Phosphorus Load Allocations for Port Bay (lbs/yr)



6.3. Margin of Safety (MOS)

The margin of safety (MOS) can be implicit (incorporated into the TMDL analysis through conservative assumptions) or explicit (expressed in the TMDL as a portion of the loadings) or a combination of both. For the Port Bay TMDL, the MOS is explicitly accounted for during the allocation of loadings. An implicit MOS could have been provided by making conservative assumptions at various steps in the TMDL development process (e.g., by selecting conservative model input parameters or a conservative TMDL target). However, making conservative assumptions in the modeling analysis can lead to errors in projecting the benefits of BMPs and in projecting lake responses. Therefore, the recommended method is to formulate the mass balance using the best scientific estimates of the model input values and keep the margin of safety in the "MOS" term. The TMDL contains an explicit margin of safety corresponding to 10% of the loading capacity, or 224.7 lbs/yr. The MOS can be reviewed in the future as new data become available.

6.4. Critical Conditions

TMDLs must take into account critical environmental conditions to ensure that the water quality is protected during times when it is most vulnerable. Critical conditions were taken into account in the development of this TMDL. In terms of loading, spring runoff periods are considered critical because wet weather events transport significant quantities of nonpoint source loads to lakes. However, the water quality ramifications of these nutrient loads are most severe during middle or late summer. Therefore, BATHTUB model simulations were compared against observed data for the summer period only. Furthermore, MapShed takes into account loadings from all periods throughout the year, including spring loads.

6.5. Seasonal Variations

Seasonal variation in nutrient load and response is captured within the models used for this TMDL. In BATHTUB, seasonality is incorporated in terms of seasonal averages for summer. Seasonal variation is also represented in the TMDL by taking 18 years of daily precipitation data when calculating runoff through MapShed, as well as by estimating septic system loading inputs based on residency (i.e., seasonal or year-round). This takes into account the seasonal effects the lake will undergo during a given year.

7.0 IMPLEMENTATION

One of the critical factors in the successful development and implementation of TMDLs is the identification of potential management alternatives, such as best management practices (BMPs) and screening and selection of final alternatives in collaboration with the involved stakeholders. Coordination with state agencies, federal agencies, local governments, and stakeholders such as the general public, environmental interest groups, and representatives from the nonpoint pollution sources will ensure that the proposed management alternatives are technically and financially feasible. NYS DEC, in coordination with these local interests, will address the sources of impairment, using regulatory and non-regulatory tools in this watershed, matching management strategies with sources, and aligning available resources to effect implementation.

NYS DEC recognizes that TMDL designated load reductions alone may not be sufficient to restore eutrophic lakes. The TMDL establishes the required nutrient reduction targets and provides some regulatory framework to effect those reductions. However, the nutrient load only affects the eutrophication potential of a lake. The implementation plan therefore calls for the collection of additional monitoring data, as discussed in Section 7.2, to determine the effectiveness of nutrient reduction management practices.

7.1. Reasonable Assurance for Implementation

This TMDL was written with the elimination of on-site septic systems as well as significant load reductions from the Village of Wolcott POTW, agriculture and developed land. As an alternative to a state of the art treatment upgrade, the Village of Wolcott POTW has the ability to connect to the Wayne County Sewer Authority WWTP located outside of the watershed which was designed with excess capacity to handle the additional flow, which would result in complete elimination of this load. If the Village of Wolcott POTW decides not to connect to the Wayne County Sewer Authority WWTP, the next permit for the Wolcott POTW will include the appropriate limit and compliance schedule that will comply with the allocations determined in this TMDL. Meeting the necessary load reductions using a staged implementation approach provides opportunity to achieve the most technically achievable load reductions earlier, while allowing time to re-evaluate the reasonable assurance of meeting other load reductions required to meet the TMDL. This is necessary because the allocations are based on an estimation of internal load and a response of that load to external load reductions. It will likely take years to see the response in Port Bay water quality from attempts to reduce watershed phosphorus load.

NYS DEC is re-evaluating its nutrient criteria for lakes based on scientific information that a higher target concentration may be appropriate to protect swimming uses. If a higher target concentration is allowable, some of the actions to reduce loads in latter stages may not be needed.

Stage 1 would be implemented by the end of 2013, and would be based on the strict discharge limit of the wastewater treatment plant discharge, along with minor load reductions from agriculture and developed land.

Stage 2 would be implemented by the end of 2020, and would be based on the elimination of the septic system load by connection to sewers, and include more significant load reductions from agriculture and developed land.

Stage 3 would be implemented by the end of 2025, and would be based on extensive implementation of management and other conservation practices on agricultural lands as well as significant load reductions from developed land.

Stage 4 would be implemented by the end of 2030, and would be based on the likely need for extensive changes to farming practices as well as significant load reductions from developed land.

7.1.1. Recommended Phosphorus Management Strategies for Septic Systems

This TMDL recommends eliminating phosphorus loading from septic systems by sewering the developed areas around the lake and pumping the effluent to the Wayne County Sewer Authority WWTP for treatment and discharge outside of the Port Bay watershed. The TMDL implementation plan schedules this load reduction for Stage 2, with a target date of 2020.

In the interim, a surveying and testing program should be implemented to document the location of septic systems and verify failing systems requiring replacement in accordance with the State Sanitary Code. The Town of Huron currently enforces a septic system law with scheduled inspections of all systems in the town. State funding is also available for a voluntary septic system inspection and maintenance program or a septic system local law requiring inspection and repair. Property owners should be educated on proper maintenance of their septic systems and encouraged to make preventative repairs.

7.1.2. Recommended Phosphorus Management Strategies for Agricultural Runoff

Merrell Farms, Inc., regulated via the federally-issued NPDES General Permits for CAFOs, is located in the Port Bay watershed. Discharges from this CAFO are considered to be *de minimis* since the barnyard is required to contain runoff from a 25-year, 24-hour rainfall event. Consequently this CAFO is given a WLA of zero (0). It is recognized that much has been done in terms of agricultural management, even though these practices are not credited by the watershed model in estimating load. The staged implementation plan for this TMDL accounts for full implementation of CAFO requirements by 2013. Despite this progress, loads from agriculture remain a dominant source of phosphorus loading to Port Bay. Without further load reductions, water quality improvements in Port Bay may not be fully realized.

The New York State Agricultural Environmental Management (AEM) Program was codified into law in 2000. Its goal is to support farmers in their efforts to protect water quality and conserve natural resources, while enhancing farm viability. AEM provides a forum to showcase the soil and water conservation stewardship farmers provide. It also provides information to farmers about CAFO regulatory requirements, which helps to assure compliance. Details of the AEM program can be found at the New York State Soil and Water Conservation Committee (SWCC) website, http://www.nys-soilandwater.org/aem/index.html.

Using a voluntary approach to meet local, state, and national water quality objectives, AEM has become the primary program for agricultural conservation in New York. It also has become the umbrella program for integrating/coordinating all local, state, and federal agricultural programs. For instance, farm eligibility for cost sharing under the SWCC Agricultural Non-point Source Abatement and Control Grants Program is contingent upon AEM participation.

AEM core concepts include a voluntary and incentive-based approach, attending to specific farm needs and reducing farmer liability by providing approved protocols to follow. AEM provides a locally led, coordinated and confidential planning and assessment method that addresses watershed needs. The assessment process increases farmer awareness of the impact farm activities have on the environment and, by design, it encourages farmer participation, which is an important overall goal of this implementation plan.

The AEM Program relies on a five-tiered process:

Tier 1 – Survey current activities, future plans and potential environmental concerns.

Tier 2 – Document current land stewardship; identify and prioritize areas of concern.

Tier 3 – Develop a conservation plan, by certified planners, addressing areas of concern tailored to farm economic and environmental goals.

Tier 4 – Implement the plan using available financial, educational and technical assistance.

Tier 5 – Conduct evaluations to ensure the protection of the environment and farm viability.

Wayne County Soil and Water Conservation District should continue to implement the AEM program on farms in the watershed, focusing on identification of management practices that reduce phosphorus loads. These practices would be eligible for state or federal funding and because they address a water quality impairment associated with this TMDL, should score well. Beginning on July 1, 2010 as part of the federal government's Great Lakes Restoration Imitative, this watershed is listed as a priority for funding through the U.S. Department of Agriculture's Environmental Quality Incentives Program. Tier 1 could be used to identify farmers that for economic or personal reasons may be changing or scaling back operations, or contemplating selling land. These farms would be candidates for conservation easements, or conversion of cropland to hay, as would farms identified in Tier 2 with highly-erodible soils and/or needing stream management. Tier 3 should include a Comprehensive Nutrient Management Plan with phosphorus indexing. Additional practices could be fully implemented in Tier 4 to reduce phosphorus loads, such as conservation tillage, stream fencing, rotational grazing and cover crops. Also, riparian buffers reduce losses from upland fields and stabilize stream banks in addition to the reductions from taking the land in buffers out of production.

Stage 2 of this implementation plan is based on bringing all agricultural operations through Tier 4 of AEM, thus implementing conservation plans by 2020. Levels of phosphorus reductions to achieve Stage 3 and 4 load allocations could only be achieved with significant changes in agricultural operations, such as converting cropland to pasture or conservation easements. It should be noted that all of the actions outlined beyond Stage 1 would be voluntary on the part of farmers.

7.1.3. Recommended Phosphorus Management for Stormwater Runoff

NYSDEC issued SPDES general permits GP-0-10-001 for construction activities, and GP0-10-002 for stormwater discharges from municipal separate stormwater sewer systems (MS4s) in response to the federal Phase II Stormwater rules. GP0-10-002 applies to urbanized areas of New York State, so it does not cover the Port Bay watershed.

Stormwater management in rural areas can be addressed through the Nonpoint Source Management Program. There are several measures, which, if implemented in the watershed, could directly or indirectly reduce phosphorus loads in stormwater discharges to the lake or watershed:

- Public education regarding:
    - Lawn care, specifically reducing fertilizer use or using phosphorus-free products, now commercially available,
    - Cleaning up pet waste, and
    - Discouraging waterfowl congregation by restoring natural shoreline vegetation.
- Management practices to address any significant existing erosion sites.
- Construction site and post construction stormwater runoff control ordinance and inspection and enforcement programs.
- Pollution prevention practices for road and ditch maintenance.
- Management practices for the handling, storage and use of roadway deicing products.
- Infiltration of stormwater from developed areas.

Stage 1 reductions are based on the public education measures. Stage 2 would include some implementation of practices to address any significant existing erosion sites, and adoption of the preventive management practices listed above. Stage 3 would take nearly complete implementation of erosion control practices and Stage 4 would be based on practical limits for infiltration of stormwater from developed areas.

7.1.2 Additional Protection Measures

Measures to further protect water quality and limit the growth of phosphorus load that would otherwise offset load reduction efforts should be considered. The basic protections afforded by local zoning ordinances could be enhanced to limit non-compatible development, preserve natural vegetation along shorelines and tributaries and promote smart growth. Identification of wildlife habitats, sensitive environmental areas, and key open spaces within the watershed could lead to their preservation or protection by way of conservation easements or other voluntary controls.

