Total Maximum Daily Load (TMDL) for Phosphorus in Bear Lake

Chautauqua County, New York

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List of acronyms

AEM	Agricultural Environmental Management
AMSL	Above mean sea level
AVGWLF	ArcView Generalized Watershed Loading Function
AWQV	Ambient water quality values
BMP	Best management practice
CAFO	Concentrated animal feeding operation
CCDOH	Chautauqua County Department of Health and Human Services
Chl-a	Chlorophyll-a
CV	Coefficient of variation
CWA	Clean Water Act
DBP	Disinfection by-product
ECL	Environmental Conservation Law
EFC	Environmental Facilities Corporation
GIS	Geographic information system
GS	Growing season
GWLF	Generalized watershed loading function
HAA	Haloacetic acids
LCI	Lake classification inventory
LA	Load allocation
MCL	Maximum contaminant level
MOS	Margin of safety
MS4	Municipal Separate Storm Sewer System
NLCD	National Land Cover Database
NOM	Natural organic matter
NRCS	Natural Resource Conservation Service
NYCDEP	New York City Department of Environmental Protection
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OTN	Onsite Wastewater Treatment Training Network
PWS	Potable water supply
RIBS	Rotating Integrated Basin Sampling
SPDES	State Pollution Discharge Elimination System
SDS	Sewage Disposal System
SUNY	State University of New York
SUNY-ESF	State University of New York College of Environmental Science and Forestry
SWCC	Soil and Water Conservation Committee
THM	Trihalomethane
THMFP	Trihalomethane formation potential
TMDL	Total maximum daily load
TOGS	Technical and Operational Guidance Series
TTHM	Total trihalomethane
UAA	Use Attainability Analysis
UFI	Upstate Freshwater Institute
USACOE	United States Army Corps of Engineers
USCB	United States Census Bureau
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WI/PWL	Waterbody inventory/priority waterbodies list
WLA	Waste load allocation
WQS	Water quality standard
WTP	Water treatment plant

Lb(s)	Pound(s)
m	meter
mg/L	Milligrams per liter
ppb	Parts per billion
µg/L	Micrograms per liter
Yr(s)	Year(s)

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

Bear Lake (Watershed Inventory/Priority Waterbodies List [WI/PWL] ID 0201-0003) is situated in the Towns of Stockton and Pomfret, within Chautauqua County, New York. The results from state sampling efforts confirm eutrophic conditions in Bear Lake, with the concentration of phosphorus in the lake violating 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. In 1998, Bear Lake 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 (NYS DEC, 2013). Based on this listing, a TMDL for phosphorus is being developed for the lake to address the impairment.

A variety of sources of phosphorus are contributing to the poor water quality in Bear Lake. The water quality of the lake is influenced by runoff events from the drainage basin, as well as loading from nearby residential septic tanks. In response to precipitation, nutrients, such as phosphorus – naturally found in New York soils – drain into the lake from the surrounding drainage basin by way of streams, overland flow, and subsurface flow. Nutrients are then deposited and stored in the lake 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.

Bear Lake is included in the 2007 Allegheny Basin WI/PWL, with *aquatic life* and *recreation* suspected to be *impaired* and *public bathing* suspected to be *stressed*. The WI/PWL indicates the impairments are known to be due to excessive weed and algae growth and dissolved oxygen/oxygen demand, and suspected to be due to nutrients (phosphorus). The listing also indicates that the primary sources of the nutrients causing the excessive weed and algae growth are suspected to be agriculture, habitat modification and possibly on-site septic systems (NYS DEC, 2007).

Since 2010 the Bear Lake Property Owners' Association, now the Bear Lake Association, has implemented a bio-control program to reduce the invasive weed population. The Association reports few algae blooms and considerably reduced invasive weeds as a result.

2.0 WATERSHED AND LAKE CHARACTERIZATION

2.1. Watershed Characterization

Bear Lake has a direct drainage basin area of 6,464 acres excluding the surface area of the lake (Figure 1). Elevations in the lake's basin range from approximately 1,683 feet above mean sea level (AMSL) to as low as 1,318 feet AMSL at the surface of Bear Lake. There are 2 main tributaries that flow into Bear Lake from the eastern and western shores (Figure 1). During the public meeting it was indicated two additional tributaries also feed Bear Lake. However, these tributaries are not included in the National Hydrography Dataset Plus (McKay et al. 2012) nor could any maps be found that showed the tributaries. They therefore could not be incorporated.

Land use and land cover in the Bear Lake drainage basin was determined from geographic information system (GIS) datasets which were modified based upon feedback received during the public meeting. Digital land use/land cover data were obtained from the 2011 National Land Cover Database (NLCD; Jin et al. 2013). NLCD 2011 is the most recent representation of land cover for the conterminous United States generated from 30 meter resolution circa 2011 Landsat satellite data. Information provided at the public meeting was used to reclassify areas to provide a better reflection of agricultural activity in the watershed. A total of 385 acres of land were reclassified. Net gains or losses of land as a result of the reclassification were: decreased shrub/scrub by 12 acres, increased grassland/herbaceous by 48 acres, increased forest by 17 acres and decreased cultivated crops by 43 acres. Additional information on the reclassification in included in Appendix B. Final acres for each land use category are included in Table 1 and represented graphically in Figure 3. The final land use/land cover map is shown in Figure 4.

NLCD land use/land cover datasets from 2001, 2006 and 2011 are now available (Homer, 2004; Fey et al., 2011; Jin et al., 2013). A review of the land use in the Bear Lake watershed across this time period reveals very little change. The acreage characterized as developed and cultivated crops are near constant. Pasture/hay acreage shows a decline of about 100 acres. Forested acres show a small decline of about 200 acres while wetland acres show a small increase of 300 acres. Much of the increase in wetland acreage is due to better characterization of wetlands in the different datasets rather than an actual increase of acres over time.

Figure 1. Bear Lake Direct Drainage Basin

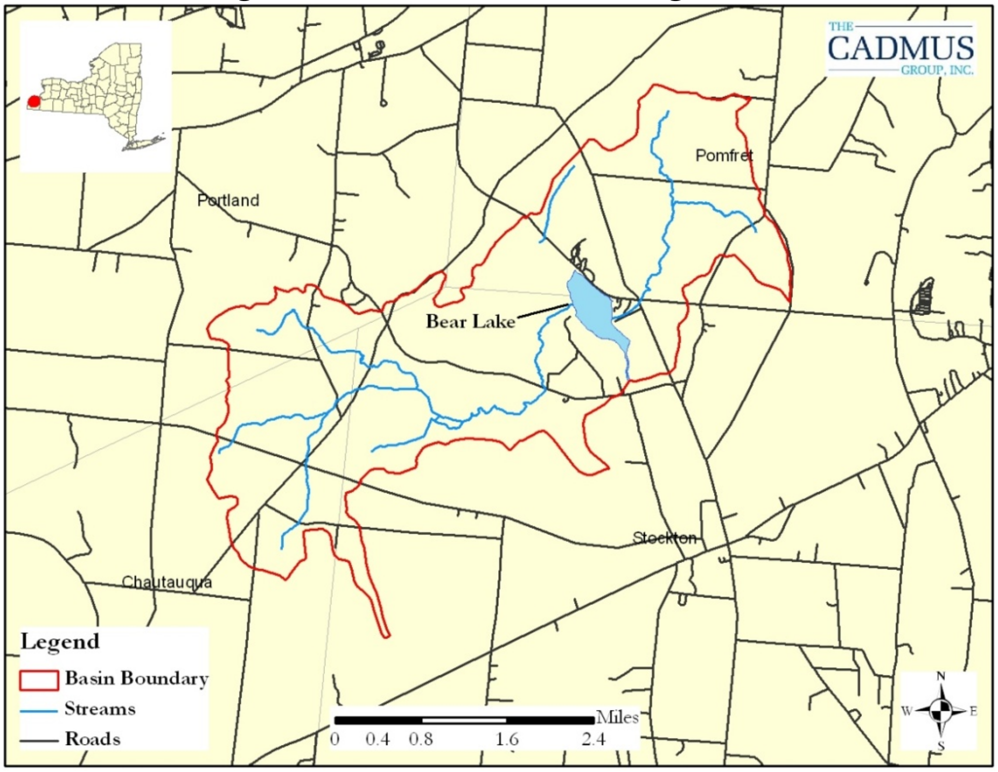


Figure 2. Aerial Image of Bear Lake

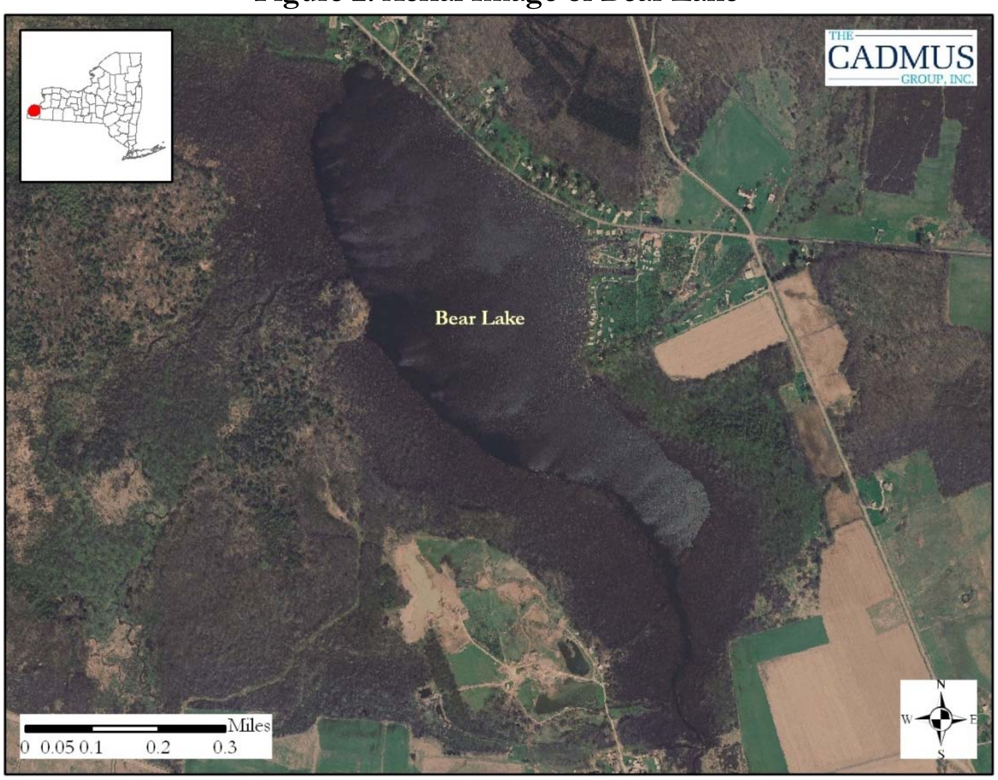


Table 1. Land Use Acres and Percent

Land Use Category	Acres	% of Drainage Basin
Open Water	**126**	**2**
Agriculture	**1,133**	**17**
Hay & Pasture	*772*	*12*
Cropland	*361*	*5*
Developed Land	**144**	**2**
Open	*136*	*2*
Low Intensity	*6*	*0.1*
Med Intensity	*2*	*0.03*
Forest	**4,309**	**65**
Deciduous	*3,178*	*48*
Evergreen	*435*	*7*
Mixed	*139*	*2*
Shrub/Scrub	*369*	*6*
Grassland/ Herbaceous	*188*	*3*
Wetlands	**878**	**13**
Woody	*680*	*10*
Emergent Herbaceous	*197*	*3*
TOTAL	**6,590**	**100**

