STORMWATER RUNOFF FROM DEVELOPED LANDS

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INTRODUCTION

Stormwater runoff is water from rain or melting snow that "runs off" across the land instead of soaking (or infiltrating) into the ground. This runoff flows over the surface of the land to the nearest stream, creek, river, lake, or pond (a "receiving water"). Stormwater runoff that receives little or no treatment before it reaches a receiving water can pick up and carry many pollutants. These contaminants can include sediment and other pollutants from construction sites, agricultural land, the surface of gravel roads, anywhere bare soil exists, as well as trash, pet waste, poorly managed grass clippings and yard waste, residuals from pesticide and fertilizer applications, and sand and salt from winter road treatments, all of which can harm receiving waters in sufficient quantities.[1]

Polluted runoff often occurs anywhere people use or alter the land. Much of the pollution problem in the developed—especially urban—landscape is caused when untreated runoff from hard—or impervious—surfaces such as rooftops, patios, sidewalks, driveways, parking areas, and roadways cannot seep into the ground and instead is conveyed directly to the nearest stream via ditches and storm drains. In Vermont, about ninety percent of our annual storm events result in one inch or less of rainfall.[2] Although such individual storm totals may sound modest, a one-inch rainstorm over one acre in an urban setting with a high percentage of impervious surfaces can produce upwards of 25,000 gallons of runoff compared to only about 2,000 gallons of runoff in a forested environment.[3] Further, a significant body of research has shown that, across a variety of climates and ecologies, once ten percent of a watershed's area is covered with impervious surfaces, receiving waters show clear signs of declining health – including impacts to hydrology and flow regimes, channel stability, in-stream habitat, water quality, and biological diversity.[4]

Current estimates from the U.S. Environmental Protection Agency ("EPA") suggest that although developed lands constitutes only 5% of the land use in the Lake Champlain Basin, phosphorus loading in stormwater runoff from developed areas comprises approximately 13.8% of the total phosphorus load delivered to the lake annually.[5] When compared to the estimated phosphorus loading from the agricultural sector—estimated to contribute about 38% of the nonpoint source phosphorus load to the lake[6]—developed lands contribute a smaller portion of phosphorus loading.

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1. NAT'L RESEARCH COUNCIL OF THE NAT'L ACADS., COMM. ON REDUCING STORMWATER DISCHARGE CONTRIBUTIONS TO WATER POLLUTION, URBAN STORMWATER MANAGEMENT IN THE UNITED STATES vii, 5 (2009), http://www.nap.edu/catalog/12465/urban-stormwater-management-in-the-united-states [https://perma.cc/DG2D-CW76].

2. VT. AGENCY OF NAT. RES., THE VERMONT STORMWATER MANAGEMENT MANUAL, VOL. 1 – STORMWATER TREATMENT STANDARDS 1-1, 1-3 (Apr. 2002), http://dec.vermont.gov/sites/dec/files/wsm/stormwater/docs/Resources/sw_manual-vol1.pdf [https://perma.cc/G8FE-9V4N] [hereinafter VERMONT STORMWATER MANUAL].

3. N.H. DEP'T OF ENVTL. SERVS., NEW HAMPSHIRE STORMWATER MANUAL, APPENDIX E: BMP POLLUTANT REMOVAL EFFICIENCY (2008), http://des.nh.gov/organization/divisions/water/stormwater/documents/wd-08-20a_apxe.pdf [https://perma.cc/V46L-ZSTE] [hereinafter APPENDIX E]

4. Thomas R. Schueler et al., *Is Impervious Cover Still Important? Review of Recent Research*, 14 J. HYDROLOGIC ENG'G 309, 309-10, 313 (Apr. 2009).