7.2 Follow-up Monitoring

A targeted post-assessment monitoring effort is necessary to determine the effectiveness of the implementation plan associated with the TMDL. Port Bay will be sampled in 2015 at its deepest location (approx. 30 feet), during the warmer part of the year (June through September) on 8 sampling dates. Grab samples will be collected at 1.5 meter and in the hypolimnion. The samples will be analyzed for the phosphorus series (total phosphorus, total soluble phosphorus, and soluble reactive phosphorus), the nitrogen series (nitrate, ammonia and total nitrogen), and chloride. The epilimnetic samples will be analyzed for chlorophyll a and the Secchi disk depth will be measured. A simple macrophyte survey will also be conducted one time during midsummer.

Depending on the speed and extent of implementation, the sampling will be repeated at a regular interval. The initial plan will be to set the interval at 5 years. In addition, as information on the DEC GIS system is updated (land use, BMPs, etc.), these updates will be applied to the input data for the models BATHTUB and MapShed and may be used to modify the TMDL or implementation plan as needed. The information will be incorporated into the NY 305(b) report as needed.

8.0 PUBLIC PARTICIPATION

NYSDEC met with the Wayne County Soil and Water Conservation District on March 4, 2010 to discuss TMDL development, refine data and to receive local input. Notice of availability of the Draft TMDL was made to local government representatives and interested parties. This Draft TMDL was public noticed in the Environmental Notice Bulletin on July 5, 2010. A 30-day public review period was established for soliciting written comments from stakeholders prior to the finalization and submission of the TMDL for EPA approval.

Letters were received from two local elected officials on behalf of the Village of Wolcott. The letters expressed concern that the TMDL requirements were unfair and imposed a financial hardship on the Village. Written comments were also received 8/4/10 and 9/22/10 from Clark Patterson Lee on behalf of the Village of Wolcott. The following is NYS DEC's response to comments:

1. **8/4/10 Comment: Clarification is requested regarding the justification for the recommended annual phosphorus Wasteload Allocation.**

    Response: Port Bay is listed on the New York State 2010 Federal Clean Water Act (CWA) Section 303(d) List of Impaired Waters for the pollutant phosphorus. The CWA requires that TMDLs are performed to address 303(d) List impairments. A TMDL is the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. The CWA and New York Environmental Conservation Law prohibit issuance of a discharge permit that contributes to an impairment of water quality standards. Permits must also be consistent with the assumptions and requirements of TMDLs. As noted in Section 7.1, the wastewater treatment reductions are considered the most technically achievable. The 96% reduction from the Village of Wolcott WWTP is required in order for water quality standards in Port Bay to be met.

    9/22/10 Comment: This allocation seems excessive for the wastewater treatment facility and presents a financial hardship on the Village that is difficult to place on other entities in the watershed. Perhaps a less stringent allocation could be permitted that fits within the means of the Village.

    Response: The CWA requires that TMDL allocations meet water quality standards. Providing relief from the stringent WLA for the Village WWTP will not ensure that water quality standards are met in Port Bay.

2. **C) 8/4/10 Comment: Directing flows collected in the Village of Wolcott to the WCWSA WWTP only relocates the problem of phosphorus discharge to the Red Creek Watershed, which drains into Lake Ontario.**

    Response: Directing the Village of Wolcott WWTP flow to the WCWSA WWTP is one option that will meet the waste load allocation specified in the TMDL. The WCWSA facility was designed with excess capacity to accommodate wastewater flows from the bay area in an effort to address the water quality impairments in the region. The WWTP provides a high degree of tertiary treatment and consistently meets the limits in their SPDES discharge permit.

    9/22/10 Comment: Does the WCWSA WWTP currently treat for phosphorus removal? Is phosphorus removal currently in the SPDES permit for the plant.

    Response: The WCWSA WWTP does not currently have a phosphorus limit in their SPDES permit. The design flow of the facility is 0.5 MGD. The Great Lakes Water Quality Agreement phosphorus restrictions apply to facilities that have a design flow of 1.0 MGD or greater.

3. **A) 8/4/10 Comment: A January 2010 report entitled "Port Bay, Wayne County, New York" by Makarewicz and Nowak from SUNY Brockport indicates that the average phosphorus concentration in Port Bay from 2003 to 2009 have decreased by over 50%. The report also shows that average phosphorus concentrations in May are around 10 μg/l and then steadily increase throughout the summer months. This trend of**

increasing phosphorus concentrations during the summer months when runoff from the watershed is at a minimum should be investigated further.

A) Response: The Makarewicz and Nowak report indicates that the average summer phosphorus concentration for 2007 and 2009 had decreased substantially from the previous years. While this is a welcome development it does not provide enough data to determine if it is a downward trend in phosphorus concentrations or if it is due to other unrelated conditions. Nevertheless, phosphorus concentrations during these two years were around 80 ug/l which is still much higher than the States Guidance Value of 20 ug/l. A similar situation occurred in 1990-1991 when phosphorus concentrations were around 90 ug/l and then increased to between 140-160 ug/l as witnessed in Figure 6 of the TMDL. The trend of increasing phosphorus concentrations in the bay during the summer months when runoff is at a minimum is typically indicative of loading from WWTPs and failing on-site septic systems. The loading from the WWTP stays relatively constant year round and plays an increasing role in phosphorus loads entering Port Bay during the summer months when runoff is at a minimum. Loading from inadequate or failing septic systems is also very likely to have a larger contribution during the summer months when seasonal home use is greatest. Also the bottom waters of Port Bay go anoxic during midsummer allowing for the release of phosphorus from the bottom muds into the water column.

A) 9/22/10 Comment: The phosphorus concentrations in May have averaged approximately 10 ug/l for the past six years and suggests that Port Bay is capable of assimilating the full loading from the Wolcott WWTF. The Village does not suggest that no limitations are needed however this data suggests that a less stringent allocation could be granted to the Village.

A) Response: The State's guidance value of 20 ug/l only applies to the summer growing season (June-September). The Department does not consider the May values to be relevant to the Wolcott WWTF discharge's impact on the impairment of Port Bay later in the growing season

B) 8/4/10 Comment: This monthly trend also contradicts the claims in Section 6.4 Critical Conditions which states that the critical time is in the spring when increased runoff conveys large non-point sources of phosphorus to the Bay. This section also states that these increased loadings become most influential in the summer however, the study suggests that increased runoff in the spring does not convey large phosphorus loadings to Port Bay. By analyzing testing only from June-September and making assumptions about loadings throughout the rest of the year, the validity of conclusions drawn about existing conditions, specifically about unmonitored non-point sources, is suspect.

B) Response: The simulated nutrient transport summary data has been added to Appendix A of the TMDL. This table shows monthly average nutrient loads to Port Bay and does in fact show increased loadings in the spring. The hydraulic residence time for Port Bay is approximately 73 days so phosphorus loads entering the bay during the spring months is still present in the bay early on in the summer growing season. Lake testing was analyzed from June-September because it represents the summer recreation season and it is the time period for which the Guidance Value of 20 ug/l is applied.

B) 9/22/10 Comment: How can the springtime phosphorus concentrations in Port Bay be so low if the phosphorus loading is so great? It seems that the information in the model does not correspond with the data.

B) Response: The lake model predicts the phosphorus concentration in Port Bay during the summer growing season (June-Sept) only.

4. **8/4/10 Comment: It does not appear that the natural uptake of phosphorus was included in the calculations of the wasteload allocation. The report concludes that all the phosphorus discharged from the WWTP ends up directly in Port Bay when in fact it flows through a thickly vegetated stream bed and wetlands before entering Port Bay. The Village would like the opportunity to perform independent testing to determine how much phosphorus is naturally absorbed by vegetation from the discharge point to Port Bay.**

   Response: While there may be some vegetative uptake in the stream during the summer in periphyton, over the course of a year nearly all of the phosphorus discharged from the WWTP would be transported to Port Bay. Particulate phosphorus from the WWTP that enters the wetlands, would likely be released during the growing season in a soluble, bioavailable form. The commenter should also be advised that the Department is developing nutrient criteria for streams which would likely also result in the need for an effluent limitation for phosphorus from the WWTP in the future.

   9/22/10 Comment: If vegetation in the summer months is able to absorb phosphorus, this would lessen the impact of WWTF loading to Port Bay during the most critical time of the year. Existing data shows that Port Bay is capable of assimilating these releases when seasonal conditions are not as severe. If NYSDEC develops nutrient criteria for streams it would presumably affect the WCWSA WWTP. If the plant does not currently treat for phosphorus then capital improvements would be needed reinforcing the Villages position that diverting flow to the regional facility for treatment does not solve the problem in an environmentally responsible and sustainable manner.

   Response: Existing water quality data collected downstream of the Village of Wolcott discharge shows extremely elevated concentrations of phosphorus. This nutrient enrichment is further verified by the Villages description of the streambed as thickly vegetated. In light of the degraded condition of the receiving stream, the request to investigate its mitigative effects prior to Port Bay will not be entertained.

   When the Department adopts nutrient criteria for flowing waters it will apply statewide and will affect the WCWSA WWTP. Should the Village continue to maintain a SPDES permit for their facility it will also be affected by this future regulation. Compliance with the criteria will undoubtedly require extremely stringentseasonal phosphorus limits for discharges to small headwater streams with little or no dilution such as the case with the Village of Wolcott WWTP. This further strengthens the Department's position that the strict WLA proposed for the Village is necessary.

7. **8/4/10 Comment: The proposed wasteload allocation of 76 lbs/yr places a tremendous hardship on the Village of Wolcott WWTF. At a permitted average daily**

flow of 0.25 MGD, the proposed allocation would result in an allocated concentration of 0.10 mg/l in the WWTF effluent.

Response: The phosphorus limit in the Village of Wolcott's SPDES Permit will likely be expressed as a load (76 lbs/yr) and applied as a 12-month rolling average to provide the permittee some degree of flexibility against the monthly fluctuation of phosphorus concentration in the treated effluent and flow. Several WWTPs in NY ranging from plants smaller than Wolcotts to the Onondaga Metro facility consistently produce effluent concentrations below 0.10 mg/l. EPA report 910-R-07-002: Advanced Wastewater Treatment to Achieve Low Concentration of Phosphorus lists many small plants treating to much higher levels. Several studies published by Water Environment Reseach Foundation (WERF) indicate that concentrations of 0.10 mg/l or lower can be achieved consistently.

9/22/10 Comment: While the Village is aware of technologies for treating phosphorus to 0.1 mg/l or lower, it is concerned that such technologies are not affordable for Wolcott residents. A less stringent limitation could allow the Village to pursue more cost-efficient and sustainable technologies what will contribute significantly to the health of Port Bay.

The Village has submitted applications for funding a capital improvement project at the WWTF and has secured hardship status with NYSEFC. The Preliminary Engineering Report submitted with the application includes processes for phosphorus removal. Perhaps the TMDL could acknowledge the Village's cooperative efforts and its desire to improve the quality of its effluent.

