Water Quality Restoration Formula Grant Target and Fund Allocation Methodology

Final, June 3, 2022

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Water Quality Restoration Formula Grant Overview

The Clean Water Service Delivery Act (Act 76 of 2019) restructures the administration and implementation of clean water funds in the State of Vermont, effective in State Fiscal Year (SFY) 2023. Act 76 of 2019 requires the establishment of Clean Water Service Providers (CWSPs) and the Water Quality Restoration Formula Grant Program.

CWSPs, for watersheds draining to Lake Champlain and Lake Memphremagog, were established by rule, effective August 12, 2021. CWSPs will be responsible for administering funds and, along with Basin Water Quality Councils (BWQCs), for identifying, prioritizing, developing, and implementing projects to meet a five-year phosphorus reduction target. The CWSPs' phosphorus reduction targets will be associated with non-regulatory activities under the Lake Champlain and Lake Memphremagog Total Maximum Daily Loads (TMDLs). The targets are meant to ensure voluntary measures (i.e., those not driven by regulations) will be implemented and TMDL targets will be achieved. Additionally, a CWSP will be responsible for the long-term operation and maintenance (O&M) of all non-regulatory clean water projects in its region.

The Water Quality Restoration Formula Grant shall be based on the annual pollutant reduction goal established for the CWSP multiplied by the standard cost for pollutant reduction. The standard cost shall include the costs of project identification, project design, and project construction. Formula Grants' fund allocations will also include the costs of administration and reporting. Clean water project types eligible for funding under Formula Grants are non-regulatory project types described in the Clean Water Initiative Program's Funding Policy and upcoming Formula Grant Guidance. Eligible projects span a range of land use sectors, including floodplain and stream restoration, buffer plantings, stormwater management improvements, wetlands restoration, lake shoreline restoration, and forest erosion controls. Formula Grant allocations may be refined over time based on availability of new data and feedback from program partners (see section titled "Current Limitations/Uncertainty and Future Recommendations" for more information). CWSPs and BWQCs will be responsible for designing how Formula Grant allocations are apportioned and awarded to project implementers within their respective basins using state-issued Guidance.

The following sections document methods used to establish:

1. Non-regulatory total phosphorus load reduction targets for Lake Champlain and Lake Memphremagog basins;
2. Standard cost for pollutant reduction by land use sector; and
3. Water Quality Restoration Formula Grant fund allocation by watershed.

The above listed steps are summarized in Figure 1. Where Formula Grant need (or demand) exceeds available funds, the targets may be scaled to align with available funds. The Vermont Clean Water Board will recommend funding levels for the Formula Grants when making its annual Clean Water Budget recommendation, and while balancing other statutory clean water funding priorities.

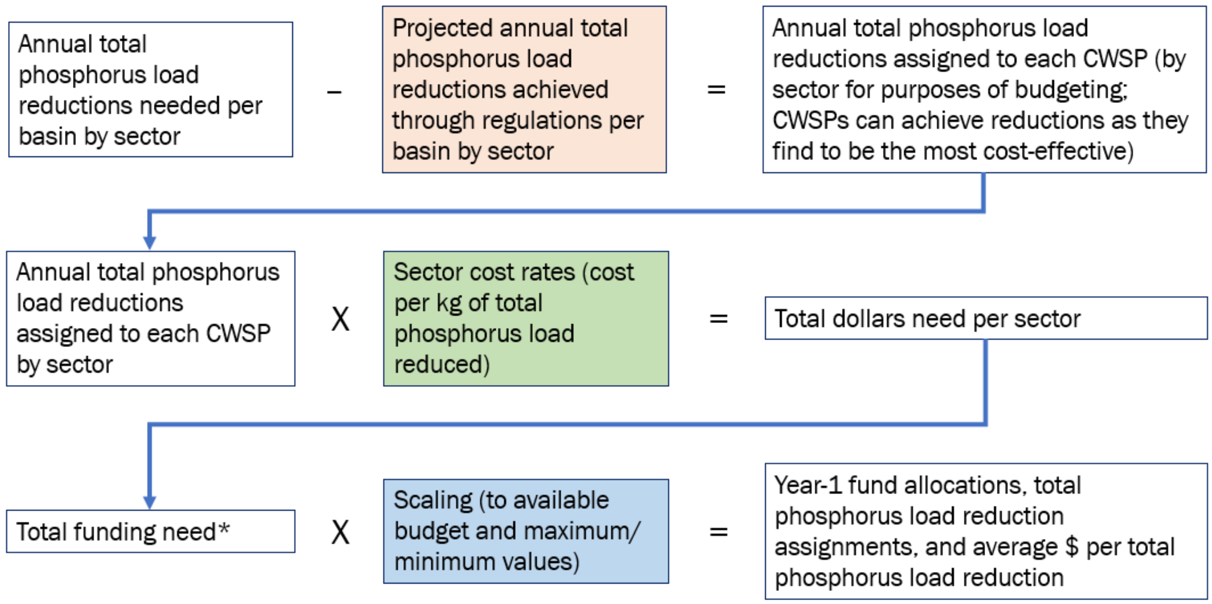

Figure 1. Process map of Water Quality Restoration Formula Grants target, cost rate, and fund allocation methodology.

Non-Regulatory Total Phosphorus Load Reduction Targets

The starting point for setting CWSP targets is a set of basin-specific TMDL reduction estimates **(Table 1 in the SFY 2023 CWSP target setting spreadsheet and Appendix A)**. Lake Champlain Basin reduction estimates were summarized by the Watershed Planning Program based on the original SWAT modeling used in the development of the Lake Champlain TMDL. Reduction estimates for the watersheds within the Champlain Basin were derived from TMDL lake segment assignments and associated land use sector-specific percent reductions. Reduction estimates have been aggregated at the tactical basin scale. (Basin and sub-basin loading and reduction targets by land use sector have been summarized in this Power BI report.) Meanwhile, the Lake Memphremagog Phosphorus load reduction targets are based directly on the Lake Memphremagog TMDL reduction targets.

It should be noted that in the case of both Lake Champlain and Lake Memphremagog watersheds, target reductions provided in this paper are based on source (AKA watershed) loading rather than delivered loading. Source load estimates are higher than delivered load estimates published in the TMDL because delivered load estimates account for attenuation between the watershed source and receiving surface water. Using the source load is in accordance with EPA guidance and existing tracking and accounting methodologies.

Act 76 identifies CWSP phosphorus reduction targets as the load reduction remaining after accounting for the implementation of regulatory programs. Each phosphorus production sector has a unique set of regulatory programs that address some portion of the TMDL reduction targets. These sector specific regulations, or their surrogates, are described below and shown in **Table 2 in the SFY 2023 CWSP target setting spreadsheet and Appendix A**.

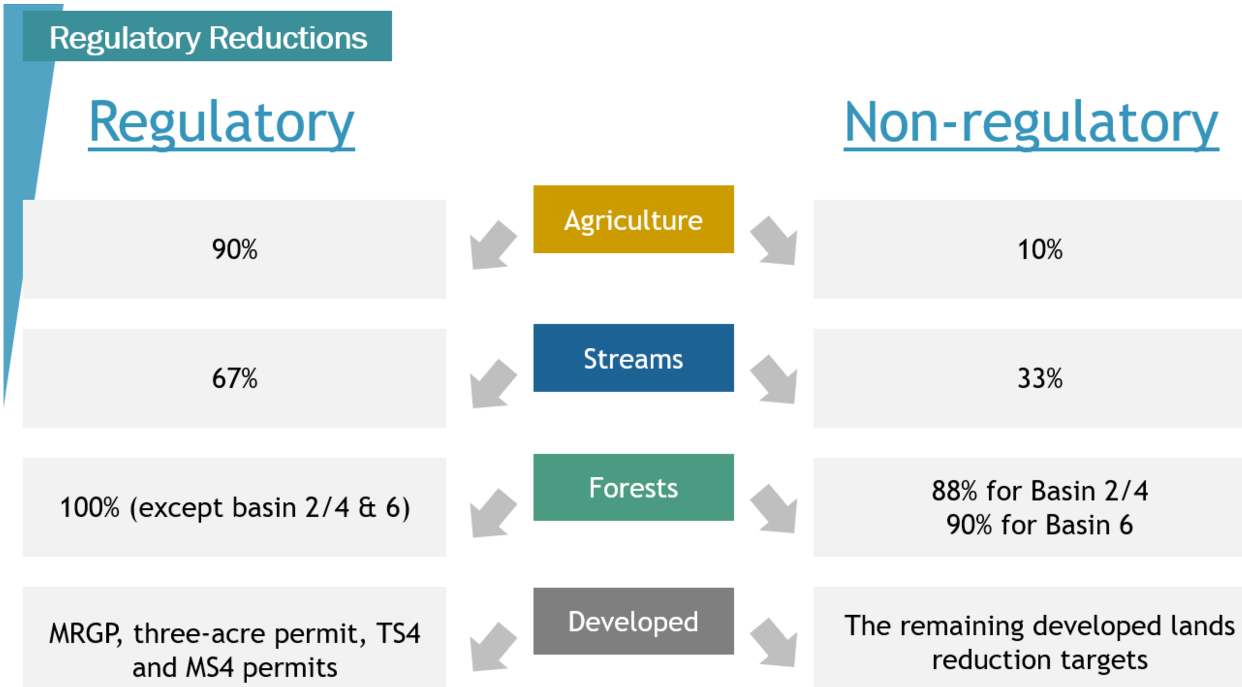

Figure 2. Regulatory vs non-regulatory phosphorus reductions for the agricultural, stream, forest and developed lands sectors.

1) **Agricultural land**. To date, agricultural load allocations in Vermont have not been broken down into clear regulatory and non-regulatory reduction categories. A brief 2021 legislative report allocated 10% of the agricultural load allocation for each lake segment to the CWSP, with the other 90% remaining under the jurisdiction of AAFM. For the purposes of developing initial targets, the 90% load reductions associated with AAFM serve as the surrogate for the regulatory load reductions in each basin. See Table 2.

2) **Forestland**. Preliminary analysis during TMDL development and subsequent forestlands consultant work suggests that a 5% reduction can be achieved via compliance with Accepted Management Practices administered by the state of Vermont. Thus, for the purposes of developing initial targets, regulatory forestland phosphorus reductions were set at 5% in all basins. The 5% reduction in forestland loading achieves the TMDL reduction targets in the Lake Memphremagog basin and in all Lake Champlain watersheds other than South Lake (Basin 2/4) and Missisquoi Bay (Basin 6). The Lake Champlain TMDL assigns Basins 2/4 a forestland phosphorus reduction target of 40% so the 5% regulatory reduction achieves 12% of the loading target for forestland for this basin leaving 88% to be assigned as part of the CWSP target. The Lake Champlain TMDL assigns Basins 6 a forestland phosphorus reduction target of 50% so the 5% regulatory reduction achieves 10% of the loading target for forestland for this basin leaving 90% to be assigned as part of the CWSP target.