Figure 3. Percent Land Use

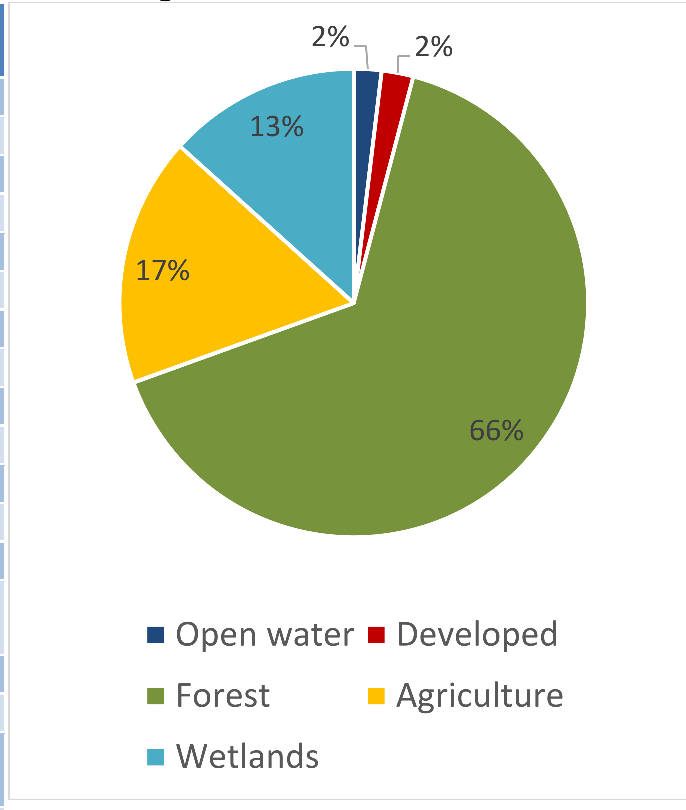
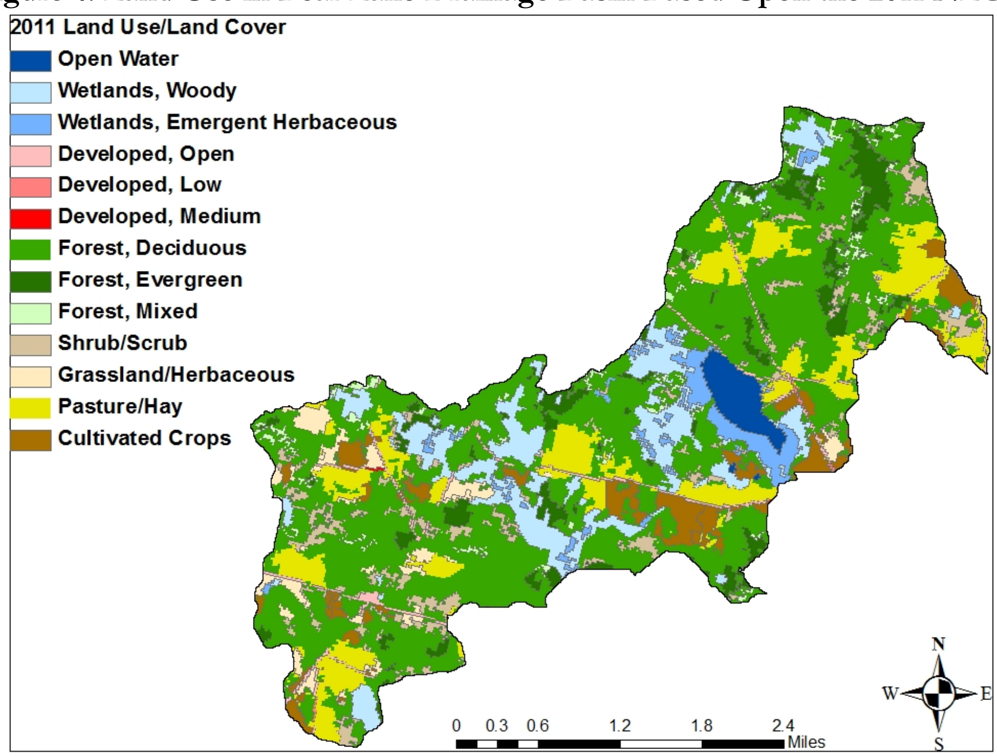


Figure 4. Land Use in Bear Lake Drainage Basin Based Upon the 2011 NLCD



2.2. Lake Morphometry

Bear Lake is a 126 acre waterbody at an elevation of about 1,318 feet AMSL. Figure 5 shows a bathymetric map for Bear Lake based on lake contour maps developed by NYS DEC. Table 2 summarizes key morphometric characteristics for Bear Lake.

Figure 5. Bathymetric Map of Bear Lake

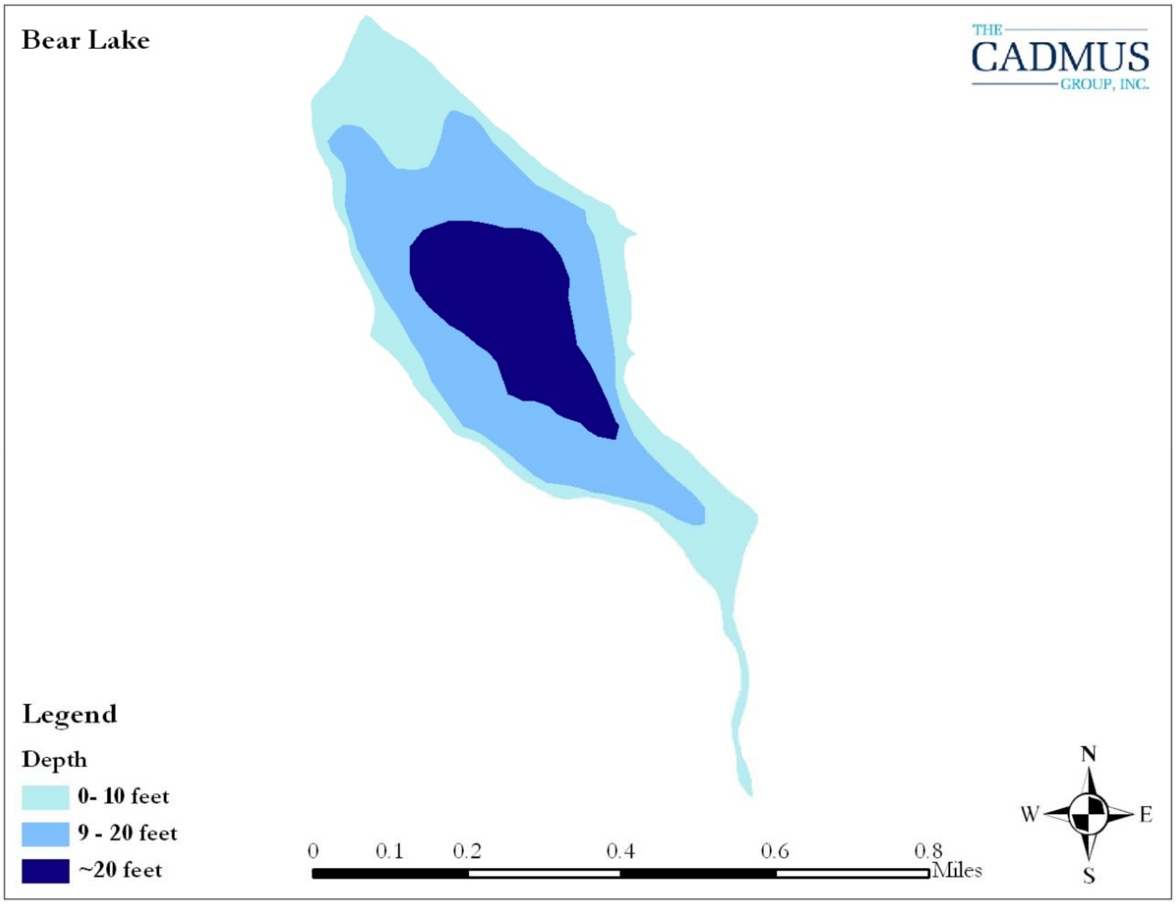


Table 2. Bear Lake Characteristics

Surface Area (acres)	126
Elevation (ft AMSL)	1,318
Maximum Depth (ft)	23
Mean Depth (ft)	12
Length (ft)	4,850
Width at widest point (ft)	1,936
Shoreline perimeter (ft)	14,106
Direct Drainage Area (acres)	6,464
Watershed: Lake Ratio	56:1
Mass Residence Time (years)	0.1
Hydraulic Residence Time (years)	0.1

2.3. Water Quality

NYS DEC's Lake Classification and Inventory (LCI) program was initiated in 1982 and is conducted by NYS DEC staff. Each year, approximately 10-25 water bodies are sampled in a specific geographic region of the state. The waters selected for sampling are considered to be the most significant in that particular region, both in terms of water quality and level of public access. Samples are collected for pH, acid neutralizing capacity, specific conductance, temperature, dissolved oxygen, chlorophyll-*a*, nutrients and plankton at the surface and with depth at the deepest point of the lake, 4-7 times per year (with stratified lakes sampled more frequently than shallow lakes). Sampling generally begins during May and ends in October.

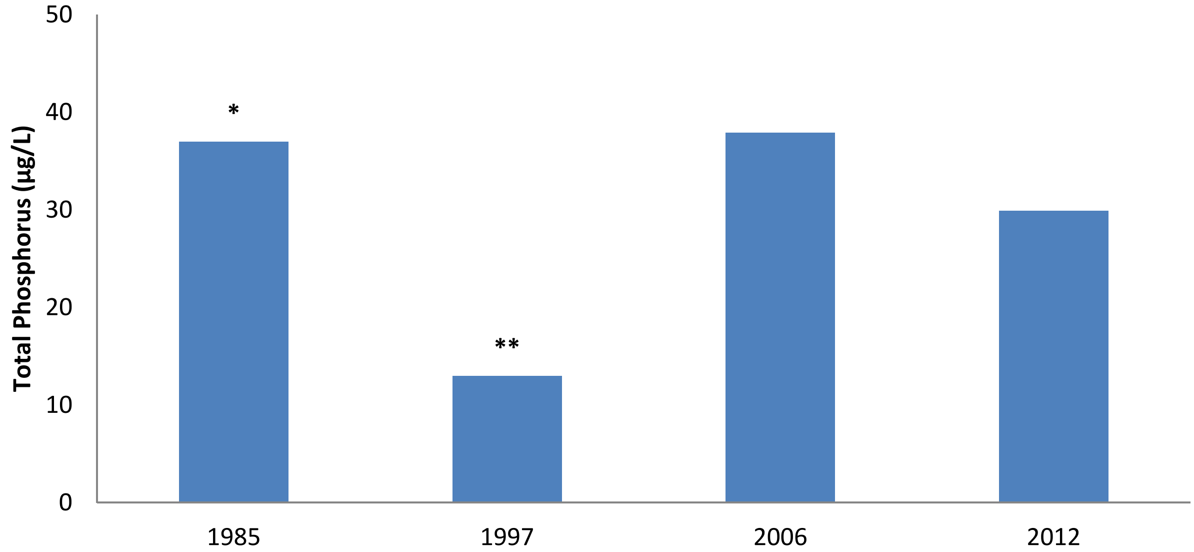
The LCI effort had been suspended after 1992, due to resource (mostly staff time) limitations, but was resumed again in 1996 on a smaller set of lakes. Since 1998, this program has been geographically linked with the Rotating Integrated Basin Sampling (RIBS) stream monitoring program conducted by the NYS DEC Bureau of Watershed Assessment. LCI sites are chosen within the RIBS monitoring basins (Susquehanna River, Long Island Sound/Atlantic Ocean and Lake Champlain basins in 2013, Genesee, Delaware and St. Lawrence River basins in 2014, the Mohawk and Niagara River basins and the Lake Ontario Minor tributaries in 2015, Upper Hudson, Seneca/Oneida/Oswego and Allegheny River basins in 2016, and Lower Hudson, Black and Chemung River basins in 2017) from among the waterbodies listed on the NYS WI/PWL for which water quality data are incomplete or absent, or from the largest lakes in the respective basin in which no water quality data exists within the NYS DEC database.