Response: Please refer to the Departments response to comment 1. While costs can inform decisions regarding the implementation of load reductions and the schedule to achieve such reductions, it is apparent that meeting water quality standards in Port Bay will require significant reductions.

9. **8/4/10 Comment: Was there any other testing performed in the watershed outside of the bay? Stream flows and nutrient concentrations would be helpful in more accurately identifying non-point sources of phosphorus.**

Response: Tributary sampling collected during 1993-1994 can be found in Nutrient Loading in Streams Entering Sodus Bay and Port Bay, NY: A Summary of Port Bay and Sodus Bay Tributary Monitoring and Stressed Stream Analysis of Glenmark and Wolcott Creeks by Makarewicz and Lewis. The report cites that the West Branch of Wolcott Creek (Williams Creek), which accepts the discharge from the Village of Wolcott WWTP, has the highest nutrient concentrations of all the tributaries to Port Bay and that it is a potential cause of increased phytoplankton and macrophyte production in the Bay. It also cites that on an annual basis, Wolcott Creek is the major contributor of nutrient loads to the Bay because it is the largest tributary in terms of flow.

9/22/10 Comment: Can the information of this report be used to help identify non-point sources of phosphorus within the Village? Was this information used in calibrating the models used to simulate loadings?

Response: The tributary data contained in the report would not be useful for identifying non-point sources of phosphorus within the VillageThe information was not used to calibrate the watershed model.

10. **8/4/10 Comment: A recently published Preliminary Engineering Report prepared for the Village shows that the costs for installing a chemical feed and disc filter systems to remove phosphorus would be just under $700,000. Annual O&M costs would add approximately $30,000. This would increase costs for each billing unit by over 25%. This presents a tremendous financial hardship for Villagers that no one else in the watershed is required to pay.**

    Response: The Department appreciates the information on the cost of upgraded treatment and acknowledges the financial consequences on village users. While costs can inform the decision of relative consequences, the load reductions in this case require significant reductions from all sources.

    9/22/10 Comment: The Village is being required to make the most significant reductions at the highest costs when compared to the rest of the watershed, while there is no guarantee that anyone else in the watershed will reduce phosphorus loads.

    Response: The CWA only has regulatory control over direct discharges to waters of the United States, which include the Village and regulated Concentrated Animal Feeding Operations. . The comment has been noted and is also addressed in Comment 12.

11. **8/4/10 Comment: The Center for Environmental Information (CEI), published a paper stating the following about phosphorus removal from wastewater streams:**

    > **"Phosphorus can be removed by sewage treatment plants, but many plants would need to be retrofitted to be effective, and the cost of the retrofitting would far exceed the costs associated with limiting phosphorus inputs through Senate Bill 3780."**

    The bill which limits the phosphorus content in dishwashing detergent and residential fertilizer was signed into law on July 15, 2010. The Village would like the opportunity to monitor influent and effluent phosphorus levels for a period of time at the WWTF to determine how this new regulation will impact loadings.

    Response: The Department proposed the Bill (http://www.dec.ny.gov/chemical/67239.html) because it was cost effective, however limiting the phosphorus content of automatic dishwashing detergent is only anticipated to reduce the phosphorus loads from domestic sewage by about ten per cent. The CEI quote is true at face value but should not be interpreted to be the answer to phosphorus reduction needs everywhere. Water quality needs in many locations will likely continue to dictate the need for wastewater treatment upgrades, albeit more expensive.

    9/22/10 Comment: The paper published by CEI states that sources of phosphorus targeted in this law may comprise anywhere from 9%-34% of phosphorus in domestic wastewater. Testing at the WWTF as this law comes into effect may affect the type of technology implemented for phosphorus removal.

Response: The Department does not anticipate that reduction in the influent concentration to the Village WWTF would make meeting the Waste Load Allocation any harder.

12. **8/4/10 Comment: The Village of Wolcott is identified as the only source of phosphorus in the watershed that will be required by law to comply with the TMDL. Agricultural sources and septic systems may voluntarily work to comply with the TMDL and there is no legal leverage to force these sources to comply. It is unfair that the Village will be required to comply almost immediately with the extreme limitations proposed in the TMDL.**

    Response: The CWA has legal control over direct discharges to waters of the United StatesThe TMDL process allows for load reductions from other sources (non-point) to be considered and should improve the chances of receiving funding to affect reductions from these sources. In the case of Port Bay, extraordinary load reductions are necessary from all sources.

    9/22/10 Comment: Given the circumstances surrounding the allocation for the WWTF, including the financial hardship of the Village residents and the desire of the Village to cooperate fully with the regulatory agencies, the Village i presented a proposal for consideration. The Village believes that this proposal offers a solution that is sustainable for the Village, while still complying with the ambitious environmental goals of the TMDL.

    Response: The proposal presented by the Village contains an allocation of 760 lbs/yr based on an effluent concentration of 1.0 mg/l. This represents a 684 lbs/yr increase from the WLA in the draft TMDL. As stated numerous times, the TMDL must set forth allocations that ensure water quality standards in Port Bay are met. The goal of the TMDL is to fully restore the water quality of Port Bay rather than partially improve upon the situation. This proposal falls far short of this goal.

    The Department requests more detailed information regarding cost estimates both for upgrading the Village WWTP as well as connecting to the WCWSA WWTP.

    The in-stream monitoring would not be necessary as part of the capital improvement project. The WLA would be applied at the end of pipe and does not take into account in-stream processing.

9.0 REFERENCES

40 CFR Part 130 Water Quality Planning and Management

ASCE Task Committee on Definition of Criteria for Evaluation of Watershed Models of the Watershed Management Committee, Irrigation and Drainage Division, 1993. Criteria for evaluation of watershed models. Journal of Irrigation and Drainage Engineering, Vol. 199, No. 3.

Day, L.D., 2001. Phosphorus Impacts from Onsite Septic Systems to Surface Waters in the Cannonsville Reservoir Basin, NY. Delaware County Soil and Water Conservation District, Walton, NY, June, 2001.

Evans, B.M., D.W. Lehning, K.J. Corradini. (2009) MapShed (Version 1.0) Users Guide. Penn State Institutes of Energy and the Environment, University Park, PA.

Evans, B.M., D.W. Lehning, K.J. Corradini, *Summary of Work Undertaken Related to Adaptation of AVGWLF for Use in New England and New York*. 2007.

Evans, B.M., D.W. Lehning, K.J. Corradini, G.W. Petersen, E. Nizeyimana, J.M. Hamlett, P.D. Robillard, and R.L. Day, 2002. A Comprehensive GIS-Based Modeling Approach for Predicting Nutrient Loads in Watersheds. Journal of Spatial Hydrology, Vol. 2, No. 2.

Haith, D.A. 1993. RUNQUAL: Runoff Quality from Development Sites Users Manual. Cornell University Department of Agricultural and Biological Engineering.

Haith, D.A. and L.L. Shoemaker, 1987. Generalized Watershed Loading Functions for Stream Flow Nutrients. Water Resources Bulletin, 23(3), pp. 471-478.

Homer, C. C. Huang, L. Yang, B. Wylie and M. Coan. 2004. *Development of a 2001 National Landcover Database for the United States. Photogrammetric Engineering and Remote Sensing*, Vol. 70, No. 7, July 2004, pp. 829.

National Atmospheric Deposition Program (NRSP-3). 2007. NADP Program Office, Illinois State Water Survey, 2204 Griffith Dr., Champaign, IL 61820.

NYS DEC, 2008. New York State 2008 Section 303(d) List of Impaired Waters Requiring a TMDL/Other Strategy. NYS Department of Environmental Conservation, Division of Water, Bureau of Watershed Assessment and Management.

New York State, 1998. 6 NYS Codes Rules and Regulations, Part 703.2, Narrative Water Quality Standards.

New York State, 1993. New York State Fact Sheet, Ambient Water Quality Value for Protection of Recreational Uses, Substance: Phosphorus, Bureau of Technical Services and Research. NYS Department of Environmental Conservation.

Pitt, R., A. Maestre, and R. Morquecho. 2008. *National Stormwater Quality Database, Version 3*. February.
http://unix.eng.ua.edu/~rpitt/Research/ms4/Table%20NSQD%20v3%20Feb%2003,%202008.xls

Sherwood, D.A., 1999, *Phosphorus Loads Entering Long Pond, A Small Embayment of Lake Ontario near Rochester, New York*. Prepared by U.S. Geological Survey in cooperation with the Monroe County Department of Health.

United States Army Corps of Engineers, Engineer Research and Development Center, 2004. Flux, Profile, and BATHTUB: Simplified Procedures for Eutrophication Assessment and Prediction. <http://el.erdc.usace.army.mil/elmodels/emiinfo.html>.

United States Census Bureau, Census 2000 Summary File 3 (SF 3) - Sample Data. *H18. AVERAGE HOUSEHOLD SIZE OF OCCUPIED HOUSING UNITS BY TENURE Average Household Size of Occupied housing Units by Tenure*. 2007, http://factfinder.census.gov/

USEPA. 2002. *Onsite Wastewater Treatment Systems Manual*. EPA/625/R-00/008. February 2002.

USEPA, 1999. Protocol for Developing Sediment TMDLs (First Edition). EPA 841-B-99-004. Office of Water (4503F), United States Environmental Protection Agency, Washington, DC.

USEPA. 1991a. Technical support document for water quality-based toxics control. Office of Water. Washington, D.C. March 1991. EPA/505/2-90-001.

USEPA. 1991b. April 1991. Guidance for Water Quality-Based Decisions: The TMDL Process. EPA 440/4-91001.

USEPA. 1990. *The Lake and Reservoir Restoration Guidance Manual*. 2nd Ed. and *Monitoring Lake and Reservoir Restoration (Technical Supplement)*. Prepared by North American Lake Management Society. EPA 440/4-90-006 and EPA 440/4-90-007.

USEPA. 1986. Technical Guidance Manual for Performing Wasteload Allocations, Book IV: Lakes, Reservoirs and Impoundments, Chapter 2: Eutrophication. EPA 440/4-84-019, p. 3-8.

Walker, W.W., Jr. 1987. Empirical Methods for Predicting Eutrophication in Impoundments. Report 4-Phase III: Applications Manual. U.S. Army Corps of Engineers Technical Report E-81-9. U.S. Army Waterways Experiment Station, Environmental Laboratory, Vicksburg, MS.

Watts, S., B. Gharabaghi, R.P. Rudra, M. Palmer, T. Boston, B. Evans, and M. Walters, 2005. Evaluation of the GIS-Based Nutrient Management Model CANWET in Ontario. In: Proc. 58^{th} Natl. Conf. Canadian Water Resources Assoc., June 2005, Banff, Canada.

Wayne County Soil and Water Conservation District, 2007. Wayne County Embayments, Resource Preservation and Watershed Enhancement Plan. USEPA GRANT NUMBER 98299000-1.

