Lake Carmi
Phosphorus Total Maximum Daily Load (TMDL)
Frequently Asked Questions

July 2022 Update

What are the pollution issues in Lake Carmi?

Phosphorus is a nutrient that causes excess plant and algae growth. While some phosphorus is necessary for aquatic life, too much phosphorus has led to frequent algae blooms, reduced water clarity, and excess aquatic plant growth in Lake Carmi. Changing weather patterns also play a role in accentuating phosphorus fueled conditions. Abnormal temperature and precipitation patterns led up to a prolonged cyanobacteria (blue-green algae) blooms in the fall of 2017 and since then as well.

The Department of Environmental Conservation (DEC) determined the target in-lake phosphorus concentration using monitoring results when residents were satisfied with the lake's condition. The **22 µg/L** target concentration, expressed as the average annual concentration (in micrograms per liter or µg/L) during the best three years (1997, 1998, and 2002) in the monitoring record.

What is a TMDL?

Because phosphorus levels exceed the 22 µg/L standard, Lake Carmi is listed as impaired, which requires a TMDL—or Total Maximum Daily Load—by the federal Clean Water Act. In 2008, DEC developed the Lake Carmi TMDL, which was approved by the United States Environmental Protection Agency. A TMDL is a **pollution budget** that estimates phosphorus pollution reaching the lake from sources in the watershed and **establishes phosphorus pollution targets** that would allow Lake Carmi to meet its phosphorus standard (22 µg/L).

How will the TMDL Action Plan help us meet phosphorus pollution targets?

The Lake Carmi Action Plan, developed by DEC with federal, state, and local partners, identifies specific actions in the watershed to meet phosphorus targets, as well as **additional monitoring and assessment needs**. This Action Plan was replaced in 2018 with the Lake Carmi Crisis response Plan. The most recent update (2022) of the Crisis Response Plan reflects the resources provided by the adoption of the 2016 Lake Champlain Phosphorus TMDL Implementation Plan, which outlines how we will reduce phosphorus loading within the entire Lake Champlain Basin, which includes Lake Carmi. The Legislature made resources available to support implementation through passage of the Vermont Clean Water Act and the Lakes in Crisis Statute. The Lake Champlain implementation plan, Act 64, the Lakes in Crisis Statute, and now Act 76 will directly support efforts to achieve clean water in Lake Carmi.

What do the required reductions mean for me?

Whether you are a landowner, farmer, municipal official, developer, or logger, as Vermonters, we all have a responsibility to protect and restore clean water. A 40% reduction in phosphorus loading is

required across all land uses in the Carmi watershed, including agricultural lands, state and municipal roads, and lakeshore properties. This requires a long-term commitment from all of us.

The Vermont Department of Forests, Parks, and Recreation designed and installed a new wastewater treatment system for the Lake Carmi State Park in 2018 which eliminated nearly all phosphorus discharges from the park facilities.

Additionally, in-lake treatment options to address internal phosphorus loading from lake sediment are being considered, which may aid the lake in its recovery as phosphorus inputs from the watershed are reduced.

In addition, in 2019, the State of Vermont supported the implementation of a whole-lake aeration system for Lake Carmi – one of the largest such systems ever installed in the country – to reduce the release of phosphorus from lake bottom sediments. The aeration system began operations during the summer of 2019 and successfully limited internal phosphorus loading from the bottom sediments. Cyanobacteria blooms still occurred in Lake Carmi during 2019, but limiting internal phosphorus loading helped reduce the frequency and duration of cyanobacteria blooms. The aeration system, which continues to operate, is an important and valuable component of the work needed to address cyanobacteria blooms, but this is not a singular solution. Conditions in 2019 demonstrated that the more intense precipitation events and warmer temperatures associated with climate change will continue to create environmental conditions conducive to blooms. It is essential that all members of the coalition continue their individual and shared efforts to reduce phosphorus pollution if we are to achieve the shared goal of lasting water quality in Lake Carmi. For more information on the aeration system's impact on water quality, click here: https://epscor.uvm.edu/LakeCarmi/.

How do we track our progress towards meeting the TMDL?

The State summarizes pollutant reductions of State-funded **clean water projects** implemented each year, including agriculture, stormwater, road erosion control, natural resources restoration, and forestry and logging erosion control projects. This data is available through the annual Clean Water Initiative **Investment Report** and the Lake Carmi Clean Water Progress Report, published every two years. For more information, visit: dec.vermont.gov/watershed/cwi/reports.

