Phosphorus TMDLs for Vermont Segments of Lake Champlain

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TABLE OF CONTENTS

CHAPTER 1. BACKGROUND

Section 303(c) of the Clean Water Act (CWA) requires states to establish water quality standards (WQS) that identify each waterbody's designated uses and the criteria needed to support those uses. Such WQS must be sufficient to ensure, wherever attainable, a level of water quality that provides for the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water.

Section 303(d) of the CWA requires states to develop lists of impaired waters that fail to meet Water Quality Standards (WQS) set by jurisdictions even after implementing technology-based and other pollution controls. The Environmental Protection Agency's (EPA) regulations for implementing CWA section 303(d) are codified in the Water Quality Planning and Management Regulations at 40 CFR Part 130. The law requires that states establish priority rankings and develop Total Maximum Daily Loads (TMDLs) for waters on the lists of impaired waters (40 CFR 130.7).

A TMDL specifies the maximum amount of a pollutant that a waterbody can receive and still meet applicable WQS. A mathematical definition of a TMDL is written as the sum of the individual wasteload allocations (WLAs) for point sources, the load allocation (LAs) for nonpoint sources and natural background, and a margin of safety (MOS)[CWA 303(d)(1)(C)]:

$$\text{TMDL} = \Sigma WLA + \Sigma LA + MOS$$

Where:

WLA = wasteload allocation, or the portion of the TMDL allocated to existing and/or future point sources.

LA = load allocation, or the portion of the TMDL attributed to existing and/or future nonpoint sources and natural background.

MOS = margin of safety, or the portion of the TMDL that accounts for any lack of knowledge concerning the relationship between effluent limitations and water quality, such as uncertainty about the relationship between pollutant loads and receiving water quality, which can be provided implicitly by applying conservative analytical assumptions or explicitly by reserving a portion of loading capacity.

The process of calculating and documenting a TMDL involves a number of tasks and—especially for a large, complex, and multijurisdictional waterbody with multiple impairments—can require substantial effort and resources. Major tasks involved in the TMDL development process include the following:

- characterizing the impaired waterbody and its watershed;
- identifying and inventorying the relevant pollutant source sectors;
- applying the appropriate WQS;
- calculating the loading capacity using appropriate modeling analyses to link pollutant loads to water quality; and
- identifying the required source allocations.

Phosphorus concentrations in Lake Champlain typically exceed Vermont's water quality standards. This TMDL report presents the results of numerous analyses and model simulations designed to calculate Lake Champlain's phosphorus loading capacity and documents the informational elements described above. Although Lake Champlain is bordered by Vermont, New York, and the Province of Quebec, the TMDLs established in this report address the 12 lake segments to which Vermont sources discharge and are affected by Vermont sources (hereafter referred to as the "Vermont portion of Lake Champlain" or "Vermont segments") for reasons explained in Sections 1.1 – 1.2. Five of these segments are exclusively within VT waters, the remainder are shared with New York and/or Quebec. As described in detail in Chapter 5, the modeling and analyses to determine base loads and loading capacity covered the full extent of the Lake Champlain watershed.

Lake Champlain is divided into thirteen segments for phosphorus management purposes, and 12 of these segments (all except Cumberland Bay) are influenced at least in part by discharges of phosphorus from sources in Vermont (Figure 1). The Lake is impaired due to excess phosphorus loadings, which have resulted in severe eutrophication in many lake segments. Consistent with the approach taken in the 2002 Lake Champlain Phosphorus TMDL (see TMDL history section below), TMDLs have been developed for all 12 of the Vermont segments (see Table 1). This approach recognizes that the lake functions as a set of hydrodynamically interconnected segments that extensively influence each other.

The TMDLs set allocations for Vermont sources of phosphorus, including permitted point sources such as wastewater treatment facilities, and municipal and transportation stormwater sources, and diffuse sources such as runoff from agriculture and forests, and stream bank erosion.

Table 1. Waterbodies Addressed by the Lake Champlain Phosphorus TMDLs

Waterbody ID Number	Waterbody Name
VT04-02L01	South Lake A
VT04-02L01	South Lake B
VT04-01L02	Port Henry
VT04-01L01	Otter Creek
VT05-10L02	Main Lake
VT05-11L01	Shelburne Bay
VT05-10L01	Burlington Bay
VT05-09L01	Malletts Bay
VT05-04L01	Northeast Arm
VT05-07L01	St. Albans Bay
VT05-01L01	Missisquoi Bay
VT05-04L02	Isle LaMotte

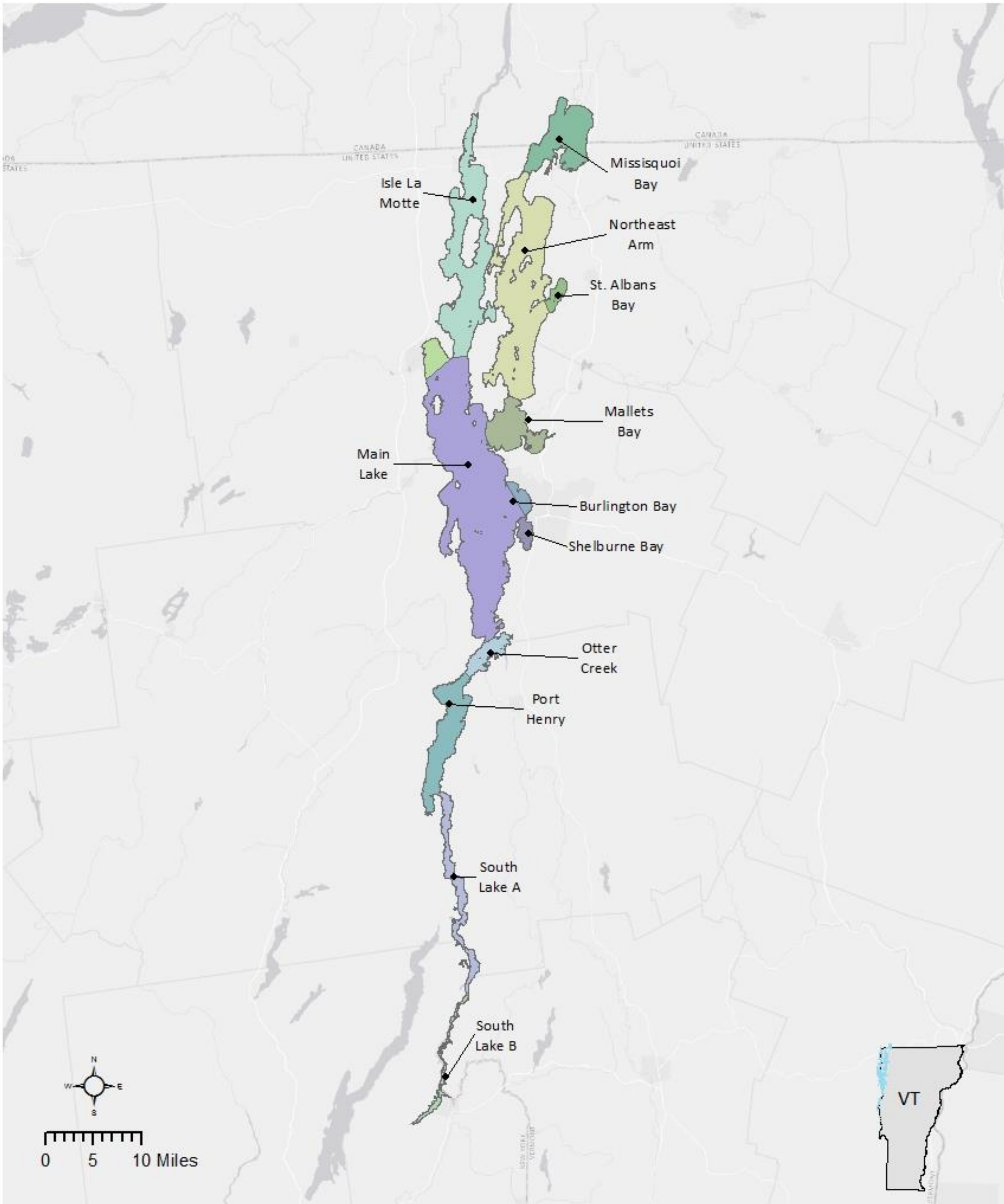

Figure 1: Lake Champlain Segments Subject to Vermont Phosphorus TMDLs. (LCBP 2012).

Data Source: ESRI, TetraTech.

Map Tracker ID: 10397.

1.1 LAKE CHAMPLAIN TMDL HISTORY: VT 2002 LAKE CHAMPLAIN TMDL

The Vermont Department of Environmental Conservation (DEC) began preparing a set of Lake Champlain phosphorus TMDLs in the late 1990s, following the development and approval by Vermont, New York, and EPA of the Lake Champlain Management Conference plan entitled "Opportunities for Action" in 1996, and the completion of a multi-year Lake Champlain diagnostic-feasibility study in 1997. Drafts of the TMDL document were circulated for public comment in 2001 and 2002, and provided to EPA for comment as well.

DEC submitted the final Lake Champlain Phosphorus TMDLs to EPA Region 1 for review and approval under Section 303(d) of the Act on September 25, 2002. The submittal addressed the nine segments of Lake Champlain that were at that time identified on Vermont's Clean Water Act Section 303(d) list of impaired waters as being impaired by phosphorus. At the same time, the New York State Department of Environmental Conservation submitted TMDLs to EPA Region 2 for the seven impaired segments identified on New York's Section 303(d) list of impaired waters (most of which overlapped with the Vermont segments). Following a review of the final TMDL package, including DEC's response to public comments, the Region approved Vermont's TMDLs on November 4, 2002. EPA Region 2 approved New York's portion of the Lake Champlain TMDLs on September 30, 2002.

1.2 LEGAL HISTORY

On October 28, 2008, the Conservation Law Foundation (CLF) filed suit in federal district court against EPA seeking to set aside the Region's November 4, 2002 approval of Vermont's Lake Champlain Phosphorus TMDLs and seeking establishment by EPA of new TMDLs. (CLF did not challenge Region 2's approval of New York's portion of the TMDLs.) The complaint alleged that EPA's approval was arbitrary, capricious, and not in accordance with law under the Clean Water Act and the Administrative Procedure Act, 5 U.S.C. § 706(2). Specifically, the complaint asserted that the 2002 TMDLs contained a variety of flaws, including insufficiently stringent wasteload allocations coupled with a lack of reasonable assurances that nonpoint source reductions would occur; an inadequate margin of safety; inadequate specificity of the stormwater component of the wasteload allocations; and failure to consider water resources effects associated with documented and predicted climate change. The State of Vermont intervened in the case.

In April 2010, CLF and EPA signed a settlement agreement, and EPA filed a motion with the court seeking a voluntary remand to allow the Region to reconsider its 2002 TMDL approval decision and a stay of the litigation. The State objected to EPA's motion and moved the court to deny the request for remand and dismiss the case. On August 25, 2010, the court granted EPA's motion for voluntary remand and stayed the case for 180 days. In the settlement agreement with CLF, EPA agreed to complete its reconsideration of the 2002 TMDLs no later than 120 days from the court's order granting the remand. That date was December 24, 2010. On December 14, 2010, EPA received a 30-day extension from CLF of the date by which EPA must issue its decision, i.e., no later than January 23, 2011.

Following the judge's order, the Region reviewed the 2002 Lake Champlain TMDLs and the administrative record in light of applicable statutory and regulatory provisions and EPA guidance available at the time of the original approval. The Region's task was to determine, after a fresh look at these materials and consideration of the allegations in CLF's complaint, whether the TMDLs were consistent with Section 303(d) of the Act and its implementing regulations. The Region focused its reevaluation on the four major contested areas of the TMDLs: margin of safety, stringency of WLAs in light of reasonable assurance that sufficient load reductions would occur, aggregation of stormwater WLAs, and climate change considerations associated with the loading capacity and hydrologic base year.

Upon reconsideration of the four contested elements of the 2002 Vermont Lake Champlain Phosphorus TMDLs, the Region concluded that two of the elements were consistent with EPA regulations and guidance available at the time of TMDL approval, and two elements were not. The aggregate expression of the stormwater component of the wasteload allocation was found to be consistent with EPA's regulations and 2002 guidance on this topic. The calculation of the loading capacity and phosphorus allocations using the 1991 hydrologic base year was also found consistent with EPA guidance and regulations, and based on sound science. However, the portions of the TMDLs addressing the margin of safety and the establishment of wasteload allocations based on assumptions that nonpoint source reductions would be achieved were found inadequate and inconsistent with EPA regulations and guidance. Accordingly, on January 24, 2011, the Region withdrew its November 4, 2002 approval of the Vermont portions of the Lake Champlain Phosphorus TMDLs and disapproved the Vermont portions of the TMDLs (USEPA 2011a, b).

1.3 WHY EPA IS ESTABLISHING THESE TMDLS

Pursuant to Section 303(d)(2) of the Act and 40 C.F.R. § 130.7(d)(2), upon disapproval of a TMDL, EPA must establish a new TMDL as determined to be necessary to implement applicable water quality standards. Accordingly, the Region commenced development of new phosphorus TMDLs for the segments in the Vermont portion of Lake Champlain. The Region will issue a public notice of the completion of these new TMDLs and will seek public comment. After considering public comments and making any appropriate revisions in response to such comments, the Region will transmit the TMDLs to the State.

1.4 TMDL PROCESS, PARTNER COORDINATION AND RESPONSIBILITIES

At the time of the disapproval of the 2002 TMDLs, EPA indicated that the new phosphorus TMDLs for the Vermont portion of Lake Champlain would be based on an evaluation of all available current information as well as any applicable updated EPA guidance. The Region anticipated there would be refinements of several aspects of the new TMDLs, not just the two components that the disapproval determined were inadequate. While EPA is responsible for establishing the new TMDLs, the Region made it clear from the outset that it intended to work collaboratively with Vermont in developing the TMDLs. In EPA's view, long-term implementation of the TMDLs will have the greatest chance of achieving the necessary phosphorus reductions through programs developed and embraced by the State. Throughout the development of the TMDLs, EPA has considered and, in many instances, incorporated the Vermont DEC's and Agency of Agriculture's scientific, technical and policy approaches.

The new TMDLs were developed in three phases. In the first phase, the scientific foundation for the TMDLs was established and public input was invited on policies and programs. In the second phase, the State developed its approach to reducing phosphorus inputs to the lake and its tributaries. In the final phase, EPA built upon the first two in developing the wasteload and load allocations and an Accountability Framework that tracks implementation actions, assesses progress and determines the need for alternative management actions, to ensure the allocations and ultimately, water quality standards, are met. Each phase is described in further detail below.

EPA quickly set to work on the scientific and technical foundation for the new TMDLs. In 2011, EPA hired a contractor (Tetra Tech) to provide modeling support, and established technical workgroups to provide input on modeling approaches and available data both for the in-lake processes and watershed dynamics. The workgroups were co-lead by scientists from EPA and DEC. Parallel to the technical workgroup process, nine stakeholder outreach sessions were held across the basin in the fall of 2011, co-hosted jointly by EPA, DEC and the VT Agency of Agriculture. This phase culminated in the completion of the in-lake and watershed models.

In the second phase, the State developed a suite of programs to achieve the phosphorus reductions that early iterations of the models indicated were necessary to achieve the water quality targets in the lake. Throughout this phase, meetings were held with representatives from EPA, DEC and the Agency of Agriculture at the staff and management levels to develop policies and programs. The State agencies were also gathering input and feedback from regulated entities. In the fall of 2013, EPA, DEC and the Agency of Agriculture hosted six public outreach sessions to solicit input on an outline of measures the State had under consideration. EPA then asked the State for a formal plan containing the set of measures Vermont was committed to implement. This phase culminated in Governor Shumlin submitting the "Vermont Lake Champlain Phosphorus TMDL Phase 1 Implementation Plan" (Vermont, 2014) to EPA in May, 2014.

In the final phase, EPA evaluated the measures contained in the Phase 1 Implementation Plan using updated versions of the TMDL models. EPA then prepared preliminary allocations for each of the lake segments. EPA's preliminary allocations and the associated reductions necessary to achieve them were the subject of five public outreach meetings conducted jointly by EPA, DEC and the Agency of Agriculture in December, 2014. In May, 2015, the Vermont General Assembly passed H.35, "An act relating to improving the quality of state waters." The law provides statutory authorities and deadlines for many of the key programs contained in the Phase 1 Implementation Plan and establishes a "Clean Water Fund" to support implementation. H.35, subsequently designated as Act 64, was signed into law by Governor Shumlin on June 16, 2015. The State then revised the Phase 1 Implementation Plan (Vermont, 2015) to ensure consistency with the new law. Based on the feedback from the meetings, the new law, and the revised Phase 1 Implementation Plan, EPA made final adjustments to establish the allocations that constitute the new Phosphorus TMDLs for the 12 segments of Lake Champlain listed in Table 1. While EPA benefited greatly from policy and program input from the State throughout this phase, the final allocations were determined by EPA.

CHAPTER 2: WATER QUALITY STANDARDS

Water Quality Standards (WQS) are the foundation for a wide range of programs under the CWA. They serve multiple purposes including establishing the water quality goals for a specific waterbody, or portion thereof, and providing the regulatory basis for establishing water quality-based effluent limits beyond the technology-based levels of treatment required by CWA Sections 301(b) and 306. The water quality criteria within WQS serve as targets or endpoints for CWA restoration activities such as TMDLs.

Water quality criteria define the chemical, physical and biological conditions which are needed to support and protect designated uses of surface waters. Most water quality criteria are numeric expressions with measurable parameters. Numeric criteria specify measurable levels of particular chemicals or conditions allowable in a water body. When pollutants cannot be precisely measured, narrative criteria are used to express a parameter in a qualitative form.

Based on the Vermont Water Quality Standards (VT WQS), Lake Champlain segments are Class B waters (Vermont Water Resource Board, 2011). The designated uses associated with Class B waters include:

1. Aquatic biota, wildlife and aquatic habitat
2. Aesthetics
3. Public water supply
4. Irrigation of crops and other agricultural uses
5. Swimming and other primary contact recreation
6. Boating, fishing, and other recreational uses

The pollutant of concern for these TMDLs is phosphorus because it is causing or contributing to excessive algal biomass in the lake, and monitoring data indicate phosphorus levels are elevated above established phosphorus criteria in the VT WQS. Section 3-04(B)(5)(b) of the VT WQS (Vermont ANR, 2014) lists the numeric phosphorus criteria for each lake segment (see Table 2 below).

The numeric, in-lake total phosphorus concentration criteria were incorporated into the Vermont Water Quality Standards in 1991. The phosphorus criteria range from 0.010 to 0.054 mg/l as shown in Table 2.

The 15 core lake stations are sampled approximately biweekly from May to early November each year. An effort is made to obtain up to 20 samples per year at each tributary site, including as high a proportion of samples as possible during high flow conditions in order to improve the precision of tributary annual mass loading estimates.

A complete description of the monitoring program for Lake Champlain can be found in the Long Term Water Quality and Biological Monitoring Quality Assurance Project Plan (LCBP, 2013) and Long Term Biological and Water Quality Monitoring Report (LCPB, 2014)

To assess attainment of annual mean total phosphorus criteria for Lake Champlain, VT DEC uses the total phosphorus concentrations obtained through the Long-Term Monitoring Program. A segment is determined to be in non-attainment/impaired when the annual mean total phosphorus concentrations in the euphotic zone in the lake segment consistently exceed the applicable total phosphorus concentration criterion in Section 3-04 B.5.b of the VT WQS (DEC, 2014b). Figure 5 shows the annual mean concentrations for each segment from 1990 to 2014 in comparison to the applicable phosphorus criterion.

Table 2. Vermont Phosphorus Criteria for Lake Champlain Segments

Lake Segment	Total Phosphorus Criterion (mg/l)*
Main Lake	0.010
Malletts Bay	0.010
Burlington Bay	0.014
Shelburne Bay	0.014
Northeast Arm	0.014
Isle LaMotte	0.014
Otter Creek	0.014
Port Henry	0.014
St. Albans Bay	0.017
Missisquoi Bay	0.025
South Lake A	0.025
South Lake B	0.054

*The Vermont Water Quality Standards specify that these criteria shall be achieved as the annual mean total phosphorus concentration in the photosynthetic depth (euphotic) zone in central, open water areas of each lake segment.