As part of LCI, a limited number of water quality samples were collected in Bear Lake during the summers of 1985, 2006 and 2012 (Figure 6). Raw data are included in Appendix F. Samples from 1985 were only collected during the months of July and August, while in 2006 and 2012 samples were collected each month from June through September. In addition to the LCI data, Bear Lake water quality data collected by the State University of New York (SUNY) Fredonia during the summer of 1997 were also obtained (Mantai, 1998). The 1997 samples were collected only during the month of July. Based upon the other years of data, particularly 2006 and 2012, phosphorus concentrations in June and July are lower than those measured in August and September. The 1997 data is therefore likely low relative to the June to September average concentration. While included here for completeness, the 1997 sample results were not used in the TMDL development. The results from these sampling efforts show eutrophic conditions in Bear Lake, with the concentration of phosphorus in the lake 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.

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 Bear Lake is *A,* which means that the best usages of the lake are: a source of water supply for drinking, culinary or food processing purposes; primary and secondary contact recreation; and fishing. The lake must also be suitable for fish propagation and survival. The lake serves as a back-up water supply for the Village of Brocton. However, the lake has not been used in this capacity since 1949 (Pers. Comm. A. Deming, Bear Lake Association).

Figure 6. Summer Mean Epilimnetic Total Phosphorus Levels in Bear Lake
***Samples collected during July and August only. **Samples collected during July only.**



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). While a guidance value of 20 µg/L (0.020 mg/L) total phosphorus has been developed for ponded waters (TOGS 1.1.1), this value was developed to be protective of aesthetics and the primary and secondary contact recreation best uses. A site specific interpretation of the narrative standard for the protection of the water supply best use has been developed as part of this TMDL. A chlorophyll-*a* (chl-*a*) target of 6 µg/L was identified as supportive of the water supply use by NYSDEC staff (Appendix A). The U.S. Army Corps of Engineers' lake model BATHTUB (USACOE, 2004) was used to identify the corresponding in-lake phosphorus concentration which predicted attainment of the target chl-*a* concentration. Based upon modeling of Bear Lake from 1982-2012, an average total phosphorus endpoint of 11 µg/L will, on average, attain the chl-*a* target of 6 µg/L and therefore be supportive of the water supply best use for Bear Lake.

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 Bear Lake TMDL. This approach consists of using MAPSHED to determine seasonal phosphorus loading to the lake, and BATHTUB to define the extent to which this load must be reduced to meet the water quality target.

The GWLF model was developed by Haith and Shoemaker (1987). GWLF simulates runoff and stream flow by a water-balance method based on measurements of daily precipitation and average temperature. The complexity of GWLF falls between that of a detailed, process-based simulation model and a simple export coefficient model that does not represent temporal variability. The GWLF model was determined to be appropriate for this TMDL analysis because it simulates the important processes of concern, but does not have onerous data requirements for calibration.

MAPSHED was developed to facilitate the use of the GWLF model via a GIS interface (Evans, 2002, 2012). Appendix B discusses the setup, calibration, and use of the MAPSHED model for lake TMDL assessments in New York.

TMDL development focused on the growing season (GS), defined here as May through September. Bear Lake has a hydraulic and mass residence time of about 2 months (Table 2) indicating that conditions in the lake are influenced primarily by conditions in the preceding few months. With the greatest water quality impacts observed in late summer, loading during the growing season has the greatest influence. Selection of this analysis period is also consistent with BATHTUB guidance for the selection of the lake response modeling period.

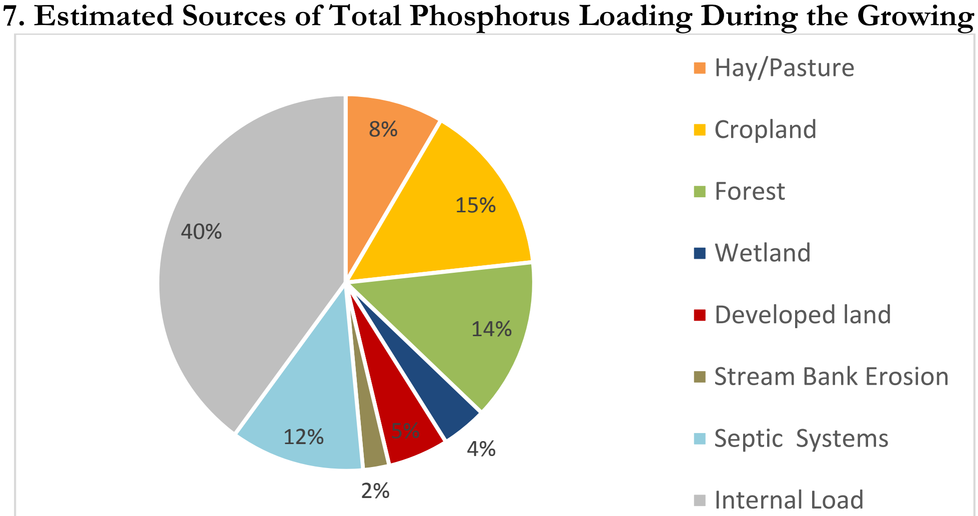
4.2. Sources of Phosphorus Loading

MAPSHED was used to estimate long-term (1982-2012) seasonal phosphorus (external) loading to Bear Lake. The estimated mean growing season (GS) load of 436 lbs of total phosphorus that enters Bear Lake comes from the sources listed in Table 3 and shown in Figure 7. Appendix B provides the detailed simulation results from MAPSHED. Individual source sector loads are discussed below.

Table 3. Estimated Sources of Phosphorus Loading to Bear Lake

Source	Total Phosphorus (lbs) during the Growing Season
Hay/Pasture	36.8
Cropland	64.6
Forest	60.6
Wetlands	17.0
Developed Land	22.7
Stream Bank Erosion	9.8
Septic Systems	50.2
Internal Load	174.2
TOTAL	**435.9**

Figure 7. Estimated Sources of Total Phosphorus Loading During the Growing Season



4.2.1. ***Residential On-Site Septic Systems***

Residential on-site septic systems contribute an estimated 50.2 lbs of phosphorus to Bear Lake during the growing season (lb/GS), which is about 11.5% of the total loading to the lake. 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 B.

Information provided during the public comment period were used to determine the population served by septic systems. Eleven residences were reported to be within 50 feet of the lake shoreline, of which only one is occupied year-round. The information provided indicated 56 residences located 50 to 250 feet from the lake shoreline. Twelve of those are occupied year-round. In addition, two seasonal campgrounds are located along the lake shore, one with 25 spots and one with 20 spots. The information provided indicated many of these spots are only utilized during the weekends. To account for occupancy during only two out of seven days, population estimates for the campgrounds were multiplied by an additional factor of 0.29. This is likely an underestimate as some sites will be occupied during the week as well, but may be countered by occupancy less than capacity at times. MapShed requires estimates of population served by normal and substandard septic systems. Within 50 feet of the lake shorelines, 100% of septic systems were categorized as short circuiting. Between 50 and 250 feet of the shorelines, 25% of septic systems were categorized as short-circuiting, 10% were categorized as ponding systems and 65% were categorized as normal systems. These assumptions are generally supported by inspection results from other lake watershed in New York. Results from Otsego and Keuka Lakes indicate slightly higher rates of failure at 50% for properties within 500 feet of the lake and 42% failure for properties within 200 feet of the lake, respectively. To convert the estimated number of septic systems to population served, an average household size of 2.57 people per dwelling or campsite was used based on the circa 2010 USCB census estimate for number of persons per households in New York State. The estimated population in the Bear Lake watershed served by normal and malfunctioning septic systems is summarized in Table 4.

4.2.2. ***Agriculture***

Agricultural land encompasses about 1,070 acres (18%) of the lake drainage basin and includes hay and pasture land (11%) and row crops (6%). Agricultural land is estimated to contribute 101.4 lbs/GS of phosphorus loading to Bear Lake, which is 23.3% of the total phosphorus loading to the lake during the growing season.

Table 4. Population Served by Septic Systems in the Bear Lake Drainage Basin

	Normally Functioning	Ponding	Short Circuiting	Total
September – May	20	3	10	33
June – August (Summer)	118	18	74	210

The agricultural contribution consists of two fractions, phosphorus, both dissolved and particulate associated with overland runoff and phosphorus originating from agricultural lands which is leached in dissolved form from the surface and transported to the lake through subsurface movement via groundwater. 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.

4.2.3. *Urban and Residential Development*

Developed land comprises 139 acres (2%) of the lake drainage basins. Loads from developed land contributes 22.7 lb/GS of phosphorus to Bear Lake, which is about 0.3% of the total phosphorus loading to the lake during the growing season. This load contains contributions from overland stormwater runoff and contributions of phosphorus originating from developed lands which is leached in dissolved form from the surface and transported to the lake through subsurface movement via groundwater. This load does not account for contributions from malfunctioning septic systems.

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. Many of the rural roads within the watershed are also characterized as developed lands. Phosphorus from these areas may be due in part to roadside ditch erosion.

4.2.4. *Forest Land and Wetlands*

Forested land comprises 4,312 acres (67%) of the lake drainage basin. Wetlands comprise an additional 878 acres (14%). The load from forested land is estimated to contribute 60.6 lbs/GS of phosphorus loading to Bear Lake, which is about 15% of the total phosphorus loading to the lake during the growing season. Wetlands are estimated to contribute 17 lb/GS, which is about 4% of the total growing season load. This load consists of both overland runoff and phosphorus originating from forest land which is leached in dissolved form the surface and transported to the lake though subsurface movement via groundwater. Phosphorus contribution from forested lands and wetlands is considered a component of background loading.

Included in this category are also lands which were classified as Grassland/Herbaceous in the NLCD. Based upon information provided in the public meeting some land within the watershed which is actively farmed by the Amish community were reclassified to be grassland/herbaceous because those lands do not receive nutrients at the same rates as more traditionally farmed lands. Characterization of these lands in this manner assigns a lower loading rate in the MapShed model. Actual loading of phosphorus from these lands is likely underestimated, but the relatively small amount of Amish farmed lands in the watershed makes this a minor impact.

4.2.5. *Groundwater Seepage*

As noted for most of the source sectors above, nonpoint sources of phosphorus are delivered to the lake through surface runoff and through phosphorus leached from the land surface and transported to the lake via groundwater. With respect to groundwater, there is typically a small "background" concentration owing to various natural sources. The GWLF manual provides estimated background groundwater phosphorus concentrations for ≥90% forested land in the eastern United States, which is 0.006 mg/L. For the Bear Lake drainage basin, in which forest and wetlands cover 77% of the watershed, the model-estimated groundwater phosphorus concentration is 0.010 mg/L. Estimates of the groundwater contributions of phosphorus are included in the estimates of phosphorus loads provided above for each of the source sectors.

4.2.6. *Stream Bank Erosion*

Stream bank erosion is estimated to contribute 9.8 lbs/GS since phosphorus may be attached to the eroded soil particles. This accounts for about 2% of the total phosphorus load to Bear Lake.

4.2.7. *Internal Load*

Lakes which have been subject to nutrient loading beyond their assimilative capacity for long periods of time may experience internal loading. This excess loading may result in the storage of phosphorus within the lake sediments which may then be released back into the lake waters when conditions are favorable. Such conditions can include resuspension 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 rooted aquatic plants, and other mechanisms that result in the release of poorly bound phosphorus.