3) **Streams**. Stream loading reductions are the focus of ongoing research. Thus, the reductions achieved by regulatory and non-regulatory programs can be approximated but not precisely assigned at this time. The Phase 1 TMDL Implementation Plan for Lake Champlain identifies passive restoration achieved through regulation as the primary mechanism to address phosphorous loading due to stream instability. The Rivers Program has estimated that two-thirds of future stream reductions will be

achieved through implementation of regulatory programs aimed at restoring stream equilibrium conditions over time. Specifically, regulatory programs that limit new encroachments and channelization practices facilitate larger scale passive restoration as rivers reconnect to floodplains and achieve a stable slope through the channel evolution process. These programs include the stream alteration permit program and flood hazard area/river corridor regulations implemented at the state and local levels. The potential for regulatory reductions will be refined with Functioning Floodplains Initiative tools, additional geospatial analysis, and considerations for strengthened regulations that further support the restoration of equilibrium conditions. The remaining 33% of the stream reduction targets were attributed to the CWSP for the implementation of stream restoration and protection projects annually, until such time that the estimates can be refined.

4) **Developed Lands**. Regulatory load reductions for developed lands have been estimated by staff in the stormwater program. Sites and activities encompassed by the estimates include those governed by the Municipal Roads General Permit (MRGP), the so called 3-acre permit, as well as the Municipal Separate Storm Sewer System General Permit (MS4) and Transportation Separate Storm Sewer System General Permit (TS4). A summary of this analysis is included below:

    a. The so called "3-acre permit" load reductions were calculated based on an estimated 35% reduction efficiency applied across the 3-acre properties in each basin. For the purposes of the funding formula, this data has been summarized by basin.

    b. Previous analyses have estimated the loading reductions that are expected based on compliance with the MRGP permit. These estimates, which anticipate conversion of road segments from not meeting or partially meeting to fully meeting standards, are the basis for the reduction estimates presented in this paper. This data has been summarized by basin. However, about 18 percent of road segments have not been assessed and thus lack load reduction estimates. Assuming these unassessed segments are similar to assessed segments in terms of compliance and loading rates then load reductions resulting from the MRGP will be 20 percent higher than currently calculated. Thus, VTDEC anticipates CWSP targets could be reduced by roughly 20 percent in future years.

       It is worth noting that the total land area attributed to roads in the Lake Champlain TMDL SWAT model was based on older land-use dataset (2006 NLCD) and is as much as double more recent and precise estimates of impervious road area based on land-use data published by the Lake Champlain Basin Program in 2011 (LCBP 2011). The original larger TMDL road surface area results in larger estimates of phosphorus loading, and associated load reduction potential than current tracking and stormwater permit reduction estimates, which are based on the smaller areas from the LCBP 2011 impervious surface analysis. This difference in in area and loading is the source of the majority of the developed lands non-regulatory reduction targets for all basins except for Missisquoi Bay which has significantly higher developed lands reduction targets. Further analysis based on the LCBP 2016 1-meter resolution land use/ land cover dataset is expected to refine the current road surface areas, associated loading, and load reduction potential through MRGP implementation and may provide more clarity on the magnitude of refinement needed which may significantly reduce the developed lands non-regulatory reduction targets.

c. Currently, TS4 estimates are provided at the lake segment scale only. Exact locations (and associated basin load reduction estimates) may shift as phosphorus control plans are developed by AOT. For the purposes of the initial funding formula, VTDEC proposes that loading for lake segments to the basins be based on where most of the loading would flow. Total load reductions for this permit program are small in the context of overall CWSP targets. Thus, these assumptions would not be expected to impact load reduction targets or costs substantially for interim load reduction targets and will be refined in the future.

d. MS4 estimates are provided based on reasonably detailed studies conducted to date. But exact locations (and associated basins) may shift as phosphorus control plans are developed or refined. This data has been provided at town and the lake segment scale. In all most cases the basin where MS4 targets should be applied is clear except for the Town of Milton where load reductions have been provided to the Lamoille Basin at this time. Total load reductions for this permit program are small in the context of overall CWSP targets so these assumptions would not be expected to impact load reduction targets or costs substantially and will be refined in the future. St Albans Town and Rutland City MS4 permit load reductions have not been estimated and will increase the MS4 reductions for Basins 3 and 5.

The phosphorus reductions estimated for these stormwater permit programs may be substantially revised as these programs are implemented and site-specific phosphorus reductions are calculated.

Estimated permit reductions are not available for the Lake Memphremagog Basin at this time. To provide an estimate of the regulatory reductions an average of regulatory reductions (excluding the MS4 permit reductions which is not in place in the Lake Memphremagog Basin) for the Lake Champlain basins excluding the Missisquoi Basin was used. The non-Missisquoi basin segments can be used as a proxy because the TMDL reduction targets were based on a similar BMP scenario and regulatory programs are similar except for the MS4 permit which is not in place in the Lake Memphremagog Basin.

Table 1. Allocation of MS4 loading to specific basins with Green – Basin 5, Yellow – Basin 8, Blue – Basin 7 and light orange for Otter Creek.

	Main Lake/ Burlington Bay/ Shelburne Bay	Mallets Bay	Otter Creek	Northeast Arm	St Albans Bay
MS4	Total Reductions	Total Reductions	Total Reductions	Total Reductions	Total Reductions
BTV	75.1				
Burlington[1]	not available				
Colchester	32.3	38.9			
Essex Junction	22.6	9.1			
Essex Town	43.6	31			
Milton		71.37		8.47	
Rutland City[2]			not available		
Rutland Town			30.48		
Shelburne	43				
South Burlington	128.3				
St. Albans City					45.5
St. Albans Town[3]					not available
UVM	39.3				
Williston	119.8				
Winooski	23.6				
Total	527.6	150.37	30.48	8.47	45.5

[1] Being permitted through the Burlington Integrated Plan, rather than the MS4

[2] Rutland City coming in for an individual MS4 permit.

[3] Phosphorus control plan has not yet been received.

Table 2. The estimated total annual phosphorus reductions that stormwater permit programs will achieve by 2036 for each CWSP basin.

Total regulatory phosphorus reduction estimates (kg)	3-acre	MRGP	TS4	MS4	Total
Basin 2 & 4 or South Lake A&B, Port Henry segments (TS4)	84.1	1031.4	158.2		1273.7
Basin 3 – or Otter Creek segment (TS4)	318.7	1504.6	248.3	30.5	2102.1
Basin 5 – or Shelburne, NE arm, St Albans, Isle le Mott (TS4)	390.1	206.1	103.8	451.0	1150.9
Basin 6 – Missisquoi, Rock, Pike OR Missisquoi Bay segment	62.4	1335.5	412.1	0.0	1810.0
Basin 7 – Lamoille- OR Mallets Bay lake segment (TS4)	189.6	1546.8	247.9	71.4	2055.7
Basin 8 – Winooski – OR Main Lake Segment (TS4)	677.8	3676.2	463.4	209.6	5027.0
Total	1722.7	9300.5	1633.7	762.4	13419.4

Table 3 in the SFY 2023 CWSP target setting spreadsheet and Appendix A simply subtracts the regulatory load reductions from the load reduction targets to show the CWSP loading targets per basin. At this time, we have not factored in the load reductions from currently completed projects because, outside of the agricultural sector, load reductions achieved have been small enough that these don't impact loading targets enough that it was worth the significant time investment do this complex analysis to ensure that none of these projects have a connection to regulatory programs.

Table 4 in the SFY 2023 CWSP target setting spreadsheet and Appendix A simply divides the total CWSP load reductions by 15 years to show the annual increase in annual phosphorus reductions necessary to meet the full CWISP targets. This table assumes that CWSP projects all have at least a 15-year lifespan, and as such the impact projects that have a shorter lifespan would need to be discounted.

Cost Rate Calculation Methodology

Pursuant to 10 V.S.A. § 922, the Secretary of Natural Resources shall publish a methodology for determining standard cost of pollutant reductions for phosphorous in the Lake Champlain watershed not later than November 1, 2021. Similarly, a methodology for determining standard cost pollutant reductions for phosphorous in the Lake Memphremagog watershed shall be published not later than November 1, 2022. The standard cost shall include the costs of project identification, project design, and project construction. The CWSP Rule further requires definition of standard project costs be developed for different clean water project types by contributing land use sector. The following methodology was applied to estimate cost rates associated with non-regulatory total phosphorus load reductions.

Cost Rate Calculations at Clean Water Project Category-Level

1. The Vermont Department of Environmental Conservation (VTDEC) identified the following project *categories* to represent the initial range of anticipated costs associated with implementing non-regulatory total phosphorus load reductions required under the Lake Champlain and Lake Memphremagog TMDLs, across contributing land use sectors. ***These project categories were identified as representative of project costs and do not define/limit Water Quality Restoration Formula Grant eligible project types.***
    a. Floodplain/stream restoration projects (floodplain storage of phosphorus from upstream subwatershed and phosphorus reduction through stream stability)[1]
    b. River corridor easements (phosphorus reduction through restoration of stream stability)
    c. Riparian buffer restoration project (phosphorus runoff treatment and phosphorus reduction through stream stability)
    d. Sub-jurisdictional (i.e., non-regulatory) stormwater treatment practices (phosphorus runoff treatment)
    e. Sub-jurisdictional road erosion control practices (phosphorus reduction through erosion control)
    f. Sub-jurisdictional forest road erosion control practices (phosphorus reduction through erosion control)
    g. Lake shoreline restoration (phosphorus reduction through bank stabilization and restoring living shorelands)
    h. Lake shoreland runoff treatment (phosphorus runoff treatment through nature-based solutions)

[1] Cost rates are based on floodplain/stream restoration projects only. Wetland restoration projects will be incorporated with its own cost rate methodology once methods to estimate phosphorus reductions associated with wetland restoration projects are in place. In the meantime, floodplain/stream restoration projects are assumed to be an analog for cost and performance associated with wetland projects.

2. The VTDEC estimated the above listed project categories' standard cost per project output unit (e.g., dollars per acre of floodplain restored/reconnected), where available, by compiling the data from the VTDEC's statewide Clean Water Reporting Framework (CWRF) database (in some cases limited to a subset of CWRF – the VTDEC Watershed Projects Database (WPD)), and other readily available cost data, such as the Chesapeake Bay Assessment Scenario Tool (CAST).
    a. As part of this step, VTDEC identified project *types* and best management practice (BMP) *types* representative of the above listed project *categories* (e.g., sub-jurisdictional stormwater treatment practices *category* is based on cost rates of multiple stormwater treatment practice *types*).
    b. Estimated cost rates include design/engineering (if applicable to the project category).
    c. Estimated cost rates do not include annual operation and maintenance (O&M) activities post construction. O&M funding will be allocated through a separate budget exercise. However, CWSPs and BWQCs are encouraged to factor long term O&M costs as part of a project's cost effectiveness in project selection.
    d. Estimated cost rates do not include project identification and development activities at the project category-level. Rather, project identification and development costs are estimated as a percentage of total funds available, described in step 6 below.
    e. Design/engineering and construction costs are frontloaded and not annualized over the project design life, reflecting the need for upfront capital investment to implement clean water projects.
3. The VTDEC estimated total phosphorus load reduction per project output unit (e.g., total phosphorus load reduction per acre of floodplain restored/reconnected), applying VTDEC's phosphorus accounting methods for estimating total phosphorus load reductions at the project-level.[2]
    a. As part of this step, VTDEC estimates the total phosphorus base load associated with a project output unit pre project implementation, using Vermont specific total phosphorus loading rates by land use category.[3]
    b. Then, VTDEC established total phosphorus load reduction efficiencies were applied as a percent reduction to the base load to estimate the total phosphorus load reduction per project output unit achieved (e.g., total phosphorus load reduction per acre of floodplain restored/reconnected). Where multiple project/BMP types were compiled to make up a project category, median efficiencies were selected.