5. LAKE CHAMPLAIN BASIN PROGRAM, ISSUES IN THE BASIN: LAKE CHAMPLAIN BASIN ATLAS (2008), http://atlas.lcbp.org/HTML/is_pnps.htm [https://perma.cc/7CP7-D8ME]; STATE OF VT., VERMONT LAKE CHAMPLAIN PHOSPHOROUS TMDL PHASE 1 IMPLEMENTATION PLAN 14, 36 (2015), https://www.vtbar.org/UserFiles/Files/EventAds/2a%20TMDL%20Materials%20Part%202a.pdf [https://perma.cc/A9T3-2SH5] [hereinafter PHASE I IMPLEMENTATION PLAN].

6. ISSUES IN THE BASIN, *supra* note 5.

However, on an acre-for-acre basis, developed-land areas generate a disproportionate share of the phosphorus load to the lake.

I. TRADITIONAL STORMWATER MANAGEMENT

Traditionally, stormwater runoff has been drained away from our homes, businesses, parking lots, and roads as quickly as possible through the use of gray or hard infrastructure—networks of drainage systems that combine gutters, curbs, storm sewers, and ditches, which carry runoff directly to the nearest receiving water without further management or treatment. While this infrastructure is very efficient in conveying runoff, it can cause significant stormwater management problems because it prevents natural infiltration processes and speeds water movement.[7] Because gray infrastructure does little to improve water quality and reduce water quantity, stormwater discharges from these systems often contribute to unhealthy stream flow regimes marked by high peak flows and chronic flash flooding, altered stream morphologies, elevated nutrient and contaminant levels, excessive sedimentation, loss of species diversity, and higher water temperatures.[8]

First generation stormwater controls focused on addressing the peak rate of storm water discharge from flood-producing storm events.[9] In the early 2000s, the need for improved stormwater management began to receive more significant attention. As stormwater management efforts evolved, they tended to be multi-pronged and included efforts to minimize the impacts of post-construction stormwater runoff by working to mimic pre-development hydrology. The suite of metrics used to guide the stormwater management design often included:

- minimizing the increase in the peak runoff rate;
- providing storage for volume, peak flow control, and water quality; and,
- providing detention storage, if required, to prevent flooding.[10]

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7. AM. RIVERS, GREEN INFRASTRUCTURE TRAINING, https://www.americanrivers.org/threats-solutions/clean-water/stormwater-runoff/ [https://perma.cc/64DP-S73P] (last visited Apr. 4, 2016).

8. VT. LEAGUE OF CITIES & TOWNS, VERMONT GREEN STORMWATER INFRASTRUCTURE (GSI) SIMPLIFIED SIZING TOOL FOR SMALL PROJECTS: FACT SHEET NO. 1: INTRODUCTION 2 (2015), http://www.vlct.org/assets/MAC/2015_GSI-Simplified-Sizing-Tool-Fact-Sheets.pdf [https://perma.cc/VE7N-Z2H9] [hereinafter FACT SHEET NO. 1].

9. OHIO ENVTL. PROT. AGENCY, POST-CONSTRUCTION Q&A DOCUMENT 2 (2007), http://www.epa.ohio.gov/dsw/storm/CGPPCQA.aspx#116545725-4-why-is-ohio-epa-requiring-the-implementation-of-post-construction-bmps [https://perma.cc/U8XM-25VF].

10. STONE ENVTL. INC., ADVANCED STORMWATER STANDARDS COMPILATION: FINAL REPORT (2012),

II. STORMWATER MANAGEMENT REGULATIONS IN VERMONT

Stormwater management for the developed landscape is particularly challenging in the Lake Champlain Basin, not only due to the decentralized nature of the discharges and the disparity of needs and funding between Vermont's modest cities and rural communities, but also (and perhaps especially) due to the multiple levels of government (local, state, and federal) responsible for implementing regulations and providing policy guidance.