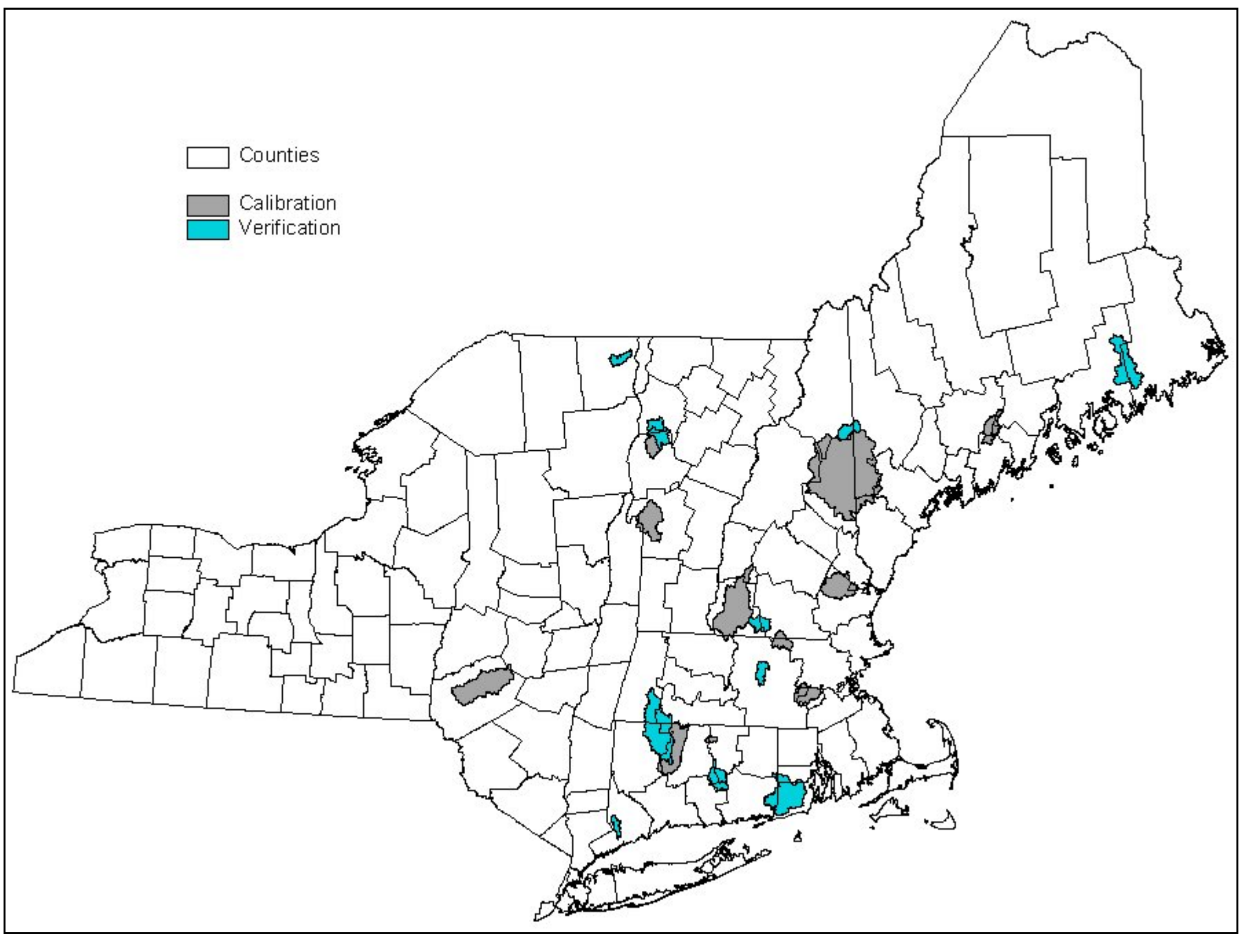
APPENDIX A. MAPSHED MODELING ANALYSIS

The MapShed model was developed in response to the need for a version of AVGWLF that would operate in a non-proprietary GIS package. AVGWLF had previously been calibrated for the Northeastern U.S. in general and New York specifically. Conversion of the calibrated AVGWLF to MapShed involved the transfer of updated model coefficients and a series of verification model runs. The calibration and conversion of the models is discussed in detail in this section.

Northeast AVGWLF Model

The AVGWLF model was calibrated and validated for the northeast (Evans et al., 2007). AVGWLF requires that calibration watersheds have long-term flow and water quality data. For the northeast model, watershed simulations were performed for twenty-two (22) watersheds throughout New York and New England for the period 1997-2004 (Figure 10). Flow data were obtained directly from the water resource database maintained by the U.S. Geological Survey (USGS). Water quality data were obtained from the New York and New England State agencies. These data sets included in-stream concentrations of nitrogen, phosphorus, and sediment based on periodic sampling.

Figure 10. Location of Calibration and Verification Watersheds for the Original Northeast AVGWLF Model



Initial model calibration was performed on half of the 22 watersheds for the period 1997-2004. During this step, adjustments were iteratively made in various model parameters until a "best fit" was achieved between simulated and observed stream flow, and sediment and nutrient loads. Based on the calibration results, revisions were made in various AVGWLF routines to alter the manner in which model input parameters were estimated. To check the reliability of these revised routines, follow-up verification runs were made on the remaining eleven watersheds for the same time period. Finally, statistical evaluations of the accuracy of flow and load predictions were made.

To derive historical nutrient loads, standard mass balance techniques were used. First, the in-stream nutrient concentration data and corresponding flow rate data were used to develop load (mass) versus flow relationships for each watershed for the period in which historical water quality data were obtained. Using the daily stream flow data obtained from USGS, daily nutrient loads for the 1997-2004 time period were subsequently computed for each watershed using the appropriate load versus flow relationship (i.e., "rating curves"). Loads computed in this fashion were used as the "observed" loads against which model-simulated loads were compared.

During this process, adjustments were made to various model input parameters for the purpose of obtaining a "best fit" between the observed and simulated data. With respect to stream flow, adjustments were made that increased or decreased the amount of the calculated evapotranspiration and/or "lag time" (i.e., groundwater recession rate) for sub-surface flow. With respect to nutrient loads, changes were made to the estimates for sub-surface nitrogen and phosphorus concentrations. In regard to both sediment and nutrients, adjustments were made to the estimate for the "C" factor for cropland in the USLE equation, as well as to the sediment "a" factor used to calculate sediment loss due to stream bank erosion. Finally, revisions were also made to the default retention coefficients used by AVGWLF for estimating sediment and nutrient retention in lakes and wetlands.

Based upon an evaluation of the changes made to the input files for each of the calibration watersheds, revisions were made to routines within AVGWLF to modify the way in which selected model parameters were automatically estimated. The AVGWLF software application was originally developed for use in Pennsylvania, and based on the calibration results, it appeared that certain routines were calculating values for some model parameters that were either too high or too low. Consequently, it was necessary to make modifications to various algorithms in AVGWLF to better reflect conditions in the Northeast. A summary of the algorithm changes made to AVGWLF is provided below.

- **ET**: A revision was made to increase the amount of evapotranspiration calculated automatically by AVGWLF by a factor of 1.54 (in the "Pennsylvania" version of AVGWLF, the adjustment factor used is 1.16). This has the effect of decreasing simulated stream flow.
- **GWR:** The default value for the groundwater recession rate was changed from 0.1 (as used in Pennsylvania) to 0.03. This has the effect of "flattening" the hydrograph within a given area.
- **GWN:** The algorithm used to estimate "groundwater" (sub-surface) nitrogen concentration was changed to calculate a lower value than provided by the "Pennsylvania" version.
- **Sediment "a" Factor:** The current algorithm was changed to reduce estimated stream bank-derived sediment by a factor of 90%. The streambank routine in AVGWLF was originally developed using Pennsylvania data and was consistently producing sediment estimates that were too high based on the in-stream sample data for the calibration sites in the Northeast. While the exact reason for this is not known, it's likely that the glaciated terrain in the Northeast is less

erodible than the highly erodible soils in Pennsylvania. Also, it is likely that the relative abundance of lakes, ponds and wetlands in the Northeast have an effect on flow velocities and sediment transport.

- **Lake/Wetland Retention Coefficients:** The default retention coefficients for sediment, nitrogen and phosphorus are set to 0.90, 0.12 and 0.25, respectively, and changed at the user's discretion.

To assess the correlation between observed and predicted values, two different statistical measures were utilized: 1) the Pearson product-moment correlation (R^2) coefficient and 2) the Nash-Sutcliffe coefficient. The R^2 value is a measure of the degree of linear association between two variables, and represents the amount of variability that is explained by another variable (in this case, the model-simulated values). Depending on the strength of the linear relationship, the R^2 can vary from 0 to 1, with 1 indicating a perfect fit between observed and predicted values. Like the R^2 measure, the Nash-Sutcliffe coefficient is an indicator of "goodness of fit," and has been recommended by the American Society of Civil Engineers for use in hydrological studies (ASCE, 1993). With this coefficient, values equal to 1 indicate a perfect fit between observed and predicted data, and values equal to 0 indicate that the model is predicting no better than using the average of the observed data. Therefore, any positive value above 0 suggests that the model has some utility, with higher values indicating better model performance. In practice, this coefficient tends to be lower than R^2 for the same data being evaluated.

Adjustments were made to the various input parameters for the purpose of obtaining a "best fit" between the observed and simulated data. One of the challenges in calibrating a model is to optimize the results across all model outputs (in the case of AVGWLF, stream flows, as well as sediment, nitrogen, and phosphorus loads). As with any watershed model like GWLF, it is possible to focus on a single output measure (e.g., sediment or nitrogen) in order to improve the fit between observed and simulated loads. Isolating on one model output, however, can sometimes lead to less acceptable results for other measures. Consequently, it is sometimes difficult to achieve very high correlations (e.g., R^2 above 0.90) across all model outputs. Given this limitation, it was felt that very good results were obtained for the calibration sites. In model calibration, initial emphasis is usually placed on getting the hydrology correct. Therefore, adjustments to flow-related model parameters are usually finalized prior to making adjustments to parameters specific to sediment and nutrient production. This typically results in better statistical fits between stream flows than the other model outputs.

For the monthly comparisons, mean R^2 values of 0.80, 0.48, 0.74, and 0.60 were obtained for the calibration watersheds for flow, sediment, nitrogen and phosphorus, respectively. When considering the inherent difficulty in achieving optimal results across all measures as discussed above (along with the potential sources of error), these results are quite good. The sediment load predictions were less satisfactory than those for the other outputs, and this is not entirely unexpected given that this constituent is usually more difficult to simulate than nitrogen or phosphorus. An improvement in sediment prediction could have been achieved by isolating on this particular output during the calibration process; but this would have resulted in poorer performance in estimating the nutrient loads for some of the watersheds. Phosphorus predictions were less accurate than those for nitrogen. This is not unusual given that a significant portion of the phosphorus load for a watershed is highly related to sediment transport processes. Nitrogen, on the other hand, is often linearly correlated to flow, which typically results in accurate predictions of nitrogen loads if stream flows are being accurately simulated.