[2] Final draft Tracking and Accounting Standard Operating Procedures (SOPs) are posted for public comment March-April 2022, available at: https://dec.vermont.gov/water-investment/statues-rules-policies/act-76#publicnotice.

[3] Total phosphorus loading rates are calibrated in the TMDL modeling and may vary by TMDL subwatershed/drainage area. In most cases, Lake Champlain basin-wide averages or medians are used for purposes of calculating cost rates, as explained in the "Cost Rate Calculation Methodology by Clean Water Project Category" section below.

4. The VTDEC estimated cost per unit of total phosphorus load reduction by relating cost per project output unit to estimated total phosphorus load reduction per project output unit.
    a. Design/engineering (if applicable) and construction costs were frontloaded and not annualized over the project design life, reflecting the need for upfront capital investment to implement clean water projects.
    b. Total phosphorus load reductions are expressed as an annual average to be consistent with the TMDLs' base load and target units. [*Cost per unit total phosphorous load reduction ($/kg/yr) = (total project construction cost + estimated design/engineering cost if applicable) / estimated total phosphorus load reduction (kg/yr)*]
    c. For context, the VTDEC also estimated cost per unit of total phosphorus load reduction directly based on cost per total phosphorus load reduction where projects in the VTDEC's Clean Water Reporting Framework (CWRF) have available phosphorus reduction estimates. CWRF data are based on data/information reported by project implementers/funding recipients.
        i. The calculation was only feasible for projects completed with phosphorus accounting methods applied. Calculations for this exercise were based on projects completed through SFY 2020 (June 30, 2020). This calculation's sample size was limited compared to the size of the cost data sample available in step 2, described above.
        ii. Additional data sources exist on BMP cost effectiveness based on pollutant reduction from other regions, however, those were not applied, as phosphorus loading rates from other regions may not be representative of Vermont.
5. VTDEC correlated clean water project categories' cost rates to TMDL land use sector to calculate average cost rates per sector, representing project design/engineering and construction costs. Then average cost rates per sector were correlated to non-regulatory targets to arrive at the Water Quality Restoration Formula Grant fund allocations, described in the "Correlating Cost Rates to Non-regulatory Targets for Water Quality Restoration Formula Grant Fund Allocations" section below.

Cost rate methodology steps 1-5 were completed for each of the clean water project categories listed above, described in the "Cost Rate Calculation Methodology by Clean Water Project Category" section of this document.

Cost Rate Calculations for Project Identification and Development

Project identification and development cost rate calculations are not tied to individual project outputs and phosphorus reductions, as one project identification effort (e.g., stormwater master plan) may identify and prioritize dozens of project opportunities for further development. Not all projects identified will be considered a high priority/cost-effective and may encounter barriers as part of project development (e.g., lack of landowner commitment). Acknowledging this complexity, the cost rate methodology estimates project identification and development funding need through a percentage cost rate of total Formula Grant funds, summarized as follows.

6. VTDEC incorporated project identification costs by estimating 3% of total Formula Grant funds will be used for project identification activities.
    a. The 3% estimate is based on the *Vermont Clean Water Initiative 2021 Performance Report* dataset that shows 3.3% of state clean water investments, SFY 2016-2021, are associated with "planning, assessment, and analytics to identify priority projects."
7. VTDEC incorporated project development costs by estimating 4% of total Formula Grant funds will be used for project development activities, *defined as supporting project implementers' capacity to conduct general project scoping to select identified projects for development, as well as specific project development to gather the information and commitments needed to bring an identified project successfully to the launch of design and/or implementation phases*.
    a. The 4% estimate is based on review of the VTDEC Clean Water Initiative Program SFY 2021 and SFY 2022 Spending Plans. The VTDEC estimated 4% was calculated by dividing the annual average dollars awarded specifically to clean water project development (numerator) by the annual average dollars awarded to statewide clean water project identification, development, design, and implementation (denominator). The 15% program delivery/administration dollars were removed as part of this calculation to avoid double counting with the 15% administration dollars in the Formula Grant fund allocation.
8. VTDEC distributed project identification and development funds to CWSP watersheds <u>proportionately based on total annual phosphorus reduction target per watershed</u> (target based on available funds and adjusted to achieve minimum CWSP funding level of approximately $650,000). This approach factors variability in magnitude of phosphorus reduction targets per watershed, but does not weight by land use sector, acknowledging project identification and development costs do not vary significantly by land use sector. In other words, project identification and development costs are not necessarily correlated directly with individual project categories' design/engineering and construction costs—some lower cost project types may require as much funding for identification and development as higher cost project types.

This cost rate and fund allocation methodology is intended to reflect, at a high-level, the cost of reducing a unit of phosphorus, annualized over the roughly fifteen-year implementation timeframe. It does not dictate how Formula Grants are allocated year-to-year at the project-level, acknowledging that the proportion of dollars awarded by project step (identification, design, construction) will vary year-to-year. For example, CWSPs may increase the percentage of funds for project identification and development work in year one, if they find that they do not have enough projects to meet targets, and in subsequent years, increase percentage of funds for design/engineering and implementation. Guidance will further define how reasonable progress is monitored as projects progress through steps from identification to implementation.

Correlating Cost Rates to Non-regulatory Targets for Water Quality Restoration Formula Grant Fund Allocations

VTDEC identified the project categories representative of implementing non-regulatory targets by sector, shown in Table 3. ***These project categories were identified as representative of project costs and do not define/limit Water Quality Restoration Formula Grant eligible project types.*** Estimated design/engineering (if applicable) and construction cost per total phosphorus load reduction per project category were averaged for each sector. These averages were then used to arrive at the estimated cost per unit phosphorus reduced by land use sector. VTDEC refers to these "average cost per unit total phosphorus reduced" as "cost rate." Each sector's cost rate was then multiplied by the non-regulatory total phosphorus load reduction targets to estimate the average annual funding need to meet non-regulatory total phosphorus reduction targets **(Table 5 in the SFY 2023 CWSP target setting spreadsheet and Appendix A)**. Targets are scaled to meet available funds, as needed **(Table 6 in the SFY 2023 CWSP target setting spreadsheet and Appendix A)**. Targets may be accelerated/decelerated in some CWSP watersheds to achieve a minimum funding level of approximately $650,000 per CWSP watershed to maintain an efficient operational scale per CWSP **(Tables 7 and 8 in the SFY 2023 CWSP target setting spreadsheet and Appendix A)**.

Water Quality Restoration Formula Grant fund allocations are for budget-level allocation purposes to disperse funds to CWSPs. This exercise does not dictate the Formula Grant implementation at the project-level but may provide a guide for CWSPs and BWQCs to evaluate projects' cost effectiveness in reducing phosphorus pollution. CWSPs, BWQCs, and project implementers will identify actual projects in their watershed of focus that will contribute toward achieving non-regulatory phosphorus reduction targets.

Table 3. Clean water project categories' estimated design/engineering (if applicable) and construction costs per total phosphorus load reduction (kg/yr) averaged to estimate "cost rate" per non-regulatory target land use sector.

Non-regulatory target land use sector	Clean water project categories representing costs of implementing non-regulatory targets	Estimated design/engineering (if applicable) and construction cost per total phosphorus load reduction ($/kg/yr)
Streams*	Floodplain/stream restoration†	$16,647
	River corridor easement	$10,041
	Riparian buffer restoration‡	$5,116
	STREAMS SECTOR AVERAGE COST RATE	$10,601
Developed	Stormwater best management practices (BMPs)	$46,026
	Non-regulatory road BMPs	$3,153
	Riparian buffer restoration‡	$5,116
	Lake shoreline restoration§	$8,333
	Lake shoreland runoff treatment	$16,482
	DEVELOPED SECTOR AVERAGE COST RATE	$15,822
Farm field††	Riparian buffer restoration‡	$5,116
	Lake shoreline restoration§	$8,333
	FARM FIELD SECTOR AVERAGE COST RATE	$6,725
Forest‡‡	Non-regulatory forest road BMPs	$15,245
	Riparian buffer restoration‡	$5,116
	Lake shoreline restoration§	$8,333
	FOREST SECTOR AVERAGE COST RATE	$9,565

Table 3 footnotes:

* Streams: Functioning Floodplain Initiative (FFI) planning tools under development will further define restoration potential by project type, including anticipated split between forms of active (e.g., floodplain/stream restoration) and passive (e.g., river corridor easement) restoration. Until more information is available, these project categories are given equal weight in the streams sector average cost rate. Floodplain restoration projects that achieve an increase in floodplain storage will have the dual benefit of contributing to phosphorus reductions in the streams sector and upland/upstream land uses, including developed, farm field, and forest land uses. FFI planning tools under development will further refine phosphorus treatment potential through floodplain storage. Until more information is available, floodplain/stream restoration projects are only incorporated in the streams sector average cost rate to avoid inflating costs in other sectors and to avoid over-estimating the on-the-ground potential for implementing floodplain/stream restoration projects.

† Floodplain/stream restoration: Cost rates are based on floodplain/stream restoration projects only. Wetland restoration project category will be incorporated with its own cost rate methodology once methods are in place to estimate phosphorus reductions associated with wetland restoration projects. In the meantime, floodplain/stream restoration projects are assumed to be an analog for cost and performance associated with wetland projects.

‡ Riparian buffer restoration: Riparian buffer phosphorus reductions associated with improved in-stream stability are credited to the streams load allocation (LA) of the Lake Champlain and Lake Memphremagog phosphorus TMDLs. Riparian buffer phosphorus reductions associated with land use conversion and overland flow treatment (i.e., treatment of phosphorus from land draining to the buffer, also known as "drainage area") are credited to the buffer drainage area's land use(s): cropland, pasture, forest, developed pervious, and/or developed impervious. Riparian buffer restoration is commonly associated with floodplain/stream restoration, wetland restoration, and river corridor easement projects. The majority of estimated total phosphorus load reduction per acre of riparian buffer restored is associated with overland flow treatment and land use conversion. VTDEC and Vermont Agency of Agriculture, Food and Markets (AAFM) will issue guidance that will address "how, for

projects in the agriculture sector proposed on farms subject to the Required Agricultural Practices Rule, the CWSP shall consult the Agency of Agriculture, Food and Markets (AAFM) to determine project eligibility" including riparian buffer projects on agricultural lands (Clean Water Service Provider Rule, § 39-304(b)). This fund allocation methodology may be updated in the future based on outcomes of VTDEC and AAFM coordination and resulting guidance.