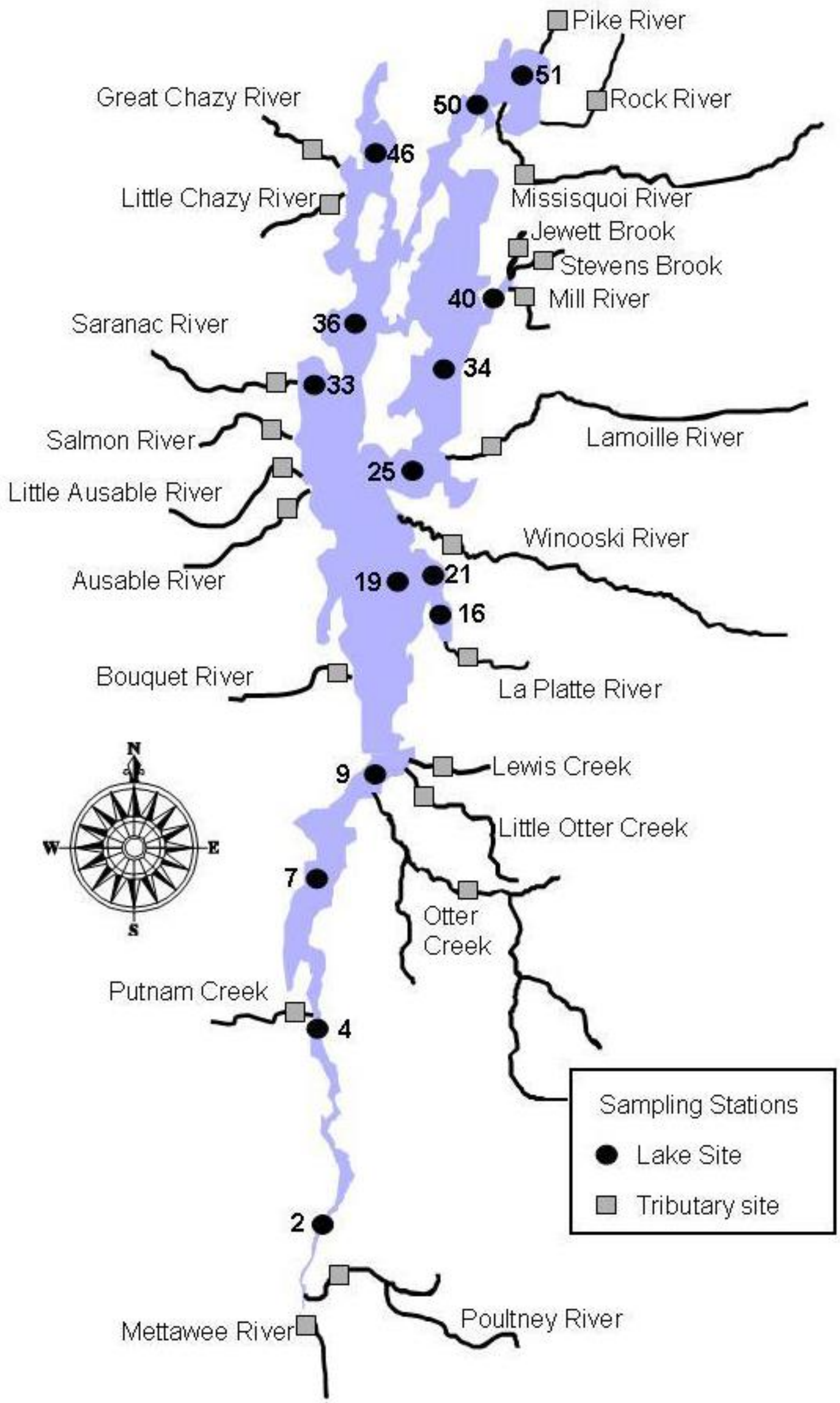

Figure 2: Sampling stations in Lake Champlain and its tributaries. LCBP, 2013

CHAPTER 3: WATERSHED AND IMPAIRMENT DESCRIPTION

3.1. GENERAL WATERSHED SETTING

Lake Champlain is one of the largest lakes in North America, and is bordered by the States of Vermont and New York and the Province of Quebec. It is 120 miles long, with a surface area of 435 square miles and a maximum depth of 400 feet. The 8,234 square mile watershed drains nearly half the land area of Vermont (56% of the basin), as well as portions of northeastern New York (37% of the basin) and southern Quebec (7% of the basin).

The Lake Champlain basin includes a large percentage of the Green Mountains in Vermont, parts of the Adirondack Mountains in New York, and the Pike River floodplain in Quebec. Sixty four percent of its land area is forested, 16% is agricultural, 10.3 % is open waters, 5.6% is developed, and 3.8% is wetlands (Figure 3).

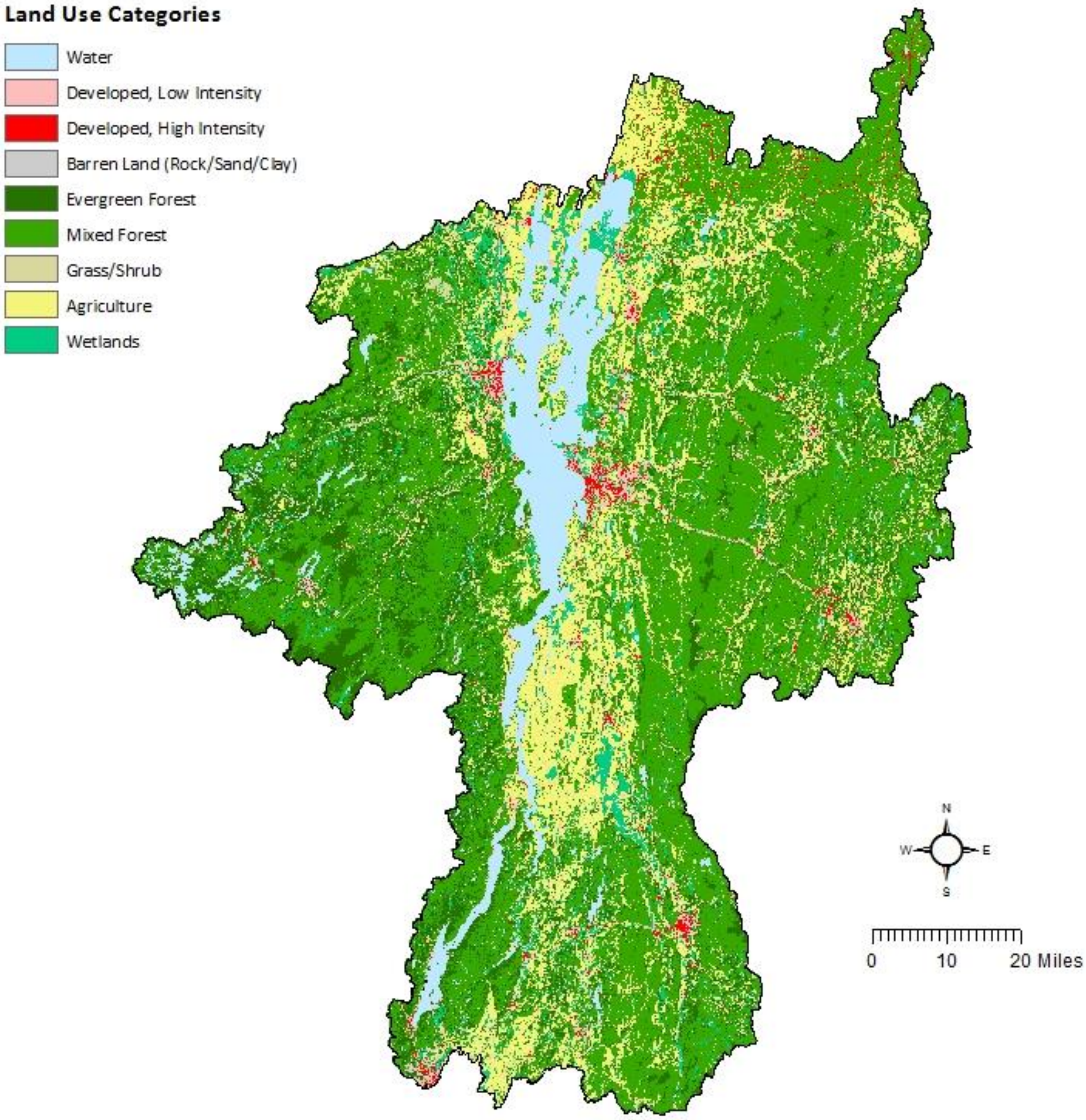

Figure 3: Land uses in the Lake Champlain basin.

Data source: Quebec Land Use/Land Cover dataset, 2001. Vermont and New York landcover, 2011. Classifications are based on the National Landcover Dataset scheme. Lake Champlain Basin Program, 2015.

3.2. POLLUTANT OF CONCERN

Lake Champlain is impaired by the nutrient phosphorus, which causes algal blooms and obnoxious odors, and leads to low dissolved oxygen concentrations, impaired aquatic life, and reduced recreational use. Phosphorus sources to the lake include agriculture, streambank erosion, developed land sources (including roads, parking lots, lawns, athletic fields, buildings, and industrial facilities), wastewater treatment plants, and forest harvesting operations and forest roads. The relative amounts of phosphorus loading from Vermont sources are shown in Figure 4. For some lake segments, internal sources of phosphorus from bottom sediments contribute a significant load.

Total phosphorus concentrations vary greatly among the lake segments, as shown in Figure 5. Lake segments such as Malletts Bay and the Main Lake have phosphorus levels in the low-mesotrophic range of 0.009-0.012 milligrams per liter (mg/l). Eutrophic conditions exist in South Lake A and B, St. Albans Bay, and Missisquoi Bay, all segments where mean phosphorus concentrations are in the range of 0.024-0.058 mg/l. While phosphorus concentrations vary among the segments, the interconnectedness of the segments (and the way each segment influences other segments) necessitates a lake-wide approach to TMDL development. Based on the 2002 TMDL approach, and the lake modeling that took into account all these interconnections, EPA has established TMDLs for all 12 segments in order to ensure that phosphorus targets are met throughout the lake.

Phosphorus has long been regarded as the primary limiting nutrient for algal growth in freshwater lakes (Wetzel, 2001). For this reason, management efforts have historically focused on reducing phosphorus inputs as the primary means to control algal blooms and improve lake water quality. This is also why the Lake Champlain segments have been listed on Vermont's Section 303(d) list as impaired for phosphorus, but not any other nutrient, such as nitrogen. In recent years, some scientists have postulated that it may also be important to control nitrogen inputs to freshwater systems to manage algae growth, but the role of nitrogen in lake restoration is still uncertain (Lewis et al., 2011; Sterner, 2008). In contrast, there is clear evidence from case histories and whole-ecosystem experiments that phosphorus reduction can successfully control algal growth (Schindler, 2012). Given the much stronger scientific basis for the importance of phosphorus in this context, these TMDLs establish allocations and reduction requirements only for phosphorus. Two additional factors reinforce the soundness of this approach: 1) nitrogen concentrations in Lake Champlain have actually been going down in recent decades, possibly due to decreasing atmospheric nitrogen deposition (Smeltzer et al., 2009), and 2) many of the best management practices (BMPs) that will be implemented to control phosphorus, also control nitrogen to some extent. These co-benefits should help continue the downward trend of nitrogen concentrations in the lake.

Water quality monitoring can be used to identify whether waters are meeting designated uses, to identify specific pollutants and their sources, determine long term trends and to screen for impairment. As noted, numeric water quality criteria identify the concentration of a chemical pollutant that is allowable, yet protects designated uses. When chemical pollutants exceed maximum or fall below minimum allowable concentrations, waters may no longer be able to support the designated uses such as fishing, swimming and drinking. Water quality conditions and use attainment may be assessed by comparing the concentrations of chemical pollutants found in surface waters to the criteria in the State's standards. In this case, total phosphorus data collected for each lake segment by Lake Champlain's long term water quality monitoring program were used to assess whether phosphorus criteria were being met and whether or not designated uses were supported.

The Lake Champlain Long-Term Water Quality and Biological Monitoring Program began in 1992 and has continued each year since then. A total of 37 monitoring stations are included in the sampling station network, which includes a core set of 15 lake stations and 22 tributary stations (Figure 2). Tributary stations are located as near to the river mouths as possible on rivers which have continuous flow gages operated by the U.S. Geological Survey (USGS) or the Quebec Ministry of Sustainable Development, Environment, and Parks. These lake and tributary stations have been sampled consistently during the entire monitoring period since 1992, with the exception of lake stations 9 and 16 which were added in 2001, and station 51 which was added in 2006. The sampling station on Rock River was added in 2007, and sites on Stevens Brook and Jewett Brook were added late in 2008. In 2010, a USGS gaging station was installed on the Mill River, bringing the total tributaries monitored to 22. Other lake stations listed in Vermont DEC and New York State DEC (VT and NY, 1997) have been sampled during short-term surveys for a limited number of water quality measurements (LCBP, 2013).

3.3 303(D) LISTINGS

At the time of the original TMDLs' development in 2002, these nine segments were on the Vermont 303(d) list as impaired for phosphorus and were high priorities for TMDL development:

South Lake A	Otter Creek	Northeast Arm
South Lake B	Main Lake	St. Albans Bay
Port Henry	Shelburne Bay	Missisquoi Bay

These segments are still not consistently meeting the applicable phosphorus water quality criteria and, following EPA's disapproval of the Lake Champlain TMDLs in 2011, they remain impaired and in need of TMDLs. Consistent with the 2002 TMDL approach, EPA is also establishing TMDLs for the other three Vermont segments due to the hydrodynamic connections among the segments and the way each segment affects the water quality of other segments. The lake modeling results indicate that phosphorus reductions are needed in all lake segments to ensure phosphorus criteria are met throughout the lake.[1] See Table 2 for a listing of all 12 segments covered by the TMDLs.

[1] The frequent exceedances of phosphorus criteria and upward phosphorus concentration trends in Malletts Bay and Isle LaMotte, together with the occasional exceedances of the phosphorus criterion in Burlington Bay, underscore the importance of including all 12 segments in the TMDL group.

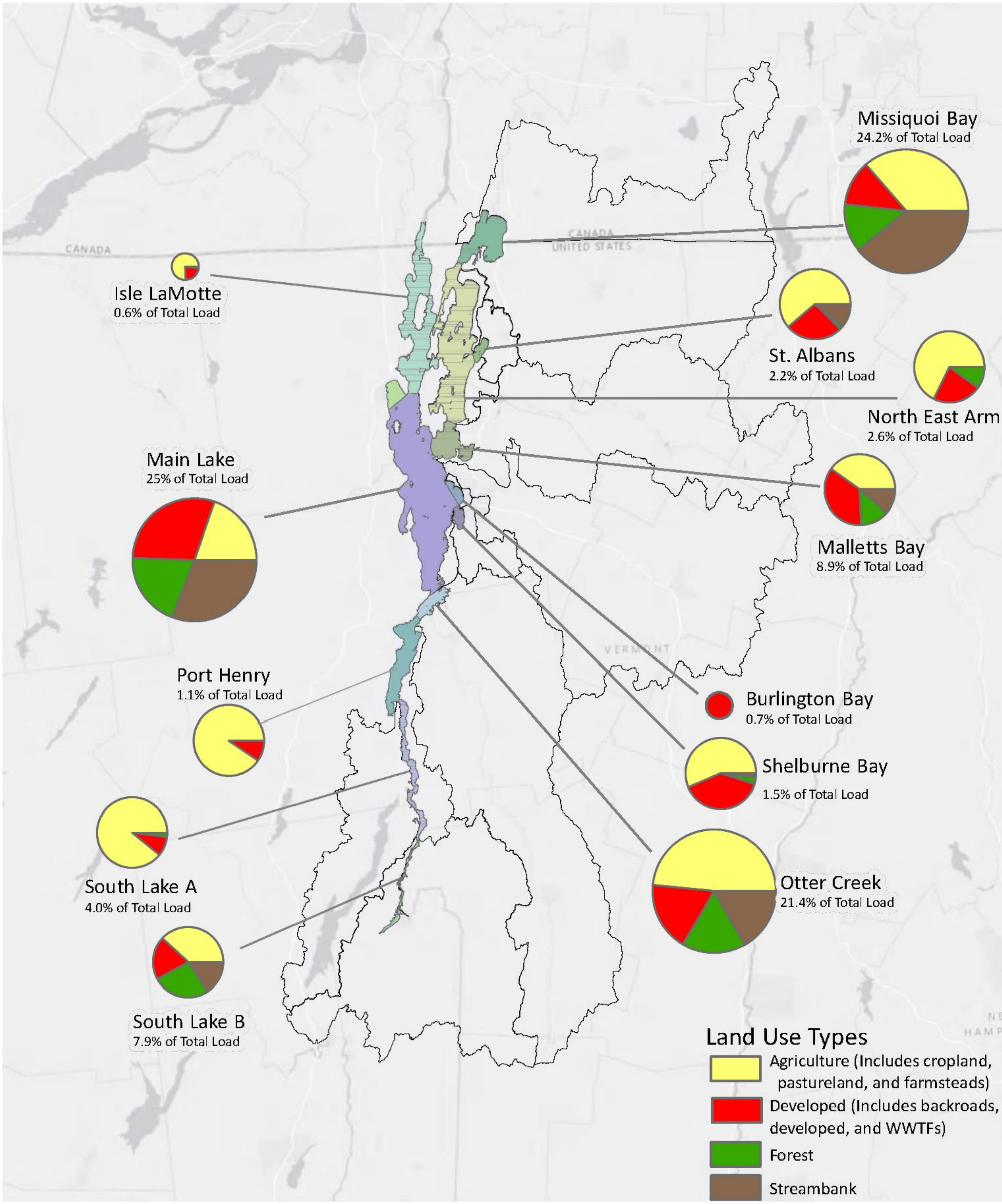

Figure 4: Vermount sources of phosphorus loading to Lake Champlain segments, by land use; annual average of 2001-2010.
Data are from TetraTech, 2015c

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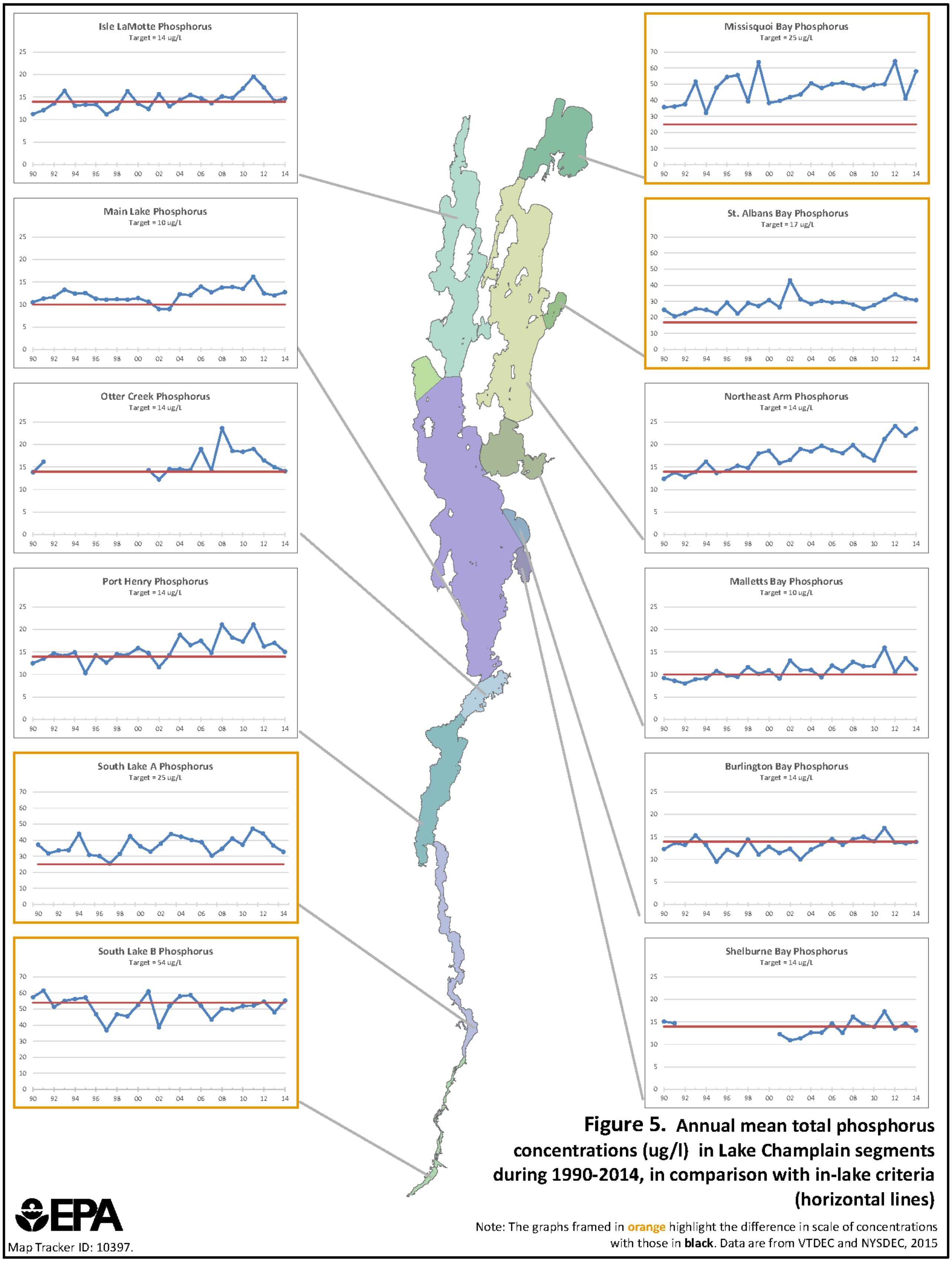

Figure 5. **Annual mean total phosphorus concentrations (ug/l) in Lake Champlain segments during 1990-2014, in comparison with in-lake criteria (horizontal lines)**

Note: The graphs framed in orange highlight the difference in scale of concentrations with those in **black**. Data are from VTDEC and NYSDEC, 2015

CHAPTER 4: SOURCES OF PHOSPHORUS LOADING TO LAKE CHAMPLAIN & SEGMENTS

Phosphorus enters Lake Champlain from multiple point and nonpoint sources in Vermont, New York, and Quebec. A total phosphorus budget, annual mass balance model, and load allocation strategy were developed by the Lake Champlain Diagnostic-Feasibility Study (Vermont DEC and New York State DEC 1997, Smeltzer and Quinn 1996, Smeltzer 1999). The budget and modeling was updated in 2012 to support EPA's establishment of new TMDLs. The updates included a revision of the original in-lake BATHTUB model and the development of a SWAT (Soil and Water Assessment Tool) model for the watershed that identified the magnitude of phosphorus loading from each lake segment watershed. Both of these modeling steps are described in more detail in Chapter 5.