How do we determine how much phosphorus is actually entering the lake and from what sources?

Models are the best tools we have available to help understand complex situations, such as what is going on in the Lake Carmi watershed. By conducting water quality testing, and to using a **water quality "model,"** we can determine the most probable contributions of phosphorus from different parts of the lake watershed. Watershed phosphorus loads were calculated using scientifically-accepted approaches for constructing a lake pollution model recommended by several States, and USEPA. The modeling exercise requires an understanding of how water flows across the landscape, the type of land uses, and approximation of precipitation that in the end carries the nutrients to the lake.

The general approach to modeling phosphorus in Lake Carmi used **estimates of watershed phosphorus loads from each land use sector**, calibrated to predict actual in-lake phosphorus concentrations. In addition, **estimates of septic and internal loads** were modeled to determine total annual loads, with breakout by land use (Figure 1).

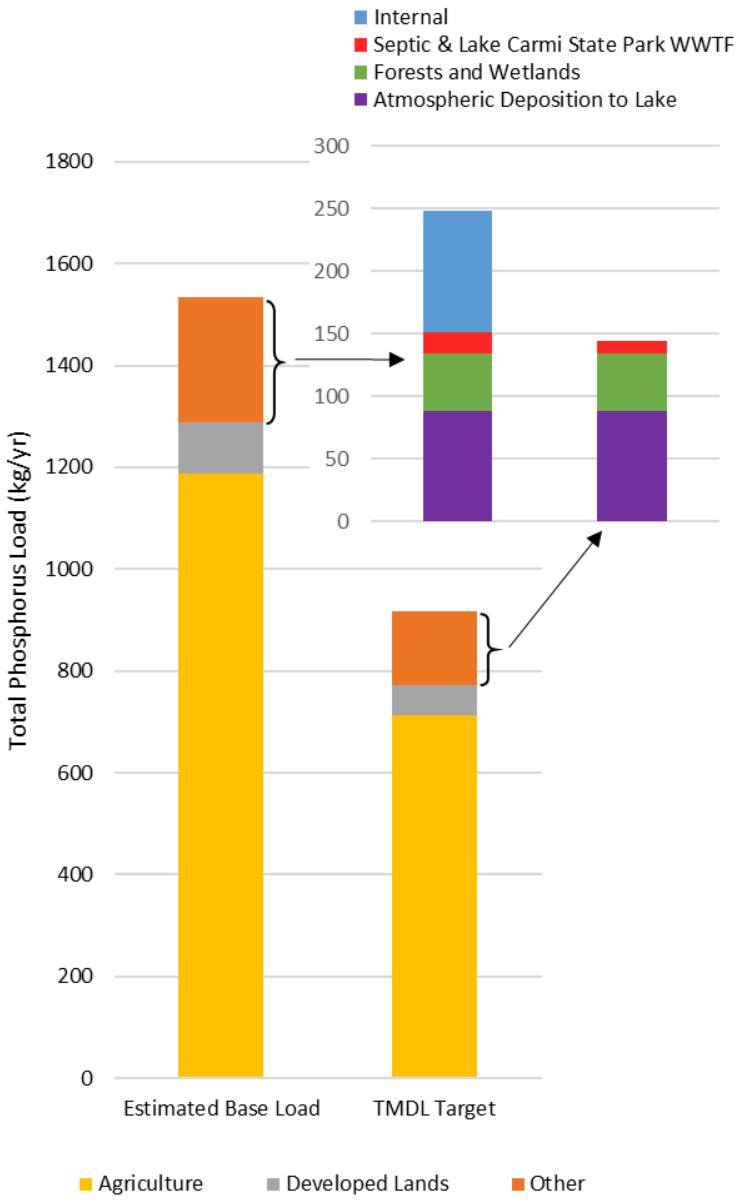

Figure 1. Estimated phosphorus pollution sources and TMDL phosphorus target, which is a 40% reduction in the total phosphorus load.

What does the modeling tell us about sources of phosphorus?

Stormwater runoff provides much of the phosphorus coming off land and going into our waters. The more intensively that a piece of land or land cover is disturbed, either by reducing stormwater infiltration from expanding impervious surfaces and erodible lands, adding nutrients, or exposing soils, the more phosphorus is exported. Agriculture exports the most amount of phosphorus as it comprises the majority of the land use in the watershed.

What assumptions went into the Lake Carmi TMDL?