§ Lake shoreline restoration: From *Standard Operating Procedures for Tracking & Accounting of Natural Resources Restoration Projects*: "Phosphorus loading and reductions from lake shorelines were not modeled in the Lake Champlain or Lake Memphremagog TMDLs as its own land use sector. As a result, phosphorus credits for shoreline stabilization projects are credited to allocations based on the adjacent land use. For example, if a shoreline restoration project is directly adjacent to developed pervious (e.g., lawns) or impervious (e.g., roads) land uses, the credit will be given to the developed lands load allocation. Shoreline restoration directly adjacent for forested and agricultural land uses will be credit to the forest and agricultural load allocations, respectively. Adjacent land uses will be determined visually in the field by reporting entities."

†† Farm field: Non-regulatory phosphorus reduction targets include 10% of the Lake Champlain and Lake Memphremagog phosphorus TMDLs' agriculture load allocation (LA). In the early stages of Formula Grant implementation, it is anticipated that the agriculture target will be achieved through implementation of natural resources restoration projects on/adjacent to agricultural fields/lands (i.e., cropland and pasture). Natural resources restoration projects that achieve overland flow treatment from a drainage area and/or floodplain storage from subwatersheds containing agricultural fields/lands will contribute to the agriculture LA. Natural resources restoration project types contributing to the agriculture LA may include floodplain/stream restoration, riparian buffer restoration, lake shoreline restoration, and wetland restoration. However, floodplain/stream restoration project costs are not averaged in the farm field sector average cost rate to avoid inflating costs and over-estimating the on-the-ground potential for implementing floodplain/stream restoration projects (see footnote "*" above for more detail). VTDEC and AAFM will issue guidance that will address "how, for projects in the agriculture sector proposed on farms subject to the Required Agricultural Practices Rule, the CWSP shall consult the Agency of Agriculture, Food and Markets (AAFM) to determine project eligibility" (Clean Water Service Provider Rule, § 39-304(b)). This fund allocation methodology may be updated in the future based on outcomes of VTDEC and AAFM coordination and resulting guidance.

‡‡ Forest: Additional forest BMPs may be incorporated once phosphorus accounting methods are in place.

Current Limitations/Uncertainty and Future Recommendations

VTDEC acknowledges that the Water Quality Restoration Formula Grant non-regulatory total phosphorus load reduction targets, cost rates, and fund allocations methodology will need to be maintained and updated over time. There are several aspects of this methodology where new/improved data may warrant future updates. There are also areas of uncertainty associated with methodology that limit VTDEC's confidence in estimating Formula Grants total funding need near term. The following list summarizes aspects of the methodology that may need to be updated to incorporate new data and address areas of uncertainty.

- Non-regulatory total phosphorus load reduction targets:
    - Total phosphorus load reductions that can be achieved through regulatory programs for several sectors;
    - Non-regulatory load reductions that are expected to be achieved through non-Formula Grant funding sources;
    - Potential shifts in the load reduction potential across non-regulatory sectors; and
    - The outputs of several ongoing studies that will be helpful in setting targets more precisely in future years.
        - One of the studies will help VTDEC address gaps in forestland BMP phosphorus and sediment accounting methodologies.
        - A separate study associated with the Functioning Floodplain Initiative will provide a better understanding of regulatory reductions in the stream sector, as well as the potential for non-regulatory reductions.
- Average cost rates per land use sector and fund allocation:
    - Further refinement phosphorus accounting methods (i.e., methods used to estimate total phosphorus load reductions at the clean water project-level);
    - Further refinement of methods to estimate cost of project identification and development activities;
    - Impacts of regional variation in cost, market volatility, and/or inflation on cost rates; and
    - Impacts of selecting cost-effective "low hanging fruit" projects in early stages of implementation on costs in later stages of implementation.

It should also be noted that funding limitations are not the only factor that may limit the state's ability to meet non-regulatory total phosphorus load reduction targets. Other limitations may include (and may vary by region) staff capacity of project implementers, willing landowners for project implementation, viable projects, tree availability at nurseries for riparian buffer plantings, and more.

VTDEC will review this methodology on an annual basis to determine if/when updates are needed to incorporate new/improved data and/or to address areas of uncertainty.

Cost Rate Calculation Methodology by Clean Water Project Category

Floodplain/Stream Restoration Projects (floodplain storage of phosphorus from upstream subwatershed and phosphorus reduction through stream stability)

Cost rates are based on floodplain/stream restoration projects only. Wetland restoration projects will be incorporated with its own cost rate methodology once methods are in place to estimate phosphorus reductions associated with wetland restoration projects. In the meantime, floodplain/stream restoration projects are assumed to be an analog for cost and performance associated with wetland projects.

Data Inputs/Outputs		Explanation
Project output unit	Acres floodplain restored/ reconnected	
Estimated $/output unit	$513 per linear foot of stream restored	Chesapeake Assessment Scenario Tool (CAST) Cost Effectiveness of BMPs, Natural BMPs Costs, project type "Stream Restoration" using the Chesapeake Bay watershed average values; based on 2018 dollar; includes design/engineering costs assumed to be 20% of construction costs; cost does not include annual O&M post construction CAST-defined Stream Restoration is similar to implementing floodplain/stream restoration projects; however, CAST cost unit is in linear feet rather than acres used by VTDEC.
	$165,305 per acre floodplain restored/ reconnected	Vermont Clean Water Reporting Framework (CWRF) Clean water projects with output measure "Acres of floodplain reconnected/restored" associated with project types "Dam Removal – Implementation" and "Floodplain/Stream Restoration – Implementation." Sample size = 9 projects. Projects completed SFY16-20 statewide; in some cases, costs may include other project outputs; added 20% to estimate design/engineering costs (adopt same assumption as CAST). Cost does not include annual O&M post construction. Median total funding per 1 acre floodplain restored/reconnected = $137,754.52, plus 20% design/engineering = $165,305.42.
Estimated total phosphorus base load per project output unit treatment area	Not applicable	The draft Functioning Floodplain Initiative (FFI) tool estimates individual projects' phosphorus reduction benefit based on projects' role moving whole stream reaches toward their least erosive state (i.e., equilibrium). Therefore, there is no estimated base load and reductions are calculated at the project-level based on stream reach context. Estimates are based on project simulations run in the draft FFI tool.
Total phosphorus load reduction efficiency	Not applicable	The draft FFI tool estimates individual projects' phosphorus reduction benefit based on role moving whole stream reaches toward their least erosive state (i.e., equilibrium). Therefore, there is no efficiency and reductions are calculated at the project-level based on stream reach context. Estimates are based on project simulations run in the draft FFI tool.
Total phosphorus load reduction per project output unit	9.20 kg/yr	Estimated total phosphorus load reduction through *improved floodplain storage* of phosphorus from upstream subwatershed. Floodplain phosphorus storage ranges 10 to 20 lbs/yr per acre (4.5-9.1 kg/yr per acre) based on the FFI project crediting methodology. The FFI simulated total phosphorus load

		reduction credits for floodplain restoration projects and identified an overall median reduction of 20.3 lbs/acre (9.2 kg/acre) (assumes riparian buffer as part of floodplain restoration and does not assume river corridor easement is in place). See overall median in Figure 3 below.
	0.73 kg/yr	Estimated total phosphorus load reduction through *improved stream stability* per acre floodplain restored based on overall median of project simulations in the draft FFI tool (assumes riparian buffer as part of floodplain restoration and does not assume river corridor easement is in place).
	9.93 kg/yr	Estimated total phosphorus load reduction per acre of floodplain restored (sum of two rows above)
Cost per unit phosphorus reduced ($/kg/yr)	**$16,647**	**Calculated based on VT CWRF cost per project output unit**
	Not available	Cost effectiveness based directly on CWRF estimated total phosphorus load reduction for context, if available
Expected design life (years)	Ranges from 20 years minimum to perpetual	VTDEC assumes floodplain/stream restoration design life is 20 years minimum. Lifespan may be extended upon verification of operation and maintenance and continued project performance. Projects protected under a river corridor easement are permanent/perpetual and protect floodplain functions to maintain a geomorphically stable condition over time.

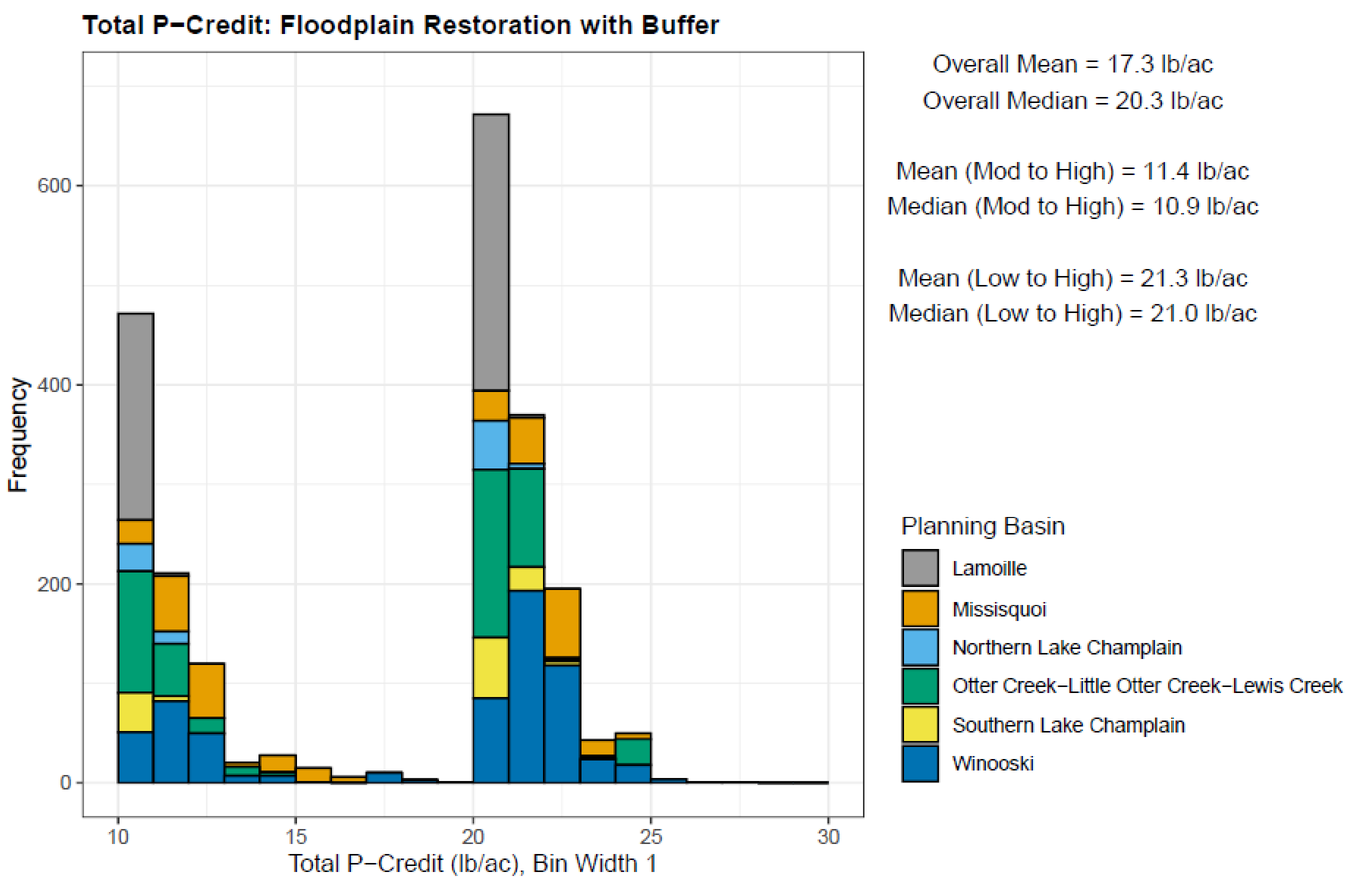

Figure 3. Histograms of FFI simulated total phosphorus load reduction associated with improved floodplain storage through floodplain restoration and buffer restoration.