The total phosphorus load to Lake Champlain from all sources was estimated to be 922 metric tons per year (mt/yr) during the 2001-2010 modeling period. As shown in Figure 6, wastewater treatment plant sources in Vermont, New York, and Quebec accounted for 7% of the total load during the same time period, with the remainder coming from agriculture, developed land, forests, and unstable stream corridors, referred to below as "streambank erosion" – the categories that together make up the "non-WWTF" load in Figure 6.

Table 3 shows the break-out of the loads among each source category for the 2001-2010 modeling period, derived from the combination of BATHTUB and SWAT modeling results. The table also shows how these loads combine with the aggregate NY and Quebec loads to add up to the total of approximately 922 metric tons per year.

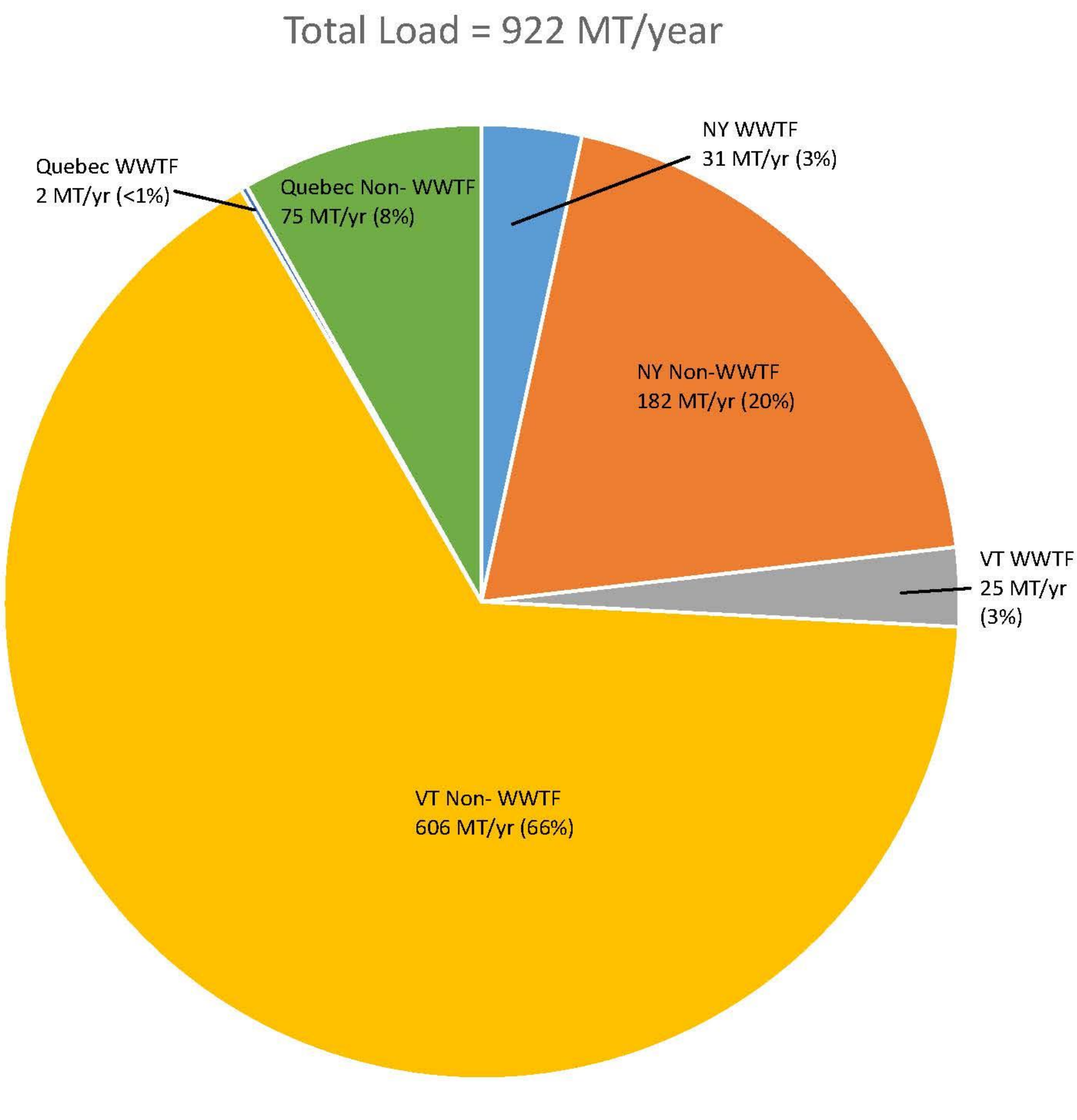

Figure 6: Lake Champlain phosphorus loads by State/Province, in metric tons per year, annual average of 2001-2010.

Sources: Data are from TetraTech, 2015a

Table 3. Phosphorus loads to each lake segment during the 2001-2010 base period (Tetra Tech 2015a, 2015b).

	2001-2010 Vermont Base Loads (mt/yr)								
Lake Segment	Wastewater	Developed	Forest	Stream	Agriculture	Total Vermont	Total New York	Total Quebec	Total Basin
South Lake B	0.6	9.0	13.6	8.3	19.6	51.1	39.4	0.0	90.5
South Lake A	0.1	2.3	0.5	0.0	23.6	26.5	24.4	0.0	50.8
Port Henry	0.0	0.7	0.04	0.0	6.3	7.0	8.4	0.0	15.4
Otter Creek	4.5	20.2	24.0	23.0	68.9	140.5	0.4	0.0	140.9
Main Lake	11.7	35.1	32.5	50.2	32.7	162.2	65.0	0.0	227.0
Shelburne Bay	0.6	3.4	0.3	0.2	5.7	10.2	0.0	0.0	10.2
Burlington Bay	2.8	1.7	0.02	0.0	0.0	4.5	0.0	0.0	4.5
Cumberland Bay	0.0	0.0	0.0	0.0	0.0	0.0	42.0	0.0	42.0
Malletts Bay	1.9	17.2	7.6	6.5	23.2	56.4	0.0	0.0	56.4
Northeast Arm	0.0	3.9	1.8	0.0	12.1	17.8	0.0	0.5	18.3
St. Albans Bay	0.9	2.6	0.2	1.5	8.6	13.9	0.0	0.0	13.9
Missisquoi Bay	1.5	17.0	20.1	40.2	57.6	136.3	0.0	72.3	208.6
Isle LaMotte	0.0	0.9	0.1	0.0	3.1	4.1	34.2	4.6	42.9
TOTAL	**24.6**	**113.9**	**100.7**	**129.9**	**261.5**	**630.6**	**213.8**	**77.4**	**921.6**

4.1 POLLUTANT SOURCE SECTOR CONTRIBUTIONS

Overall, the largest source of phosphorus is the agricultural sector, followed by streambank erosion, developed land, and forests. However, the importance of each sector varies considerably by lake segment watershed: For example, while agricultural sources are dominant in watersheds such as Otter Creek and Missisquoi Bay, developed land and streambank erosion are the largest sources to the Main Lake segment (see Figure 4). Forest land contributes a relatively small amount of phosphorus per unit area (the loading rate) but because forest land covers such a huge amount of the basin (see Figure 3) it represents a fairly large source of phosphorus in some watersheds. Wastewater treatment plants generate a very small percentage of the overall Vermont phosphorus load to the lake (currently about 3%) but they constitute a significantly higher percentage of the load to some lake segments, such as St. Albans Bay, particularly when the permitted load at the design capacity of a plant is considered.

The major sources of phosphorus within each sector also vary by lake segment, but some general trends are clear from the modeling work completed by Tetra Tech (2015b and 2015c). Within the agricultural sector, cropland is by far the largest phosphorus source, followed by pasture and farmsteads. Within the developed land sector, back roads are the single largest source category in most lake segment watersheds, due primarily to erosion and sedimentation from poorly managed roadside ditches. Impervious surfaces in residential, commercial and industrial land use categories (as a group) represent the next largest developed land source in most watersheds. Highly eroding, unstable stream reaches account for the majority of the phosphorus inputs from stream corridors. Within the forest sector, the vast majority of the phosphorus load comes from erosion along forest roads and active harvest areas.

CHAPTER 5: ESTABLISHING LAKE SEGMENT LOADING CAPACITIES

5.1 MODELING METHODS

The establishment of phosphorus loading capacities is a fundamental part of the TMDL process because they identify the amount of phosphorus that each segment can receive and still meet the applicable phosphorus criteria. The load allocations to point and nonpoint sources must be set so as not to exceed the loading capacities of each segment. Loading capacities are typically derived by using water quality models that establish a relationship between the amount of the pollutant (in this case phosphorus) entering the lake and the pollutant concentrations in each segment. Note, however, that in this case the loading capacities were established using a somewhat different process from the simplified approach described above. This is because each individual segment of Lake Champlain (each with its own phosphorus criterion and therefore its own TMDL) affects the phosphorus levels in a number of other segments, especially the nearest segments. This means that the loading capacities for a particular segment must be set at a level that not only allows the phosphorus criterion in that segment to be met, but also allows phosphorus criteria to be met in all other segments within its sphere of influence. Given this situation, there is not just one mathematical loading capacity for each segment; there are multiple options for loading capacities that together result in all segment criteria being met. The modeling approach described in the remaining sections, particularly 5.1.1 and 5.2, allows for consideration of a variety of combinations of load reduction scenarios among the various lake segments that together allow all segment criteria to be met.

5.1.1 BATHTUB MODEL REVISION

In the 1990s, a phosphorus mass balance model for Lake Champlain was developed by the Lake Champlain Diagnostic-Feasibility Study (Vermont DEC and New York State DEC 1997). This model was used to derive the loading capacities for the 2002 Lake Champlain TMDLs. The model considered the circulation patterns within the lake, and established a predictive link between the in-lake total phosphorus concentrations and the phosphorus loading from each lake segment watershed.

The original Lake Champlain phosphorus model was based on a modified version of the U.S. Army Corps of Engineers BATHTUB program (Walker 1987). The model used an annual steady-state approach with spatial segmentation that accounted for diffusive exchange mixing and advective transport of water and phosphorus between 13 lake segments (Vermont DEC and New York State DEC 1997, Smeltzer and Quinn 1996, Smeltzer 1999). The model was used to analyze alternative combinations of load reductions from each lake segment watershed in Vermont, Quebec, and New York, and to predict the load reductions required to attain the in-lake phosphorus criteria in each lake segment. The model was calibrated using chloride and total phosphorus concentrations from a two-year data set (1990-1992).

For the new TMDLs, EPA contracted with Tetra Tech to update the original BATHTUB model, using monitoring data collected from 1991 through 2010 through the Lake Champlain Long-Term Monitoring Program (see program description in Chapter 3, and Vermont DEC and New York State DEC, 2015) . The set-up and calibration of this model is described in detail in a separate report (Tetra Tech 2015a), but the main steps included:

1) Generation of tributary nonpoint source and point source flows and water quality parameter loads, using the FLUX32 software and monitoring data collected between 1990 and 2011;
2) Preparation of BATHTUB model input datasets for steady-state simulation of 2-year duration and other time periods between 1990 and 2011; and
3) Calibration and validation of the resulting updated BATHTUB model, using lake monitoring data collected between 1990 and 2011.

5.1.2 SWAT MODEL DEVELOPMENT

While most of the inputs used to run the BATHTUB model were based on monitoring data, monitoring data were not available for phosphorus inputs from some smaller tributaries and areas that drain directly into the lake rather than into a major river. For these areas, the load estimates from the watershed model SWAT (Soil and Water Assessment Tool) were used as inputs to BATHTUB. The SWAT model was set up primarily to estimate phosphorus loads from different source sectors within the basin (in support of the load and wasteload allocation process and the development of reasonable assurance), but a secondary use was to provide these estimates of phosphorus from direct drainage areas for use in the BATHTUB model. A brief discussion of the SWAT model and its set-up for the Lake Champlain Basin is provided below.

SWAT was jointly developed by the U.S. Department of Agriculture's Agricultural Research Service and Texas A&M University's, AgriLife Research Division. SWAT is a basin-scale, continuous model that operates on a daily time step. It is designed to predict the impact of management on water, sediment and agricultural chemical yields in watersheds and is capable of predicting water quantity, water quality and sediment yields from large, complex watersheds with variable land uses, elevations and soils. The model is physically based, computationally efficient and capable of continuous simulation over long periods.

In SWAT a watershed is divided into sub-basins, which are then further subdivided into hydrologic response units (HRUs) on the basis of unique combinations of land use, soil and slope class. Hydrology and water quality computations are performed at the level of each HRU. They are summed to the sub-basin level and routed through channels, ponds, wetlands or lakes to the watershed outlet. Hydrology in SWAT is based on the water balance. Overland flow runoff volume is computed using the Natural Resources Conservation Service (NRCS) curve number method. Curve numbers are a function of hydrologic soil group, vegetation, land use, cultivation practice and antecedent moisture conditions.

The Lake Champlain Basin is composed of eight 8-digit Hydrologic Unit Code (HUC8) watersheds. Tetra Tech developed a discrete SWAT model for each of these HUC8 watersheds, as well as for direct drainage areas to the lake. The watershed models were calibrated and validated for daily hydrology, as well as monthly sediment and phosphorus loadings.

The SWAT modeling results were used for three main purposes as part of TMDL development:

1) To quantify annual phosphorus loads from existing land-use and watershed process sources – this information is needed for the establishment of load and wasteload allocations;
2) To support the estimates of phosphorus load reductions potentially achievable through implementation of a mix of BMPs – an important part of evaluating the level of "reasonable assurance" that allocations for nonpoint sources can be achieved; and

3) To estimate phosphorus loads from unmonitored drainage areas for input to the lake model (BATHTUB).

The calibrated SWAT model was also used to project potential changes in phosphorus loading to the lake due to climate change. To develop the projections, Tetra Tech ran the SWAT model using data for six regionally downscaled climate change scenarios (based on four underlying Global Climate Change models) from the National Center for Atmospheric Research (NCAR) North American Regional Climate Change Assessment Program (NARCCAP) project, representative of the future period 2040-2070 (Mearns, 2009). The results from the six climate change scenarios were compared with the current conditions (baseline loads) to project potential changes in phosphorus inputs to the lake from each major tributary for the mid-century time period.

For a much more detailed description of the set-up and calibration of the SWAT model, see Tetra Tech (2015b). For more information on the use of the model in evaluating potential effects of climate change, see Tetra Tech (2015d).

5.1.3 THE BMP SCENARIO TOOL

The BMP (Best Management Practice) Scenario Tool is a spreadsheet-based modeling tool designed to estimate how much phosphorus reduction could potentially be achieved by various mixes of BMPs in each watershed. It uses SWAT-generated baseline loading rates for each land use sector together with BMP efficiency information to estimate the amount of phosphorus reduction potentially achievable from a wide variety of user-selected BMP scenarios in each lake segment watershed. EPA made extensive use of the Scenario Tool when evaluating whether there was sufficient reasonable assurance that load allocations could and would be met. The Scenario Tool also includes phosphorus loading amounts both at the source (e.g., at a field or parking lot at the upper end of a large sub-watershed) and at the mouths of the major tributaries to the Lake – referred to as the delivered loads. The delivered loads take into account attenuation (or phosphorus storage or loss on route to the lake) estimated by the SWAT model. More details on this tool are included in Tetra Tech (2015c).

5.1.4 QUALITY ASSURANCE FOR MODEL DEVELOPMENT

A number of steps were taken to ensure that the modeling work in support of the TMDL was conducted in accordance with standard modeling practices, and that modeling uncertainty was within acceptable ranges for this type of application. These steps included: 1) the establishment of technical workgroups (as described in Chapter 1) to review and provide input on the modeling approach; 2) an evaluation of potential modeling approaches conducted by EPA’s contractor followed by its recommendations of the selected approaches with input from members of the technical workgroups and EPA (Tetra Tech, 2011 and 2012a); 3) the preparation of a quality assurance project plan that addressed performance expectations for both the BATHTUB and SWAT models (Tetra Tech, 2012b); 4) Internal quality assurance reviews completed by the contractor following completion of the modeling work (Tetra Tech, 2014a and 2014b); and 5) an outside technical review of the modeling work conducted by independent modeling experts unaffiliated with this project (WaterVision, 2015).

5.2 DEVELOPMENT AND APPLICATION OF THE LAKE SPREADSHEET MODEL FOR TMDL LOAD REDUCTION ANALYSIS

The calibrated BATHTUB model (Tetra Tech, 2015a) was transferred into a spreadsheet format (Microsoft Excel®) in order to facilitate the analysis of TMDL load reduction policy options and scenarios. The spreadsheet lake model used the same lake segmentation scheme and mass balance equations on which the BATHTUB model for Lake Champlain was based, solving the mass balance equations using iterative calculation methods in Excel®. The spreadsheet model produced the same lake phosphorus concentration predictions when given the same input data, but without the prediction uncertainty estimates provided by BATHTUB.

Model parameters for the exchange flows and net sedimentation rates were maintained in the spreadsheet model as calibrated by Tetra Tech (2015a), except for the following modifications for St. Albans Bay and Missisquoi Bay. The calibrated internal phosphorus loading rate of 4.2 $mg/m^2/d$ for St. Albans Bay was set to zero for the TMDL load reduction analysis to represent the expectation that excessive internal loading will be eliminated over time, possibly with a sediment phosphorus inactivation treatment as a final lake restoration step. The BATHTUB model formulation for Missisquoi Bay was replaced in the spreadsheet model by the predictions from a more mechanistic phosphorus model for the bay (LimnoTech, Inc., 2012) that considered internal sediment-water phosphorus transfers and their long-term response to reductions in external phosphorus loads from the bay's watershed. The long-term response of phosphorus concentrations in Missisquoi Bay was modeled using the following equation derived from LimnoTech, Inc. (2012, 2015):

$$Y = 53.74 - 47.04\ X$$

Where:

Y = predicted bay annual average total phosphorus concentration (µg/L) 70 years after watershed load reduction is achieved
X = percent (as decimal fraction) watershed phosphorus load reduction from base period rates

Refer to Section 6.2.1 for more information on internal phosphorus loading.