Bear Lake is known to exhibit excessive aquatic plant growth and measurements have shown periods of low dissolved oxygen in the bottom waters of the lake. Measurements from 2012 also show increasing phosphorus concentrations in the bottom of Bear Lake during the period of stratification. Over a period of 36 days phosphorus concentrations increased from 0.0281 mg/L on June 25th to 0.132 mg/L on July 31st. The available data from 2012 was used to produce a rough estimate of 0.6 to 2.2 mg/m^2/day for the sediment phosphorus release rate. An internal load of 1.1 mg/m^2/day of phosphorus was estimated using the BATHTUB lake model. This loading rate produced good agreement between the measured and modeled in lake total phosphorus concentrations during the BATHTUB model calibration. This corresponds to a growing season load of 174.2 lb of phosphorus, or about 40% of the total.

4.2.8. *Other Sources*

Atmospheric deposition, wildlife, waterfowl, and domestic pets are also potential sources of phosphorus loading to the lake. 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 lake is accounted for in the lake model, though it is small in comparison to the external loading to the lake.

5.0 DETERMINATION OF LOAD CAPACITY

5.1. Lake Modeling Using the BATHTUB Model

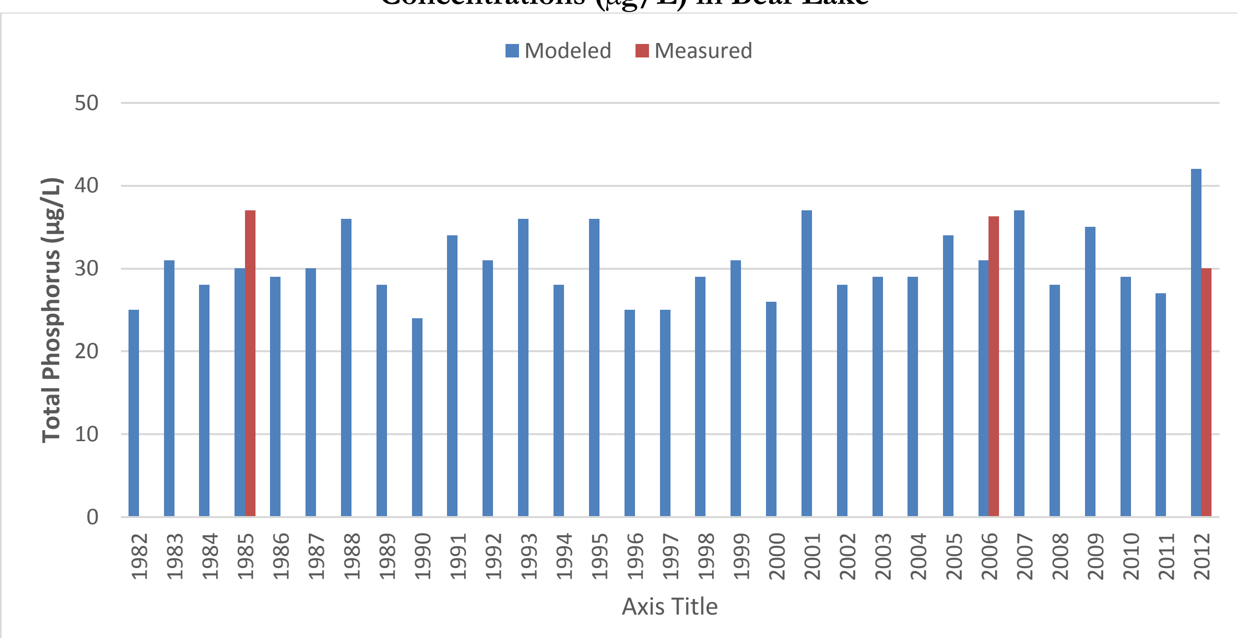
BATHTUB was used to define the relationship between phosphorus loading to the lake and the resulting concentrations of total phosphorus in the lake. The U.S. Army Corps of Engineers' BATHTUB model predicts eutrophication-related water quality conditions (e.g., phosphorus, nitrogen, chlorophyll-*a*, and 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 C 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 lake, phosphorus loads from MAPSHED were used to drive the BATHTUB model, which produced a simulation of water quality in Bear Lake for the period 1982-2012. The results of the BATHTUB simulation were compared against the average of the lake's observed summer mean phosphorus concentrations for the years 1985, 2006 and 2012. As discussed in Section 2.3 the 1997 data was not used for the model calibration. The combined use of MAPSHED and BATHTUB provides a decent fit to the observed data for Bear Lake (Figure 8).

The BATHTUB model was used as a "diagnostic" tool to derive the total phosphorus load reduction required. NYSDEC staff have identified 6 μg/L as the seasonal average chlorophyll-*a* (chl-*a*) concentration which is supportive of Class *A* water supply best use (Appendix A). BATHTUB was run iteratively, reducing the phosphorus load each run, until the model predicted a 6 μg/L average chl-*a* concentration over the model period of 1982-2012. The corresponding lake total phosphorus growing season average concentration was 11 μg/L. Under these conditions the

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



maximum allowable growing season total phosphorus load to the lake is estimated to be 94.8 lb. The equivalent daily load is 0.62 lb total phosphorus.

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

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

The TMDL allocations for Bear Lake are presented as growing season (May – September) loads. The seasonal allocations are consistent with the timing of the delivered phosphorus loads which lead to the summer impairments observed in Bear Lake (Section 4.1).

6.1. Wasteload Allocation (WLA)

There are no permitted wastewater treatment plant dischargers in the Bear Lake basin. There are also no Municipal Separate Storm Sewer Systems (MS4s) in the basin. Therefore, the WLA is set at 0 (zero), and all of the loading capacity is allocated to the load allocation.

6.2. Load Allocation (LA)

The Growing Season LA is set at 85.3 lbs. Nonpoint sources that contribute total phosphorus to Bear Lake include loads from developed land, agricultural land, and malfunctioning septic systems. Table 5 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. Internal loading is given zero allocation under the assumption that, as excess external loading in removed, internal loading will be reduced over time as excess phosphorus exits the system. Phosphorus originating from natural sources (including forested land, wetlands, and stream banks) is assumed to be unlikely to be reduced further and therefore the load allocation is set at current loading.

6.3. Margin of Safety (MOS)

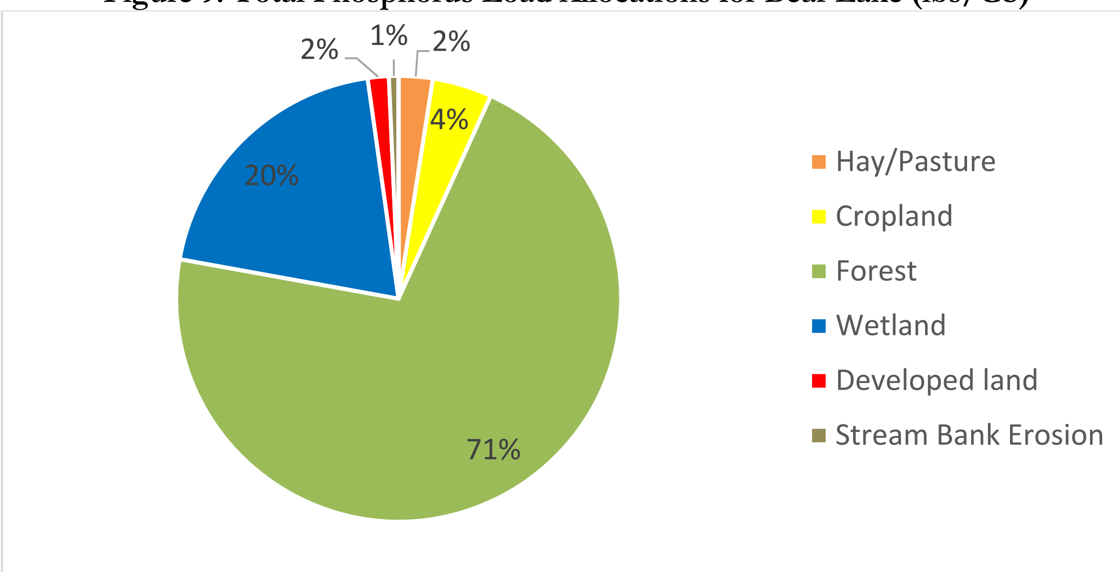
The margin of safety (MOS) can be implicit (incorporated into the TMDL analysis through conservative assumptions) or explicit (expressed in the TMDL as a portion of the loadings) or a combination of both. For the Bear Lake TMDL, the MOS is explicitly accounted for during the allocation of loadings. An 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

Table 5. Total Phosphorus Load Allocations for Bear Lake*

Source	Total Phosphorus Load (lbs) During the Growing Season			% Reduction
	Current	Allocated	Reduction	
Agriculture	101.4	5.8	95.6	94%
Developed Land	22.7	1.3	21.4	94%
Septic Systems	50.2	0	50.2	100%
Forest, Wetland, and Natural Background	77.6	77.6	0	0%
Stream Bank Erosion	9.8	0.6	9.2	94%
Internal Load	174.2	0	174.2	100%
LOAD ALLOCATION	**435.9**	**85.3**	**350.6**	**80%**
Point Sources	0	0	0	0%
WASTELOAD ALLOCATION	**0**	**0**	**0**	**0%**
LA + WLA	**435.9**	**85.3**	**350.6**	**80%**
Margin of Safety	---	9.5	---	---
TOTAL	**435.9**	**94.8**	**---**	**---**

*Daily equivalent values are provided in Appendix E

Figure 9. Total Phosphorus Load Allocations for Bear Lake (lbs/GS)



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 9.5 lb/GS. While the MOS is needed to account for uncertainties within the modeling and analysis, the good agreement between the measured and modeled water quality parameters indicates that the models have captured the major driving forces in this system. The use of a modest MOS is therefore supported. 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. Due to low hydraulic and mass retention times of about 1-2 months for average conditions in Bear Lake, lake water quality responses are driven primarily by conditions during the preceding 1-2 months. Based upon the historic data, critical conditions in the lake have occurred during August and September when high temperatures and high phosphorus concentrations can drive excessive algal growth. The May through September period is therefore the critical period for the analysis as is captures the important loading period from the watershed and the observed critical response period in the lake. Additionally, the modeling period of 1982-2012 captures a wide range of inflow volumes and phosphorus concentrations from the watershed ensuring that the water quality objectives are achieved over a wide range of environmental conditions.

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 31 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 BMPs in collaboration with the involved stakeholders. NYSDEC, in coordination with these local interests, will address the sources of impairment, using regulatory and non-regulatory tools in that watershed, matching management strategies with sources, and aligning available resources to effect implementation.

This TMDL was developed to protect all of the currently identified best uses for Bear Lake. In this case, the phosphorus endpoint was selected to achieve a chlorophyll-*a* concentration supportive of the water supply best use. It is recognized that Bear Lake has not been used for water supply for more than 60 years. Furthermore, the Village of Brocton, for whom Bear Lake serves as an back-up water supply source, may begin using Lake Erie as a water supply source as part of a regional water supply project. Should that occur, Bear Lake may be abandoned altogether as a water supply source. Such a project, however, is still in the early planning phase.

Given the extent of load reduction needed to reach the TMDL specified here and the potential for Bear Lake to be discontinued as a water supply, it is prudent to consider the potential future uses of Bear Lake. If Brocton abandons Bear Lake as a water supply, the lake could be reclassified to Class *B*, which would still be supportive of primary and secondary contact recreation and fishing as well as being suitable for fish and wildlife propagation and survival. Such a reclassification would be carried out through a use attainability analysis (UAA). A Class *B* lake would be subject to less stringent chlorophyll-*a* and total phosphorus concentrations. Load allocations tables capable of supporting the Class *B* uses have been included in Appendix D. Should Bear Lake be reclassified the allocations in Appendix D would supersede the allocations appearing in Table 5. Even for a Class *B* lake, significant load reductions would still be needed from the current levels. As such, implementation of the TMDL as provided here should not be delayed.

7.1. Reasonable Assurance for Implementation

Meeting the loading limits specified in this TMDL will require reductions from nonpoint sources. Implementation will rely upon existing programs which have proven successful in reducing loads from the targeted source sectors. For the agricultural source sector, implementation relies upon voluntary installation of BMPs. Financial assistance and resource conservation provides incentives for participation. Septic systems fall under the jurisdiction of the Chautauqua County Health Department.