River Corridor Easement (phosphorus reduction through restoration of stream stability)

Data Inputs/Outputs		Explanation
Project output unit	Acres riparian corridor conserved	
Estimated $/output unit	Not available	Chesapeake Assessment Scenario Tool (CAST) No cost data available.
	$3,213 per acre riparian corridor conserved	Vermont Clean Water Reporting Framework (CWRF) Clean water projects with output measure "Acres of riparian corridor conserved" associated with project type "River Corridor Easement – Implementation." Sample size = 25 projects. Projects completed SFY16-20 statewide; in some cases, costs may include other project outputs; added 20% to estimate design costs (adopt same assumption as CAST for stream restoration projects). Unlike other clean water project categories, river corridor easement costs currently include easement stewardship funds, which would cover O&M costs for this project type. Median total funding per 1 acre of riparian corridor conserved = $2,677.12, plus 20% design/engineering = $3,212.54.
Estimated total phosphorus base load per project output unit treatment area	Not applicable	The draft FFI tool estimates individual projects' phosphorus reduction benefit based on projects' role moving whole stream reaches toward their least erosive state (i.e., equilibrium). Therefore, there is no estimated base load and reductions are calculated at the project-level based on stream reach context. Estimates are based on project simulations run in the draft FFI tool.
Total phosphorus load reduction efficiency	Not applicable	The draft FFI tool estimates individual projects' phosphorus reduction benefit based on projects' role moving whole stream reaches toward their least erosive state (i.e., equilibrium). Therefore, there is no efficiency and reductions are calculated at the project-level based on stream reach context. Estimates are based on project simulations run in the draft FFI tool.
Total phosphorus load reduction per project output unit	0.32 kg/yr	The draft FFI tool estimated total phosphorus load reduction credits for river corridor easement projects and identified an overall median reduction of 0.7 lbs/acre (0.32 kg/acre) (assumes riparian buffer revegetation). See *Standard Operating Procedures for Tracking & Accounting of Natural Resources Restoration Projects*, Appendix G, Table 19.
Cost per unit phosphorus reduced ($/kg/yr)	**$10,041**	**Calculated based on VT CWRF cost per project output unit** (Cost effectiveness expected to improve if implemented with active floodplain/stream restoration)
	Not available	Cost effectiveness based directly on CWRF estimated total phosphorus load reduction for context, if available
Expected design life (years)	Perpetual	River corridor easements are permanent and protect floodplain functions to maintain a geomorphically stable condition over time.

Riparian Buffer Restoration Project (phosphorus runoff treatment and phosphorus reduction through stream stability)

Data Inputs/Outputs		Explanation
Project output unit	Acres of riparian buffer restored	
Estimated $/output unit	$3,062	Chesapeake Assessment Scenario Tool (CAST) Cost Effectiveness of BMPs, Developed BMPs Costs Project type "Forest Buffers" using the Chesapeake Bay watershed average values; based on 2018 dollar; design/engineering costs not applicable; cost does not include annual O&M post construction
	$7,214	Vermont Clean Water Reporting Framework (CWRF) Clean water projects with output measure "Acres of riparian corridor buffer planted/restored" associated with project type "River – Planting." Sample size = 102 projects. Completed SFY16-20 statewide; in some cases, costs may include other project outputs; design/engineering costs not applicable; cost does not include annual O&M post construction. Median total funding per 1 acre of riparian corridor buffer planted/restored = $7,214 (typically includes project scoping and development).
Estimated total phosphorus base load per project output unit treatment area	1.8 kg/yr estimated total phosphorus base load for drainage area treated per acre of riparian buffer restored	1 acre of riparian corridor buffer planted/restored is assumed to treat runoff from 5 adjacent acres. Based on estimated drainage areas of actual buffer projects in the VTDEC Watersheds Projects Database, buffers' drainage areas are on average made up of the following land uses by %: • Cropland (Weighted-Average) 25% • Developed Impervious (WA) 3% • Developed Pervious (WA) 9% • Forest (WA) 58% • Pasture 3% • Roads Paved 2% Based on Lake Champlain basin-wide median total phosphorus loading rates, and the average breakdown of land use treated above, the estimated base load of the 5-acre drainage area treated by 1-acre of buffer is 1.8 kg/yr.
Total phosphorus load reduction efficiency	40% plus land use conversion	The Chesapeake Bay Program provides different efficiencies for buffers in different geographic regions of the Bay watershed, ranging from 30 to 50% (Chesapeake Bay Program, 2014). Vermont and the Chesapeake Bay watershed have similar plains, piedmont, and mountainous regions, thus averaging the corresponding Chesapeake Bay phosphorus load reduction efficiencies would provide a more robust estimate of riparian buffer effectiveness than adopting any single region's efficiency. The average total phosphorus reduction efficiency of the Chesapeake Bay regions most similar to Vermont's biophysical regions was calculated as 39%.
Total phosphorus load reduction per project output unit	0.72 kg/yr	Estimated total phosphorus load reduction *through treatment of drainage area*; calculated by multiplying base load by efficiency above.
	0.24 kg/yr	Total phosphorus load reduction *through land use conversion* per acre of buffer planted, assumed to convert from developed pervious to forest land use. Based on Lake Champlain basin-wide median total phosphorus loading rates.

	0.45 kg/yr	Estimated total phosphorus load reduction through *improved stream stability* per acre riparian buffer restored of 1.0 lbs/acre (0.45 kg/acre); based on overall median of project simulations in the draft FFI tool. See Figure 4 below.
	1.41 kg/yr	Estimated total phosphorus load reduction per acre of riparian buffer restored (sum of three rows above)
Cost per unit phosphorus reduced ($/kg/yr)	**$5,116**	**Calculated based on VT CWRF cost per project output unit**
	$2,442	Cost effectiveness based directly on CWRF estimated total phosphorus load reduction for context, if available Reviewed clean water projects completed SFY16-20 statewide with output measure "Acres of riparian corridor buffer planted/restored" associated with project type "River – Planting" with total phosphorus load reduction estimates. Sample size = 74 projects. Median total funding per 1 kg/yr total phosphorus load reduction = $2,442, Average total funding per 1 kg/yr total phosphorus load reduction = $8,740. *Only accounts for treatment of runoff, not land use conversion (calculation added in SFY21) and stream stability (under development through FFI). Methodology to estimate area treated by buffer updated in 2021 to a more conservative approach, which may explain the higher cost per unit total phosphorus reduced, above.*
Expected design life (years)	20	VTDEC phosphorus accounting methodology assumes riparian buffer restoration design life is 20 years for buffers implemented in 2021 and beyond. Lifespan may be extended upon verification of operation and maintenance and continued project performance.

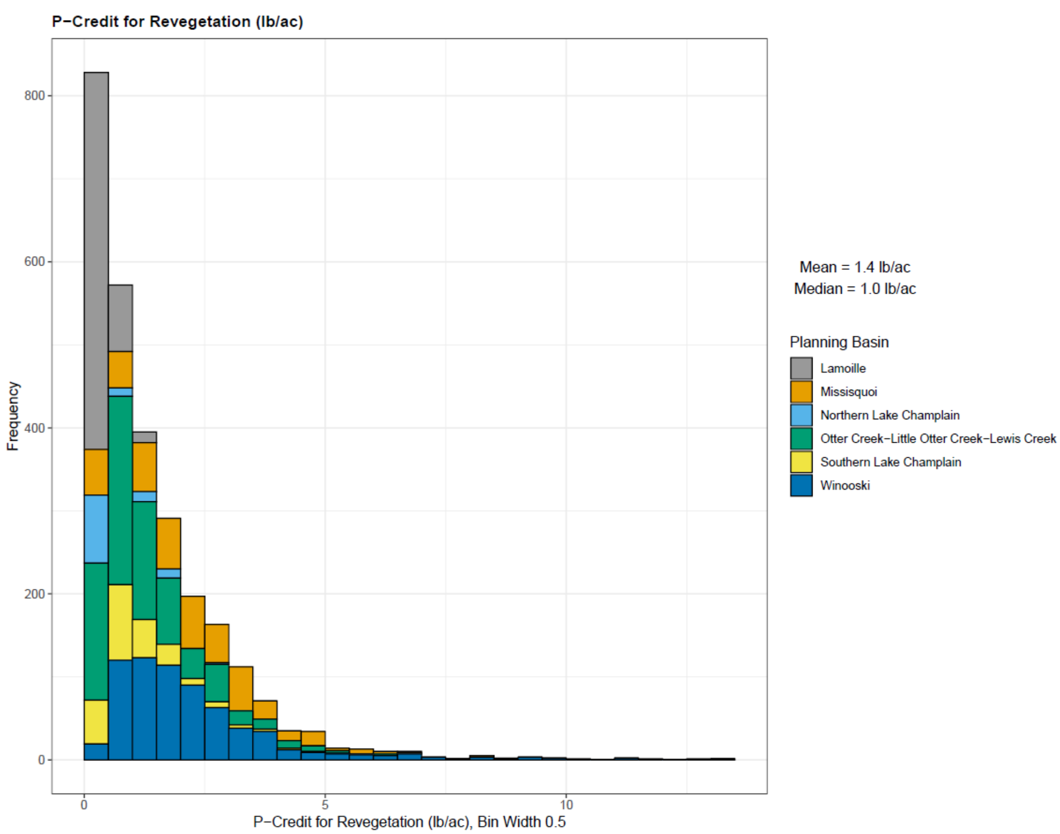

Figure 4. Histograms of FFI simulated total phosphorus load reduction associated with improved stream stability through riparian buffer restoration.

Sub-Jurisdictional Stormwater Treatment Practices (phosphorus runoff treatment)

<table>
<tr><th colspan="2">Data Inputs/Outputs</th><th>Explanation</th></tr>
<tr><td>Project output unit</td><td>Acres of existing impervious surface treated</td><td></td></tr>
<tr><td rowspan="2">Estimated cost per project output unit</td><td>$36,521 per acre of impervious surface treated</td><td>Chesapeake Assessment Scenario Tool (CAST) Cost Effectiveness of BMPs, Developed BMPs Costs

Averaged the capital costs (design/engineering and construction, not land) for the following BMP types, using the Chesapeake Bay watershed average values; based on 2018 dollar; averages are based on the average of the median value for new/redevelopment and retrofits; assumes median design/engineering costs at 22.5% of construction cost; cost does not include annual O&M post construction.