The spreadsheet lake model was initialized with phosphorus loading and hydrologic input data for the 2001-2010 base period, aggregated as totals for each lake segment watershed. The base period phosphorus loads were partitioned by state/province using estimates provided by Tetra Tech (2015a). The Vermont base period phosphorus loads were further partitioned into the source categories listed in Table 4 based on delivered load estimates obtained from the Lake Champlain TMDL Scenario Tool (Tetra Tech, 2015c).

Before using the spreadsheet model to analyze the Vermont segments' loading capacities and load reduction scenarios, phosphorus loads to each of the six New York segments were set equal to the total loading capacities defined in the 2002 Lake Champlain Phosphorus TMDLs for those segments (Vermont DEC and New York State DEC, 2002). This ensured that the New York allocations and attendant/current obligations on discharges were preserved and accounted for. Early in the process, EPA asked New York State DEC whether it wanted to update its portion of the TMDL at the same time. NY DEC declined to reopen its TMDL. Still, EPA provided the opportunity for New York to participate in the technical effort to develop the models and provided occasional technical briefings. As a result, the loading capacities and allocations specified for New York segments in the original 2002 TMDLs remain unchanged. The Vermont TMDL load reduction analysis assumed that the new total loading capacity for Missisquoi Bay would be shared on a 60/40% basis between Vermont and Québec, consistent with the 2002 Agreement between the Gouvernement du Québec and the State of Vermont Concerning Phosphorus Reduction in Missisquoi Bay (Québec & Vermont, 2002).

Table 4. Source categories for Vermont phosphorus loads.

Source categories included in the wasteload allocation
Wastewater discharges
Stormwater from Developed land, excluding back roads
Stormwater from Back roads
Treated combined sewer overflow (Burlington Main Facility)
Agriculture production areas
Source categories included in the load allocation
Forest land
Stream channel instability/erosion
Agricultural land

The lake spreadsheet modeling tool provided the ability to select from a menu of policy scenarios for each of the wasteload allocation source categories listed in Table 4, along with the load allocation categories of forestland and streambanks (see Appendix B for further details). Once the allocations for these source categories were specified for each segment, the load reduction percentages applied to the agricultural load allocation category for each lake segment watershed were adjusted until the predicted lake phosphorus concentrations attained the in-lake water quality criteria in each lake segment, with allowances for a 5% margin of safety in each lake segment and for the allocations for future growth in stormwater loads specified in Tables 7 and 8 in Chapter 6.

The following approaches were used when applying reductions to the nonpoint source load allocation categories.

1. In keeping with Vermont's desire to apply basic measures uniformly across the basin, a minimum reduction in agricultural source loads was applied to all lake segment watersheds except for Burlington Bay, where no reduction was applied since agricultural nonpoint sources are minimal.
2. Additional agricultural source load reduction percentages were applied equally to the South Lake B and South Lake A watersheds since both watersheds have common characteristics and influence the loads that would achieve the phosphorus criterion in the South Lake A segment.
3. Additional agricultural source load reduction percentages were applied equally to the Otter Creek and Main Lake watersheds to ensure consistent treatment of agricultural lands in the central part of the lake when determining the loads that would achieve the phosphorus criterion in the Main Lake.
4. As described in Section 6.2, more modest reductions to the forest category (and to some extent the streambank category) were specified in many segments, as there was sufficient capacity to achieve most of the reductions needed in the agricultural category. More stringent reductions were required for these categories in the South Lake B and Missisquoi Bay segments.

The application of these approaches resulted in the identification of the lake segment loading capacities and percent reductions described in detail in Section 6.2 and shown in Tables 7 and 8.

The loading capacities and wasteload and load allocations are expressed in terms of annual loads. EPA's November 15, 2006 guidance entitled "Establishing TMDL 'Daily' Loads in Light of the Decision by the U.S. Court of Appeals for the D.C. Circuit in *Friends of the Earth, Inc. v. EPA, et al.*, No.05-5015, (April 25, 2006) and Implications for NPDES Permits," recommends that TMDLs express allocations in terms of daily time increments, consistent with the D.C. Circuit's ruling. This guidance also acknowledges that the decision of the U.S. Court of Appeals for the Second Circuit, *NRDC v. Muszynski*, 268 F.3d 91 (2nd Cir. 2001), established the controlling legal precedent for cases brought in the Second Circuit, which includes Vermont. In this decision, the Court held that the Clean Water Act does not require TMDLs to be expressed in terms of daily loads, but on remand the Court required a reasoned explanation for the choice of any particular non-daily load. EPA believes there is a reasonable basis for not including daily loads in these TMDLs. In-lake concentrations of phosphorus in Lake Champlain are not affected by variations in daily inputs because the lake has a long residence time of about two years. In evaluating the best expression of loading, EPA determined that an annual load allocation is the most appropriate measure of how phosphorus affects Lake Champlain. Neither daily nor seasonal loads as accurately represent the effect of phosphorus loading to the lake. In addition, Vermont's WQS express the applicable phosphorus criteria in terms of annual mean total phosphorus concentrations. The expression of the loading capacity and wasteload and load allocations on an annual basis is therefore a logical and effective approach in this case.

5.3 SEASONAL VARIATION

The Clean Water Act and implementing regulations require that a TMDL be established with consideration of seasonal variations.

For Lake Champlain, critical conditions occur during the summer season when algae growth is more likely to interfere with uses. However, water quality in the lake is generally not sensitive to seasonal or short term phosphorus loading. With a water residence time of about two years (Vermont DEC and New York State DEC, 1997), the lake generally responds to loadings that occur over longer periods of time (e.g., annual loads). Accordingly, the in-lake numeric phosphorus criteria are expressed as annual mean values (see Table 2) and were selected to be protective of uses during all seasons, including the summer season. As described in Section 5.1.1, the Lake Champlain TMDLs were developed using a steady-state modeling approach that supported the establishment of annual average phosphorus allocations designed to achieve the phosphorus criteria. Meeting the phosphorus criteria on an annual basis automatically addresses any concerns due to seasonal variation, given that the criteria were established to be protective during all seasons.

5.4 CONSIDERATION OF CLIMATE CHANGE

EPA considered climate change to the extent feasible. As described in Section 5.1.2, EPA's contractor, Tetra Tech, used the calibrated Lake Champlain SWAT model to project mid-century potential changes to phosphorus loads to the lake with six different precipitation and temperature projections derived from global climate change models. The model runs projected a possible overall average increase in phosphorus loading of approximately 30% for the period 2040 – 2070, assuming other factors remain the same. However, there are a variety of reasons why the results of this approach to projecting climate change impacts should be viewed with caution. First, as discussed in Vermont's Phase 1 Implementation Plan, this projected increase likely overestimates the potential effect of climate change on the lake, because it does not take into account the fact that under these future scenarios the loading capacity of the lake will be larger due to increased lake volume and flushing rates that will accompany the increased flows projected by the model. Once the mitigating factor of increased flow volume is considered (as indicated by flow-weighted average tributary inflow concentrations) DEC calculated that the projected climate change scenarios would likely increase the effective phosphorus loads by about 15%. However, even that estimate may be overstated, since the modeling is driven by one, pessimistic greenhouse gas emissions scenario (A2), so the full range of emission scenarios is not represented. This means that the modeling projections rely on only the more extreme end of the range of possible climatic changes. An additional concern is the time factor: the analyses project phosphorus loads for the average of the period 2040-2070, which is beyond the timeframe for which TMDLs are typically designed to be applicable, and the path of change between now and that far off point is not included in the analyses so it is not known whether phosphorus load increases might occur gradually or ramp up more abruptly as the mid-century point nears.

However, recognizing that climate change could cause at least a modest increase in phosphorus loads to the lake, the State included measures in its Phase 1 Implementation Plan that will mitigate the phosphorus increases projected by the modeling. Examples of these measures include: a focus on agricultural and stormwater practices that infiltrate water and therefore minimize phosphorus runoff even during large, high intensity rainfall events; new agricultural practice requirements to stabilize soil (such as the gully stabilization requirements specified in Act 64); and stream corridor policies (such as those included in Act 110) that call for managing rivers and streams to achieve naturally stable stream conditions – conditions that will still perform well and minimize streambank erosion even with a changing climate.

As described in Section 6.3, EPA allocated a 5% margin of safety (MOS) for each segment, to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality. EPA considered whether it was necessary to increase the MOS above 5% to account for uncertainties related to potential climate change effects. Given that: 1) any increases in phosphorus loads to the lake due to climate change are likely to be modest (i.e., 15%), and 2) the State's implementation strategy includes measures that will mitigate possible increases due to climate change, EPA determined that it was not necessary to increase the MOS above the 5% already identified to account for possible, far-term effects of climate change.

CHAPTER 6: ESTABLISHING ALLOCATIONS

As described earlier, a TMDL can be described as the sum of the individual wasteload allocations (WLAs) for point sources, the load allocation (LAs) for nonpoint sources and natural background, and a margin of safety (MOS). Under the regulatory definition of WLA at 40 C.F.R. § 130.2(h) and EPA's longstanding interpretation, point sources that discharge pollutants to waters of the United States and are subject to the jurisdiction of the National Pollutant Discharge Elimination System (NPDES) permit program are required to be assigned to the WLA. All other sources – both point sources and nonpoint sources – are included in the load allocation. States (and EPA) have the discretion to include point sources that are not subject to the NPDES permit program in the WLA portion of a TMDL, but they are not required to do so. (Wayland and Hanlon, 2002). This chapter describes the allocations that are established and how EPA developed them. It first details the general approach EPA took when considering the whole Vermont portion of Lake Champlain. It then describes how the general approach was applied to the different lake segments.

EPA developed the allocations in close consultation with the State. Given the predominant role of precipitation driven runoff from certain point and nonpoint sources, the initial focus of the state agencies was on policies and programs to address these sources. Vermont committed early in the process to a Lake Champlain basin-wide approach to measures to control loads from developed land, agricultural lands, forested land and stream banks. In the modeling and spreadsheet analyses, the proposed measures were applied to the relevant land use type in each of the lake segments. EPA focused on the Wastewater Treatment Facilities to determine what reductions might be necessary to achieve the water quality standards, both lake-wide and within each segment. The sections that follow describe in detail the general approach to each part of the allocation.

6.1 WASTELOAD ALLOCATION - GENERAL APPROACH

The phosphorus wasteload allocations in the Lake Champlain TMDLs for Vermont point sources are divided into two groupings. The first includes the Vermont Wastewater Treatment Facilities (WWTFs) whose discharges are authorized by Vermont's NPDES permits. The second contains stormwater-related phosphorus sources in the general category of developed land sources, which includes stormwater runoff from sources such as municipal and residential areas, construction sites, state highways and back roads. This developed land category incorporates stormwater sources that require state NPDES permits; stormwater sources that are subject to other, non-NPDES, state permits; and other stormwater runoff from developed land that may not be subject to either type of state permit (such as stormwater from small land areas below the State's permitting threshold). More information on the approach to the stormwater portion of the WLAs is included below in Section 6.1.2. Information on the WWTF portion of the WLAs is included immediately below in Section 6.1.1.

6.1.1 WASTEWATER TREATMENT FACILITIES WASTELOAD ALLOCATIONS

As detailed in Chapter 4, wastewater treatment facilities are not the dominant source of phosphorus to Lake Champlain as a whole, nor to any of the individual impaired lake segments. As noted above, the initial focus of the state agencies was on policies and programs to address the other sources of phosphorus loadings. Vermont's Phase 1 Implementation Plan contained an explicit policy preference to not allocate any additional phosphorus reductions to the WWTFs. However, recognizing that the final allocations might include reductions to WWTFs, the State requested EPA to apply the following principles:

- Reductions in wastewater allocations should be targeted only to facilities in those lake segment watersheds where the currently permitted wastewater load represents a significant proportion of the total phosphorus load from all Vermont sources, and where wastewater upgrades would meaningfully reduce the phosphorus reduction burden placed on non-wastewater sources.
- TMDL-based discharge permit limits should be defined as annual average phosphorus loading rates, rather than as concentration limits, in order to allow operational flexibility in attaining the limits.
- New permit requirements should be implemented through compliance schedules that allow sufficient time for planning, budgeting, and engineering, and that advantage of cost-efficient opportunities to couple phosphorus upgrades with other planned facility construction projects.
- Other forms of flexibility should be available to achieve the wasteload allocation in an optimally cost-effective manner, including phosphorus trading and integrated permitting.

For each lake segment, EPA considered both the relative contribution of the WWTFs and the degree of reduction required for developed land and nonpoint sources. EPA determined that a targeted approach is appropriate -- reductions in allowable WWTF phosphorus discharges are a necessary component of the wasteload allocation in some, but not all, lake segments.

In determining any necessary reductions, EPA established a baseline by looking first at the allowable discharges from each WWTF, that is, the amount of phosphorus the facility is authorized to discharge at design flow rates under the current NPDES permit. These permits reflect the wasteload allocations made in the 2002 TMDLs.

For the Port Henry, Otter Creek, Malletts Bay, Northeast Arm, and Isle LaMotte segments, where the combined WWTF permitted discharges comprised less than 10% of the total phosphorus base load, and the developed land and nonpoint reduction needed was 30% or less, EPA's WLAs for the WWTFs are the same WLAs for those facilities as in the 2002 TMDLs. This is reasonable because the WWTFs' contributions are relatively small, and reductions at the WWTFs would not meaningfully change the reductions needed from non-WWTF sources.

In the Main Lake, Shelburne Bay, Burlington Bay and St. Albans segments, the loads allocated to the WWTFs in the 2002 TMDL range between 16 and 97% of the segments' base loads. EPA considers these to be significant contributions and has determined that further WWTF load reductions are appropriate in these segments.

In the South Lake A and B and Missisquoi Bay segments, although the loads allocated to the WWTFs in 2002 TMDL are less than 5%, of the base loads, the needed load reductions from developed lands and nonpoint sources exceed 50%. This percent reduction was considered high enough that EPA included the WWTFs in consideration for further reductions.

Having established the lake segments that require WWTF reductions, EPA then considered which factors should be used to determine how the allocations would be set. EPA evaluated the annual loading impacts of these facilities and subdivided them into three groups. The first group includes facilities with design flow capacities less than 0.10 million gallons per day (MGD). These small facilities typically have simple treatment systems and discharge very small phosphorus loads. The second group consists of facilities with design flows between 0.10 and 0.20 MGD. The third group comprises facilities with design flows greater than 0.20 MGD. These facilities are generally the most technically sophisticated treatment plants, contribute the largest portion of the WWTF load, and provide the best opportunities to achieve significant reductions.

EPA then considered a range of phosphorus loads for each of the three groups. Given the minor contribution of the small facilities, EPA determined that further reductions would have negligible impact. Thus, they were given the same allocations as in the 2002 TMDLs. EPA next considered the range of phosphorus concentration limits that are achieved in practice at facilities throughout New England. A phosphorus discharge limit of 0.10 milligram per liter (mg/l) is currently considered to represent very good treatment practices. A discharge limit of 0.20 mg/l is routinely achievable at facilities with flow greater than 0.20 MDG, while a limit of 0.8 mg/l is achieved widely and is already required of all facilities with flow greater than 0.20 MGD in Vermont.

After further consideration of the contributions of the WWTFs within each affected segment, EPA made total segment WWTF wasteload allocations equivalent to setting the phosphorus limit at 0.2 mg/l at design flow for the facilities with flow greater than 0.20 MGD and at 0.8 mg/l at design flow for the WWTFs in the middle-sized group. EPA determined that extra reductions that could be achieved by requiring a WLA that reflects a limit of 0.1 mg/l at the facilities with flow greater than 0.20 MGD were small relative to the nonpoint source contribution and Vermont felt that investments in nonpoint source reductions should be a higher priority.

As described in more detail in Section 6.1.2, eleven facilities (Burlington Main, East and North, Enosburg, Fair Haven, Middlebury, Montpelier, Richford, Rutland, St. Albans and Vergennes) have combined sewers in at least part of their sewer system and are subject to DEC's Combined Sewer Overflow (CSO) policy for reducing CSO discharges. EPA has not made separate allocations for phosphorus loads from CSOs except for Burlington Main. For the remaining ten combined systems, EPA has included the portion of phosphorus load contributed by untreated the wastewater in the CSO discharges in the allocations for the relevant WWTFs. When setting permit limits to be consistent with the assumptions of the TMDL, DEC must account for the wastewater phosphorus loads discharging from CSOs within the allocations for the relevant WWTFs.

Consistent with the 2002 TMDLs, individual wasteload allocations are specified for each WWTF discharge to Lake Champlain or to a lake tributary. Since EPA has evaluated the WWTF allocations at the segment level and then made assignments to individual facilities, EPA is providing in these TMDLs an option for Vermont to make changes to the individual WWTF allocations within a lake segment as long as the adjusted combined allocations do not exceed the total WWTF allocation for that segment. The Main Lake and the relatively small and closely connected Burlington Bay and Shelburne Bay segments may be treated as a single lake segment for the purpose of wastewater load reallocations, since loads from each of these segment's watersheds have an approximately equal impact on phosphorus concentrations in the critical Main Lake segment. If reallocations are to be made, DEC will follow its established Wasteload Allocation Process (VT Agency of Natural Resources, 1987), which requires public notice and at least one public meeting. DEC must provide written notification to EPA if and when it commences proceedings under the Wasteload Allocation Process to reallocate WWTF loads within any Lake Champlain segment.

When implementing the TMDLs through NPDES permits, EPA acknowledges that DEC intends to employ flexible approaches including:

- Effluent phosphorus limits in permits will be expressed as total annual mass loads.
- Construction of upgraded phosphorus treatment facilities will not be required until actual phosphorus loads approach 80% of the facilities' WLAs.
- Phosphorus compliance schedules in discharge permits will allow adequate time for planning, engineering and municipal budgeting.

The specific application of this approach within each segment is described in the next section. The net effect of the WWTF WLAs is to reduce the allowable annual WWTF load from 55.8 metric tons to 32.3 metric tons, a 42% reduction compared to the WLAs established in the 2002 TMDL.

6.1.1.1 SEGMENT-SPECIFIC WWTF ALLOCATIONS

This section describes how the facility specific WWTF allocations were developed for each lake segment. Segments with similar characteristics are grouped together. Consistent with the 2002 TMDLs, individual wasteload allocations are specified for each WWTF discharge to Lake Champlain or to a lake tributary. The facility-specific WWTF allocations are listed in Table 9 in the summary section at the end of this chapter.

<u>South Lake A & B</u>

The South Lake is shallow and narrow. It is divided into segments A (northern of the two) and B for water quality purposes. The phosphorus load is dominated by nonpoint sources; stormwater runoff from agricultural and forested lands contribute approximately 75% of the load. There are six WWTFs in the South Lake, three with flow greater than 0.20 MGD and three with flow less than 0.10 MGD.

Consistent with the allocation approach described in Section 6.1.1, the three small facilities (Benson, Orwell and West Pawlet) were given the same allocations as in the 2002 TMDLs. The three larger facilities are all in South Lake B. At current permit limits, which are based on the 2002 WLAs, they account for only six percent of the total loading capacity for the segment. Although the nonpoint source reductions required in South Lake segments are high, EPA carefully evaluated the planned non-WWTF measures with the BMP Scenario Tool (described in Section 5.1.3) and determined that the expected reductions can and will be met. As described further in Section 7.1, EPA has determined that there is reasonable assurance that the modeled reductions will be achieved. EPA therefore has not required additional reductions at the three larger WWTFs (Castleton, Fair Haven and Poultney) and instead has established the same allocations as in the 2002 TMDL.

<u>Port Henry, Otter Creek, Malletts Bay, Northeast Arm, Isle LaMotte</u>

These five segments are generally the closest to meeting the applicable phosphorus criteria. There are no WWTFs discharging to the Port Henry and the Northeast Arm segments. In the Otter Creek, Malletts Bay and Isle LaMotte segments, the combined WWTF loads at current permit limits (which reflect the 2002 WLAs) comprise less than 10% of the total phosphorus loading capacity and the developed land and nonpoint reduction needed is 30% or less. Section 7.1 describes EPA's determination that there is reasonable assurance that these reductions will be achieved. EPA therefore has not required additional reductions at the WWTFs in these segments and EPA has assigned the WWTFs the same wasteload allocation as in the 2002 TMDLs. The facilities are: Alburgh, Brandon, Fairfax, Hardwick, Jeffersonville, Johnson, Middlebury, Milton, Morrisville, Otter Valley Union High School, Pittsford,

Pittsford Fish Hatchery, Proctor, Rutland City, Salisbury Fish Hatchery, Shoreham, Vergennes, Wallingford, West Rutland, and Perrigo Nutritionals.