7.1.1. *Recommended Phosphorus Management Strategies for Septic Systems*

Septic systems are the second largest controllable source of phosphorus to Bear Lake. Short of connection of all of the septic systems to a centralized wastewater treatment facility (discussed further below), reduction of the septic system load to the extent needed will necessitate a robust program to address substandard systems. A systematic approach, such as the formation of a management district, may be beneficial to achieving this. New York State has begun to offer funding for the abatement of inadequate onsite wastewater treatment systems through the development and implementation of a septic system management program by a responsible management entity. Additionally, for new systems, the Chautauqua County Department of Health and Human Services (CCDOH) is responsible for ensuring that septic systems are installed properly. Malfunctioning systems which discharge to surface waters may also be referred to NYSDEC of CCDOH. To further assist municipalities, NYSDEC is involved in the development of a statewide training program for onsite wastewater treatment system professionals. A largely volunteer industry group called the Onsite Wastewater Treatment Training Network (OTN) has been formed. NYSDEC has provided financial and staff support to the OTN.

The CCDOH is taking an active approach to addressing septic systems. Staff have been trained and certified by the OTN. Two workshops were organized by Cornell University and the Chautauqua Lake Management Commission for homeowner education on improved wastewater management for lakeshore communities. The workshops were recorded and posted online. More information can be found at http://wri.eas.cornell.edu/NYSP2I_workshops.html.

On March 25, 2014 a new policy (#2014-1) was issued by CCDOH which requires the inspection upon property transfer of the sewage disposal system (SDS) by Sanitarians assigned to the CCDOH. For systems located within 250 feet of major waterbodies, including Bear Lake, which also meet one or more of the following conditions:

- The facilities SDS is unpermitted
- The facility's permitted SDS is older than 30 years
- The SDS serving the facility is in significant non-compliance with Appendix 75-A Wastewater Treatment Standard – Individual Household Systems (NYSDOH 2010)

CCDOH is requiring the more rigorous OTN – Water-Sewage Survey. Facilities which do not meet the above requirements are required to undergo a Standard Water-Sewage Survey. However, if such facilities are found to be in significant non-compliance with Appendix 75-A, a OTN – Water-Sewage Survey is required. SDSs determined to be unmaintained, failing or in significant non-compliance with Appendix 75-A will be issued a Notice of Violation and an approved installation permit to correct the violation must be obtained prior to property transfer.

The Chautauqua County Board of Health is also considering promulgating new rules which would require special management of septic systems around lakes including regular inspections. Similar requirements have been established for other lakes in New York State. A robust inspection program such as this would make substantial progress towards addressing the septic system loads. Funding which could help establish and support such a program should be pursued.

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. 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.

Removal of the septic system source load could also be achieved by connection of the properties to sanitary sewers and an associated wastewater treatment plant that discharges outside of the watershed. Existing nearby wastewater treatment plants include the Lily Dale Sewer District wastewater treatment facility owned by the Town of Pomfret, located approximately 3 miles to the east near the Village of Cassadaga, and the Brocton Sewage Treatment Plant owned by the Village of Brocton, located approximately 4 miles to the northwest. Such a project would cost roughly $2-3 million. Potential funding sources include DEC/EFC Engineering Planning grants, DEC Water Quality Improvements Projects grants, Clean Water State Revolving Fund, NYS Community Development Block Grants, NYS Local Government Efficiency Program, Appalachian Regional Commission Area Development Grant Program and the USDA Rural Development grants. The schedule for a sewering project will depend upon the extent of local interest and involvement and upon the ability of a local party to secure funding. A rough schedule will include:

- Developing interest and coordination between impacted municipalities (1 yr)
- Initial feasibility study (1 yr)
- Execute inter-municipal agreement and formation of a sewage district (2 yrs)
- Securing funding (3 yr)
- Project design and implementation (3 yrs)

Further work should be conducted to determine if this is a viable option. J.C. Smith at NYS Environmental Facilities Corporation can help interested parties develop such a project.

On July 15, 2010, New York State passed the Household Detergent and Nutrient Runoff Law (Chapter 205 of the laws of 2010) that prohibits the sale of automatic dishwasher detergent that contains more than 0.5 percent phosphorus by weight. Studies show that this measure could reduce the phosphorus content of domestic sewage by approximately 10 percent.

7.1.2. *Recommended Phosphorus Management Strategies for Agricultural Runoff*

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 Concentrated Animal Feeding Operation (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.

Chautauqua 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.

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. Ideally, Tier 3 would include a Comprehensive Nutrient Management Plan with phosphorus indexing at the appropriate stage in the planning process. 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 reducing load by taking land out of production.

BMP implementation occurs at the local level. The agricultural community, in coordination with technical experts, are best able to identify and implement BMPs that will work for the conditions which exist in the field. Table 6 contains a partial list of BMPs with associated costs and phosphorus removal efficiencies to help guide the implementation process. Cost and efficiency information was retrieved from the Chesapeake Bay Program's *Chesapeake Assessment Scenario Tool* (Devereux and Rigelman, 2014). Costs are annualized over the lifespan of each practice. A successful strategy will likely rely upon a number of different BMPs. The example strategy that follows tries to balance cost effectiveness and acceptance by the agricultural community.

Cover crops are generally a well-received BMP within the agricultural community, although they are not necessarily the most cost effective on a dollar per pound of phosphorus reduction basis. Implementation of cover crops on the 361 acres of row crops is estimated to reduce the agricultural phosphorus load by 36.1 pounds per growing season at an annual cost of $26,400. There are approximately 2.4 miles (3.9 kilometers) of streams within the watershed bordered by agricultural lands. Full implementation of forest buffer strips would remove approximately 13 pounds of phosphorus per growing season at an annual cost of $1,360. Nutrient management on both row crops (361 acres) and on pasture (772 acres) is estimated to reduce phosphorus loading by 113 lbs per growing season at a total annual cost of $4,420. Multiple BMPs on the same land may result in less cumulative load reductions. Additional monitoring during the implementation phase may indicate additional BMP implementation is required. Based upon the costs above, implementation of the agricultural sector could be achieved at an estimated annual cost of $10,000 – $30,000.

For the strategy outlined above the BMPs are non-structural. The implementation timeline will depend primarily upon availability of funding and willing local partners. Assuming both can be identified, an initial five year implementation period is suggested with a goal of having 75% of all practices implemented during that time. Difficulties in obtaining either, however, will necessitate a

Table 6: Estimated BMP cost efficiencies

Best Management Practice	**Lifespan**	**Unit**	**Cost**	**Phosphorus Reduction**	**Cost**
	Years		$/unit	lb/unit	$/lb
Nutrient Management Plan	3	acre	3.9	0.1	31
Stream restoration	20	feet	6.92	0.1	91
Septic connection	25	system	527	5.3	99
Land retirement to pasture	10	acre	169	1.5	113
Grass buffers	10	acre	147	1.0	144
Forest buffers	75	acre	231	1.5	156
Tree planting	75	acre	70	0.4	187
Septic pumping	3	system	88	0.3	338
Cover crops	1	acre	73	0.1	530
Stream Fencing	10	acre	5307	6.3	843
Wetland restoration	15	acre	544	0.5	1034
Bioswale	50	acre	922	0.9	1049
Bioretention/raingarden	25	acre	1127	1.0	132
Dry ponds	50	acre	365	0.2	1556

longer implementation schedule. Reassessment following five years of implementation is suggested to determine if sufficient practices have been put in place and if additional or different BMPs are needed. A second five year implementation period may be needed to reach 100% implementation. The most readily available source of funding is through the AEM program. Interested parties are encouraged to work with the Chautauqua County Soil & Water Conservation District for assistance with identifying opportunities, obtaining funding and implementing projects.

7.1.3. *Recommended Phosphorus Management Strategies for Urban Stormwater Runoff*

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

Developed lands are estimated by the model to be a minor part of the total phosphorus load delivered to the lake. However, areas of active erosion, such as road ditches on steep grades can be a significant source of sediment and associated phosphorus and should stabilized, as recommended by the Chautauqua County Soil and Water Conservation District.

Minor reductions may still be realized through the Nonpoint Source Management Program. There are several measures, which if implemented in the watershed, could directly or indirectly reduce phosphorus loads.

- Public education regarding:
    - Lawn care, specifically reducing fertilizer use or using phosphorus-free products now commercially available. The NYS Dishwasher Detergent and Nutrient Runoff Law restricts the sale and application of fertilizers containing phosphorus.
    - Cleaning up pet waste.
    - Discouraging waterfowl by restoring natural shoreline vegetation.
- Construction site and post construction stormwater runoff control ordinance, inspection and enforcement programs.
- Pollution prevention practices for road and ditch maintenance.
- Management practices for the handling, storage and use of deicing products.

The NYS Dishwasher Detergent and Nutrient Runoff Law (ECL §17-21), which went into effect in 2012, should provide the load reduction needed from the developed land source sector through restrictions on the phosphorus content of fertilizer. As the law has already taken effect, no additional action is needed.

7.1.4. *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 promote smart growth, limit non-compatible development and preserve natural vegetation along shorelines and tributaries. 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.

Timber harvesting was indicated as an important industry within the watershed during the public meeting. NYSDEC has staff available who can assist with responsible forest management and has also identified a number of best management practices specific to the industry. More information and assistance can be obtained from the regional NYSDEC office, which for Bear Lake is located in Buffalo. It should also be noted that these activities may require permits from NYSDEC and that local regulations may also be applicable.

7.2. Follow-up Monitoring

A targeted post-assessment monitoring effort will be initiated to determine the effectiveness of the implementation plan associated with this TMDL. Sampling will be coordinated with the existing Lake Classification and Inventory (LCI) program. Samples will be 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. The program is next scheduled to conduct sampling in the basin in 2016 to 2018 and then every 5 years subsequent.

8.0 PUBLIC PARTICIPATION

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 23, 2014. A 30-day public review period was established for soliciting written comments from stakeholders prior to the finalization and submission of the TMDL for USEPA approval. At the request of several stakeholders the public comment period was extended. Comments were accepted through close of business on September 5th, 2014. Notice of the extension appeared in the August 27th, 2014 issue of the Environmental Notice Bulletin.

A public meeting was held on August 14, 2014 in Stockton, NY to discuss the Draft TMDL and solicit any feedback from interested parties. Notice of the meeting appeared in the July 23, 2014 ENB notice and postcards were mailed to residences within the watershed. Notice of the Draft TMDL and public meeting were also sent to the Towns with land within the watershed, to Chautauqua County, and to the Village of Brockton. The president of the Bear Lake Association, who was also notified of the Draft TMDL and the public meeting, announced the document and meeting during the Association's annual meeting. An additional meeting was held on August 15, 2014 to discuss the Draft TMDL with the Chautauqua Lake Water Quality Task Force.

8.1 Response to Comments

Comments were received from the following:

- Bear Lake Association
- Bernie Klaich, Water Quality Task Force member representing the Bear Lake Association
- Kim Sherwood
- Dr. Robert H. Deming, Secretary, Bear Lake Association
- Chautauqua County Department of Health

Comments received, and associated responses are below. In some cases similar comments have been grouped together or otherwise aggregated as appropriate.

8.1.1. *General*

1. I appreciate the role NYSDEC has in protecting beneficial water uses.

   Response: The comment is noted.

2. Include a list of acronyms.

   Response: A list of acronyms has been included.

3. "Over the past couple of decades, the lake has experienced degraded water quality that has reduced the lake's recreational and aesthetic value….impairments known to be due to excessive weed and algae growth, suspected to be due to nutrients, phosphorus" (page 4).