• Bioretention/raingardens - A/B soils, underdrain
• Bioretention/raingardens - A/B soils, no underdrain
• Bioretention/raingardens - C/D soils, underdrain
• Bioswale
• Infiltration Practices w/ Sand, Veg. - A/B soils, no underdrain
• Infiltration Practices w/o Sand, Veg. - A/B soils, no underdrain
• Vegetated Open Channels - A/B soils, no underdrain
• Vegetated Open Channels - C/D soils, no underdrain
• Wetlands and Wet Ponds</td></tr>
<tr><td>$41,884 per acre of existing impervious surface treated</td><td>Vermont Clean Water Reporting Framework (CWRF)

Cost effectiveness based directly on actual stormwater BMPs' estimated acres of existing impervious surface treated for clean water projects completed SFY16-20 statewide, with BMP types listed below, and output measure "Acres of existing impervious surface treated." Sample size = 45 projects after removing 1 outlier (retrofit to an existing wet pond). In some cases, costs may include other project outputs. Cost does not include annual O&M post construction.

Median total cost per acre of existing impervious surface treated = $34,191, average total cost per acre of existing impervious surface treated = $50,426. Selected median value of $34,191 plus 22.5% estimated design/engineering (adopt same assumption as CAST) for total $41,884 per acre of existing impervious surface treated.

• Bioretention
• Bioretention with underdrain
• Extended Dry Detention Pond
• Grass Swale (Conveyance)
• Gravel Wetland
• Infiltration Basin
• Infiltration Trench
• Porous Pavement
• Surface Infiltration
• Wet Pond/Created Wetland</td></tr>
<tr><td>Estimated total phosphorus base load per project</td><td>2.02 kg/year estimated total phosphorus base load for drainage area treated per 1-</td><td>For every 1 acre of existing impervious surface treated, BMP is assumed to also treat 3 acres of developed pervious surface (drainage area treated is on average 25% developed impervious and 75% developed pervious), based on estimated</td></tr>
</table>

output unit treatment area	acre of existing impervious surface treated	drainage areas of actual stormwater BMPs in the Watershed Projects Database (filtered to BMP types listed above, sample size = 46 projects). Based on Lake Champlain basin-wide median weighted area total phosphorus loading rates for developed impervious (1.15 kg/acre/yr) and pervious (0.29 kg/acre/yr), and the average breakdown of land use treated above, the estimated base load for drainage area treated per 1-acre of existing impervious surface treated by a stormwater BMP is 2.02 kg/yr.
Total phosphorus load reduction efficiency	45%	Stormwater BMP total phosphorus load reduction efficiencies vary by practice type, area treated, storage volume, and infiltration rate (if applicable). The median and average estimated total phosphorus load reduction efficiency of actual stormwater BMPs in the Watershed Projects Database is 45% (filtered to BMP types listed above, sample size = 46 projects).
Total phosphorus load reduction per project output unit	0.91 kg/year	Estimated total phosphorus load reduction per acre of impervious surface treated
Design and construction cost per unit phosphorus reduced ($/kg/yr)	**$46,026**	**Calculated based on VT CWRF cost per project output unit**
	$58,818	Cost effectiveness based directly on CWRF estimated total phosphorus load reduction for context, if available Cost effectiveness based directly on actual stormwater BMPs' estimated total phosphorus load reductions for clean water projects completed SFY16-20 statewide, with CWRF BMP types listed above, and output measure "Acres of existing impervious surface treated" with total phosphorus load reduction estimates. Sample size = 42 projects after removing 1 outlier (retrofit to an existing wet pond). In some cases, costs may include other project outputs. Cost does not include annual O&M post construction. Median total funding per 1 kg/yr estimated total phosphorus load reduction = $48,015, average total funding per 1 kg/yr estimated total phosphorus load reduction = $77,707. Selected median value of $48,015 plus 22.5% estimated design/engineering (adopt same assumption as CAST) for total $58,818 per 1 kg/yr total phosphorus load reduction.
Expected design life (years)	10	VTDEC phosphorus accounting methodology assumes stormwater treatment practice design life is 20 years. Non-regulatory projects are assigned an initial 10-year design life, which can be extended upon verification of operation and maintenance and continued project performance.

Sub-Jurisdictional Road Erosion Control Practices (phosphorus reduction through erosion control)

Data Inputs/Outputs		Explanation
Project output unit	Road miles brought up-to Municipal Roads General Permit (MRGP) standards	Projects must be located on non-municipal/non-regulatory hydrologically connected road segments and bring whole road segments into full compliance with the Municipal Roads General Permit (MRGP) standards to be eligible for Formula Grant funds; non-hydrologically connected municipal and private road segments are not eligible due to limited water quality benefit
Estimated $/output unit	$86,011 per mile (converted from $16.29 per linear foot)	Chesapeake Assessment Scenario Tool (CAST) Cost Effectiveness of BMPs, Developed BMPs Costs Project type “Dirt & Gravel Road Erosion & Sediment Control - Driving Surface Aggregate with Outlets” using the Chesapeake Bay watershed average values; based on 2018 dollar; design/engineering costs not applicable; cost does not include annual O&M post construction BMPs are not fully aligned with MRGP standards but provide a frame of reference for cost of road work. Project type defined as: “Reduce the amount of sediment runoff from dirt and gravel roads through the use of driving surface aggregates (DSA) such as durable and erosion resistant road surface and through the use of additional Drainage Outlets (creating new outlets in ditchline to reduce channelized flow).” (Note: application of surface aggregates and/or road paving are not part of MRGP standards and are not eligible for funding due to high cost and limited water quality benefit)
	$50,767 per mile brought up-to MRGP standards	Vermont Clean Water Reporting Framework (CWRF) Municipal Roads Grants-in-Aid projects result in whole road segments changing from not meeting or partially meeting to fully meeting MRGP standards. Estimated cost per mile used here is based on projects on Class 3 roads that changed from not meeting to fully meeting MRGP standards, based on data analysis completed by Fitzgerald Environmental, January 2021. Dataset captures projects completed through SFY20. Median cost = $67,689 and average cost = $88,796 per mile. Design/engineering costs not applicable. Cost does not include annual operation and maintenance post construction. The median cost of $67,689 was scaled to 75%, acknowledging that private roads are typically 50% the width of municipal roads (one-lane versus two-lane). The narrower travel surface would result in lower cost for cross drainage culverts. However, cost of linear practices is constant regardless of travel surface width, which is why cost was not scaled to 50%. Municipal Roads Grants-in-Aid projects include a mix of road segments with baseline MRGP compliance status of “does not meet” and “partially meets” MRGP standards. This exercise is based on costs of Municipal Roads Grants-in-Aid projects with a baseline status of “does not meet,” with the assumption that most private roads will have a baseline status of “does not meet” MRGP standards. For context, the Municipal Roads Grants-in-Aid cost distribution ranges from a minimum of $5,621 per mile to a maximum of $183,610 per mile (excluding outliers), depending on project complexity. Municipal Roads Grants-in-Aid projects implemented through SFY20 are in the early stages of MRGP implementation, and municipalities are required to address the highest priority segments that do not meet MRGP standards first, which have the highest costs. Municipal road project costs estimated here are likely on the higher range and may decrease as more data on project cost become available over time.

Estimated total phosphorus base load per project output unit treatment area	20.12 kg/mi/yr	1. VTDEC established MRGP linear loading rates for the Lake Champlain Basin in the *DRAFT Standard Operating Procedures for Tracking & Accounting of Developed Lands Regulatory Projects & Non-Regulatory Clean Water Projects*. 2. This exercise assumes most sub-jurisdictional roads are unpaved and utilizes total phosphorus linear loading rates for unpaved Class 1-3 hydrologically connected roads (see Appendix E Table E-3 of *DRAFT Standard Operating Procedures for Tracking & Accounting of Developed Lands Regulatory Projects & Non-Regulatory Clean Water Projects*). 3. Assumes baseline condition of sub-jurisdictional roads "does not meet" MRGP standards. Project must be located on hydrologically connected road segments and bring road segments into full compliance with MRGP standards to be eligible for Formula Grant funds. 4. MRGP linear total phosphorus loading rate (converted from kg/km/yr to kg/mi/yr to align with project output measure) median value across TMDL drainage areas, averaged across slope classes, for unpaved roads, not meeting standards = 26.82 kg/mi/yr. 5. This exercise assumes 75% of total phosphorus baseload for non-municipal/non-regulatory road segments at 20.12 kg/mi/yr, as private roads are typically 50% of municipal road width (one-lane versus two-lane). The narrower travel surface would result in lower phosphorus load from travel lane for private roads compared to municipal roads. However, most phosphorus loading originates from road shoulders, which is constant regardless of travel surface width, which is why phosphorus was not scaled to 50%.
Total phosphorus load reduction efficiency	80%	6. Estimated total phosphorus baseload and load reductions are based on change in MRGP compliance status. Change from not meeting to fully meeting MRGP standards results in an 80% total phosphorus load reduction. 7. Total phosphorus load reduction efficiency ranges from 80%, if road segment's baseline MRGP compliance status is "does not meet," to 40% if road segment's baseline MRGP compliance status is "partially meets." The 80% reduction efficiency was selected with the assumption that most private roads will have a baseline status of "does not meet."
Total phosphorus load reduction per project output unit	16.10kg/mi/yr	8. Estimated total phosphorus load reduction associated with road mile changing from not meeting to fully meeting MRGP standards.
Cost per unit phosphorus reduced ($/kg/yr)	**$3,153**	**Calculated based on cost per project output unit**
	$11,597	Cost effectiveness based directly on CWRF estimated total phosphorus load reduction for context, if available Municipal Roads Grants-in-Aid projects resulting in whole road segments being brought up to MRGP standards, completed through SFY20, with total phosphorus load reduction estimates; sample size = 239 projects. Cost does not include annual O&M post construction. Design/engineering costs not applicable. Median total funding per 1 kg/yr total phosphorus load reduction = $11,597, average total funding per 1 kg/yr total phosphorus load reduction = $28,558. Selected median value of $11,597 per 1 kg/yr total phosphorus load reduction. Municipal Roads Grants-in-Aid projects are on a combination of road segments that "do not meet" and "partially meet" MRGP standards pre-implementation

		(mix of 40% and 80% total phosphorus load reduction efficiency), which may result in a lower cost effectiveness compared to projects that are on road segments that do not meet MRGP standards pre-implementation (80% total phosphorus load reduction efficiency). This may explain the higher cost per unit total phosphorus reduced compared to project output-based estimate above.
Expected design life (years)	8 years	Based on MRGP estimated design life, VTDEC phosphorus accounting methodology assumes road BMPs design life is 8 years. Non-regulatory projects are assigned an initial 8-year design life, which can be extended upon verification of operation and maintenance and continued project performance.