Main Lake, Shelburne Bay and Burlington Bay

The Main Lake, Burlington Bay and Shelburne Bay segments generally receive inputs from the most developed parts of the Vermont portion of the Lake Champlain basin. EPA views the Burlington Bay and Shelburne Bay segments to be part of the larger Main Lake watershed, since loads from each Bay segment have an approximately equal impact on phosphorus concentrations in the critical Main Lake segment. The currently permitted WWTF contributions in these segments ranges from 16 to 97% of the total segment base load and should be reduced. EPA has made WWTF waste load allocations equivalent to setting the phosphorus limit at 0.2 mg/l at design flow for the 17 facilities with flows greater than 0.20 MGD. Those facilities are: Barre City, Burlington East, Burlington Main, Burlington North, Essex Junction, Hinesburg, Global Foundries, Shelburne #1 and #2, Montpelier, Northfield, Richmond, South Burlington Airport Parkway, South Burlington Bartletts Bay, Stowe, Waterbury and Winooski. Seven of these facilities have recently made upgrades or have the ability to make process improvements that would enable them to meet permit limits consistent with the new allocations without major construction upgrades. These include, Essex Junction, South Burlington Airport Parkway, Shelburne #1 and #2, South Burlington Bartlett Bay, Stowe, and Waterbury. EPA assigned WLAs for the two WWTFs in the middle-sized group (Plainfield and Williamstown) equivalent to setting the phosphorus limit at 0.8 mg/l at design flow. EPA assigned the two facilities with flows less than 0.10 MGD (Cabot and Marshfield) the same WLAs as in the 2002 TMDLs. There are two exceptions to this general approach. The 2002 WLAs for Weed Fish Culture Station and Burlington Electric were lower than a limit equivalent to 0.2 mg/l at design flow. The more stringent 2002 allocations have been retained and are already reflected in the permit limits for these facilities.

St. Albans Bay

The St. Albans Bay watershed drains approximately 50 square miles of agricultural, forested, and urban land into the relatively shallow St. Albans Bay. The terrain is fairly flat and contains some of the richest farmland in the State. Agriculture, forested lands, and streambank instability account for 73% of the annual phosphorus loading. There are two WWTFs that discharge to this segment. Their currently permitted load accounts for 27% of the total loading capacity, and should be reduced. Consistent with the general approach, the St. Albans WWTF was assigned a load equivalent to setting the phosphorus limit at 0.2 mg/l at design flow. The Northwest State Correctional Institution has flow less than 0.10 MGD was assigned the same allocation as in the 2002 TMDL.

Missisquoi Bay

Missisquoi Bay, although much larger in surface area and shared with the province of Quebec, shares some important features with St Albans Bay. It is shallow, and dairy farming dominates the phosphorus loading from the watershed. Agricultural and forested lands account for 91% of the land use in the Vermont portion of the basin. Agricultural and forested lands, and streambank instability, contribute 88% of the base load of phosphorus to the bay. Eight WWTFs discharge to Missisquoi Bay, five with flow greater than 0.20 MGD, two with flow less than 0.10 MGD and one in the middle group.

Although the currently permitted WWTF loads account for 8.5% of the total loading capacity for the segment, EPA found that there were not sufficient non-WWTF measures that could meet water quality standards without reductions at the treatment plants. Consistent with the overall allocation approach, EPA assigned the five larger WWTFs (Enosburg Falls, Richford, Rock Tenn, Swanton and Troy/Jay) WLAs equivalent to setting the phosphorus limits at 0.2 mg/l at design flows. The Troy/Jay facility has already been upgraded and its current permit is already consistent with this new WLA. EPA assigned the one facility in the mid-size group (N. Troy) a WLA equivalent to setting the limit at 0.8 mg/l at design flow. Consistent with the overall approach, EPA assigned one of the small facilities (Sheldon Springs) the same allocations as in the 2002 TMDL. For the other (Newport Center), the 2002 allocation was based on assumptions that have proved to be operationally incorrect. EPA set the new allocation for Newport Center using assumptions similar to the other small facilities that are generally retaining the 2002 allocation (equivalent to a phosphorus limit of 2.0 mg/l at design flow).

6.1.1.2 FUTURE GROWTH IN WASTEWATER LOADS

EPA's definitions of wasteload and load allocations refer to both future, as well as existing, point and nonpoint sources (40 C.F.R. 130.2(g) and (h)). The Vermont Wasteload Allocation Process requires that future population growth be considered in establishing wasteload allocations. Capacity for future growth in wastewater flows is built into the design and permitting of wastewater treatment facilities, and future growth capacity is therefore included in the individual facility wasteload allocations listed in Table 9.

The allowance made within the TMDLs' wasteload allocations for future increases in wastewater flows and phosphorus loads can be assessed by comparing the permitted flows and the phosphorus wasteload allocations with current discharge rates. The 2001-2010 average base load of phosphorus discharged from all Vermont WWTFs was 24.6 metric tons per year (mt/yr). This comprises 76% of the TMDLs' combined WWTF wasteload allocation of 32.3 mt/yr.

6.1.2 DEVELOPED LAND WASTELOAD ALLOCATIONS

EPA interprets 40 C.F.R. § 130.2(h) to mean that allocations for point source discharges subject to the NPDES permit program must be included in the wasteload allocation portion of the TMDL.[2] (Wayland and Hanlon, 2002). In addition to wastewater treatment facility discharge permits, the NPDES program includes the following other permit types in Vermont.

- Phase 2 municipal separate storm sewer system (MS4) permits

- Permits issued for stormwater discharges from certain parcels based on Residual Designation Authority (RDA)

- Certain individual stormwater permits

- Discharge permits which authorize combined sewer overflows (CSOs)

- General construction site stormwater permits (CGP)

[2] Point source discharges that are not regulated by the NPDES program may be included in either the WLA or the LA portion of the TMDL. (Id.)

- General multi-sector industrial stormwater permits (MSGP)

- Concentrated Animal Feeding Operation (CAFO) permits

Unlike continuous discharges from WWTFs, stormwater runoff is driven by brief and intermittent rainstorms or snowmelt events, and is highly variable in quantity and phosphorus content from one event to the next. Monitoring phosphorus loads in stormwater runoff is technically difficult and expensive because of the variable nature of these events, making it difficult to assign and enforce facility-specific effluent limits. Data are not available from CSOs (other than the CSO discharging to Burlington Bay) and stormwater outfalls to characterize their individual phosphorus loads for the purpose of the TMDLs. Phosphorus loads from construction sites are especially challenging to monitor or estimate. Because of these monitoring difficulties and the geographic scale of the Lake Champlain Phosphorus TMDLs, it was not technically feasible to separate the allocations for stormwater sources requiring NPDES permits from the allocations for other stormwater nonpoint and non-NPDES regulated point source categories based on land use. EPA guidance states that NPDES-regulated stormwater discharges may either be expressed as individual wasteload allocations (for each source, for example) or as a single categorical allocation for all NPDES-regulated stormwater discharges when data are insufficient to assign each source an individual wasteload allocation.(Wayland and Hanlon, 2002; Sawyers and Best-Wong, 2014). The 2002 guidance also explains that stormwater discharges from sources not currently subject to NPDES regulations may also be included in the wasteload allocation portion of a TMDL.

The NPDES stormwater-related phosphorus sources listed above (except for CAFOs) are included in the general WLA category of developed land sources. This category also includes runoff from non-NPDES regulated point source and nonpoint sources such as residential areas, small construction sites, and back roads, since it is not technically feasible to distinguish loads among the various sources and accurately separate the allocations into WLAs and LAs. In addition, some stormwater discharges from developed land may in the future become subject to NPDES permits (through the exercise of residual designation, for example), and including the loads within the WLA now is reasonable and consistent with EPA's guidance discussed above. Phosphorus loading from developed land was estimated using the SWAT model, as described in Chapter 5. The WLA portion of these TMDLs includes a category for developed land sources, while recognizing that this category incorporates both point sources that require NPDES permits, and point and nonpoint sources that do not require such permits. An explanation of why EPA chose to establish an aggregate WLA for developed land sources is included below.

<u>Available Information on Phosphorus Loads in Vermont Stormwater and CSO Permitted Discharges in the Lake Champlain Basin</u>

EPA guidance encourages the establishment of separate WLAs for stormwater permit categories and even individual dischargers if sufficient information exists on phosphorus loads associated with each NPDES permit category and/or discharger. (Sawyers and Best-Wong, 2014). EPA carefully reviewed available data pertaining to the permitting categories listed above. As shown in Table 5, EPA found that sufficiently detailed spatial and pollutant loading information is not available for any of the permit categories. Note that a category for future stormwater permits is also included in Table 5 because EPA is aware that Vermont intends to establish several new permit categories in the near future, one or more of which may require NPDES permits, as indicated in the revised Phase I Implementation Plan and in Act 64.

The primary spatial data set that is available and relates to stormwater permitting is the “urbanized area” coverage. Municipal systems within the “urbanized area” are required to obtain MS4 permit coverage. In cases of highly urbanized municipalities, it may seem reasonable to assume that the “urbanized area” could be used to provide a reasonable approximation of the MS4 area. However, not all areas within the “urbanized area” are served by the MS4 drainage systems, as some areas are served by private storm sewer systems and other areas are served by natural drainage networks (i.e., stormwater flows directly into stream systems that are not part of the MS4 network).

No pollutant loading-related information is available from MSGP facilities, and given the varied nature of the facility types, area covered, and exposure practices, there is no way to estimate the loading at the present time. Also, since the MSGP doesn’t cover stormwater from parking lots and roofs outside of areas of industrial activity, any MSGP load estimates would not reflect total loads from the entire operation.

Another factor for consideration in setting appropriate stormwater related WLAs is that the sites covered by the RDA, MSGP, and CGP permits are located both within and outside of the “urbanized area.” This factor is important for two primary reasons:

1. It further limits the use of the “urbanized area” as a surrogate for the MS4s since the area includes other permit categories; and
2. The “urbanized area” does not encompass all stormwater permitted discharges so that the “urbanized area” cannot be used as a “catch all” for all stormwater permit categories.

A review of available information related to Vermont CSO discharges to Lake Champlain indicates that there is insufficient information to estimate annual phosphorus loads from untreated CSOs. However, average annual phosphorus loads have been calculated for the only CSO treatment facility in the Lake Champlain basin – the facility located in Burlington. Continuous simulation hydrologic/hydraulic models have not been developed for the combined sewer systems in Vermont. Consequently, there is not a reliable means for calculating annual discharge volumes for the untreated CSOs, which are needed to calculate loads.

Without estimates of loads, mass based WLAs are not possible for the untreated CSOs. The current plan is to have all untreated CSOs be in compliance with the level of control specified in the CSO policy. Quantifying the actual phosphorus load reduction associated with bringing the untreated CSOs into compliance is not possible at this time. However, these sources are accounted for in the TMDLs. The effects of CSO discharges were captured in the baseline tributary monitoring data used in both the BATHTUB and SWAT modeling steps and the phosphorus loads from these discharges are included in the developed land and WWTF allocations. The TMDLs call for reductions in the amount of phosphorus entering these CSOs - and therefore discharged through CSO outfalls - through the developed land allocations described below. Since there are not separate allocations for stormwater discharging from CSO in compliance with the CSO policy, the State must account for these stormwater phosphorus loads within the allocations for developed land. As noted in Section 6.1.1, the State must similarly account for the wastewater phosphorus loads discharging from compliant CSOs within the allocations for the relevant WWTFs.

Table 5: Summary of Assessment for Characterizing Loads for Stormwater, CSO, and Agricultural Production Area Permitting Universe for the Lake Champlain TMDL		
NPDES Permit Category	Can Load be Calculated for TMDL?	Basis for Determining whether Loads can be Calculated
MS4	No	Actual drainage areas for the 15 MS4 systems are not well mapped. The mapping of urbanized areas includes non-MS4 area as well as area covered by some of the RDA, CGP, and MSGP permits.
Residual Designation Tier 1 & 2 (≥ 1 impervious acre)	No	Spatial data exists for the sites but the scale and resolution of the spatial data used in the SWAT model are not sufficient to provide estimates for individual parcels. More detailed site level data are needed.
Residual Designation Tier 3 (≤ 1 impervious acre)	No	Spatial data exists for the sites but the scale and resolution of the spatial data used in the SWAT model are not sufficient to provide estimates for individual parcels. More detailed site level data are needed.
Future Stormwater Permits	No	Scope of potential future permits is not yet determined.
Construction General Permit	No	Spatial data of areas subject to CGP are not available.
Multi-Sector General Permit	No	Spatial data of areas subject to MSGP are not available.
Communities with Untreated CSO Discharges	No	Estimates of discharge flows from active untreated CSO are non-existent.
Treated CSO discharge	Yes	DMR flow and water quality data were used to quantify annual phosphorus loads to LC.
Agricultural Production Area Discharges	Yes	SWAT-generated load data were used to quantify the existing loads from production areas

Estimates of annual phosphorus loads are available for Burlington's CSO treatment facility. Therefore, a mass based WLA has been established for this discharge, as shown in Table 7. The WLA requires a 10% reduction below existing loading levels. This WLA was established by assuming the same level of source reduction to the impervious area draining to the CSO as was assumed for the portion of Burlington draining directly to the Bay (i.e., the developed land WLA for Burlington Bay) – see discussion in the following paragraphs for how the developed land WLAs were established.

For the reasons discussed above, EPA has established WLAs for developed land within each lake segment (see Table 7). The developed land WLAs set overall allocations and reduction targets for all developed land within each lake segment. To comply with the WLAs, the permitting authority (VT DEC) will need to demonstrate that the combined effect of the mix of permits issued will achieve enough phosphorus reduction to meet the allocation. Some permit categories are better suited than others at achieving phosphorus reductions through retrofit requirements. One benefit of establishing overall WLAs for developed land is that it provides a certain amount of flexibility to the permitting authority – DEC has the opportunity to consider the totality of the stormwater permitting programs as it designs the most effective program to achieve the overall load reduction. However, it will be important for DEC to establish a phosphorus load tracking and accounting system to guide permit requirements and eventually assess permit and WLA compliance.

Discharges of manure, litter, and process wastewater from CAFOs are subject to NPDES permits and, therefore, require wasteload allocations. Vermont issued a general permit for medium CAFOs in 2013 but to date, there are no CAFOs currently covered by the permit. Large and small CAFOs would receive individual permits and the State has not permitted any at this time. Any NPDES permits issued by DEC for CAFOs would prohibit discharges of manure, litter, and process wastewater except when precipitation causes an overflow during greater than 25 year/24 hour storm events. In anticipation of the possibility that a number of CAFOs may be permitted in the future, the TMDL includes allocations for all agricultural production areas in the Champlain Basin (based on data available in 2013, as described in Tetra Tech, 2015b) on the wasteload allocation side of the TMDL equation. This is similar to the approach described above for developed land stormwater WLAs, in that the agricultural production areas WLAs cover discharges from both NPDES-regulated and non-NPDES regulated agricultural production areas. The allocations were determined by applying an 80% reduction to the SWAT-generated base loads for production areas (referred to as "farmsteads" in the SWAT modeling and scenario tool reports). The 80% reduction level was used to approximate the reduction estimated to be feasible with state-of-the-art barnyard management BMPs that will be required as part of the State's commitment to inspections and required BMP implementation in addition to CAFO inspections. This reduction level is also consistent with what would be achieved by CAFOs subject to NPDES permit requirements, as described above. The remaining 20% of the base load was used as the wasteload allocation. This allocation was totaled for each lake segment watershed to establish an overall wasteload allocation for agricultural production areas for each lake segment watershed, as shown in Table 7. Note that any phosphorus runoff from fields, including runoff from land application of manure, litter, and process wastewater by CAFOs consistent with nutrient management plans developed in accordance with CAFO requirements, will remain part of the load allocation as non-NPDES regulated agricultural stormwater discharges (See 40 CFR § 122.23(e)).

6.1.2.1 SETTING THE WLA LEVELS FOR DEVELOPED LAND

The approach to setting the developed land WLAs varied by lake segment. For Missisquoi Bay and South Lake B segments, where the achievement of the total loading capacity will be extremely challenging, EPA used the scenario tool to simulate a level of stormwater treatment considered aggressive but still feasible to accomplish given EPA's experience with other watersheds in New England. For South Lake B, the WLA was based on reductions that could be achieved with stormwater retrofits equivalent to the combination of 100% of hydrologically connected unpaved road segments, and 25% of other impervious area (commercial, industrial, and residential land uses, excluding area above class D soils), and 25% of paved roads on A and B soils. For Missisquoi Bay, the WLA was based on the same level of retrofits to unpaved roads (100% of hydrologically connected segments), but with retrofits to 60% of other impervious area (excluding impervious area above class D soils) and 50% of paved roads above A and B soils.

For the Otter Creek, Main Lake, Shelburne Bay, Burlington Bay, Malletts Bay and St. Albans Bay segments, where less overall reduction is needed (and where the Scenario Tool indicates more opportunities for reduction exist than are needed across all sector sources), the developed land WLAs were based on a more moderate level of stormwater retrofits. These WLAs were set based on reductions achievable through retrofitting the equivalent of the combination of 10% of non-road impervious area above A and B soils, 25% of paved roads on A and B soils, and 100% of hydrologically connected unpaved road segments.

Four small lake segment watersheds (South Lake A, Port Henry, Isle LaMotte and Northeast Arm) include so little developed land that phosphorus reductions from the developed land sector can generally only be influenced by treatment of roads rather than other impervious cover. Therefore, the WLAs for these segments were set based on the same level of road retrofits as described immediately above, but without any retrofits to non-road impervious cover beyond that needed to meet the future growth allocations (see next section for a description of how the future growth allocations were derived and factored into the wasteload allocations). Refer to Appendix B for a more detailed description and matrix of the extent and type of stormwater retrofits simulated for each lake segment watershed. The simulations also took into account phosphorus reductions associated with the Vermont restrictions on phosphorus lawn fertilizer use, as described in Tetra Tech (2015c).

6.1.2.2 FUTURE GROWTH FROM DEVELOPED LAND

DEC developed estimates for future growth of impervious area over the next 20 years based on past development trends, a few local assessments, and the number of past construction permits. The analysis considered new phosphorus loads from both jurisdictional development (future development subject to stormwater permits) and sub-jurisdictional development (future growth associated with smaller developments not currently subject to stormwater permits). The analysis assumed a high level of phosphorus treatment for future jurisdictional development (based on provisions in the new Vermont stormwater manual currently in preparation) and very little phosphorus control for sub-jurisdictional development. EPA used the results of this analysis to establish future growth allocations for each lake segment watershed as shown in Table 7. These allocations were subtracted from the initial developed land wasteload allocation (as established using the procedures described above) for each lake segment. The DEC future growth analysis in included in Appendix A.

6.2 LOAD ALLOCATION

The TMDL load allocations apply to the non-NPDES regulated point sources and nonpoint sources in the categories of agriculture, forest land, and streambank erosion. The approach to setting the load allocations varied by lake segment. For Missisquoi Bay and South Lake B segments, where the achievement of the total loading capacity will be extremely challenging, EPA's Scenario Tool indicated that the maximum amount of BMP implementation possible within the watersheds will be necessary to meet the total loading capacity (in combination with applicable WLAs). Therefore, EPA set the allocations based on phosphorus reductions simulated to result when a very extensive suite of management practices are implemented within each sector. For Missisquoi Bay, the allocations reflect a 65% reduction from streambanks, a 60% reduction from forest lands, and an 83% reduction from agricultural sources. For South Lake B, where less overall reduction is needed, the allocations reflect a 30% reduction from streambanks, a 60% reduction from forest lands, and a 59% reduction from agricultural sources. The streambank reduction is greater in the Missisquoi Bay watershed because of the greater amount (and higher erosion status) of unstable stream reaches in that watershed.