   To the contrary, since 2010 when the Bear Lake Property Owners' Association (now the Bear Lake Association) implemented a lake management plan and bio control program under the direction of Dr. Robert Johnson of Racine Johnson Aquatic Ecologists, the lake has experienced few algae blooms and considerably reduced invasive weeds. The report of that program and its results since 2010 were sent to NYSDEC and can be made more widely available.

   Response: The paragraph has been revised to indicate that the assessment in question is from the 2007 version of the Priority Waterbodies List (PWL), which is the most recent PWL assessment available. The information provided in the comment has been added to better reflect the current state of the lake.

4. "maximum depth—20ft" (page 9). Is this figure accurate? Bear Lake history has it that the lake is 35 ft. at its deepest.

   Response: The bathymetric map for Bear Lake shows a 20 foot contour but not a 30 foot contour. NYSDEC has collected dissolved oxygen measurements at a depth of 23 feet. While an exhaustive search was not conducted, efforts were made to locate the deepest part of the lake when conducting the field measurements. Field staff involved with the sampling believe the lake is not much deeper than 23 feet. The table has been changed to 23 feet.

5. 2007 PWL listing:
   a. What is the 2007 PWL?
   b. …"primary sources of the nutrients causing the excessive weed and algae growth are suspected (?)…and possibly on-site septic systems." This is vague; undocumented; and 7 years old.

   Response: PWL refers to the Waterbody Inventory/Priority Waterbodies List (WI/PWL) and is a statewide inventory (database) of New York State waterbodies which characterize water quality, the degree to which water uses are supported, progress toward the identification of water quality problems and likely sources, and activities to restore and protect each individual waterbody. Additional information can be found on the WI/PWL website: http://www.dec.ny.gov/chemical/23846.html. The WI/PWL listing for Bear Lake can be found here: http://www.dec.ny.gov/docs/water_pdf/pwlallgyconw.pdf.

The 2007 assessment is the most recent available. Updating of the WI/PWL listing follows the RIBS sampling 5 year cycle. WI/PWL staff anticipate the release of an updated WI/PWL for the Alleghany River basin, including Bear Lake, by the end of 2014.

Assessments of impact, types of pollutant and sources of pollutants are based upon staff observations, knowledge of potential sources, and analysis of chemical and biological samples collected from the waterbody. The use of "known, suspected, and possible" reflects the level of certainty about any conclusions reached. NYSDEC's Bureau of Water Assessment and Management maintain the WI/PWL and can provide additional information on assessment and listing methodology.

6. Does Brocton still consider Bear Lake a water source? If not and they haven't for years, nor intend to in the future , why is the lake still classified as a Class A lake? Were it a Class B lake, what would the expected phosphorus load be?

Response: The New York State Department of Health's source water assessment program, completed in 2004, includes Bear Lake as a water supply source for the Village of Brocton. Nothing has been received which indicates the designation of Bear Lake as a water supply source has changed.

Classification of waterbodies as Class A is independent of whether they actually serve as a source of potable water. Reclassification of a waterbody is accomplished through a use attainability analysis, which could be undertaken in a process separate from this TMDL.

Were the lake to be reclassified, the TMDL for a Class B Bear Lake is included in the TMDL as Appendix D.

7. Is waterfowl loading really accounted for elsewhere? Given what's been stated about proximity to the lake of malfunctioning septic systems, is it possible this contribution is bigger than it seems? This is a variable that could be managed to some extent with alternative shoreline management strategies undertaken by landowners. It may be worth exploring this contribution in more detail.

Response: Without specific data on waterfowl it is not possible to explicitly incorporate their phosphorus contribution into the model. The calibration process is used to match model predictions to measured values and includes changing model coefficients to better capture local conditions. For example, increasing the developed lands phosphorus loading rate would be one method to account for the additional load created by waterfowl, assuming they are primarily associated with developed lands. Without sufficient data to justify other actions, waterfowl are incorporated into the model implicitly through the calibration process.

8. The Dennis Sabella property purchased in July borders most of the south east side of the lake. What restrictions will be required of Mr. Sabella as he logs that property? Bear Lake, with over 70% of its shoreline undeveloped and the largest wetland in the county, has nesting Great Blue Herons, and American Eagles and recently Fishers, and is the only lake in the county that uses bio control [using weevils and moths] exclusively to effectively control invasive weeds and algae to improve lake quality. That being the case, will the NYDEC take an active role in attempting to secure the Sabella property lakefront for conservation to help maintain the health of this very special lake? Conservation of that land could do more to improve the quality of Bear Lake than any of the other proposed recommendations in the draft TMDL.

Response: Conservation of this property would certainly be useful for preventing the creation of new sources of phosphorus as the result of development or logging activities. It will not, however, address the existing sources of phosphorus from the rest of the watershed.

A permit may be necessary to harvest timber on private lands. Anyone considering such should contact the Regional Permit Administrator at the local NYSDEC office, which for Bear Lake is the Region 9 office in Buffalo. One should also be aware that there may be local laws, ordinances or regulations which regulate timber harvesting and associated activities. Resources are also available through the NYSDEC Region 9 office to assist with the long-term health and productivity of forests.

The natural resource supervisor for NYSDEC Region 9 was consulted regarding this property as well. While aware of it, he indicated NYSDEC has no current plans regarding this property and that The Nature Conservancy may be a better fit with respect to conservation.

8.1.2. *Lake Phosphorus*

9. While a target total phosphorus (TP) concentration of 10 μg/L would ensure that the highest use of the lake (drinking water) is attained, it is not practical for a shallow, eutrophic lake like Bear Lake or our other inland lakes in Chautauqua County. I understand the science behind you using TP as an indicator to achieve a chlorophyll a concentration protective of public health and feel it has merit. However, a TP goal of 10 μg/L would likely be impossible to achieve. In addition, it would set a dangerous precedence for other lakes in our county used for drinking water (i.e. Chautauqua Lake), so that they would eventually be required to achieve the same goal under future TMDLs. As you know Chautauqua Lake's TMDL was recently completed and POTWs discharging into it are preparing to spend ~ $10 million to reduce their phosphorus contributions in an effort to achieve a 20 μg/L TP goal in the lake. Therefore this Department requests that the same 20 μg/L goal used for development of the Chautauqua Lake TMDL be used for Bear Lake.

Response: Revised modeling based upon the comments received indicates a total phosphorus concentration of 11 μg/L is supportive of the drinking water best use for Bear Lake. This endpoint was identified as protective of all of the best uses of Bear Lake. It is a site specific endpoint which was based upon the best available science at the time of preparation of this TMDL. A 20 μg/L endpoint would not be sufficiently protective to allow Bear Lake to support all classified best uses.

10. Are the relatively low P concentrations in June and July typical across other regions of NY? If so, why? Would that relate to soil moisture relatively early in the growing season? Uptake by plants? Others?

Response: Findley Lake, also in Chautauqua County, has more than twice the surface area and a greater maximum depth than Bear Lake, but similar average depth. Findley Lake also has monitoring data from 1986 to 2000 which overall shows an increase of phosphorus concentrations in the lake as the summer progresses.

In Bear Lake, the 2012 data provides some evidence that increases in late summer phosphorus concentrations may be influenced by lake turnover bringing lake bottom waters to the surface. These bottom waters become enriched with phosphorus due to the anoxic conditions which develop in the deeper portions of the lake. Additional data would be needed to determine if that is the case and if it is a regular occurrence.

11. Why does the "draft report" nowhere speak to the "internal load," where it comes from, and how 100% of it is to be eliminated [Table 5].

Response: Internal load is discussed in Section 4.2.6, Section 6.2 and Appendix C.

Reduction of watershed loads of phosphorus into the lake will reduce internal loading as excess phosphorus makes it way out of the lake system. This approach will likely to take a long time.

Nutrient precipitation and deactivation may also be used to remove phosphorus from the water column and sequester it in the sediments. "Diet for a Small Lake" discusses options for reductions of phosphorus contributions from sediments. A copy of the book is available here: http://www.dec.ny.gov/chemical/82123.html. An internet search for phosphorus removal in lakes can provide additional resources. Note that a permit may be required from NYSDEC prior to the addition of any chemicals to lakes. NYSDEC is also looking into several best management practices which may be used to address excess nutrients in lakes.

12. What is the 'decay process' for nutrients in-lake? I assume uptake I assimilation by plants? How is this allocated/accounted for and distinguished from P stored in-lake sediments?

Response: Long term loss mechanisms for phosphorus contained within the lake waters includes: loss via the lake outlet, permanent loss to the lake sediments and loss via material removed from the lake i.e. fish and aquatic plants. The lake model accounts for the first two mechanisms while the third is likely negligible. Short term losses may include uptake by plants, algae and the lake food chain and loss to sediments which are later resuspended or released from sediments due to changes in lake chemistry. Temporary storage of phosphorus in sediment may be an important part of overall phosphorus loading to the lake (see Section 4.2.6). These mechanisms are not long term losses, but rather part of the phosphorus cycle within the lake system.

13. Over what period of time is it assumed that internal loading would go to zero if external loading was halted/significantly reduced?

Response: It is not possible to provide an estimate using the Bathtub model. A more complex bio-geochemical model would need to be used to better understand the relationship between phosphorus loading, algal growth and decay, hypolimnetic oxygen demand and phosphorus release from the sediments.

14. Can curves be included which will show the water quality changes expected as the phosphorus load is reduced?

Response: The model was run several times at 100%, 80%, 60%, 40% and 20% of the current loading rate. Figure 10 shows how the phosphorus, chlorophyll-a and Secchi disk depths are predicted to change for the different loading rates on average for the 31 year model period.

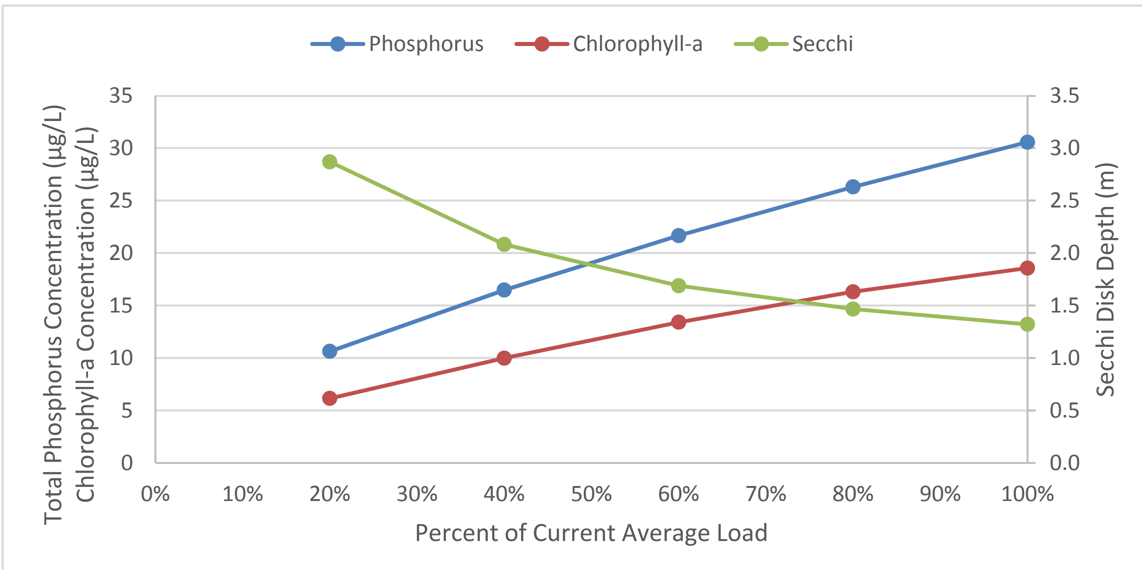


Figure 10. Predicted changes in lake water quality parameters with phosphorus load reductions.