As expected, the monthly Nash-Sutcliffe coefficients were somewhat lower due to the nature of this particular statistic. As described earlier, this statistic is used to iteratively compare simulated values against the mean of the observed values, and values above zero indicate that the model predictions are better than just using the mean of the observed data. In other words, any value above zero would indicate that the model has some utility beyond using the mean of historical data in estimating the flows or loads for any particular time period. As with R^2 values, higher Nash-Sutcliffe values reflect higher degrees of correlation than lower ones.

Improvements in model accuracy for the calibration sites were typically obtained when comparisons were made on a seasonal basis. This was expected since short-term variations in model output can oftentimes be reduced by accumulating the results over longer time periods. In particular, month-to-month discrepancies due to precipitation events that occur at the end of a month are often resolved by aggregating output in this manner (the same is usually true when going from daily output to weekly or monthly output). Similarly, further improvements were noted when comparisons were made on a mean annual basis. What these particular results imply is that AVGWLF, when calibrated, can provide very good estimates of mean annual sediment and nutrient loads.

Following the completion of the northeast AVGWLF model, there were a number of ideas on ways to improve model accuracy. One of the ideas relates to the basic assumption upon which the work undertaken in that project was based. This assumption is that a "regionalized" model can be developed that works equally well (without the need for resource-intensive calibration) across all watersheds within a large region in terms of producing reasonable estimates of sediment and nutrient loads for different time periods. Similar regional model calibrations were previously accomplished in earlier efforts undertaken in Pennsylvania (Evans et al., 2002) and later in southern Ontario (Watts et al., 2005). In both cases this task was fairly daunting given the size of the areas involved. In the northeast effort, this task was even more challenging given the fact that the geographic area covered by the northeast is about three times the size of Pennsylvania, and arguably is more diverse in terms of its physiographic and ecological composition.

As discussed, AVGWLF performed very well when calibrated for numerous watersheds throughout the region. The regionalized version of AVGWLF, however, performed less well for the verification watersheds for which additional adjustments were not made subsequent to the initial model runs. This decline in model performance may be a result of the regionally-adapted model algorithms not being rigorous enough to simulate spatially-varying landscape processes across such a vast geographic region at a consistently high degree of accuracy. It is likely that un-calibrated model performance can be enhanced by adapting the algorithms to reflect processes in smaller geographic regions such as those depicted in the physiographic province map in Figure 11.

Fine-tuning & Re-Calibrating the Northeast AVGWLF for New York State

For the TMDL development work undertaken in New York, the original northeast AVGWLF model was further refined by The Cadmus Group, Inc. and Dr. Barry Evans to reflect the physiographic regions that exist in New York. Using data from some of the original northeast model calibration and verification sites, as well as data for additional calibration sites in New York, three new versions of AVGWLF were created for use in developing TMDLs in New York State. Information on the fourteen (14) sites is summarized in Table 7. Two models were developed based on the following two physiographic regions: Eastern Great Lakes/Hudson Lowlands area and the Northeastern Highlands area. The model was calibrated for each of these regions to better reflect local conditions, as well as ecological and hydrologic processes. In addition to developing the above mentioned physiographic-based model calibrations, a third model calibration was also developed. This model calibration represents a composite of the two physiographic regions and is suitable for use in other areas of upstate New York.

Figure 11. Location of Physiographic Provinces in New York and New England

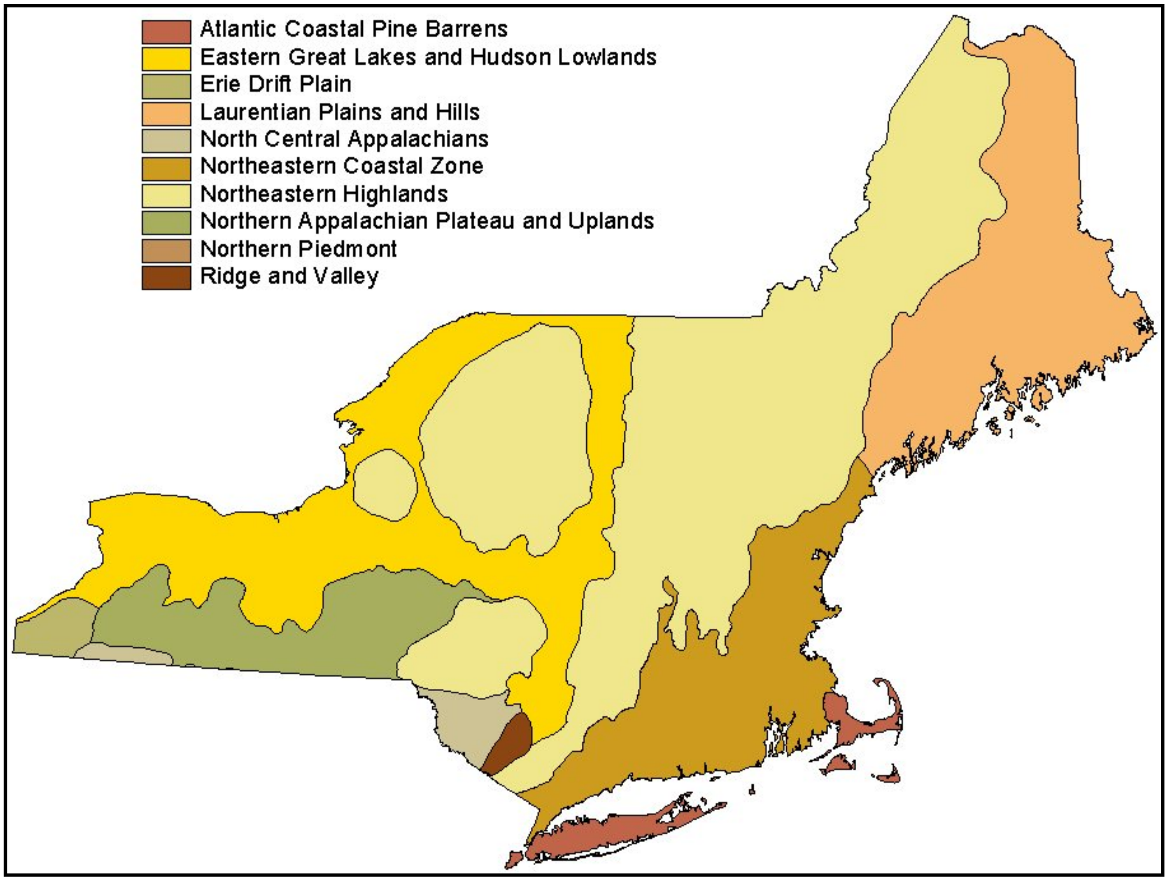


Table 7. AVGWLF Calibration Sites for use in the New York TMDL Assessments

Site	Location	Physiographic Region
Owasco Lake	NY	Eastern Great Lakes/Hudson Lowlands
West Branch	NY	Northeastern Highlands
Little Chazy River	NY	Eastern Great Lakes/Hudson Lowlands
Little Otter Creek	VT	Eastern Great Lakes/Hudson Lowlands
Poultney River	VT/NY	Eastern Great Lakes/Hudson Lowlands & Northeastern Highlands
Farmington River	CT	Northeastern Highlands
Saco River	ME/NH	Northeastern Highlands
Squannacook River	MA	Northeastern Highlands
Ashuelot River	NH	Northeastern Highlands
Laplatte River	VT	Eastern Great Lakes/Hudson Lowlands
Wild River	ME	Northeastern Highlands
Salmon River	CT	Northeastern Coastal Zone
Norwalk River	CT	Northeastern Coastal Zone
Lewis Creek	VT	Eastern Great Lakes/Hudson Lowlands

Conversion of the AVGWLF Model to MapShed and Inclusion of RUNQUAL

The AVGWLF model requires that users obtain ESRI's ArcView 3.x with Spatial Analyst. The Cadmus Group, Inc. and Dr. Barry Evans converted the New York-calibrated AVGWLF model for use in a non-proprietary GIS package called MapWindow. The converted model is called MapShed and the software necessary to use it can be obtained free of charge and operated by any individual or organization who wishes to learn to use it. In addition to incorporating the enhanced GWLF model, MapShed contains a revised version of the RUNQUAL model, allowing for more accurate simulation of nutrient and sediment loading from urban areas.

RUNQUAL was originally developed by Douglas Haith (1993) to refine the urban runoff component of GWLF. Using six urban land use classes, RUNQUAL differentiates between three levels of imperviousness for residential and mixed commercial uses. Runoff is calculated for each of the six urban land uses using a simple water-balance method based on daily precipitation, temperature, and evapotranspiration. Pollutant loading from each land use is calculated with exponential accumulation and washoff relationships that were developed from empirical data. Pollutants, such as phosphorus, accumulate on surfaces at a certain rate (kg/ha/day) during dry periods. When it rains, the accumulated pollutants are washed off of the surface and have been measured to develop the relationship between accumulation and washoff. The pervious and impervious portions of each land use are modeled separately and runoff and contaminant loads are added to provide total daily loads. RUNQUAL is also capable of simulating the effects of various urban best management practices (BMPs) such as street sweeping, detention ponds, infiltration trenches, and vegetated buffer strips.

Set-up of the "New York State" MapShed Model

Using data for the time period 1990-2007, the calibrated MapShed model was used to estimate mean annual phosphorus loading to the lake. Table 8 provides the sources of data used for the MapShed modeling analysis. The various data preparation steps taken prior to running the final calibrated MapShed Model for New York are discussed below the table.

Table 8. Information Sources for MapShed Model Parameterization

WEATHER.DAT file	
Data	**Source or Value**
	Historical weather data from Sodus Center, NY and Oswego, NY National Weather Services Stations
TRANSPORT.DAT file	
Data	**Source or Value**
Basin size	GIS/derived from basin boundaries
Land use/cover distribution	GIS/derived from land use/cover map
Curve numbers by source area	GIS/derived from land cover and soil maps
USLE (KLSCP) factors by source area	GIS/derived from soil, DEM, & land cover
ET cover coefficients	GIS/derived from land cover
Erosivity coefficients	GIS/ derived from physiographic map
Daylight hrs. by month	Computed automatically for state
Growing season months	Input by user
Initial saturated storage	Default value of 10 cm
Initial unsaturated storage	Default value of 0 cm
Recession coefficient	Default value of 0.1
Seepage coefficient	Default value of 0
Initial snow amount (cm water)	Default value of 0
Sediment delivery ratio	GIS/based on basin size
Soil water (available water capacity)	GIS/derived from soil map
NUTRIENT.DAT file	
Data	**Source or Value**
Dissolved N in runoff by land cover type	Default values/adjusted using GWLF Manual
Dissolved P in runoff by land cover type	Default values/adjusted using GWLF Manual
N/P concentrations in manure runoff	Default values/adjusted using AEU density
N/P buildup in urban areas	Default values (from GWLF Manual)
N and P point source loads	Derived from SPDES point coverage
Background N/P concentrations in GW	Derived from new background N map
Background P concentrations in soil	Derived from soil P loading map/adjusted using GWLF Manual
Background N concentrations in soil	Based on map in GWLF Manual
Months of manure spreading	Input by user
Population on septic systems	Derived from census tract maps for 2000 and house counts
Per capita septic system loads (N/P)	Default values/adjusted using AEU density

Land Use

The 2001 NLCD land use coverage was obtained, recoded, and formatted specifically for use in MapShed. The New York State High Resolution Digital Orthoimagery (for the time period 2003 – 2005) was used to perform updates and corrections to the 2001 NLCD land use coverage to more accurately reflect current conditions. Each basin was reviewed independently for the potential need for land use corrections; however individual raster errors associated with inherent imperfections in the satellite imagery have a far greater impact on overall basin land use percentages when evaluating smaller scale basins. As a result, for large basins, NLCD 2001 is generally considered adequate, while in smaller basins, errors were more closely assessed and corrected. The following were the most common types of corrections applied generally to smaller basins:

1) Areas of low intensity development that were coded in the 2001 NLCD as other land use types were the most commonly corrected land use data in this analysis. Discretion was used when applying corrections, as some overlap of land use pixels on the lake boundary are inevitable due to the inherent variability in the aerial position of the sensor creating the image. If significant new development was apparent (i.e., on the orthoimagery), but was not coded as such in the 2001 NLCD, than these areas were re-coded to low intensity development.