For most of the remaining lake segments, where less overall reduction is needed (and where the Scenario Tool indicates that more opportunities for reduction exist than are needed across all sector sources), the allocations were set as follows: EPA first analyzed how much reduction could be achieved from all sources of phosphorus, and then established the wastewater treatment plant and developed land WLAs as described in Section 6.1 for each segment. EPA then established LAs for agriculture, streambanks and forests to achieve the remaining needed reductions. The South Lake A, Port Henry, Burlington Bay, Northeast Arm and Isle LaMotte segments each have relatively small amounts of unstable stream corridors and were not broken out separately due to modeling constraints. Any streambank erosion discharges in these segments are captured in the developed land, agriculture and forest allocations and will be addressed by measures that will reduce erosion within the stream corridors.

Note that virtually all of the land in the Burlington Bay watershed is in the developed land category, so there are no load allocations for Burlington Bay.

As a general procedure, EPA set the forest and streambank loads in all segments first, and then set the agriculture loads based on the remaining capacity, taking into account the amount of reduction found to be achievable from agricultural sources using the Scenario Tool. Given that there is less detailed information on the forest load sources and magnitudes available from the SWAT modeling work, EPA chose to rely on only a modest reduction (5%) from the forest sector for the lake segment watersheds where less overall reduction is needed. However, as noted above, in Missisquoi Bay and South Lake B, the forest reduction goals were set at 60%, due to the large reductions needed in these segments and the relatively large phosphorus loads from forest lands in these segment watersheds. Streambank allocations were set at a moderate reduction level (the level that assumes stabilization of reaches with phosphorus loads in the top 50th percentile) for the large lake segment watersheds other than Missisquoi Bay and South Lake B. Reductions from streambanks are important, but are expected to take many decades to occur, as the restoration strategy depends in part on actions that will facilitate natural stream evolution processes. Note that the scale of the SWAT modeling effort did not permit the generation of streambank loading estimates for many of the smaller lake segment watersheds dominated by direct drainage to the lake. This precluded EPA from establishing separate streambank load allocations for these segments. As noted above, for South Lake B, a higher level of reduction from streambanks was established, based on stabilization of reaches with phosphorus loads above the 25th percentile. For Missisquoi Bay, given that nearly all reaches are unstable (not at equilibrium conditions), the streambank allocation was set at a level that assumed phosphorus reduction from all reaches.

The agricultural load allocations were then set based on the remaining loading capacity available, with consideration of the total amount of reduction found to be achievable in each sector. As noted in Section 5.2, consistent with Vermont's desire to apply basic measures uniformly across the basin, a minimum reduction in agricultural source loads was applied to all lake segment watersheds except for Burlington Bay, where no reduction was applied since agricultural sources are minimal. Beyond the 20% minimum, agricultural source load reduction percentages were applied equally to the South Lake B and South Lake A watersheds since both watersheds have common characteristics and influence the loads that would achieve the phosphorus criterion in the South Lake A segment. Additional agricultural source load reduction percentages were applied equally to the Otter Creek and Main Lake watersheds to ensure consistent treatment of agricultural lands in the central part of the lake when determining the loads that would achieve the phosphorus criterion in the Main Lake. For more information on the bases for the estimates of phosphorus reductions achievable in each sector, refer to Appendix B.

6.2.1 INTERNAL SEDIMENT CONSIDERATIONS – ST. ALBANS BAY AND MISSISQUOI BAY

One challenge inherent in lake phosphorus modeling efforts is to characterize the transfer of phosphorus between the water column and the bottom sediment. A certain portion of the phosphorus in particulate form typically settles out of the water column and becomes part of the bottom sediment. In addition, depending on the amount of phosphorus stored in the bottom sediment and the chemical characteristics of the water/sediment interface, some phosphorus can be released back into the water column. The modeling took this exchange of phosphorus with the bottom sediment into account for all segments as part of the model calibration step, as described in Tetra Tech (2105a). Whether the bottom sediment acts as either a source or a sink for phosphorus, the transfer is factored into the model's indication of the reductions needed from watershed sources to meet the water quality targets in each segment.

In 10 out of 12 lake segments, much more phosphorus is settling out into the bottom sediments than is being returned. In the other two segments, St. Albans Bay and Missisquoi Bay, site specific studies (referenced below) have found that a large internal load from the sediment will persist for many years. Additional information on the sediment/phosphorus dynamics in both St Albans Bay and Missisquoi Bay is included below.

Studies have found that St. Albans Bay and Missisquoi Bay have accumulated substantial amounts of phosphorus in the bottom sediment. This stored phosphorus represents an additional source of phosphorus for these segments, expected to be released to the water column over time.

The 2002 Lake Champlain Phosphorus TMDL included a discussion of the internal phosphorus loading problem in St. Albans Bay. The Bay has been subject to excessive phosphorus loading over a period of many decades, resulting in severe algae blooms during the summer. A major phosphorus removal upgrade of the St. Albans City Wastewater Treatment Facility in 1987 significantly reduced phosphorus loading to the Bay. However, phosphorus concentrations in the Bay did not decline as expected after the treatment plant upgrade. Internal phosphorus loading from phosphorus stored in the Bay's sediments, along with ongoing, excessive phosphorus loading from the Bay's watershed, were found to be responsible for the continued high phosphorus concentrations in St. Albans Bay.

The phosphorus modeling analysis used to derive the total loading capacity for St. Albans Bay in the 2002 Lake Champlain TMDL assumed that net internal loading to the Bay would decline to zero over time once external watershed loads were reduced. This assumption was considered to be conservative since in most other Lake Champlain segments, much more phosphorus is being transferred to the bottom sediment than is being returned to the water column.

To test the assumption that internal loading would decline within a reasonable time period without in-lake intervention, DEC sponsored research on the phosphorus content of St. Albans Bay sediments and the chemical mechanisms that lead to its release into the water column. The study (Druschel et al., 2005) concluded that there remains a substantial reservoir of phosphorus in the sediments of St. Albans Bay which has the potential to contribute phosphorus to the water in the Bay for a long period of time into the future.

In light of these findings, DEC initiated a "Phase 1 Feasibility Study for the Control of Internal Phosphorus Loading in St. Albans Bay" which was completed by ENSR Corp. (ENSR, 2007). The study evaluated several alternative methods for controlling internal loading in the Bay as to technical feasibility, cost, and environmental impacts. Methods evaluated included circulation, dredging, chemical phosphorus inactivation in the sediments, and tributary dosing.

Phosphorus concentrations in the tributary streams draining to St. Albans Bay are among the highest in the Lake Champlain basin because of uncontrolled nonpoint sources in the Bay's watershed. If these external phosphorus sources are not adequately reduced before an in-lake treatment takes place, the longevity and effectiveness of an internal treatment would be seriously compromised. The 2002 Lake

Champlain TMDL stated that progress in reducing nonpoint source phosphorus loading to St. Albans Bay should be a prerequisite before any in-lake treatment is attempted to control internal phosphorus loading. The Phase 1 Feasibility Study reiterated this strong recommendation. EPA concurs with this recommended approach, and expects that the load and wasteload allocations applying to the watershed sources (shown in Table 7) will be achieved prior to controlling internal loading sources.

Based on the extensive research and modeling done on internal phosphorus dynamics in St. Albans Bay, it is unlikely that control of external watershed phosphorus loading sources alone will result in the full attainment of water quality standards in the Bay. An in-lake treatment to control internal phosphorus loading will likely be necessary as a final step in the restoration of the Bay. Given that such an in-lake treatment approach is expected to be feasible and implemented if necessary, EPA did not establish a separate sediment load allocation for St. Albans Bay and assumed a net sedimentation balance, similar to that of other Lake Champlain segments without excessive internal loading.

The internal sediment situation in Missisquoi Bay is somewhat different. Similarly to St. Albans Bay, recent detailed studies of phosphorus dynamics in Missisquoi Bay (LimnoTech, 2012 and 2015) found that a large amount of phosphorus is currently stored in the bottom sediments and is expected to be released gradually for many decades to come. However, unlike the St. Albans Bay case, there does not appear to be an option to control (as with an alum treatment, for example) the bottom sediment source, should that be deemed desirable in the future. This is because the phosphorus sediment build-up covers a very large area (22,000 acres) and much of this area is within a national wildlife refuge or outside the U.S. border (making such approaches much more challenging), and the potential environmental impacts of such treatment to such a large area would be much greater. The allocations in Table 7 for the watershed sources take into account a continual source from the sediment that would slowly decline if adequate watershed load reductions are achieved. The allocations were based on the level of reduction the LimnoTech report (2015) indicated would be needed to eventually achieve the phosphorus criterion in the bay (projecting results out to 70 years in the future), factoring in the long-term loading from the bottom sediment.

6.3 MARGIN OF SAFETY

The statute and regulations require that a TMDL include a margin of safety ("MOS") to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality (CWA §303(d)(1)(C); 40 C.F.R. §130.7(c)(1)). EPA's 1991 TMDL Guidance (USEPA, 1991) explains that the MOS may be implicit, i.e., incorporated into the TMDL through conservative assumptions in the analysis, or explicit, i.e., expressed in the TMDL as loadings set aside for the MOS. If the MOS is implicit, the conservative assumptions in the analysis that account for the MOS must be described. If the MOS is explicit, the loading set aside for the MOS must be identified.

Although there are conservative assumptions built into the modeling approach, one of the lessons learned from the review of the 2002 TMDL approval, where an implicit margin of safety was used, was that in a system as complex as Lake Champlain, it is difficult to assure conservatism in every lake segment. In light of this complexity, EPA has allocated an explicit margin of safety equal to five percent of the total loading capacity for each segment. The uncertainty analysis completed as part of the lake modeling indicated that the average area-weighted prediction error of the model for 1991-2010 (which includes both the calibration and validation periods) was +4.15 percent. A positive prediction error value means that the model predicted higher phosphorus concentrations than monitored values, indicating that there is conservatism built into the model. Negative prediction error values indicate that the model predicted somewhat lower phosphorus concentrations than the actual monitored concentrations for this period, indicating that the model is somewhat under estimating (on average) the extent to which phosphorus loads elevate in-lake concentrations. On a segment by segment basis, the average prediction error for the 1991-2010 period ranged from -7.97% to +17.77% across the 12 TMDL segments (see Table 6). The prediction error for 10 of 12 segments was above zero, with only two segments below zero – Northeast Arm and Isle LaMotte (at -2.8 and -7.97 respectively). Both of these segments receive an extremely small percentage of the total phosphorus load to the lake (2.8% and 0.6% respectively), and are assigned allocations that translate to only modest overall reductions (12% and 13%). These two segments are also dominated by agricultural land, and the specified reductions from agricultural sources are just a small fraction of the anticipated phosphorus reduction expected as a result of the State's new required agricultural practices, based on EPA's Scenario Tool analysis. Specifically, the TMDLs include agricultural source reductions of approximately 20% for these two segments, and EPA's analysis indicates that agricultural load reductions of more than 60% are expected in each case (see Appendix B). Given these mitigating circumstances for the two segments with the negative prediction errors, and the conservatism demonstrated by the modeling results for all other segments and the lake as a whole, EPA is confident that the 5% explicit MOS is adequate for these TMDLs.

Table 6. BATHTUB Model Prediction Error, 1991-2010. Source: (Tetra Tech, 2015a).

Lake Segment	Model Prediction Error
South Lake B	+0.05
South Lake A	+13.16
Port Henry	+9.57
Otter Creek	+13.57
Main Lake	+5.25
Shelburne Bay	+17.77
Burlington Bay	+5.16
Malletts Bay	+5.72
Northeast Arm	-2.80
St. Albans Bay	+5.65
Missisquoi Bay	+13.32
Isle LaMotte	-7.97
Lake-wide area-weighted average	+4.15

6.4 TMDL ALLOCATION SUMMARY

The resulting allocations by sector for each lake segment are shown in Table 7. The percent reductions needed to achieve these various allocations by lake segment are shown in Table 8. The final WWTF allocations are listed in Table 9. Facilities with allocations different from the 2002 TMDLs are shown in italics. Figure 7 presents a graphical depiction of the change from the base loading to the TMDL allocation.

Table 7. Allocations by Lake Segment.

Lake Segment	2001-2010 Base Load	Total Loading Capacity	WWTF WLA	CSO WLA	Developed Land WLA	Future Growth WLA	Ag Prod Area WLA	Total WLA	Forest LA	Streams LA	Agriculture LA	Total LA	5% MOS
01. South Lake B	51.09	28.90	1.62	*	6.89	0.04	0.22	8.78	5.45	5.75	7.49	18.68	1.45
02. South Lake A	26.45	12.52	0.23	-	1.79	0.00	0.16	2.18	0.47	†	9.24	9.72	0.63
03. Port Henry	7.02	5.91	0.00	-	0.59	0.00	0.02	0.62	0.04	†	4.96	5.00	0.30
04. Otter Creek	140.52	105.87	11.98	*	15.69	0.48	0.41	28.56	22.78	13.76	35.48	72.02	5.29
05. Main Lake	162.18	127.64	9.85	*	26.77	1.44	0.43	38.48	30.90	35.66	16.22	82.77	6.38
06. Shelburne Bay	10.18	8.90	0.72	-	2.64	0.28	0.04	3.68	0.30	0.09	4.39	4.78	0.45
07. Burlington Bay	4.54	3.16	1.46	0.78	0.50	0.22	0.00	2.97	0.02	†	0.00	0.03	0.16
09. Malletts Bay	56.39	46.46	3.24	-	12.65	0.68	0.31	16.88	7.19	3.58	16.49	27.26	2.32
10. Northeast Arm	17.82	15.50	0.00	-	3.55	0.04	0.08	3.68	1.71	†	9.34	11.05	0.78
11. St. Albans Bay	13.94	10.55	1.13	*	2.03	0.36	0.04	3.56	0.23	0.69	5.54	6.46	0.53
12. Missisquoi Bay	136.33	48.64	2.00	*	11.88	0.34	0.64	14.87	8.02	13.97	9.35	31.34	2.43
13. Isle La Motte	4.10	3.59	0.11	-	0.77	0.02	0.02	0.91	0.08	†	2.42	2.50	0.18
TOTAL	630.56	417.64	32.34	0.78	85.76	3.90	2.38	125.16	77.18	73.49	120.93	271.60	20.88

*CSO allocation included as part of Developed Land

†Stream allocation included in Developed Land WLA and Agriculture and Forest LA

- No CSOs in segment

Table 8. Percent reductions needed to meet TMDL allocations

Lake Segment	Total Overall	Waste water[1]	CSO	Developed Land[2]	Ag Prod Areas	Forest	Streams	Agriculture
01. South Lake B	43.4%	0.0%		23.7%	80%	60.0%	30.5%	59.5%
02. South Lake A	52.7%	0.0%		21.0%	80%	5.0%		59.5%
03. Port Henry	15.8%			10.6%	80%	5.0%		20.0%
04. Otter Creek	24.7%	0.0%		22.2%	80%	5.0%	40.1%	46.9%
05. Main Lake	21.3%	61.1%		23.8%	80%	5.0%	28.9%	46.9%
06. Shelburne Bay	12.5%	64.1%		21.3%	80%	5.0%	55.0%	20.0%
07. Burlington Bay	30.5%	66.7%	10.0%	38.1%	0%	0.0%		0.0%
09. Malletts Bay	17.6%	0.0%		26.3%	80%	5.0%	44.9%	23.9%
10. Northeast Arm	13.0%			9.8%	80%	5.0%		20.0%
11. St. Albans Bay	24.3%	59.4%		21.8%	80%	5.0%	55.0%	34.3%
12. Missisquoi Bay	64.3%	51.9%		30.1%	80%	60.0%	65.3%	82.8%
13. Isle La Motte	12.4%	0.0%		12.0%	80%	5.0%		20.0%
TOTAL	33.8%	42.1%	10.0%	24.1%	80%	23.4%	43.4%	51.5%

[1] % change from current permitted loads

[2] Includes reductions needed to offset future growth

Table 9. Vermont Individual WWTF Phosphorus Wasteload Allocations

(*Facilities with allocations different from the 2002 TMDLs are shown in italics.*)

Facility	Lake Segment	Design Flow (mgd)	Currrent Permit Load (mt/yr)	TMDL Wasteload Allocation (mt/yr)	Change in Permitted Load (mt/yr)
Benson	01 South Lake B	0.018	0.122	0.122	0.000
Castleton	01 South Lake B	0.480	0.397	0.397	0.000
Fair Haven	01 South Lake B	0.500	0.414	0.414	0.000
Poultney	01 South Lake B	0.500	0.414	0.414	0.000
West Pawlet	01 South Lake B	0.040	0.276	0.276	0.000
Orwell	02 South Lake A	0.033	0.228	0.228	0.000
Brandon	04 Otter Creek	0.700	0.580	0.580	0.000
Middlebury	04 Otter Creek	2.200	1.823	1.823	0.000
Otter Valley Union High School	04 Otter Creek	0.025	0.173	0.173	0.000
Pittsford	04 Otter Creek	0.085	0.483	0.483	0.000
Pittsford Fish Hatchery	04 Otter Creek	2.600	0.691	0.691	0.000
Proctor	04 Otter Creek	0.325	0.359	0.359	0.000
Rutland City	04 Otter Creek	8.100	5.634	5.634	0.000
Salisbury Fish Hatchery	04 Otter Creek	1.310	0.181	0.181	0.000
Shoreham	04 Otter Creek	0.035	0.242	0.242	0.000
Vergennes	04 Otter Creek	0.750	0.621	0.621	0.000
Wallingford	04 Otter Creek	0.120	0.829	0.829	0.000
West Rutland	04 Otter Creek	0.450	0.364	0.364	0.000
Barre City	*05 Main Lake*	*4.000*	*3.314*	*1.105*	-2.209
Burlington East	*05 Main Lake*	*1.200*	*0.994*	*0.331*	-0.663
Burlington Electric	05 Main Lake	0.365	0.017	0.017	0.000
Burlington North	*05 Main Lake*	*2.000*	*1.657*	*0.552*	-1.105
Cabot	05 Main Lake	0.050	0.041	0.041	0.000
Essex Junction	*05 Main Lake*	*3.300*	*2.569*	*0.911*	-1.658
Global Foundries	*05 Main Lake*	*8.000*	*5.531*	*2.210*	-3.321
Marshfield	05 Main Lake	0.045	0.311	0.311	0.000
Montpelier	*05 Main Lake*	*3.970*	*3.290*	*1.097*	-2.193
Northfield	*05 Main Lake*	*1.000*	*0.829*	*0.276*	-0.553
Plainfield	*05 Main Lake*	*0.125*	*0.691*	*0.138*	-0.553
Richmond	*05 Main Lake*	*0.222*	*0.184*	*0.061*	-0.123
South Burlington Airport Park.	*05 Main Lake*	*3.300*	*1.906*	*0.911*	-0.995
Stowe	*05 Main Lake*	*1.000*	*0.282*	*0.276*	-0.006
Waterbury	*05 Main Lake*	*0.510*	*0.563*	*0.141*	-0.422
Weed Fish Culture Station	05 Main Lake	11.500	0.914	0.914	0.000
Williamstown	*05 Main Lake*	*0.150*	*1.036*	*0.166*	-0.870
Winooski	*05 Main Lake*	*1.400*	*1.160*	*0.387*	-0.773