8.1.3. *Onsite Wastewater Treatment (Septic) Systems*

15. How does DEC know that the total phosphorous (lbs.) for septic systems is 55.5 lbs?

Response: Typical septic tanks are not designed to remove phosphorus. Characterization of septic tank influent and effluent indicates little phosphorus removal in the septic tank itself (Lowe et al., 2009). In a well-designed and properly functioning septic tank, effluent is dispersed through a leach field where it percolates through unsaturated soils for additional treatment. Phosphorus may be removed via attachment to soil, but the extent to which this occurs depends on many factors. Any phosphorus removal is an added benefit but is not generally a parameter around which systems are designed.

Estimates of septic system loads are based upon residency data, average per capita loading rates and location. Systems sited near waterbodies are more likely to be substandard and thus more likely to contribute phosphorus. The watershed model uses this information to estimate the septic system load to the lake. The data provided during the public comment period was used to refine the load attributed to septic systems. Load reductions due to reduced seasonal occupancy rates and information on system proximity to the lake shore were mostly offset by the addition of additional populations served by septic systems due to a number of seasonal campgrounds which were not included in the previous estimates. The revised growing season load was estimated to be 50.2 lbs.

16. The majority of the discussion relative to on-site septic systems focuses on the area within 250 feet of the lake, and for good reason. However, on-site systems throughout the watershed's contributing area may be non-functional and therefore contributing to the phosphorus load. Is this possibility considered or is it thought to be negligible?

Response: Any septic systems in the watershed may be substandard, but those closest to the lake are likely to have the greatest impact. Beyond 250 feet from the lake many of the pressures which lead to substandard systems are reduced or absent, such as small lot size and proximity to surface waters. Of the systems in the rest of the watershed, those of greatest concern would be those which are in close proximity to or deliver effluent directly to streams, as these waterways create a direct path for the delivery of effluent and phosphorus to the lake. Relative to the number of systems along the lakeshore, however, the number of substandard systems in the rest of the watershed is considered to be much smaller.

17. "Approximately 81% of the homes around the lake are assumed to be year-round residences, 19% seasonally occupied". Not sure where this data came from, but not correct. Source of these data? I count 13 homes that are year-round and 56 that are seasonal. There are also 35 campers in the Conservation Club which has frequent Health Dept. testing of its septic system and around 15 campers at the Clever Campground which varies each year, fewer this year. All of these campers are seasonal, most here on weekends only.

Response: The occupancy rates were based on census data. The estimates initially provided by Cadmus (contractor originally hired by U.S. EPA to develop this TMDL) based on the 2000 Census data were confirmed using the 2007-2011 American Community Survey 5-year estimates. Estimates of seasonal residency were taken from census tracts 360 and 364.02. The first tract had a seasonal residency rate of 10.1% and covered the Town of Pomfret excluding the Dunkirk/ Fredonia area. The second tract has a seasonal residency rate of 34.5% and covered the Town of Stockton and part of the Town of Chautauqua.

The information provided in this comment is considered to better reflect the residency rates in the Bear Lake watershed. Populations served by septic systems while using the seasonal Conservation Club Camp (25 camp sites) and the Clever Campground (20 camp sites) were added into the analysis as well. The numbers given have been used to revise the analysis detailed in Section 4.2.1 for the population served by septic systems.

18. "Within 50ft. of shore land, there are 15 houses … 100% categorized as short-circuiting".

There are only 11 houses and a camper within 50 ft. of the lake shore. Five of those houses are on the canal at the North East end of the lake, at least one of which has a Health Dept. approved septic. There are six houses and a camper within 50 ft. of the water on the North West end of the lake. One house has not been lived in for many years, one not for four years and one has been lived in only 5 days a year for the past two years. Two of the six homes have new, Health Dept. approved septic systems. The camper does not use a septic system. 10 of the 11 houses and the camper are seasonal, many used only on weekends. One house on the canal is year-round. Of the 56 houses that are within 250 ft. of the lake, only 13 of them are year round, the rest seasonal. There are at least four that I know of and maybe more with new septic systems.

Response: Aerial photographs were overlain with a 50 foot and 250 buffer and the number of residences counted directly. Tree cover and other buildings (e.g. garages, boat houses) can introduce some uncertainty. The numbers given have been used to revise the analysis of population served in Section 4.2.1.

19. Given the information provided in Comments 17 and 18, there is much less septic use than assumed in this draft, most residences are seasonal, clearly 100% are not short-circuiting, and many have such minimal use as to not likely have any negative effect on the phosphorus loading. Better and more current demographic data will be needed in the final TMDL document. The corrected data could show the effect of septic much less than 11%.

Response: The information provided in Comments 17 and 18 were used to refine the estimates for the population served by septic systems used in the MapShed model (see Section 4.2.1). The population during the September through May period was reduced from 137 to 33. Comments received indicated the presence of two campgrounds near the lake shore, the populations for which were not included in the initial estimates. The June through August estimates of population served by septic systems therefore increased from 170 to 210 people. The majority of the increased population were estimated to be served by normal systems and only small increases of 5 and 2 people served by ponding and short-circuiting systems, respectively, were estimated.

The lake is modeled during the growing season, from May through September. During the September through May period the occupancy rates were revised downwards significantly, but for the June through August summer recreation period the estimates were revised upwards. Thus, significant population reductions occurred for only two of the five months in modeling period. The overall impact is a slight decrease in the growing season phosphorus load attributed to septic systems. Additional revisions to the MapShed model based upon the comments received resulted in a small decrease in the predicted overall total phosphorus load to Bear Lake (see Section 4.2) such that septic systems are still estimated to contribute approximately 11.5% of the total load.

20. If the septic source of phosphorus loading is only 11%, it doesn't sound like we have a huge septic problem, correct?

Response: The septic load must be considered relative to the controllable load and the total load reduction needed. A total load reduction of 350.5 lbs is needed, 14% of which can be attained by addressing the septic system load. Furthermore, given the high level of overall phosphorus reduction needed, the septic system load, along with all of the other controllable loads, must be reduced. Addressing the septic system contribution is therefore an important and necessary part of the implementation plan.

21. Table 5 indicates that WLA for agriculture and developed land each be reduced by 98% and septic systems be reduced by 100%. A 20 μg/L TP goal is more realistic and attainable than a 10 μg/L goal. The TMDL also included a WLA table for the 20 μg/L goal (Appendix D, Table 14) where TP from agriculture and developed land should be reduced by 35% each, and TP from septic systems still be reduced by 100%. I was afforded the opportunity to review an earlier draft of the TMDL while it was in preparation. This early draft contained a similar table in Appendix D where agriculture, developed land and septic system TP loads must be reduced by 46% each to achieve a 20 μg/L goal. This early draft table is much more realist and equitable among these three sources. Therefore Chautauqua County Department of Health requests that the modeling be adjusted so the three sources discussed here all attain a 46% reduction of TP loading to the lake.

    Response: The 20 μg/L endpoint and the load allocation table in Appendix D would only applicable if Bear Lake is reclassified to be a Class B waterbody. Currently, Bear Lake is a Class A waterbody, thus the load allocations in Table 5 apply.

    The comment regarding equitability of load reductions from the different sources is noted. As the load reductions indicated are voluntary the same total load reductions could be achieved by addressing all the sources equitably or by focusing upon one or more source sectors depending upon funding and interest. It should be noted, however, that a substantial load reduction from the nonpoint source sector is still needed no matter how that is achieved. A 100% load reduction is still recommended in Appendix D because the inclusion of sewering as part of the implementation plan in the TMDL provides greater assurance that the load reduction will be achieved and maintained in the long term. It is also worth noting that some funding opportunities consider whether a project will implement actions specified in a TMDL or other management plan as part of the process for determining funding prioritization.

22. Findley Lake has been used for septic system comparison which may not truly be accurate. Findley Lake load for septic systems amounts to 45% of the total load. Bear Lake's septic system load is only 11%. Based on the low septic system load at Bear Lake it appears that even with perfect compliance the change in the lake would be minimal (but we still should strive to achieve that level).

    Response: During the preparation for the public meetings, it was specifically requested that an update on the Findley Lake TMDL be provided during the meeting. The difference between the proportions of loading attributed to septic systems is noted, however, there are similarities that make the comparison informative. Most notably, both lakes have been listed as impaired due to phosphorus due solely to non-point sources. The large septic system load in the Findley Lake watershed has prompted the town to pursue funding to sewer the area. That may or may not be the case for Bear Lake, but that decision remains at the local level.

8.1.4. *Agriculture*

23. There is no discussion of current site-specific practices (with or without best management practices) relative to phosphorus loading from agricultural lands. Was there any investigation of those practices and if so were any adjustments to modeling done to reflect them?

Response: In accordance with Agriculture and Markets law, to protect farmer privacy there are restrictions on the data which can be made available to NYSDEC regarding farm operations, including BMP implementation. The Bear Lake watershed is considerably smaller than the scale at which data can be made available. However, some information was provided during the public meeting which has been used to refine the representation of agricultural lands in the watershed (see Comment 29)

24. In general, buffer strips seem like they might be most effective in pastures, though I can certainly envision some benefit in hay and row crop settings too. Their cost estimates and efficiencies are presumably tied to a minimum width, which is not stated here but it might help further discussions with agricultural producers. Also, maybe some caution is necessary here. It seems many of our streams generally are still experiencing downcutting / incision, widening or all of the above. Will implementing vegetated buffer strips on unstable streams be a good I sound investment for farmers? Are there cost-share programs to stabilize stream banks prior to instituting buffer strips and thus increase the long-term investment of them? If I understand correctly (as of a few years ago), CREP funding cannot be used in association with unstable streams.

Response: To be eligible for most cost share programs buffers must meet NRCS design standards which specify a minimum width. For riparian forest buffers the required minimum width is 35 feet. An established buffer may help to prevent erosion, but as noted, stabilization of a stream bank may be needed prior to establishment of a new buffer in order for the practice to be successful. Stream bank stabilization would also be beneficial as it would reduce the phosphorus load delivered to Bear Lake from eroded soils.

8.1.5. *Sewering*

25. The cost assigned to sewering seems low.

Response: The cost for sewering is only an estimate. Final costs may be higher or lower depending upon a number of site specific factors and the project design. A preliminary engineering report would help refine the cost estimate.

26. The recommendation to build a sewer treatment facility or connect to existing treatment facility would appear to be cost prohibitive for the small improvement.

Response: While this TMDL does not create a requirement to build a sewer system or treatment facility, removing the phosphorus load attributed to septic systems is an important part of the implementation plan. The septic system load represents 11.5% of the total phosphorus load and 27% of the load which can be directly addressed through management actions. Achieving the needed load reduction relies upon significant load reductions from all of the controllable sources, including septic systems. A number of potential funding sources have been identified in Section 7.1.1 to help offset the costs.

27. The TP contribution from septic systems calculated by the computers models used to develop the TMDL seem reasonable. However, a 100% reduction of septic system TP contributions is unrealistic unless a public sewage collection and treatment system were to be constructed. The draft TMDL recommends just such a solution and during the public meetings you suggested that funding in the form of grants and low or no interest loans for such a project is attainable. Chautauqua County Department of Health has been involved in several such projects over the past twenty years and it is our experience that such funding is extremely competitive and difficult to get.

Response: The potential funding sources which have been identified are competitive funding opportunities. Specification of sewering as a needed management action in this TMDL may help applications be more competitive.

8.1.6. ***Data and Datasets***

28. Local weather data for Stockton area should be used instead of the Dunkirk/Fredonia weather which has close proximity and major impact from Lake Erie.

Response: No weather data from the Stockton area was available. Data from the Dunkirk/Fredonia represent the closest stations to Bear Lake which covers the entire modeling period. Additional weather data from Sinclairville, NY (GHCND:USC00307772), located 9 miles southeast of Bear Lake (lat:42.267, long: -79.25) was retrieved from the National Climate Data Center database. However, data from this station was only a partial record covering 1982-01-01 to 2003-07-31 and only included precipitation data. Data from the Dunkirk/Fredonia area was still needed to provide temperature data and to create a complete precipitation record through 2012-12-31. Data from both Dunkirk/Fredonia and Sinclairville were used to refine the analysis.