2) Areas of water that were coded as land (and vice-versa) were also corrected. Discretion was used for reservoirs where water level fluctuation could account for errors between orthoimagery and land use.

3) Forested areas that were coded as row crops/pasture areas (and vice-versa) were also corrected. For this correction, 100% error in the pixel must exist (e.g., the supposed forest must be completely pastured to make a change); otherwise, making changes would be too subjective. Conversions between forest types (e.g., conifer to deciduous) are too subjective and therefore not attempted; conversions between row crops and pasture are also too subjective due to the practice of crop rotation. Correction of row crops to hay and pasture based on orthoimagery were therefore not undertaken in this analysis.

In addition to the corrections described above, low and high intensity development land uses were further refined for some lakes to differentiate between low, medium, and high density residential; and low, medium, and high density mixed urban areas. These distinctions were based primarily upon the impervious surface coverage and residential or mixed commercial land uses. The following types of refinements were the focus of the land use revision efforts:

1) Areas of residential development were identified. Discretion was used in the reclassification of small forested patches embedded within residential areas. Care was taken to maintain the “forest” classification for significant patches of forest within urban areas (e.g. parks, large forested lots within low-density residential areas). Individual trees (or small groups of trees) within residential areas were reclassified to match the surrounding urban classification, in accordance with the land use classifications described in the MapShed manual. Areas identified as lawn grasses surrounding residential structures were reclassified to match the surrounding urban classification, in accordance with the land use classifications in the MapShed manual.

2) Areas of medium-density mixed development were identified. Discretion was used during the interpretation and reclassification of urban areas, based on the land use classification definitions

in the MapShed manual. When appropriate, pixels were also reclassified as "low" or "high" density mixed development.

3) Golf courses were identified and classified appropriately.

Total phosphorus concentrations in runoff from the different urban land uses was acquired from the National Stormwater Quality Database (Pitt, *et al.*, 2008). These data were used to adjust the model's default phosphorus accumulation rates. These adjustments were made using best professional judgment based on examination of specific watershed characteristics and conditions.

Phosphorus retention in wetlands and open waters in the basin can be accounted for in MapShed. MapShed recommends the following coefficients for wetlands and pond retention in the northeast: nitrogen (0.12), phosphorus (0.25), and sediment (0.90). Wetland retention coefficients for large, naturally occurring wetlands vary greatly in the available literature. Depending on the type, size and quantity of wetland observed, the overall impact of the wetland retention routine on the original watershed loading estimates, and local information regarding the impact of wetlands on watershed loads, wetland retention coefficients defaults were adjusted accordingly. The percentage of the drainage basin area that drains through a wetland area was calculated and used in conjunction with nutrient retention coefficients in MapShed. To determine the percent wetland area, the total basin land use area was derived using ArcView. Of this total basin area, the area that drains through emergent and woody wetlands were delineated to yield an estimate of total watershed area draining through wetland areas. If a basin displays large areas of surface water (ponds) aside from the water body being modeled, then this open water area is calculated by subtracting the water body area from the total surface water area.

<u>On-site Wastewater Treatment Systems ("septic tanks")</u>

MapShed, following the method from GWLF, simulates nutrient loads from septic systems as a function of the percentage of the unsewered population served by normally functioning vs. three types of malfunctioning systems: ponded, short-circuited, and direct discharge (Haith et al., 1992).

- **Normal Systems** are septic systems whose construction and operation conforms to recommended procedures, such as those suggested by the EPA design manual for on-site wastewater disposal systems. Effluent from normal systems infiltrates into the soil and enters the shallow saturated zone. Phosphates in the effluent are adsorbed and retained by the soil and hence normal systems provide no phosphorus loads to nearby waters.

- **Short-Circuited Systems** are located close enough to surface water (~15 meters) so that negligible adsorption of phosphorus takes place. The only nutrient removal mechanism is plant uptake. Therefore, these systems are always contributing to nearby waters.

- **Ponded Systems** exhibit hydraulic malfunctioning of the tank's absorption field and resulting surfacing of the effluent. Unless the surfaced effluent freezes, ponding systems deliver their nutrient loads to surface waters in the same month that they are generated through overland flow. If the temperature is below freezing, the surfacing is assumed to freeze in a thin layer at the ground surface. The accumulated frozen effluent melts when the snowpack disappears and the temperature is above freezing.

- **Direct Discharge Systems** illegally discharge septic tank effluent directly into surface waters.

MapShed requires an estimation of population served by septic systems to generate septic system phosphorus loadings. In reviewing the orthoimagery for the lake, it became apparent that septic system estimates from the 1990 census were not reflective of actual population in close proximity to the shore. Shoreline dwellings immediately surrounding the lake account for a substantial portion of the nutrient loading to the lake. Therefore, the estimated number of septic systems in the drainage basin was refined using a combination of 1990 and 2000 census data and GIS analysis of orthoimagery to account for the proximity of septic systems immediately surrounding the lake. If available, local information about the number of houses within 250 feet of the lakes was obtained and applied. Great attention was given to estimating septic systems within 250 feet of the lake (those most likely to have an impact on the lake). To convert the estimated number of septic systems to population served, an average household size of 2.61 people per dwelling was used based on the circa 2000 USCB census estimate for number of persons per household in New York State.

MapShed also requires an estimate of the number of normal and malfunctioning septic systems. This information was not readily available for the lake. Therefore, several assumptions were made to categorize the systems according to their performance. These assumptions are based on data from local and national studies (Day, 2001; USEPA, 2002) in combination with best professional judgment. To account for seasonal variations in population, data from the 2000 census were used to estimate the percentage of seasonal homes for the town(s) surrounding the lake. The failure rate for septic systems closer to the lake (i.e., within 250 feet) were adjusted to account for increased loads due to greater occupancy during the summer months. If available, local information about seasonal occupancy was obtained and applied. For the purposes of this analysis, seasonal homes are considered those occupied only during the month of June, July, and August.

Groundwater Phosphorus

Phosphorus concentrations in groundwater discharge are derived by MapShed. Watersheds with a high percentage of forested land will have low groundwater phosphorus concentrations while watersheds with a high percentage of agricultural land will have high concentrations. The GWLF manual provides estimated groundwater phosphorus concentrations according to land use for the eastern United States. Completely forested watersheds have values of 0.006 mg/L. Primarily agricultural watersheds have values of 0.104 mg/L. Intermediate values are also reported. The MapShed -generated groundwater phosphorus concentration was evaluated to ensure groundwater phosphorus values reasonably reflect the actual land use composition of the drainage basin and modifications were made if deemed unnecessary.

Point Sources

If permitted point sources exist in the drainage basin, their location was identified and verified by NYS DEC and an estimated monthly total phosphorus load and flow was determined using either actual reported data (e.g., from discharge monitoring reports) or estimated based on expected discharge/flow for the facility type.

Concentrated Animal Feeding Operations (CAFOs)

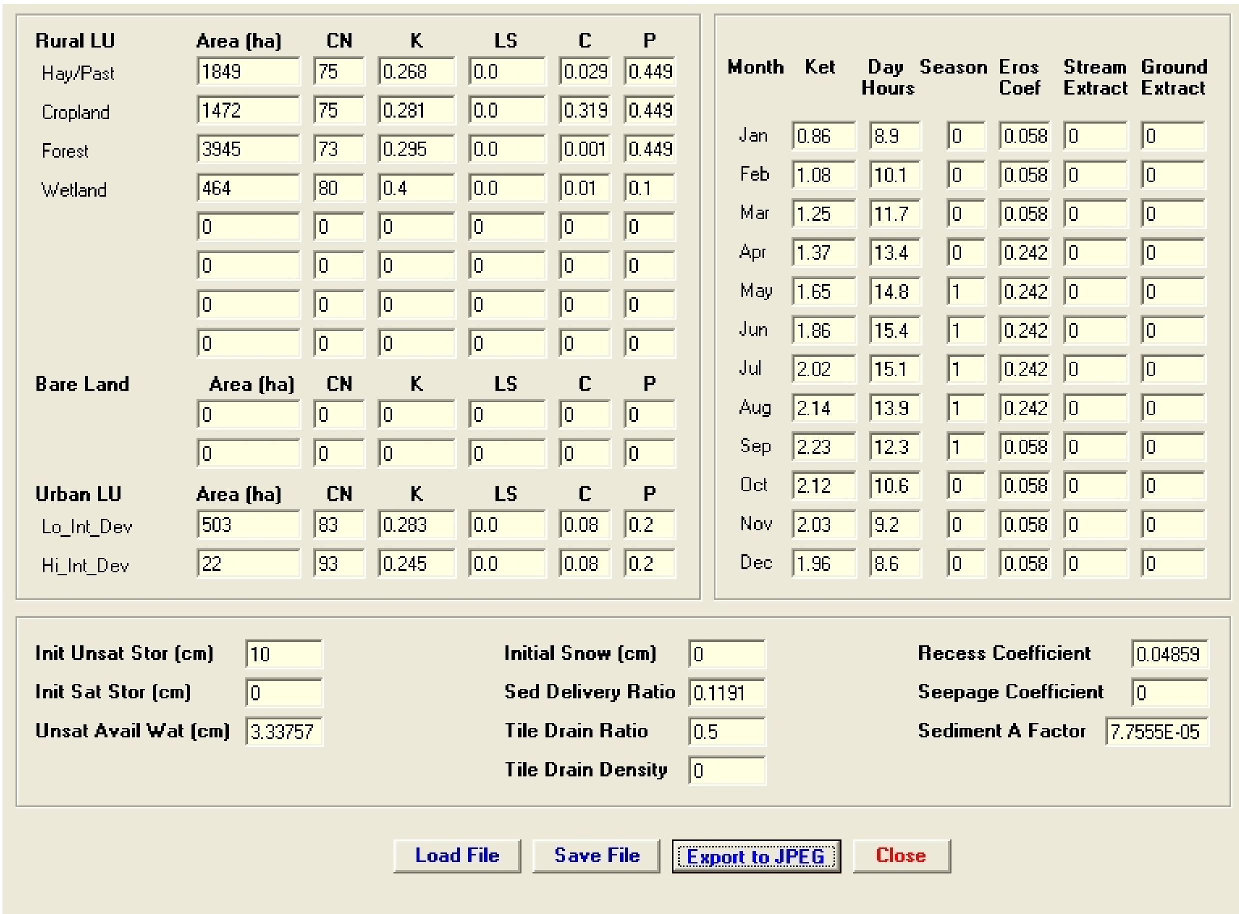
A state-wide Concentrated Animal Feeding Operation (CAFO) shapefile was provided by NYS DEC. CAFOs are categorized as either large or medium. The CAFO point can represent either the centroid of the farm or the entrance of the farm, therefore the CAFO point is more of a general gauge as to where further information should be obtained regarding permitted information for the CAFO. If a CAFO point is located in or around a basin, orthos and permit data were evaluated to determine the part of the farm with the highest potential contribution of nutrient load. In ArcView, the CAFO shapefile was positioned over the basin and clipped with a 2.5 mile buffer to preserve those CAFOS that may have associated cropland in the basin. If a CAFO point is found to be located within the boundaries of the drainage basin, every effort was made to obtain permit information regarding nutrient management or other best management practices (BMPs) that may be in place within the property boundary of a given CAFO. These data can be used to update the nutrient file in MapShed and ultimately account for agricultural BMPs that may currently be in place in the drainage basin.