Sub-Jurisdictional Forest Road Erosion Control Practices (phosphorus reduction through erosion control)

Data Inputs/Outputs		Explanation
Project output unit	Forest road miles brought up-to *Acceptable Management Practices (AMPs) for Maintaining Water Quality on Logging Jobs in Vermont* standards	Projects must be located on non-regulatory hydrologically connected forest road segments and bring whole road segments into full compliance with the AMP standards to be eligible for Formula Grant funds; non-hydrologically connected forest road segments are not eligible due to limited water quality benefit
Estimated $/output unit	$56.45 per acre harvested	Chesapeake Assessment Scenario Tool (CAST) Cost Effectiveness of BMPs, Natural BMPs Costs Project type “forest harvesting” using the Chesapeake Bay watershed average values; based on 2018 dollar; design/engineering costs not applicable; cost does not include annual O&M post construction Forest harvesting is defined as, “Forest harvesting practices are a suite of BMPs that minimize the environmental impacts of road building, log removal, site preparation and forest management. These practices help reduce suspended sediments and associated nutrients that can result from forest operations.” CAST-defined suite of BMPs is similar to implementing AMP standards, however, CAST cost unit is in acres rather than linear unit used by Vermont. (Note: harvesting sites with regulatory requirement to meet AMPs is not eligible for Formula Grant funds, but this CAST practice type provides a frame of reference for cost of forest road/trail work.)
	$33,845 per mile	Vermont Clean Water Reporting Framework (CWRF) Limited data are available in CWRF on forest road BMPs’ cost effectiveness. Until better forest road project data are available in CWRF, estimated cost per forest road mile brought up to AMP standards is based on scaled Municipal Roads Grants-in-Aid project costs. Municipal Roads Grants-in-Aid projects result in whole road segments changing from not meeting or partially meeting to fully meeting MRGP standards. Estimated cost per mile used here is based on projects on Class 3 roads that changed from not meeting to fully meeting MRGP standards. Dataset captures projects completed through SFY20. Median cost = $67,689 and average cost =

		$88,796 per mile. Design/engineering costs not applicable. Cost does not include annual operation and maintenance post construction. Municipal Road Grants-in-Aid median cost is scaled to 50% to estimate cost per forest road mile, based on the Type 2 forest road. Type 2 forest roads are estimated to be 50% of the cost of municipal road projects, as Type 2 forest roads are approximately 50% the width of Class 3 municipal roads and AMP standards require stone line ditch. Type 3 forest roads are estimated to be 33% of the cost of municipal road projects, as Type 3 forest roads are approximately 33% the width of Class 3 municipal roads, but without the stone line requirement. Type 4 forest roads would be similar in cost to Type 3 forest roads because the AMP standards are similar, except Type 4 forest roads do not require permanent structural BMPs. Formula Grants are most likely to fund work on private Type 2 or 3 forest truck roads, with some Type 4 forest roads. To be conservative, Type 2 forest road costs are used here, as these have the highest cost. It should be noted that AMP standards involve stream crossing improvements where MRGP standards do not, which further supports selecting Type 2 forest road costs to be conservative.
Estimated total phosphorus base load per project output unit treatment area	2.78 kg/mi/yr	VTDEC established forest truck road loading rates by county in the DRAFT *Standard Operating Procedures for Tracking & Accounting of Natural Resources Restoration Projects,* Appendix A, based on contract work completed by Watershed Consulting Associates. The average estimated truck road phosphorus loading rate across soil types, slopes, and runoff potential for Grand Isle, Franklin, Addison, and Chittenden County, converted from kg/100-meter road segment/yr to kg/mi/yr is 2.78 kg/mi/yr. The average is calculated giving equal weight to all soil types, slopes, and runoff potential classes. In the future, an area-weighted calculation may be calculated and applied for this estimate instead of an equally weighted average.
Total phosphorus load reduction efficiency	80%	Estimated total phosphorus load reduction based on change from not meeting to fully meeting AMP standards. Total phosphorus load reduction efficiency ranges from 80%, if road segment's baseline AMP compliance status is "does not meet," to 40% if road segment's baseline AMP compliance status is "partially meets." The 80% reduction efficiency was selected with the assumption that most forest roads on private lands will have a baseline status of "does not meet."
Total phosphorus load reduction per 1 project output unit	2.22 kg/mi/yr	Estimated total phosphorus load reduction per forest road mile brought from not meeting to fully meeting AMP standards through implementation of suite of forest road BMPs
Cost per unit phosphorus reduced ($/kg/yr)	**$15,245**	**Calculated based on cost per project output unit**
	Not available	Cost effectiveness based directly on CWRF estimated total phosphorus load reduction for context, if available
Expected design life (years)	5 years	The design life for projects/practices meeting AMP compliance standards lasts until the segment is assessed in the next REI or 5 years for truck roads and 10 years for skid trails (whichever is sooner).

Lake Shoreline Restoration (phosphorus reduction through bank stabilization and restoring living shorelines)

Data Inputs/Outputs		Explanation
Project output unit	Linear feet of lakeshore restored	
Estimated $/output unit	$110 per linear foot shoreline restored	Chesapeake Assessment Scenario Tool (CAST) Cost Effectiveness of BMPs, Natural BMPs Costs Project type "urban shoreline management" subcategory "non-structural" representing cost of projects that use natural habitat elements only (e.g., vegetation); selected high-cost range to be conservative; based on 2018 dollar; design/engineering costs not applicable; cost does not include annual O&M post construction.
	$141 per linear foot of lakeshore restored	Watershed Projects Database (WPD) Median cost per linear foot of lakeshore restored through stabilization practices by "Lake Shoreland – Implementation" project type; completed SFY16-20 statewide. Sample size = 4 projects, range = $61-$612. In some cases, costs may include other shoreland project outputs; cost does not include annual O&M post construction.
	$150 per linear foot of lakeshore restored	VTDEC Lakes and Ponds Program lake shoreline restoration case studies using bioengineering methods based on 10-15-foot project width.
Estimated total phosphorus base load per project output unit treatment area	0.021 kg/foot/year	Unlike other clean water project types, TMDL Soil and Water Assessment Tool (SWAT) model phosphorus loading rates are not used in the phosphorus accounting calculations for bioengineered shoreline stabilization practices. Rather, the baseline condition is defined as the volume of erosion prior to remediation, following the approach used by Chesapeake Bay Program (2019). $Volume\ of\ sediment\ erosion\ (ft^3) = Length\ of\ Shoreline\ (feet) * Average\ Bank\ Height\ (feet) * Average\ Shoreline\ Recession\ Rate\ (\frac{feet}{year})$ Shoreline recession rates are grouped into the following categories for simplified reporting in Vermont: • Low erosion: 2 inches per year (0.167 feet/year) • Moderate erosion: 4 inches per year (0.33 feet/year) • Severe erosion: 6 inches per year (0.5 feet/year) Volume of sediment erosion (ft^3) is converted to kilograms of phosphorus using sediment bulk density (34.0 kg/ft^3; Ishee et al. 2015) and sediment phosphorus concentration values (0.000621 kg TP/kg sediment; Ishee et al. 2015). Estimated total phosphorus base load per 1 foot of lakeshore restored assumes 1 foot of shoreline length, 3 feet of shoreline height, and a moderate erosion rate of 0.33 feet per year for estimated 0.99 cubic feet volume of sediment erosion. Volume of sediment erosion is converted to total phosphorus baseload by multiplying sediment bulk density and sediment phosphorus concentration rates to estimate total phosphorus load of 0.021 kg/foot/year base load.

Total phosphorus load reduction efficiency	85%	The Chesapeake Bay Program provides a 100% efficiency for shoreline stabilization projects because the erosion equation above only accounts for fastland sediment, but shoreline stabilization projects prevent both fastland erosion (erosion of land that lies above the waterline) and nearshore erosion (erosion of sediments in the shallow region just below the waterline). As a result, this accounting method should theoretically provide a conservative estimate of the phosphorus prevented from eroding. This efficiency, however, is later lowered by 33% (Virginia) or 55% (Maryland) depending on the percentage of sand in the shoreline because sand is not a detriment to Chesapeake Bay water quality. There is also additional flexibility for local or state agencies to give partial or no credit for shoreline stabilization sites that are at continued risk of erosion (e.g., storm and wave events impact the base of the bank). VTDEC believes, however, that the sediment bulk density and phosphorus content conversions used above appropriately consider the contribution of sand to shoreline phosphorus in Vermont. VTDEC also believes that there does not need to be additional conservativeness in the efficiency for sites at continued risk of erosion since Vermont's inland lakes are subject to less erosive forces than the tidal Chesapeake Bay. Rather than adopting the Chesapeake Bay's original 100% efficiency, VTDEC is adopting a conservative 85% reduction for shoreline stabilization projects in Vermont.
Total phosphorus load reduction per project output unit	0.018 kg/foot/year	Estimated total phosphorus load reduction per 1 foot of lakeshore restored
Cost per unit phosphorus reduced ($/kg/yr)	**$8,333**	**Calculated based on cost per project output unit based on Lakes and Ponds Program case studies, summarized above.**
	Not available	Cost effectiveness based directly on CWRF estimated total phosphorus load reduction for context, if available
Expected design life (years)	10 years	The Chesapeake Bay Program gives a five-year design life which may be extended if the efficacy of the site merits extension. The shorelines within the Chesapeake Bay, however, are exposed to greater hydrodynamic forces (e.g., tides, waves) than the shorelines of inland lakes within Vermont, suggesting a 5-year design life may be an overly conservative estimate. Considering this and the best professional judgement of the VTDEC Lakes and Ponds Program, the initial design life of bioengineered stabilization projects in Vermont is 10 years, but this may be extended upon verification.

Lake Shoreland Runoff Treatment (phosphorus runoff treatment through nature-based solutions)

Data Inputs/Outputs		Explanation
Project output unit	Acres of existing impervious surface treated	
Estimated $/output unit	$19,327 per acre impervious surface treated	Chesapeake Assessment Scenario Tool (CAST) Cost Effectiveness of BMPs, Developed BMPs Costs Averaged the capital costs (design/engineering and construction, not land) for BMP types "Bioretention/raingardens - A/B soils, no underdrain" and "Bioswale" – BMP types are representative of small-scale green stormwater infrastructure typically implemented as part of a lake shoreland project. Averages are based on the average of the median value for new/redevelopment and retrofits, using the Chesapeake Bay watershed average values; based on 2018 dollar; assumes median design/engineering costs at 20% for bioretention and 22.5% for bioswale of construction cost. Cost does not include annual O&M post construction.
	$14,339 per acre impervious surface treated	VTDEC Watershed Projects Database (WPD) $11,949 median cost per acre of impervious surface treated for "Lake Shoreland – Implementation" projects reporting acres of impervious surfaces treated, completed SFY16-20 statewide (sample size = 11, range = $10,603-$35,280); in some cases, costs may include other project outputs; cost does not include annual O&M post construction. Estimated design/engineering costs at 20% of construction cost (adopt same assumption as CAST for Bioretention BMP) for total of $14,339 per acre of existing impervious surface treated.
Estimated total phosphorus base load per project output unit treatment area	2.02 kg/year estimated total phosphorus base load for drainage area treated per 1-acre of existing impervious surface treated	Refer to sub-jurisdictional stormwater treatment practices estimated total phosphorus base load per project output unit treatment area. It is important to note, however, that shoreland drainage areas base load may be lower than other stormwater drainage areas due to the smaller nature of shoreland practices.
Total phosphorus load reduction efficiency	43%	Most shoreland BMPs can be accounted for using the stormwater bioretention, infiltration trench, and grass conveyance swale accounting methods. The median efficiency for these practice types in the Watershed Projects Database is 43% (sample size = 24). It is important to note, however, that shoreland efficiencies may be lower than these stormwater efficiencies due to the smaller nature of shoreland practices. Tree canopy expansion is also an eligible shoreland practice which receives a 23.8% efficiency applied to 94 ft^2 of developed pervious land for each tree planted. Native revegetation (conversion of developed pervious land uses to native vegetation by the implementation of "no mow" zones or native shrub plantings) is also a shoreland practice that receives a land use conversion credit from developed pervious (median 0.29 kg/acre/year) to range brush (median 0.07 kg/acre/year) land use, which is approximately a 76% reduction. Since most shoreland practices are small scale green stormwater infrastructure, a 43% reduction is adopted here.