The phosphorus loading estimates to Lake Carmi were derived using the best available land use and phosphorus runoff information at the time the TMDL was written. Since that time, a new and more precise water quality model was developed as a tool for the Lake Champlain TMDL, called the Clean Water Roadmap. To verify that the Lake Carmi water quality model is still reasonable, DEC scientists recently compared the total phosphorus loads each model produced (Figure 2). The Clean Water Roadmap predicts that loading to Lake Carmi from agricultural land uses remains similar to the original estimate (although acreage has decreased), and that developed and forested land sources are somewhat higher (more acreage is attributed). This comparison confirms the need for over 600 kg/yr of phosphorus loads to be reduced annually, with agriculture being the major source (Figure 1).

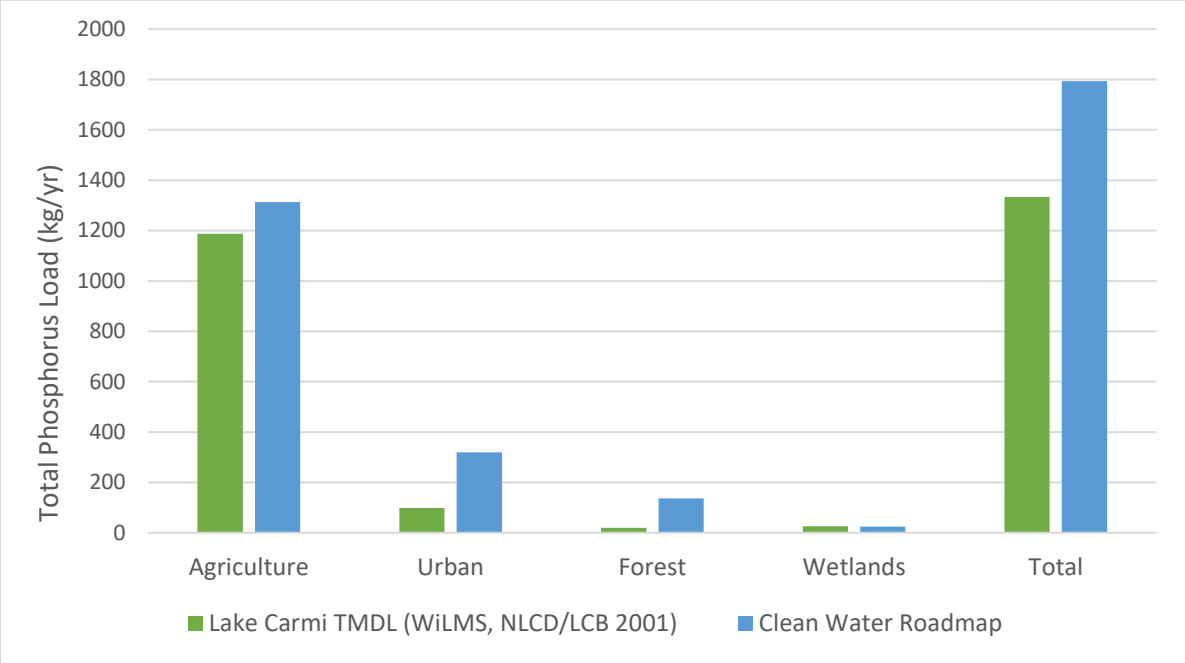

Figure 2. Total phosphorus export by land use, from the Lake Carmi watershed.

How much phosphorus can the lake handle (total loading capacity)?

The total loading capacity is the maximum phosphorus loading rate that can be discharged to Lake Carmi waters and still attain the TMDL target concentration. To estimate the total loading capacity, WiLMS models were used to simulate the in-lake annual phosphorus concentration resulting from reductions in total loads. Using this approach the **Total Loading Capacity was estimated to be 1,027 kg P/yr.**

How did we account for uncertainty in the development of the TMDL?

An additional **margin of safety** is added to account for uncertainty. The plan to meet acceptable phosphorus levels in the lake will include the reduction of more phosphorus than the model recommends. The DEC incorporated a 10% margin of safety into the TMDL to account for any uncertainty that the established total loading of 1,027 kg/yr will bring about the necessary in-lake phosphorus concentration of 22 µg/l. The application of this margin of safety covers all contributing phosphorus sources to ensure that the target concentration will be met.

For additional information on the TMDL and pollution reduction efforts in the Lake Carmi watershed, please visit http://dec.vermont.gov/watershed/cwi/restoring/carmi.