Municipal Separate Storm Sewer Systems (MS4s)

Stormwater runoff within Phase II permitted Municipal Separate Storm Sewer Systems (MS4s) is considered a point source of pollutants. Stormwater runoff outside of the MS4 is non-permitted stormwater runoff and, therefore, considered nonpoint sources of pollutants. Permitted stormwater runoff is accounted for in the wasteload allocation of a TMDL, while non-permitted runoff is accounted for in the load allocation of a TMDL. NYS DEC determined there are no MS4s in this basin.

MapShed Model Simulation Results

Input Transport File

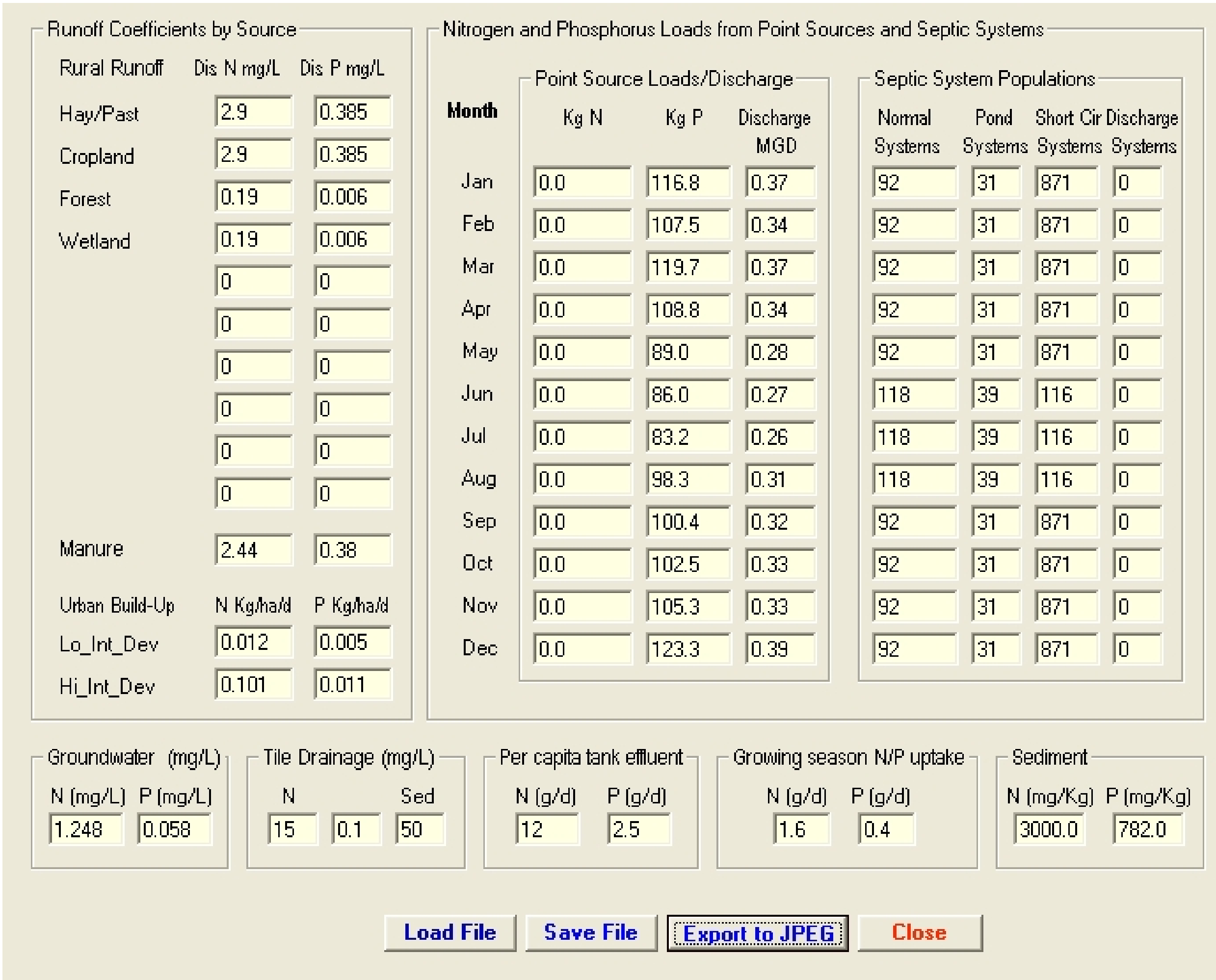


Rural LU	Area (ha)	CN	K	LS	C	P
Hay/Past	1849	75	0.268	0.0	0.029	0.449
Cropland	1472	75	0.281	0.0	0.319	0.449
Forest	3945	73	0.295	0.0	0.001	0.449
Wetland	464	80	0.4	0.0	0.01	0.1
	0	0	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	0
Bare Land	**Area (ha)**	**CN**	**K**	**LS**	**C**	**P**
	0	0	0	0	0	0
	0	0	0	0	0	0
Urban LU	**Area (ha)**	**CN**	**K**	**LS**	**C**	**P**
Lo_Int_Dev	503	83	0.283	0.0	0.08	0.2
Hi_Int_Dev	22	93	0.245	0.0	0.08	0.2

Month	Ket	Day Hours	Season	Eros Coef	Stream Extract	Ground Extract
Jan	0.86	8.9	0	0.058	0	0
Feb	1.08	10.1	0	0.058	0	0
Mar	1.25	11.7	0	0.058	0	0
Apr	1.37	13.4	0	0.242	0	0
May	1.65	14.8	1	0.242	0	0
Jun	1.86	15.4	1	0.242	0	0
Jul	2.02	15.1	1	0.242	0	0
Aug	2.14	13.9	1	0.242	0	0
Sep	2.23	12.3	1	0.058	0	0
Oct	2.12	10.6	0	0.058	0	0
Nov	2.03	9.2	0	0.058	0	0
Dec	1.96	8.6	0	0.058	0	0

Init Unsat Stor (cm)	10	Initial Snow (cm)	0	Recess Coefficient	0.04859
Init Sat Stor (cm)	0	Sed Delivery Ratio	0.1191	Seepage Coefficient	0
Unsat Avail Wat (cm)	3.33757	Tile Drain Ratio	0.5	Sediment A Factor	7.7555E-05
		Tile Drain Density	0		

Input Nutrient File



Nutrient Transport Summary

GWLF-E Loads for file: port_g-0

Period of analysis: 18 years from 1990 to 2007

	Kg X 1000		Nutrient Loads (Kg)			
Month	Erosion	Sediment	Dis N	Total N	Dis P	Total P
Jan	0.0	51.9	7172.7	7211.9	577.6	590.5
Feb	0.0	52.1	6558.7	6603.1	555.1	569.8
Mar	0.0	59.9	8663.1	8723.9	724.2	744.0
Apr	0.0	48.9	6253.9	6293.8	475.3	487.0
May	0.0	29.7	3095.7	3122.0	289.7	297.2
Jun	0.0	15.5	1014.3	1030.2	147.2	151.2
Jul	0.0	11.5	849.8	876.5	162.4	169.9
Aug	0.0	9.2	520.1	546.0	144.0	151.1
Sep	0.0	10.5	842.5	871.6	193.2	200.6
Oct	0.0	22.9	2203.8	2254.6	306.0	321.4
Nov	0.0	38.4	4441.2	4507.0	412.4	432.6
Dec	0.0	51.5	6907.4	6961.3	574.4	591.9
Totals	0.0	401.9	48523.1	49001.8	4561.4	4707.2

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APPENDIX B. BATHTUB MODELING ANALYSIS

Model Overview

BATHTUB is a steady-state (Windows-based) water quality model developed by the U. S. Army Corps of Engineers (USACOE) Waterways Experimental Station. BATHTUB performs steady-state water and nutrient balance calculations for spatially segmented hydraulic networks in order to simulate eutrophication-related water quality conditions in lakes and reservoirs. BATHTUB's nutrient balance procedure assumes that the net accumulation of nutrients in a lake is the difference between nutrient loadings into the lake (from various sources) and the nutrients carried out through outflow and the losses of nutrients through whatever decay process occurs inside the lake. The net accumulation (of phosphorus) in the lake is calculated using the following equation:

$$\text{Net accumulation} = \text{Inflow} - \text{Outflow} - \text{Decay}$$

The pollutant dynamics in the lake are assumed to be at a steady state, therefore, the net accumulation of phosphorus in the lake equals zero. BATHTUB accounts for advective and diffusive transport, as well as nutrient sedimentation. BATHTUB predicts eutrophication-related water quality conditions (total phosphorus, total nitrogen, chlorophyll-a, transparency, and hypolimnetic oxygen depletion) using empirical relationships derived from assessments of reservoir data. Applications of BATHTUB are limited to steady-state evaluations of relations between nutrient loading, transparency and hydrology, and eutrophication responses. Short-term responses and effects related to structural modifications or responses to variables other than nutrients cannot be explicitly evaluated.

Input data requirements for BATHTUB include: physical characteristics of the watershed lake morphology (e.g., surface area, mean depth, length, mixed layer depth), flow and nutrient loading from various pollutant sources, precipitation (from nearby weather station) and phosphorus concentrations in precipitation (measured or estimated), and measured lake water quality data (e.g., total phosphorus concentrations).

The empirical models implemented in BATHTUB are mathematical generalizations about lake behavior. When applied to data from a particular lake, actual observed lake water quality data may differ from BATHTUB predictions by a factor of two or more. Such differences reflect data limitations (measurement or estimation errors in the average inflow and outflow concentrations) or the unique features of a particular lake (no two lakes are the same). BATHTUB's "calibration factor" provides model users with a method to calibrate the magnitude of predicted lake response. The model calibrated to current conditions (against measured data from the lakes) can be applied to predict changes in lake conditions likely to result from specific management scenarios, under the condition that the calibration factor remains constant for all prediction scenarios.