Total phosphorus load reduction per 1 project output unit	0.87 kg/year	Estimated total phosphorus load reduction per acre of impervious surface treated.
Cost per unit phosphorus reduced ($/kg/yr)	**$16,482**	**Calculated based on VTDEC WPD cost per project output unit**
	Not available	Cost effectiveness based directly on CWRF estimated total phosphorus load reduction for context, if available
Expected design life (years)	10 years	VTDEC phosphorus accounting methodology assumes lake shoreland practices receive a practice design life of 10 years. Non-regulatory projects are assigned an initial 10-year design life, which can be extended upon verification of operation and maintenance and continued project performance.

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Final draft is posted for public comment March-April 2022, available at: https://dec.vermont.gov/water-investment/statues-rules-policies/act-76#publicnotice.

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Appendix A. Clean Water Service Provider Phosphorus Reduction Target and Fund Allocations

1) Phosphorus reduction targets by basin and land use (kg)	Farm Field	Developed	Forest	Stream	Total
Basin 2 & 4 - Poultney, Mettawee, South Lake Champlain	33,731	2,999	5,860	4,694	47,284
Basin 3 - Otter, Lewis, Little Otter	48,390	5,085	1,331	14,314	69,120
Basin 5 - Northern Lake Champlain Direct	10,992	3,108	137	1,516	15,753
Basin 6 - Missisquoi, Rock, Pike	49,114	7,371	11,415	30,695	98,595
Basin 7 - Lamoille	7,455	4,499	491	3,278	15,723
Basin 8 - Winooski	13,937	8,632	1,904	16,638	41,111
Lake Memphremagog	10,557	2,580	327	2,489	15,953
Total	174,176	34,274	21,465	73,624	303,539
Percent of reduction for CWSP - typical basin	10%	Permit based	0%	33%	

2) Regulatory phosphorus reductions (kg)	Farm Field	Developed	Forest	Stream	Total
Basin 2 & 4 - Poultney, Mettawee, South Lake Champlain	30,358	1273.7	733	3,145	35,509
Basin 3 - Otter, Lewis, Little Otter	43,551	2102.1	1,331	9,590	56,574
Basin 5 - Northern Lake Champlain Direct	9,893	1150.9	137	1,016	12,196
Basin 6 - Missisquoi, Rock, Pike	44,203	1810.0	1,142	20,566	67,720
Basin 7 - Lamoille	6,710	2055.7	491	2,196	11,452
Basin 8 - Winooski	12,543	5027.0	1,904	11,147	30,622
Lake Memphremagog[1]	9,501	1,151	327	1,668	12,647
Total reduction	156,758	14,570	6,064	49,328	226,721

3) CWSP total load reduction targets-totals (kg)	Farm Field	Developed	Forest	Stream	Total	Percent
Basin 2 & 4 - Poultney, Mettawee, South Lake Champlain	3,373	1,725	5,128	1,549	11,775	15.3%
Basin 3 - Otter, Lewis, Little Otter	4,839	2,983	-	4,724	12,546	16.3%
Basin 5 - Northern Lake Champlain Direct	1,099	1,957	-	500	3,557	4.6%
Basin 6 - Missisquoi, Rock, Pike	4,911	5,561	10,274	10,129	30,875	40.2%
Basin 7 - Lamoille	746	2,443	-	1,082	4,271	5.6%
Basin 8 - Winooski	1,394	3,605	-	5,491	10,489	13.7%
Lake Memphremagog	1,056	1,429	-	821	3,307	4.3%
Total	17,418	19,704	15,401	24,296	76,819	

4) CWSP annual load reduction increase needed to meet TMDL targets (kg)	Farm field	Developed	Forest	Stream	total	Percent
Basin 2 & 4 - Poultney, Mettawee, South Lake Champlain	224.9	115.0	341.8	103.3	785.0	15.3%
Basin 3 - Otter, Lewis, Little Otter	322.6	198.9	0.0	314.9	836.4	16.3%
Basin 5 - Northern Lake Champlain Direct	73.3	130.5	0.0	33.4	237.1	4.6%
Basin 6 - Missisquoi, Rock, Pike	327.4	370.7	684.9	675.3	2,058.4	40.2%
Basin 7 - Lamoille	49.7	162.9	0.0	72.1	284.7	5.6%
Basin 8 - Winooski	92.9	240.3	0.0	366.0	699.3	13.7%
Lake Memphremagog	70.4	95.3	0.0	54.8	220.4	4.3%
Total	1,161.2	1,313.6	1,026.7	1,619.7	5,121.2	100.0%

5) CWSP annual funding level to meet targets (onetime)	Farm field	Developed	Forest	Stream	Total annual cost design/ engineering and construction	7% total annual cost project ID/dev	Total annual cost all project steps (excludes O&M)	15% admin	Total project + 15% admin
CWSP Cost/kg/yr[3]	$6,725	$15,822	$9,565	$10,601					
Basin 2 & 4 - Poultney, Mettawee, South Lake Champlain	$1,512,161	$1,819,867	$3,269,522	$1,094,778	$7,696,328	$579,293	$8,275,621	$1,460,404	$9,736,025
Basin 3 - Otter, Lewis, Little Otter	$2,169,324	$3,146,358	$-	$3,338,445	$8,654,127	$651,386	$9,305,513	$1,642,149	$10,947,662
Basin 5 - Northern Lake Champlain Direct	$492,771	$2,064,319	$-	$353,576	$2,910,666	$219,082	$3,129,748	$552,308	$3,682,057
Basin 6 - Missisquoi, Rock, Pike	$2,201,781	$5,865,755	$6,550,840	$7,158,974	$21,777,350	$1,639,155	$23,416,506	$4,132,325	$27,548,830
Basin 7 - Lamoille	$334,208	$2,577,176	$-	$764,526	$3,675,910	$276,681	$3,952,591	$697,516	$4,650,107
Basin 8 - Winooski	$624,796	$3,802,595	$-	$3,880,470	$8,307,860	$625,323	$8,933,183	$1,576,444	$10,509,627
Lake Memphremagog	$473,270	$1,507,647	$-	$580,587	$2,561,504	$192,801	$2,754,305	$486,054	$3,240,359
Total	$7,808,310	$20,783,717	$9,820,362	$17,171,356	$55,583,745	$4,183,723	$59,767,467	$10,547,200	$70,314,668

6) CWSP annual funding based on funds available	Farm field	Developed	Forest	Stream	Total annual cost design/engineering and construction	7% total annual cost project ID/dev	Total annual cost all project steps (excludes O&M)	15% admin	Total project + 15% admin
Basin 2 & 4 - Poultney, Mettawee, South Lake Champlain	$150,539	$181,172	$325,489	$108,988	$766,189	$57,670	$823,859	$145,387	$969,246
Basin 3 - Otter, Lewis, Little Otter	$215,962	$313,228	$-	$332,350	$861,540	$64,847	$926,387	$163,480	$1,089,867
Basin 5 - Northern Lake Champlain Direct	$49,057	$205,508	$-	$35,199	$289,764	$21,810	$311,574	$54,984	$366,558
Basin 6 - Missisquoi, Rock, Pike	$219,193	$583,951	$652,152	$712,694	$2,167,989	$163,182	$2,331,171	$411,383	$2,742,555
Basin 7 - Lamoille	$33,271	$256,564	$-	$76,110	$365,946	$27,544	$393,490	$69,439	$462,930
Basin 8 - Winooski	$62,200	$378,558	$-	$386,310	$827,068	$62,252	$889,321	$156,939	$1,046,260
Lake Memphremagog	$47,115	$150,090	$-	$57,799	$255,004	$19,194	$274,198	$48,388	$322,586
Total	$777,337	$2,069,071	$977,641	$1,709,451	$5,533,500	$416,500	$5,950,000	$1,050,000	$7,000,000

7) CWSP annual funding based on funds available & min	Farm field	Developed	Forest	Stream	Total annual cost design/ engineering and construction	7% total annual cost project ID/dev[1]	Total annual cost all project steps - (excludes O&M)	15% admin	Total project + 15% admin
Basin 2 & 4 - Poultney, Mettawee, South Lake Champlain	$150,539	$181,172	$325,489	$108,988	$766,189	$64,813	$831,002	$146,647	$977,649
Basin 3 - Otter, Lewis, Little Otter	$215,962	$313,228	$0	$332,350	$861,540	$69,055	$930,595	$164,223	$1,094,817
Basin 5 - Northern Lake Champlain Direct	$86,990	$364,418	$0	$62,417	$513,825	$34,714	$548,539	$96,801	$645,340
Basin 6 - Missisquoi, Rock, Pike	$155,420	$414,054	$462,413	$505,341	$1,537,228	$120,503	$1,657,731	$292,541	$1,950,272
Basin 7 - Lamoille	$46,716	$360,242	$0	$106,867	$513,825	$33,005	$546,830	$96,499	$643,330
Basin 8 - Winooski	$62,200	$378,558	$0	$386,310	$827,068	$57,737	$884,805	$156,142	$1,040,947
Lake Memphremagog	$94,936	$302,426	$0	$116,463	$513,825	$36,673	$550,498	$97,147	$647,644
Total	$812,763	$2,314,099	$787,902	$1,618,736	$5,533,500	$416,500	$5,950,000	$1,050,000	$7,000,000

[1] Distributed based on total TP reduction targets per watershed (available and minimum funds)

8) Reduction targets based on available and minimum funds (kg)	Farm field	Developed	Forest	Stream	total	Cost (project & admin)	cost per kg	Percentage
Basin 2 & 4 - Poultney, Mettawee, South Lake Champlain	22.4	11.5	34.0	10.3	78.1	$977,649	$12,510	16%
Basin 3 - Otter, Lewis, Little Otter	32.1	19.8	0.0	31.3	83.3	$1,094,817	$13,149	17%
Basin 5 - Northern Lake Champlain Direct	12.9	23.0	0.0	5.9	41.9	$645,340	$15,418	8%
Basin 6 - Missisquoi, Rock, Pike	23.1	26.2	48.3	47.7	145.3	$1,950,272	$13,423	29%
Basin 7 - Lamoille	6.9	22.8	0.0	10.1	39.8	$643,330	$16,166	8%
Basin 8 - Winooski	9.2	23.9	0.0	36.4	69.6	$1,040,947	$14,953	14%
Lake Memphremagog	14.1	19.1	0.0	11.0	44.2	$647,644	$14,647	9%
Total	120.9	146.3	82.4	152.7	502.2	$7,000,000	$13,939	