Hinesburg	*06 Shelburne Bay*	*0.250*	*0.276*	*0.069*	-0.207
Shelburne #1	*06 Shelburne Bay*	*0.440*	*0.348*	*0.122*	-0.226
Shelburne #2	*06 Shelburne Bay*	*0.660*	*0.497*	*0.182*	-0.315
South Burlington Bart. Bay	*06 Shelburne Bay*	*1.250*	*0.878*	*0.345*	-0.533
Burlington Main	*07 Burlington Bay*	*5.300*	*4.392*	*1.464*	-2.928
Fairfax	09 Malletts Bay	0.078	0.539	0.539	0.000
Hardwick	09 Malletts Bay	0.371	0.410	0.410	0.000
Jeffersonville	09 Malletts Bay	0.077	0.532	0.532	0.000
Johnson	09 Malletts Bay	0.270	0.224	0.224	0.000
Milton	09 Malletts Bay	1.000	0.829	0.829	0.000
Morrisville	09 Malletts Bay	0.550	0.352	0.352	0.000
Perrigo Nutritionals	09 Malletts Bay	0.425	0.352	0.352	0.000
Northwest State Correctional	11 St. Albans Bay	0.040	0.028	0.028	0.000
St. Albans City	*11 St. Albans Bay*	*4.000*	*2.762*	*1.105*	-1.657
Enosburg Falls	*12 Missisquoi Bay*	*0.450*	*0.373*	*0.124*	-0.249
Newport Center	*12 Missisquoi Bay*	*0.042*	*0.006*	*0.116*	0.110
North Troy	*12 Missisquoi Bay*	*0.110*	*0.760*	*0.122*	-0.638
Richford	*12 Missisquoi Bay*	*0.380*	*0.420*	*0.105*	-0.315
Rock Tenn	*12 Missisquoi Bay*	*2.500*	*1.260*	*0.691*	-0.569
Sheldon Springs	12 Missisquoi Bay	0.054	0.373	0.373	0.000
Swanton	*12 Missisquoi Bay*	*0.900*	*0.746*	*0.249*	-0.497
Troy/Jay	*12 Missisquoi Bay*	*0.800*	*0.221*	*0.221*	0.000
Alburgh	13 Isle LaMotte	0.130	0.108	0.108	0.000
Total			55.802	32.336	-23.465

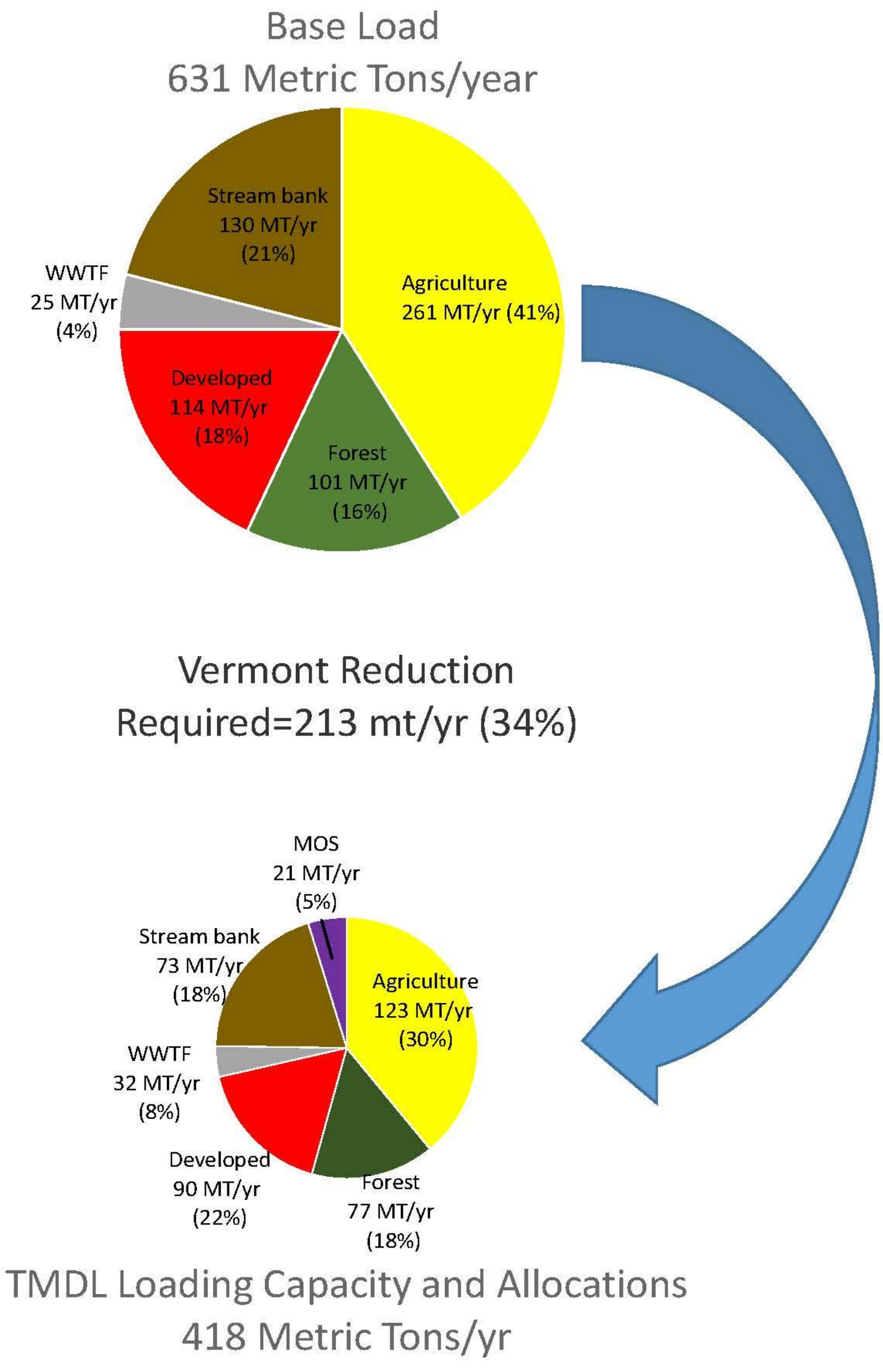

Figure 7: Vermont Lake Champlain base phosphorus loads, 2001-2010, compared to Vermont Lake Champlain TMDL loading capacity and allocations, by sector, in MT/yr

Sources: Data for base loads are from TetraTech, 2015a

EPA
Map Tracker ID: 10397

CHAPTER 7: REASONABLE ASSURANCE & ACCOUNTABILITY FRAMEWORK

7.1 REASONABLE ASSURANCE – BACKGROUND

Section 303(d) of the CWA requires that a TMDL be "established at a level necessary to implement the applicable water quality standard." EPA regulations define a TMDL to include WLAs and LAs, and provide that "[i]f best management practices or other nonpoint source pollution controls make more stringent load allocations practicable, then wasteload allocations can be made less stringent." 40 C.F.R. §130.2(i). EPA's TMDL guidance further explains that when a TMDL is developed for waters impaired by both point and nonpoint sources, and the WLA is based on an assumption that nonpoint source load reductions will occur, the TMDL must provide "reasonable assurances" that nonpoint source control measures will achieve expected load reductions in order for the TMDL to be approvable (USEPA, 1991; see also Perciasepe, 1997). This information is necessary for EPA to determine that the TMDL, including the load and wasteload allocations, has been established at a level necessary to implement water quality standards.

Where a TMDL is developed for waters impaired by both point and nonpoint sources (and non-NPDES-regulated point sources), EPA's determination of reasonable assurance that the TMDL's LAs will be achieved considers whether practices capable of achieving the specified pollutant load: (1) are technically feasible at a level required to meet allocations; and (2) have a high likelihood of implementation. Where there is a demonstration that nonpoint source (and non-NPDES regulated point source) load reductions can and will be achieved, a TMDL writer can determine that reasonable assurance exists and may also, if sufficient load reductions are reasonably assured, allocate greater loadings to NPDES-regulated point sources as WLAs than would otherwise be required.

One basis for EPA's disapproval of the 2002 TMDLs was a finding that the establishment of wasteload allocations based on assumptions that nonpoint source reductions would be achieved was inadequate and inconsistent with EPA regulations and guidance (USEPA 2011a, b). EPA examined two questions: 1) Was there reasonable assurance that nonpoint source control actions will occur, and 2) If these actions occur, was there reasonable assurance that they would achieve enough phosphorus reduction to meet the load allocations specified in the TMDL.

EPA found that the 2002 TMDL document identified only one program which provided reasonable assurance that specified nonpoint source control measures would occur and would result in specific phosphorus reductions compared to baseline loads. The magnitude of reductions expected from this program was less than one percent of the reductions needed to meet the load allocations. EPA was unable to identify any programs or activities in existence at the time of the TMDL submittal that provided assurance that nonpoint source reductions would occur, and that anticipated reductions would be sufficient to meet the TMDL load allocations. EPA thus concluded that the TMDL's level of assurance that necessary load reductions would occur was insufficient to support establishment of less stringent wasteload allocations for the wastewater treatment plants than would otherwise be required.

As described below, for the new Lake Champlain TMDLs, numerous elements combine to provide robust assurance that the necessary load reductions will occur and will achieve sufficient phosphorus reductions to meet the specified load allocations.

7.2 REASONABLE ASSURANCE – GENERAL APPROACH

Each of the Vermont segments of Lake Champlain is dominated by nonpoint sources, with the exception of Burlington Bay. Without a demonstration of reasonable assurance that relied-upon nonpoint source reductions will occur, the Lake Champlain TMDLs would have to assign commensurate reductions to the point sources. EPA communicated this point in an October 22, 2013 letter to DEC Commissioner Mears (USEPA, 2013). Vermont subsequently indicated a clear policy preference to focus on obtaining most if not all of the necessary reductions from nonpoint sources and the point sources (both NPDES and non-NPDES regulated) associated with developed lands, through application of measures uniformly across the Lake Champlain basin. In addition to the policy benefit of consistent requirements across the basin, Vermont was also hoping to minimize reductions at wastewater treatment facilities (WWTFs).

After analyzing all available information, EPA determined that there is reasonable assurance that the nonpoint source (and non-NPDES regulated point source) reductions can and will be achieved and that such reductions are sufficient to enable EPA to allocate greater loadings to the WWTFs than would otherwise be required. EPA's conclusion that there is reasonable assurance that such reductions can and will be achieved rests on the following major factors:

1. Vermont's Phase 1 Implementation Plan, as revised in August, 2015, contains a detailed listing of specific, technically feasible commitments made by the State. Many of the most important milestones in the Plan are included in Act 64, signed into law by Governor Shumlin on June 16, 2015.
2. EPA's modeling and scenario tools enabled the quantification of reductions achievable from the measures contained in the Phase 1 Implementation Plan, and allowed for verification that these reductions are sufficient to meet load allocations for each segment. This is described in detail in Appendix B.
3. EPA has developed an Accountability Framework to provide a sufficient backstop to ensure a high likelihood that implementation of the nonpoint source measures will occur.

Each factor is further described below.

The step-wise manner in which the Lake Champlain TMDLs were developed has yielded a very detailed description of the nonpoint source reductions needed to achieve the load allocations and the stormwater sources in the wasteload allocations. EPA's initial modeling of the revised phosphorus capacity of each lake segment provided an early target for the State and EPA to use in determining the suite of measures necessary to achieve water quality standards. Vermont developed a draft implementation plan and EPA provided extensive comments. The final set of nonpoint source measures and measures applicable to runoff from developed lands were submitted in advance of the final TMDL development as part of the Phase 1 Implementation Plan and reflected the State's commitments as transmitted by Governor Shumlin on May 29, 2014 to the EPA Administrator and Regional Administrator. Authorization for key actions included in the plan and milestone dates were included in Act 64. Vermont provided a revised Phase 1 Implementation Plan in August, 2015, incorporating the deadlines contained in Act 64.

Key among these new measures are the following, which will be applied across the entire watershed:

- Issuance of general permits to control runoff from State Highways, and municipal paved and unpaved roads;
- Issuance of a general permit to address stormwater from existing developed lands equal or greater than 3 acres;

- Revision of the Municipal Separate Storm Sewer System (MS4) general permit;
- Revision of the Vermont Stormwater Management Manual;
- Adoption of a "stormwater practices handbook" for managing runoff from non-jurisdictional projects;
- Revision of the "Required Agricultural Practices" (formerly the "Accepted Agricultural Practices") including such programs as Nutrient Management Planning, Livestock Exclusion and certification of manure applicators;
- Creation of a Small Farm Operation certification program; and
- Revision of the Acceptable Management Practices for forestry.

As such, EPA had a very specific and well defined list of measures to use to evaluate expected phosphorus reduction amounts in each lake segment watershed.

Of equal importance are the financial resources needed to implement the new and revised programs identified in the revised Phase 1 Implementation Plan. In January 2015, Governor Shumlin's Inaugural Address and his recommended budget for state fiscal year 2016 provided the details of the financial foundation. At the end of the legislative process, Act 64 established a Clean Water Fund, structured so that it can serve as a repository for federal and private funding sources in addition to state appropriations. Vermont will contribute approximately $5.3 million annually, to be raised from a surcharge on the value of property subject to property transfer tax for three years. The criteria for prioritizing allocation of funds are aligned well with the new programs required in Act 64. In the interim, alternative approaches to generating revenue for the Clean Water Fund beyond 2018 will be considered. The Vermont Capital Bill also increased the amount of funding dedicated to implementation of polluted stormwater runoff by $1.25 million over the next two years. Act 64 also appropriates funds for 13 new positions at DEC and 7 new positions at the Agency of Agriculture in the fiscal year beginning July 1, 2015. The new staff positions will give these agencies the additional resources needed to implement the Phase 1 Implementation plan, and track progress over time.

Significant new federal funding has also been secured to support TMDL-related actions in Vermont. In August, 2014, U.S. Department of Agriculture Secretary Vilsack announced that that up to $45 million will be provided to protect and improve soil and water quality in the Lake Champlain Basin in Vermont over the next five years. This represents nearly a doubling of the pace of investments made through the Natural Resource Conservation Service. In January, 2015 the USDA announced another $16 million in federal funds to improve Lake Champlain's water quality as part of USDA's Regional Conservation Partnership Program.

As described in Chapter 5, EPA expended significant time and effort to build Lake Champlain-specific models and scenario tools to support the development of the TMDLs. These tools were built with the kinds of pollution reduction measures in mind that EPA expected would be required during the implementation phase. Once Vermont had identified the measures and the scope and scale of their application, EPA was able to quantify the reductions achievable in each of the lake segments. These reductions were then fed back into the lake model to ensure that the net effect of the Wasteload and Load allocations would achieve the water quality standards. The specific BMPs chosen for simulation were based on the available data and their suitability for modeling. These BMPs can be implemented and will achieve the allocated loads. Other combinations of BMPs can achieve the same result. In implementing the allocations Vermont may choose other combinations of measures based on factors such as site-specific conditions, cost-effectiveness, or newly developed measures, as long as they achieve the same outcome.

A summary of how the measures in the State's plan were translated to BMPs in the Scenario Tool and the associated phosphorus reductions is included in Appendix B. A description of the additional assurance provided for Missisquoi Bay is described in the next section (7.2.1).

Finally, EPA has developed an Accountability Framework, detailed in section 7.3, to provide a transparent and understandable way for all interested parties to gauge Vermont's progress in implementing the TMDLs. The milestones are all drawn from Vermont's Phase 1 Implementation Plan and thus reflect the State's commitments. EPA will provide interim and final assessments of Vermont's progress against these milestones to the state and the public. EPA has also laid out the range of actions EPA would consider taking if Vermont does not make satisfactory progress.

7.2.1 REASONABLE ASSURANCE – MISSISQUOI BAY

Missisquoi Bay presents the greatest challenge in attaining water quality standards. It is dominated by nonpoint sources and will require implementation measures above and beyond what will be required in other segments. EPA's analysis assumed especially large reductions from agricultural, streambank, and forest sources in the Missisquoi Bay lake segment watershed. The additional measures described below provide assurance that the additional reductions from these sources will be achieved.

For agriculture, Vermont will visit all known livestock operations in Franklin County and assess them for water quality violations and concerns. The program includes an evaluation of site-specific practices by assessing farm infrastructure, nutrient management planning and management practices. Farms will be required to address any violations of the "Required Agricultural Practices" as well as install site-specific BMPs where necessary to comply with water quality standards. Specific details can be found in the Missisquoi Bay – Enhanced Implementation section of the revised Phase 1 Implementation Plan. (Chapter 5, Section J, Vermont, 2015). The farm specific analyses will be prioritized based on prior identification of farms likely to present the greatest threat to water quality, often referred to as "critical source areas."

This farm-by-farm approach provides additional assurance that the widespread application of measures assumed in EPA's modeling analyses will be carried out on the ground. The focus on critical source areas also provides assurance that the especially large reduction amounts required in the Missisquoi watershed will be achieved. This is because EPA's analysis of the maximum achievable reduction amount for Missisquoi Bay assumed average phosphorus loading rates based on soil type, slope, and land use. However, it has been well documented (Stone Environmental, 2011) that much greater than average phosphorus loads can be generated from small pockets of land that EPA's modeling was unable to detect due to the relatively coarse modeling scale. By focusing on these critical source areas, in addition to other areas, the State will be able to achieve greater reductions than those estimated by EPA.

For streambanks, in addition to all the actions in the river management section of the Phase 1 Plan, DEC has committed in the revised Phase 1 Implementation Plan to the following supplemental measures for Missisquoi Bay:

1) The State will put extra resources/effort into identification of opportunities for re-establishing connections to floodplains, and working with landowners to make these reconnections happen; and

2) The State will invest extra resources/effort into identification of opportunities where active intervention in bank erosion processes could be most effective, and then implementing practices as further described in Chapter 5, Section J of the revised Phase 1 Implementation Plan.

These measures have been shown to be effective at reducing phosphorus loading from streambanks, and the extra effort DEC is committing to these actions provides assurance that the additional phosphorus reductions assumed (in EPA's modeling analysis) from streambank erosion in the Missisquoi Bay watershed will eventually be achieved.

For forests, beyond the updates to the Acceptable Management Practices and the increased enforcement described in the forest management section of the Phase 1 Implementation Plan, the State has committed to the following additional actions in the Missisquoi and South Lake watersheds: Two foresters with the Department of Forests, Parks and Recreation will lead a focused effort in these two lake segment watersheds to accelerate implementation of NRCS cost-share practices funded through the Regional Conservation Partnership Program (RCPP) to improve water quality and reduce phosphorus. These practices include erosion control on active forest trails and landings; installation of bridges, fords, and culverts at stream crossings; restoring forest riparian areas; and mulching. The State will leverage the NRCS Forest Trails and Landings Practice to encourage landowners to address soil erosion and sedimentation associated with logging roads and log landings (the major sources of phosphorus within the forest sector). State funds will be used to leverage federal funds to make this a no-cost practice for landowners in these watersheds for the first five years of the TMDL implementation period. The State has also expanded its Portable Skidder Bridge Program to provide complete coverage for the Missisquoi Bay watershed. In addition, the State will use select LiDAR (Light Detection and Ranging) mapping in the watershed to identify eroding, abandoned and retired forest roads, skid trails and log landings. They will use this information to identify and fund restoration projects. These efforts, combined with the major enhancements to the Acceptable Management Practices (including in particular practices that address erosion and sedimentation at water crossings, forest roads, log landings, and forest harvest sites) provides assurance that the additional phosphorus reductions assumed from forest lands (in EPA's analysis for these watersheds) will be achieved.

7.2.2 REASONABLE ASSURANCE – SOUTH LAKE B

Although the South Lake B segment is physically very different from Missisquoi Bay, significant reductions from forested lands are also necessary in this segment's watershed. Forested land contributes close to 25% of the phosphorus load in the South Lake B segment – the highest percent contribution from forests of any segment. Similarly to Missisquoi Bay, EPA's analysis assumed a much greater reduction of phosphorus from forest land for the South Lake B watershed than from other lake segment watersheds. See the discussion of forest management measures included immediately above for Missisquoi Bay for a description of the reasonable assurance that the additional phosphorus reductions from forest land in the South Lake B watershed will occur.

7.3 ACCOUNTABILITY FRAMEWORK

EPA's prior experience with implementation of the 2002 Lake Champlain TMDLs and with the development of the Chesapeake Bay TMDL, suggests that it is important to establish an accountability framework that guides water quality restoration of Lake Champlain. The accountability framework, including Vermont's Phase 1 and Phase 2 Implementation Plans, will help ensure implementation of the Lake Champlain TMDL but is not itself part of the TMDLs. The Lake Champlain TMDL accountability framework has the following elements:

1. The "Vermont Lake Champlain Phosphorus TMDL Phase 1 Implementation Plan," May 29, 2014, as revised in August 2015;
2. The Tactical Basin Plans (also referred to as "Phase 2 Implementation Plans") that DEC will develop for each of the major basins in Vermont;
3. EPA's commitment to track and assess Vermont's progress through a clear and transparent "report card" process;
4. EPA's commitment to take appropriate federal action if Vermont fails to meet the key milestones in the Phase 1 report card or the implementation schedules in the Phase 2 (Tactical Basin) Plans.