29. "…digital land use/land cover data …2001". Thirteen year old data? If you have 2001 and 2006 NLCD data and changes were "minor," why use the 2001 data rather than the 2006 data?

Response: The 2001 dataset was used when the models were originally developed by a contractor for the U.S. Environmental Protection Agency. The 2001 dataset, at that time, was the most current available. When NYSDEC was tasked with completing the work previously started, the 2006 dataset had been released. The two datasets were compared to determine the extent to which they differed. As indicated in the draft TMDL about 2% of the land use had changed. It was determined that this minor difference would not substantially change the results of the analysis, thus loading the 2006 dataset into the model was not pursued.

The Multi-Resolution Land Characteristics Consortium (MRLC) recently released the NLCD 2011 (Jin et al., 2013). This new dataset is the most up to date available and has been used in the revisions. This dataset was then updated manually using information about agricultural lands provided during the public meeting. Section 2.1 has been revised to include information on the new land use data and on revisions made based upon the comments received.

30. With respect to changes made to NLCD data for use in smaller basin (such as Bear Lake) I assume whether or not (and if so, how) the agricultural fields are fertilized could make a big difference in nutrient loading. Again, considering the implications of waste load allocation and the objectives of the TMDL in the first place and the potential impacts to livelihoods, it may be important to attempt distinguishing/correcting between agricultural land uses.

Response: Due to privacy requirements, that level of detail regarding agricultural practices is not available to NYSDEC. The commentor is correct in that timing, location and means of application of manure or fertilizer can have a large impact on nutrient loading. Without specific data, the model uses default parameter values for this process. Best management practices for fertilizer or manure application can reduce the impact of these activities.

Farming activities are covered under the load allocation in TMDLs. Confined animal feeding operations (CAFOs) are covered by permits and therefore would be included in the waste load allocation, but there are no CAFOs in the Bear Lake watershed. Thus, there are no requirements in this TMDL regarding load reductions from farming activities, only voluntary implementation.

See also the response to Comment 29 regarding updates to the land use information.

31. "high resolution color orthophotos were used to manually update and refine land use categories for portion of the drainage basin to reflect current conditions in the drainage basin". From what data are the photos?

Response: As that work was completed by a contractor to the U.S. EPA, the exact date of the photos is not known, but documents provided by the contractor indicates the photos were from the 2000 – 2004 period. See Comment 29 regarding the use of an updated dataset to revise the document.

32. Restricting your data sets for phosphorous in the lake to 2006 and 2012 is mind-bogglingly simplistic! Shouldn't we have more recent data in this 2014 draft? Perhaps you could wait until the 2015 and 2016 years for some purposeful comparisons?

Response: Data from 1985 was also used. The data used represents the data available for Bear Lake and is believed to be sufficient to characterize the lake. As the trophic state of the lake is unlikely to change substantially in such a short period of time, the incorporation of 2015 data would provide more information on inter annual variability, but would be unlikely to produce substantially different results.

33. Bear Lake [Association] has implemented a biocontrol program in 2010. Improvements to the lakes health became evident in the 2012 timeframe and have improved each year. The current TMDL only reflects baseline data which is significantly older and does not reflect those biocontrol improvements. It would appear that the baseline TMDL should reflect the best available data at time of incorporation.

Response: The lake was sampled in 2012 and the modeling extends through 2012. The 2012 sampling results indicate phosphorus concentrations similar to other years and elevated chlorophyll-a concentrations. More than one year of data post biocontrol implementation data would be needed to undertake an assessment of the impact of the biocontrol program on the lake.

34. We believe that water sampling along with a sediment sample are prudent and need to be taken and support data incorporated into the TMDL.

Response: Continued monitoring of the lake in the long term is needed to demonstrate improvements in water quality as discussed in Section 7.2. The participation of the Bear Lake Association or other interested parties in the CSLAP program would be one way to collect the additional data.

In response to discussion at the public meeting the existing dataset was reexamined. Using data from the 2012 LCI survey, an estimate of the internal loading rate was calculated. The rate, 0.65 – 2.2 mg/m^2/day agreed well with the internal loading rate used in the model (1.1 mg/m2/day) given that only a few data points were available upon which the analysis could be based. The data currently available is sufficient for this analysis but analysis could also be refined in the future as additional data becomes available.

35. I do not see anywhere is this draft that you have used empirical or "boots on the ground" data. Do you have any useful data from the Chautauqua County Department of Health about the last two decades of septic system replacements? Bill Boria from CCDOH says he has that data set. Why not use it instead of your model.

Response: Some additional information was provided by Chautauqua County Department of Health regarding septic systems, however, information on system replacements was not provided. However, since septic systems are not generally designed to remove phosphorus, information on system age would provide little additional information.

Also see Comment 29 regarding updating the land use information.

36. I appreciate the methodology of developing Water Quality criteria to protect beneficial uses and the need to develop a/some response variables for practical standards. However, this evolving methodology and quantitative phosphorus standard, applied through contemporary TMDL protocols, imposes significant costs on permitted dischargers (ratepayers) and may also be costly even for non-permitted dischargers. If DEC is going to continue refining the permitted WQ standards, should more/adaptive WQ monitoring be conducted to validate that targets are realistically attainable?

Response: The chlorophyll-a concentration identified within this document as protective of the drinking water best use was developed based upon peer reviewed research (Callinan 2013). The corresponding phosphorus concentration was determined using the Bathtub model of Bear Lake.

While the load reductions are substantial, there are no indications that these targets are unobtainable. As implementation of this TMDL relies upon voluntary actions, no costs are imposed upon permitted discharges (of which there are none in the Bear Lake watershed) or non-permitted dischargers.

37. Some WQ monitoring in our area so far suggests that phosphorus loading is closely tied to storm events and not as closely associated with daily flows. Also, there seems to be general consensus among resource management professionals in our area that at least anecdotally, storms seem to be more frequent and more localized over the last decade or so than what they remember historically. Obviously, there are limitations to such generalizations, but they do seem to align with some WQ monitoring data in our area. Perhaps this dynamic should be further investigated and considered in developing Load Allocations (LAs).

Response: The watershed model uses daily precipitation and temperature data as inputs. Storms are captured as part of the total daily precipitation, but these time series do not have sufficient resolution to represent individual storms of lesser duration. When selecting a model, it is best to match the complexity of the model to the complexity of the system being studied and the available data. The use of higher resolution data (1 hour or 15 minute) would require the use of a more complex watershed model. It is not clear the additional complexity is necessary or that sufficient data would be available to drive such a model. See also the response to Comment 45.

8.1.7. *Modeling*

38. How is tile drainage handled in the modeling process?

Response: To the best of our knowledge there are no tile drained agricultural lands within the watershed. Therefore tile drained lands were not included in the model.

39. Groundwater seepage (page 15) - Does the last sentence in that paragraph state that the groundwater concentrations of phosphorus associated with each of the listed land uses is built into their respective contributions? Would this portion then represent 'background loading' due to groundwater with anything over those amounts contributed from land use?

Response: The MapShed model output contains only an aggregated groundwater contribution which includes contributions from geology (considered background) as well as contributions from the overlying land uses. Disaggregation of the total groundwater load into the different source sectors (background, agriculture, urban, etc.) is based upon an estimate of the natural background concentration of phosphorus in groundwater and the proportions of different land uses in the watershed.

40. Why are simulated mean concentrations so much higher than modeled concentrations in this chart and why are there so few modeled and so many simulated? And where are the actual data?

Response: Simulations of the watershed and lake were run for the entire 1982 to 2012 period, which produced the modeled summer mean total phosphorus concentrations shown in red in Figure 8. Summer average phosphorus measurements are only available for the years in which measurements were made: 1985, 1997, 2006 and 2012. As explained in Sections 2.3 and 5.2, the 1997 data were not used because those measurements were made only during July and therefore not representative of the entire summer period.

As the model was calibrated to match the average concentrations across the three years for which sufficient data was available, the 1985 and 2006 modeled values are a little lower than the measured concentrations while the 2012 modeled value is a little higher than the measured concentration.

Raw data have been included as Appendix F.

41. Kudos for the model refinement to better reflect dynamics in various regions of NYS, but do the coefficients for the 'hybrid' Eastern Great Lakes I Hudson Lowlands and the Northeastern Highlands really apply to the Northern Appalachian Plateau and Uplands? I appreciate the monitoring and economic challenge with developing regional models that have 'good fit', but given the potential impact on residents, ratepayers and communities having to adhere to WLAs and complying with LAs, I would argue there's ample reason to invest in I validate intra-state regional models and validate their fit for the purpose intended.

Response: The comment is noted. Lacking a model or sufficient data to calibrate a model for the Northern Appalachian Plateau and Uplands the Eastern Great Lakes and Hudson Lowlands coefficients were used as a reflection of the best available data at the time the modeling was undertaken.

42. Regarding the validation of MAPSHED (formerly AVGWLF), all the calibration has been done in part of the Northeast with much more rock than we generally have in our soils. How much, if any difference might that make in background P loading? Given that calibration modeling including sediment loads (and phosphorus is bound to sediment), what are the implications? Could this influence background loading of phosphorus in far-western NY?

Response: Differing geologic conditions could impact soil erosion rates, phosphorus concentrations on eroded soils and background concentrations of phosphorus in groundwater. These processes have associated parameter values which may be modified by the model user. However, without site specific data to indicate a different value would be more accurate, the values generated during the Northeast MapShed model were retained.

43. GWR**:** How does decreasing the default play out with respect to the apparent close relationship between the road drainage network and the stream network? It seems that relationship could in many cases increase storm response volume and decrease time to peak. If nutrient loads are strongly related to surface flow, this might have some bearing for watershed I nutrient modeling.

Response: The road drainage network is not simulated in the watershed model. The reduction of GWR during the Northeast model calibration was done to better match predicted and observed conditions in the Northeast. While changing this value may have the impacts described relative to what occurs in Pennsylvania, the value used better captures conditions in the Northeast.

44. Sediment "a" Factor**:** If there are inherent sediment supply differences in WNY compared to the region where the calibration/verification was done (or in which parts of PA were investigated), it could throw this variable off considerably. Anecdotally, many of us who look at these things routinely see ongoing bed and bank erosion in our area. This may be due more to episodic dynamics than chronic daily events, but maybe should be considered in future modeling refinements. Also note that in our region, our glacial sediments are very erodible, even though that may not be the case in other parts of the Northeast.

Response: The "sediment A factor" relates directly to the stream bank load calculated by the MapShed model. A watershed specific value is calculated based upon the following watershed characteristics which have found to influence bank erosion: percent developed land, animal density, curve number, soil erodibility and mean watershed slope. Soils with a higher erodibility than estimated by the model would lead to greater stream bank erosion loads but field measurements would be needed to justify adjusting this parameter.

45. What does 'getting the hydrology correct' mean if in fact, there is relatively new complexity in the contemporary hydrologic data set? The June 2011 issue of the Journal of the American Water Resource Association was devoted entirely to the concept that precipitation patterns are changing. A general 'take-home' message seemed to be that we can no longer rely comfortably on past hydrologic precipitation I flow relationships. Again, I appreciate the challenges and responsibilities NYSDEC faces, but getting the hydrology right by fitting it to past relationships may not be entirely suitable for future uses.

Response: As indicated in the comment, "getting the hydrology correct" (page 53) refers to matching the modeled stream flows to past measurements of stream flow. One must rely upon past measurements to calibrate a model. A calibrated model may then be used to explore the impacts of future changes such as the changing precipitation patterns noted. The impacts of a changing climate on water quality continues to be the focus of much research. The comment on using historic data to ensure uses are attained in a changing future is germane and is a challenge facing many water quality and quantity managers.

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