Model Set-up

Using descriptive information about Port Bay and its surrounding drainage area, as well as output from MapShed, a BATHTUB model was set up for Port Bay. Mean annual phosphorus loading to the lake was simulated using MapShed for the period 1990-2007. After initial model development, NYS DEC sampling data were used to assess the model's predictive capabilities and, if necessary, "fine tune" various input parameters and sub-model selections within BATHTUB during a calibration process. Once calibrated, BATHTUB was used to derive the total phosphorus load reduction needed in order to achieve the TMDL target.

Sources of input data for BATHTUB include:

- Physical characteristics of the watershed and lake morphology (e.g., surface area, mean depth, length, mixed layer depth) - Obtained from CSLAP and bathymetric maps provided by NYS DEC or created by the Cadmus Group, Inc.
- Flow and nutrient loading from various pollutant sources - Obtained from MapShed output.
- Precipitation – Obtained from nearby National Weather Services Stations.
- Phosphorus concentrations in precipitation (measured or estimated), and measured lake water quality data (e.g., total phosphorus concentrations) – Obtained from NYS DEC and Monroe County.

Tables 9 – 12 summarize the primary model inputs for Port Bay, including the coefficient of variation (CV), which reflects uncertainty in the input value. Default model choices are utilized unless otherwise noted. Spatial variations (i.e., longitudinal dispersion) in phosphorus concentrations are not a factor in the development of the TMDL for Port Bay. Therefore, division of the lake into multiple segments was not necessary for this modeling effort. Modeling the entire lake with one segment provides predictions of area-weighted mean concentrations, which are adequate to support management decisions. Water inflow and nutrient loads from the lake's drainage basin were treated as though they originated from one "tributary" (i.e., source) in BATHTUB and derived from MapShed.

BATHTUB is a steady state model, whose predictions represent concentrations averaged over a period of time. A key decision in the application of BATHTUB is the selection of the length of time over which water and mass balance calculations are modeled (the "averaging period"). The length of the appropriate averaging period for BATHTUB application depends upon what is called the nutrient residence time, which is the average length of time that phosphorus spends in the water column before settling or flushing out of the lake. Guidance for BATHTUB recommends that the averaging period used for the analysis be at least twice as large as nutrient residence time for the lake. The appropriate averaging period for water and mass balance calculations would be 1 year for lakes with relatively long nutrient residence times or seasonal (6 months) for lakes with relatively short nutrient residence times (e.g., on the order of 1 to 3 months). The turnover ratio can be used as a guide for selecting the appropriate averaging period. A seasonal averaging period (April/May through September) is usually appropriate if it results in a turnover ratio exceeding 2.0. An annual averaging period may be used otherwise. Other considerations (such as comparisons of observed and predicted nutrient levels) can also be used as a basis for selecting an appropriate averaging period, particularly if the turnover ratio is near 2.0.

Precipitation inputs were taken from the observed long term mean daily total precipitation values from the Sodus Center, NY and Oswego, NY National Weather Services Stations for the 1990-2007 period. Evapotranspiration was derived from MapShed using daily weather data (1990-2007) and a cover factor dependent upon land use/cover type. The values selected for precipitation and change in lake storage have very little influence on model predictions. Atmospheric phosphorus loads were specified using data collected by USGS from a collection site in Monroe County New York

(Sherwood, 1999). Atmospheric deposition is not a major source of phosphorus loading to Port Bay and has little impact on simulations.

Lake surface area, mean depth, and length were derived using GIS analysis of bathymetric data. Depth of the mixed layer was estimated using a multivariate regression equation developed by Walker (1996). Existing water quality conditions in Port Bay were represented using an average of the observed summer mean phosphorus concentrations for years 1990-1991, 2003-2006, and 2009. These data were collected through NYS DEC's CSLAP and SUNY Brockport. The concentration of phosphorus loading to the lake was calculated using the average annual flow and phosphorus loads simulated by MapShed. For years with observed data, the concentration of internal loading was calculated using the concentration of external loading, the hydraulic residence time, and lake phosphorus concentrations. Otherwise, the concentration of internal loading was calculated assuming concentrations were proportional to the average of years with observed data. To obtain flow in units of volume per time, the depth of flow was multiplied by the drainage area and divided by one year. To obtain phosphorus concentrations, the nutrient mass was divided by the volume of flow.

Internal loading rates reflect nutrient recycling from bottom sediments. Internal loading rates are normally set to zero in BATHTUB since the pre-calibrated nutrient retention models already account for nutrient recycling that would normally occur (Walker, 1999). Walker warns that nonzero values should be specified with caution and only if independent estimates or measurements are available. In some studies, internal loading rates have been estimated from measured phosphorus accumulation in the hypolimnion during the stratified period. Results from this procedure should not be used for estimation of internal loading in BATHTUB unless there is evidence the accumulated phosphorus is transported to the mixed layer during the growing season. Specification of a fixed internal loading rate may be unrealistic for evaluating response to changes in external load. Because they reflect recycling of phosphorus that originally entered the reservoir from the watershed, internal loading rates would be expected to vary with external load. In situations where monitoring data indicate relatively high internal recycling rates to the mixed layer during the growing season, a preferred approach would generally be to calibrate the phosphorus sedimentation rate (i.e., specify calibration factors < 1). However, there still remains some risk that apparent internal loads actually reflect under-estimation of external loads.

Table 9. BATHTUB Model Input Variables: Model Selections

Water Quality Indicator	Option	Description
Total Phosphorus	01	2^{nd} Order Available Phosphorus*
Phosphorus Calibration	01	Decay Rate*
Error Analysis	01	Model and Data*
Availability Factors	00	Ignore*
Mass Balance Tables	01	Use Estimated Concentrations*

* Default model choice

Table 10. BATHTUB Model Input: Global Variables

Model Input	Mean	CV
Averaging Period (years)	0.5	NA
Precipitation (meters)	0.525	0.2*
Evaporation (meters)	0.301	0.3*
Atmospheric Load (mg/m^2-yr)- Total P	29.773	0.5*
Atmospheric Load (mg/m^2-yr)- Ortho P	17.166	0.5*

* Default model choice

Table 11. BATHTUB Model Input: Lake Variables

Morphometry	Mean	CV
Surface Area (km^2)	1.86	NA
Mean Depth (m)	4.008	NA
Length (km)	2.436	NA
Estimated Mixed Depth (m)	3.9	0.12
Observed Water Quality	**Mean**	**CV**
Total Phosphorus (ppb)	134.26	0.5
Internal Load	**Mean**	**CV**
Total Phosphorus (mg/m^2-day)	21.15	0.5

* Default model choice

Table 12. BATHTUB Model Input: Watershed "Tributary" Loading

Monitored Inputs	Mean	CV
Total Watershed Area (km^2)	82.55	NA
Flow Rate (hm^3/yr)	37.519	0.1
Total P (ppb)	123.015	0.2
Organic P (ppb)	121.576	0.2

Model Calibration

BATHTUB model calibration consists of:

1. Applying the model with all inputs specified as above
2. Comparing model results to observed phosphorus data
3. Adjusting model coefficients to provide the best comparison between model predictions and observed phosphorus data (only if absolutely required and with extreme caution.

Several t-statistics calculated by BATHTUB provide statistical comparison of observed and predicted concentrations and can be used to guide calibration of BATHTUB. Two statistics supplied by the model, T2 and T3, aid in testing model applicability. T2 is based on error typical of model development data set. T3 is based on observed and predicted error, taking into consideration model inputs and inherent model error. These statistics indicate whether the means differ significantly at the 95% confidence level. If their absolute values exceed 2, the model may not be appropriately calibrated. The T1 statistic can be used to determine whether additional calibration is desirable. The t-statistics for the BATHUB simulations for Port Bay are as follows:

Year	Observed	Simulated	T1	T2	T3
1990	91	121	-0.58	-1.08	-0.51
1991	92	138	-0.80	-1.48	-0.69
2003	160	131	0.40	0.74	0.35
2004	149	132	0.24	0.44	0.21
2005	167	129	0.51	0.94	0.44
2006	148	129	0.27	0.51	0.24
Average	134	134	0.00	0.00	0.00

In cases where predicted and observed values differ significantly, calibration coefficients can be adjusted to account for the site-specific application of the model. Calibration to account for model error is often appropriate. However, Walker (1996) recommends a conservative approach to calibration since differences can result from factors such as measurement error and random data input errors. Error statistics calculated by BATHTUB indicate that the match between simulated and observed mean annual water quality conditions in Port Bay is good. Therefore, BATHTUB is sufficiently calibrated for use in estimating load reductions required to achieve the phosphorus TMDL target in the lake.

APPENDIX C. TOTAL EQUIVALENT DAILY PHOSPHORUS LOAD ALLOCATIONS

Source	Total Phosphorus Load (lbs/d)			% Reduction
	Current	Allocated	Reduction	
Agriculture*	13.398	3.014	10.384	78%
Developed Land*	2.115	1.057	1.058	50%
Septic Systems	3.767	0	3.767	100%
Forest, Wetland, Stream Bank, and Natural Background*	1.258	1.258	0.000	0%
Internal Loading	86.856	0	86.856	100%
LOAD ALLOCATION	**107.394**	**5.329**	**102.065**	**95%**
Point Sources	7.321	0.208	7.113	97%
Village of Wolcott WWTP (NY0020303)	5.205	0.208	4.997	96%
Reckitt Benckiser, Inc. (NY0078531)	2.116	0	2.115	100%
Merrell Farms Inc. (NYA000120)	0	0	0	0%
WASTELOAD ALLOCATION	**7.321**	**0.208**	**7.113**	**97%**
LA + WLA	**114.715**	**5.537**	**109.178**	**95.2%**
Margin of Safety	---	0.615	---	---
TOTAL	**114.715**	**6.152**	**---**	**---**

* Includes phosphorus transported through surface runoff and subsurface (groundwater)

APPENDIX D. DISCHARGE DATA FOR WASTEWATER TREATMENT PLANTS

Wolcott Wastewater Treatment Plant (SPDES ID: NY0020303)

Month	Estimated Total Phosphorus (mg/l)	Discharge (MGD)
January	3	0.25
February	3	0.23
March	3	0.26
April	3	0.23
May	3	0.17
June	3	0.17
July	3	0.18
August	3	0.20
September	3	0.19
October	3	0.20
November	3	0.22
December	3	0.26

Reckitt Benckiser, Inc. (SPDES ID: NY0078531)

Month	Total Phosphorus (mg/l)	Estimated Discharge (MGD)
January	2.3	0.12
February	2.3	0.11
March	2.3	0.11
April	2.3	0.11
May	2.3	0.11
June	2.3	0.10
July	2.3	0.07
August	2.3	0.11
September	2.3	0.13
October	2.3	0.13
November	2.3	0.12
December	2.3	0.12

This facility is no longer operating and its permit has been discontinued.