A major basis of EPA's determination that there is reasonable assurance of load reductions for the Lake Champlain TMDLs is the revised Phase 1 Implementation Plan. The plan is the roadmap for how Vermont, in partnership with federal and local governments, will achieve and maintain the reductions necessary to meet the TMDLs' phosphorus allocations. The accountability framework covers two distinct timeframes. Through the end of 2017, the major focus is on putting in place the regulatory changes or new programs identified in the Phase 1 Implementation Plan that provide the platform for longer term success, along with the resources needed to accomplish them. Also important during this period is the development of four Phase 2 Implementation Plans and the enhanced implementation of key programs already in place. Beginning in 2018, the accountability framework is built around the priority milestones contained in the each of the Phase 2 Implementation (Tactical Basin) Plans.

In addition, as described in the Phase 1 Implementation Plan, the Vermont agencies are developing the capability to track BMP implementation for both agricultural and non-agricultural BMPs. DEC is developing a primary system that will document the location and phosphorus reduction capabilities of all BMPs for projects supported by DEC and Clean Water Fund dollars or implemented as part of compliance with regulatory programs. The Agency of Agriculture is developing a database in partnership with USDA and seven other organizations to track the implementation of agricultural BMPs. Using data exchange capabilities, projects and BMP implementation tracked by the agricultural BMP database will be brought into DEC's system at the appropriate summary level. In addition, for road networks, DEC will incorporate BMP tracking either directly, or through data exchange approaches, in partnership with VT Agency of Transportation. EPA is helping to support the development of parts of this tracking system, but the system will be managed and populated by DEC in cooperation with other Vermont agencies. The tracking system will be used to assess progress, particularly at the lake segment watershed scale as the Phase 2 plans are implemented.

7.3.1 ACCOUNTABILITY FRAMEWORK THROUGH 2017

EPA has identified early key milestones in the Phase 1 Implementation Plan that are crucial to the long-term success of implementing the TMDLs and will constitute the main component of the accountability report card. A few other milestones are focused on implementation of key existing programs. These items are taken directly from the revised Phase 1 Implementation Plan. Many of these items are either authorized by or have deadlines for completion in Act 64, as noted below.

By Dec 30, 2015

- Obtain statutory authority to certify manure applicators (completed by passage of Act 64)
- Target CAFO inspections and prioritize inspections of Small Farm Operations in Missisquoi Bay and St. Albans Bay.
- Report to EPA with spending plan capacity
- Publish stormwater management practices handbook for non-jurisdictional projects (Act 64, Sec. 33)

By Dec 30, 2016

- AAP revisions adopted [with expected elements] (Act 64, Sec. 4)
- Small Farm Operation certification program rule adopted (Act 64, Sec. 3)
- Livestock exclusion incentive program in place (Act 64, Sec. 4)
- Develop matrix and small farm template for nutrient management planning
- Develop Environmental Stewardship Incentive program in priority watersheds
- Mandate certification of custom manure applicators (Act 64, Sec. 16)
- Develop requirements for farmer training programs (Act 64, Sec. 15)
- Issue Final TS4 permit
- Adopt final Vermont Stormwater Management Manual
- Establish Municipal Stormwater Technical Assistance program
- Forestry AMP revisions completed (Act 64, Sec. 49)
- Legislature establishes Clean Water Improvement Fund (completed by passage of Act 64)
- Tactical Basin Plans (Phase 2) complete for Lamoille and Missisquoi basins
- Updated Report to EPA with spending plan capacity

EPA will issue an interim report card in early 2017 assessing Vermont's success in meeting these milestones.

By Dec 30, 2017

- NMP milestones completed
- Targeted funding for agricultural BMP and Nutrient Management Plan implementation provided in Missisquoi Bay, St. Albans Bay and South Lake
- Report to legislature on recommendations for tile drains (Act 64, Sec. 5)
- Issue Final Municipal Roads General Permit (Act 64, Sec. 31)
- Issue Final Developed Lands General Permit (Act 64, Sec. 31)
- Tactical Basin Plans (Phase 2) completed for Poultney, Mettawee and Lower Lake Champlain

EPA will issue a final report card in early 2018 assessing Vermont's success in meeting these milestones. If EPA finds Vermont has failed to make satisfactory progress, EPA may take one or more of the following actions:

- Revise the TMDLs to reallocate additional load reductions from nonpoint to point sources, such as wastewater treatment plants (e.g., reduce the wasteload allocations for facilities in the South Lake B, Main Lake, Shelburne Bay, Burlington Bay, St. Albans Bay and Missisquoi Bay segments to loads equivalent to the limit of phosphorus removal technology).

- Expand NPDES permit coverage to unregulated sources. For example, exercise Residual Designation Authority (RDA) to increase the number of sources or communities regulated under the NPDES permit program.
- Increase and target federal enforcement and compliance assurance in the watershed.

7.3.2 ACCOUNTABILITY FRAMEWORK BEYOND 2017

Beyond 2017, the accountability framework will shift to gauging progress on a watershed- specific basis, keyed to whether VT implements the measures in each of the Phase 2/Tactical Basin Plans. Each Tactical Basin Plan will cover a 5 year period and be subsequently revised and reissued for the next 5 year phase. Interim updates will be made as needed during the cycle. Each Tactical Basin Plan will include an "Implementation Table" that lays out the priority actions to be taken by specific dates. Those actions and dates will constitute the report card elements for the specific basin. EPA envisions issuing an interim report card halfway through each cycle and a formal assessment at the end of the cycle.

The tactical basin plan implementation tables translate the results of the integrated assessments into specific geographically explicit areas for project-level intervention, and to support programmatic and partner installation of BMP's in order to reduce phosphorus loads by a projected amount for each tactical plan cycle. These science-based assessments also serve to identify where additional regulatory program requirements may be brought to bear by the relevant programs. Tactical plan implementation tables will be frequently updated to reflect the implementation of practices that are required as a result of regulatory program requirements.

The issuance of the initial Phase 2 Implementation Plans for four of the six basins are included as key milestones in the first phase of the accountability framework. The Phase 2 Implementation Plans for the other two basins will be part of the 2018 and 2019s revision of those Tactical Basin Plans. The cycles for the Tactical Basin Plans are staggered to better distribute the workload. The expected schedule for the plans and report cards over three cycles (15 years) is outlined below.

<u>Lamoille and Missisquoi Basins</u>
2016 – Tactical Basin Plan (Phase 2) issued [included in 1st phase accountability framework]
2019 – Interim report card
2021 – Final report card; revised Tactical Basin Plan (Phase 3)
2024 – Interim report card
2026 – Final report card; revised Tactical Basin Plan (Phase 4)
2029 – Interim report card
2031 – Final report card; revised Tactical Basin Plan (Phase 5)

<u>Poultney, Mettawee and Lower Lake Champlain Basins</u>
2017 – Tactical Basin Plan (Phase 2) issued [included in 1st phase accountability framework]
2020 – Interim report card
2022 – Final report card; revised Tactical Basin Plan (Phase 3)
2025 – Interim report card
2027 – Final report card; revised Tactical Basin Plan (Phase 4)
2030 – Interim report card
2032 – Final report card; revised Tactical Basin Plan (Phase 5)

Winooski Basin
2018 – Tactical Basin Plan (Phase 2) issued [included in 1st phase accountability framework]
2021 – Interim report card
2023 – Final report card; revised Tactical Basin Plan (Phase 3)
2026 – Interim report card
2028 – Final report card; revised Tactical Basin Plan (Phase 4)
2031 – Interim report card
2033 – Final report card; revised Tactical Basin Plan (Phase 5)

Otter Creek, Little Otter Creek, Lewis Creek Basin
2019 – Tactical Basin Plan (Phase 2) issued [included in 1st phase accountability framework]
2022 – Interim report card
2024 – Final report card; revised Tactical Basin Plan (Phase 3)
2027 – Interim report card
2029 – Final report card; revised Tactical Basin Plan (Phase 4)
2031 – Interim report card
2034 – Final report card; revised Tactical Basin Plan (Phase 5)

Upper Lake Champlain Basin
2015 – Tactical Basin Plan issued [precedes TMDL, not yet Phase 2 in scope]
2020 – Feedback on 2015 plan implementation; revised Tactical Basin Plan (Phase 2)
2023 – Interim report card
2025 – Final report card; revised Tactical Basin Plan (Phase 3)
2028 – Interim report card
2030 – Final report card; revised Tactical Basin Plan (Phase 4)

If EPA finds Vermont has failed to make satisfactory progress in any of the report cards described above, EPA may take one or more of the following actions for the lake segment in question:

- Revise the TMDL for the segment to allocate load reductions from nonpoint to point sources, such as wastewater treatment plants.
- Expand NPDES permit coverage to unregulated sources. For example, exercise Residual Designation Authority (RDA) to increase the number of sources, operations or communities regulated under the NPDES permit program.
- Increase and target federal enforcement and compliance assurance in the watershed.

EPA expects that such actions would be tailored to address any shortcoming in the specific basin or segment. However, if EPA determines that systematic shortcomings are occurring in multiple basins, EPA reserves the option to consider broader scale actions.

CHAPTER 8: IMPLEMENTATION

EPA guidance (USEPA, 1999) recommends that each TMDL have associated implementation plan, although such plan is not part of the TMDL. As discussed below, Vermont has developed a detailed implementation framework for the Lake Champlain TMDLs, which involves several phases of actions designed to achieve the phosphorus reductions established in the TMDLs. The first phase focuses on policy decisions and programs that would apply across the Vermont portion of the Lake Champlain watershed. The second phase focuses on the six major basins through tactical plans that determine what specific programs will be applied to specific parts of a basin and in what priority order. Future phases are envisioned as five year updates to the second phase plans.

Phase 1

At EPA's request, Vermont developed and submitted the "Vermont Lake Champlain Phosphorus TMDL Phase 1 Implementation Plan" in May, 2014. The Phase 1 Implementation Plan provided Vermont's detailed strategy for addressing nonpoint sources and stormwater point sources across Vermont portion of the Lake Champlain basin. Vermont updated the Phase 1 Implementation Plan in August 2015 to include measures and programs developed subsequent to the original plan and to include relevant references to Act 64, which provides authorization for some programs and deadlines for implementing certain actions. Table 1 and Figure 1 in the Executive Summary of the revised Phase 1 Implementation Plan provide the major steps the State will take, by major source category, to put in place all the programs that will be deployed across the Lake Champlain basin. Many of these steps will be completed between 2015 and the end of 2017.

As described in Chapter 7, the Phase 1 Implementation Plan submitted in 2014 and revised in 2015 was sufficiently detailed to allow EPA to quantify the associated reductions and determine that the load allocations and the stormwater portions of the wasteload allocations can and will be achieved. Elements of the revised Phase 1 Implementation Plan also provide the key milestones in the Accountability Framework.

The 2014 Phase 1 Implementation Plan did not provide detail on how the wasteload allocations for the Wastewater Treatment Facilities would be implemented since EPA had not yet identified the WLAs for those facilities. The revised plan provides a schedule by which Vermont will reissue WWTF permits, generally following the basin planning approach described further below in Phase 2.

When implementing the wasteload allocations for WWTFs through NPDES permits, EPA acknowledges that DEC intends to employ flexible approaches including:

- Effluent phosphorus limits in permits will be expressed as total annual mass loads.
- Construction of upgraded phosphorus treatment facilities will not be required until actual phosphorus loads approach 80% of the TMDL limits.
- Phosphorus compliance schedules in discharge permits will allow adequate time for planning, engineering and municipal budgeting.

As described in Section 6.1.1, some reallocation between WWTFs within the same lake segment may be considered, following DEC's Wasteload Allocation Process (Administrative Rule 87-46). The Main Lake, Burlington Bay and Shelburne Bay segments may be treated as a single segment for the purpose of wastewater reallocation since loads from each of these segment's watersheds have an approximately equal impact on phosphorus concentrations in the critical Main Lake segment.

Phase 2

For many years Vermont has employed a river basin planning process. In recent years the process was revised to develop tactical plans that highlight the projects or actions needed to protect or restore specific waters and identify appropriate funding sources to complete the work. These Tactical Basin Plans are designed to guide all watershed work; the issues identified in these plans are the ones that will be prioritized for management attention, including funding. The Tactical Basin Plans have a five year cycle, with updates on a biannual basis.

The second phase of implementing the Lake Champlain TMDLs will connect the tools developed in the first phase to Vermont's existing tactical basin planning process. This allows Vermont to take advantage of existing planning processes, watershed coordinators, and all the connections to watershed groups and other partners who do implementation on the ground. It ensures that the strategic thinking in the TMDLs development and Phase 1 implementation is translated into prioritized tactics. As described in Section 7.3.2, the Accountability Framework for implementation beyond 2017 will be based on the actions contained in the prioritized implementation tables contained in these Phase 2 plans. In addition to the implementation of actions geared to reduce discharges of phosphorus from nonpoint sources and developed lands in each basin, the DEC will also revise affected WWTF NPDES permits, generally during the first year of implementation in each basin. The expected issuance of specific permits is included in the Wastewater Treatment Facility section of the revised Phase 1 Implementation Plan (Chapter 3, Section B, Vermont, 2015).

The first of the Phase 2 Tactical Basin Plans will be developed in 2016 for the Lamoille and Missisquoi basins. Phase 2 plans for the Poultney, Mettawee and Lower Lake Champlain basins will be developed in 2017. The Phase 2 plan for the Winooski basin will be completed in 2018. The Phase 2 plan for the Otter, Little Otter and Lewis Creek basin will be completed in 2019. The Phase 2 plan for the Upper Lake Champlain Basin will be completed in 2020.

Phase 3 and Beyond

EPA and Vermont anticipate that the revisions to the Phase 2 Tactical Basin Plans will benefit not only from what has been learned in the specific basin, but from lessons learned across the whole Lake Champlain basin. Those revised Tactical Basin Plans will constitute the third phase of implementation. Subsequent iterations of the Tactical Basin Planning process would constitute further phases of implementation.

Staged Implementation in St. Albans Bay

Compared to most of Lake Champlain, there are additional challenges to achieving water quality standards in St. Albans Bay. There is a significant sediment phosphorus load in this relatively shallow bay. It will take a significant amount of time before there will be a net reduction in the amount of phosphorus sequestered in the sediments. The implementation strategy for St. Albans Bay is designed to minimize the input of new phosphorus from the tributaries first. Thus the first stage will focus primarily on nonpoint source reductions and upgrading the St. Albans WWTF. Once the tributary input of phosphorus has been substantially reduced, if water quality standards are not yet attained in the bay, Vermont will continue with the evaluation, design, and permitting of an in-lake treatment to control internal phosphorus loading in the bay.

The most heavily phosphorus laden sediments in St. Albans Bay are confined to a relatively well-defined area. Prior studies have evaluated the possibility of treatment with alum at the hot spot area. Once the tributary input of phosphorus to St. Albans Bay has been significantly reduced, Vermont will evaluate whether an intervention is feasible, affordable and would accelerate achieving water quality standards.

Implementation in Missisquoi Bay

Missisquoi Bay faces the most significant challenges in attaining water quality standards. This basin has the largest percent of land in agricultural use, and many of its streams are in unstable condition. There is also already a significant sediment phosphorus load. Achieving the load allocation in Missisquoi Bay is a long-term proposition.

In light of the many challenges in the basin, Vermont has included a specific Missisquoi Bay section in the revised Phase1 Implementation Plan intended to accelerate the reduction of phosphorus inputs from the tributaries to the bay. As detailed in the Reasonable Assurance discussion for Missisquoi Bay (Section 7.2.1), the State will make enhanced phosphorus reduction efforts to address agricultural, forestry, and unstable stream corridor sources,

Unlike St. Albans Bay, there are no real prospects for interventions to address the existing sediment phosphorus sediment load in Missisquoi Bay. It is significantly larger than St. Albans Bay and the phosphorus-rich sediments are more widely distributed. Parts of the bay are in Canada and other sections are part of a wildlife refuge. Given these constraints, it is unlikely that dredging or treatment of the sediments will be feasible. Natural processes will deplete the phosphorus in the sediment over a long period of time as watershed load reductions are achieved.

CHAPTER 9: PUBLIC PARTICIPATION

The Lake Champlain TMDLs were developed with extensive public participation over the course of three and one half years. Much of the participation was conducted jointly by EPA and the Vermont agencies, the remainder was conducted by the Vermont agencies.

Public participation was initiated in the fall of 2011 through a series of outreach sessions hosted by EPA, the Vermont DEC and Agency of Agriculture at various locations across the basin. Stakeholders were invited to provide input on sources of the phosphorus problem and suggested solutions. Participants of an In-Lake Modeling Workgroup and a Watershed Analysis Workgroup provided input on models for use in developing the TMDL. EPA invited scientists and others with technical expertise to contribute data and their opinions on the models. These workgroup meetings continued over the course of nearly two years.

In early 2013, the Agency of Agriculture launched a facilitated dialogue with interested farmers which evolved into a working group that continued to provide input to the Agency on measures under consideration for the farming sector. At the same time, the DEC was engaged in dialogue with stormwater and wastewater sector groups. In the summer of 2013, EPA held a modeling workshop, providing interested parties with a view of the fruits of the in-lake and watershed models.

In November 2013, DEC and the Agency of Agriculture released a draft "State of Vermont Proposal for a Clean Lake Champlain" for public review (Vermont, 2013). In December, EPA, the DEC and the Agency of Agriculture hosted public outreach sessions in Rutland, Middlebury, Montpelier, Burlington, St. Albans and Swanton. The meetings were advertised on the EPA and DEC websites and through press announcements. The meetings provided interested parties an update on the TMDL development process and the opportunity to provide feedback on a draft set of measures the Vermont agencies were considering to address nonpoint sources and point sources of stormwater, posted on their websites. Summaries of the feedback provided by meeting attendees were later posted on the DEC website.

On March 31, 2014, Vermont released a draft Phase 1 Implementation Plan for EPA review and posted the document and transmittal letter on DEC's website. On May 29, 2014, Governor Shumlin sent Vermont's Phase 1 Implementation Plan to EPA and DEC posted the letter and document on its website.

In December 2014, EPA, the DEC and the Agency of Agriculture again hosted public outreach sessions in Rutland, Middlebury, Burlington and St. Albans. The meetings were advertised on the EPA and DEC websites and through press announcements. EPA presented proposed wasteload and load allocations for each lake segment and the Vermont agencies reviewed the control strategies that would be used to achieve the stormwater portion of the wasteload allocations and the load allocations. The public presentation was posted on EPA's website. A summary of the feedback received at the sessions and comments received after the meetings was posted on the DEC website.

Pursuant to 40 C.F.R. § 130.7(d)(2), EPA is issuing a public notice in parallel with the release of these TMDLs, opening a 30 day public comment period. After considering public comment and making any revisions deemed appropriate, EPA will transmit the final Lake Champlain TMDLs to Vermont for incorporation into its current Water Quality Management plan.

CHAPTER 10: REFERENCES

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CHAPTER 11: ABBREVIATIONS AND ACRONYMS

BMP	Best Management Practice
CAFO	Consolidated Animal Feeding Operation
CFR	U.S. Code of Federal Regulations
CGP	Construction General Permit
CLF	Conservation Law Foundation
CSO	Combined Sewer Overflow
CWA	Clean Water Act
DEC	Vermont Department of Environmental Conservation
EPA	U.S. Environmental Protection Agency
HRU	Hydrologic Response Unit
HUC	Hydrologic Unit Code
LA	Load Allocation
LCBP	Lake Champlain Basin Program
MDDEP	Quebec Ministry of Sustainable Development, Environment, and Parks
MGD	Million Gallons per Day
mg/l	milligrams per liter
µg/L	micrograms per liter
MOS	Margin of Safety
MSGP	Multi-sector General Permit
MS4	Municipal Small Separate Sewer System
mt/yr	Metric tons per year
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service, U.S. Department of Agriculture
NYSDEC	New York State Department of Environmental Conservations
RDA	Residual Designation Authority
SWAT	Soil and Water Assessment Tool
TMDL	Total Maximum Daily Load
USGS	U.S. Geological Survey
WLA	Wasteload Allocation
WQS	Water Quality Standards
WWTF	Wastewater Treatment Facility

APPENDICES

APPENDIX A

Future Growth from Developed Lands in the Lake Champlain Basin, Stormwater Management Program, VTDEC. June 23, 2015

Available at: http://www.epa.gov/region1/eco/tmdl/lakechamplain.html

APPENDIX B

Cross-walk between the Phase 1 Plan and EPA's scenario runs to be inserted here

Available at: http://www.epa.gov/region1/eco/tmdl/lakechamplain.html