The Clean Water Act of 1972 ("CWA") focused efforts on the protection of rivers, streams, and lakes from pollution.[11] As part of this Act, EPA created the National Pollutant Discharge Elimination System ("NPDES"). NPDES is used to track and control sources of pollution through permits. EPA delegated the authority to issue and to enforce NPDES permits to the State of Vermont in 1974.[12] Beginning in 1997, the State of Vermont regulated discharges from large construction sites under the NPDES program.[13] Since that date, all construction projects that disturb five or more acres of soil have been required to install and maintain adequate erosion prevention and sediment control measures. Since September 2006, all construction projects disturbing [one acre or more of] soil must obtain authorization to discharge from their construction project, and usually this authorization occurs under Vermont Agency of Natural Resources' ("ANR") Stormwater Construction General Permit.[14]

In addition to managing construction-related disturbance under the CWA, Vermont has adopted its own stormwater permitting program to help manage the post-construction stormwater discharges that federal law leaves unregulated.[15] ANR has issued operational permits under state authority since the late 1970s, with the scope of the permit program expanding over

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http://dec.vermont.gov/sites/dec/files/wsm/stormwater/docs/ManualUpdate/sw_advanced_standards_compilation.pdf [https://perma.cc/6J2H-3WK8].

11. U.S. ENVTL. PROT. AGENCY, LAWS & REGULATIONS: SUMMARY OF THE CLEAN WATER ACT, http://www.epa.gov/laws-regulations/summary-clean-water-act [https://perma.cc/R8W9-YFZC] (last updated Oct. 8, 2015).

12. Laura Murphy, *Story of a De-Delegation Petition: Nuts, Bolts, & Happy Endings in Vermont*, 15 VT. J. ENVTL. L. 565, 567 (2014), http://vjel.vermontlaw.edu/files/2014/04/Murphy_forprint.pdf [https://perma.cc/P2BG-4SVM].

13. KIM L. GREENWOOD, UNCHECKED AND ILLEGAL: HOW ANR IS FAILING TO PROTECT VERMONT'S LAKES AND STREAMS, VT. NAT. RESOURCES COUNCIL (2008), http://vnrc.org/wp-content/uploads/2012/09/Unchecked_and_Illegal.pdf [https://perma.cc/3CHS-RXZB].

14. *Id.* at 9; STATE OF VT., AGENCY OF NAT. RES., DEP'T OF ENVTL. CONSERVATION, GENERAL PERMIT FOR 3-9020 FOR STORMWATER RUNOFF FROM CONSTRUCTION SITES 2–3 (2008).

15. Daniel D. Dutcher & David J. Blythe, *Water Pollution in the Green Mountain State: A Case Study of Law, Science and Culture in the Management of Public Water Resources*, 13 VT. J. ENVTL. L. 705, 718 (2012), http://vjel.vermontlaw.edu/files/2013/06/Water-Pollution-in-the-Green-Mountain-State.pdf [https://perma.cc/TAX8-Y86J].

time.[16] "Program technical standards were updated in 1980, 1987, 1997, and 2002."[17] Jurisdiction under Vermont's stormwater permitting program depends on the amount of impervious surface created by new development, and since 2002 it has been set at one acre of impervious cover.[18] Although Vermont adopted its first standards for stormwater treatment in 1981, and those have undergone several significant revisions, current standards are largely unchanged since the Vermont Stormwater Management Manual was promulgated in 2002.[19]

Although, compared to many other states, Vermont has a relatively long history of stormwater management, the majority of existing impervious surface in Vermont, however, was developed before the current post-construction stormwater regulations went into effect in 2002 or "was sub-jurisdictional at the time of development, and consequently does not have stormwater permit coverage" or, often, any stormwater treatment system.[20] Further, a significant percentage of new development currently occurring in Vermont falls below the one-acre of impervious surface jurisdictional threshold, with stormwater discharge permitting applying primarily to commercial and industrial sites and, to a more limited extent, highway projects and large residential developments.[21] This is evidenced, in part, by the fact that ANR receives approximately three times as many applications for construction permit coverage where the regulatory threshold is one acre of disturbance as it does applications for post-construction permit coverage where the threshold is one acre of impervious surface.[22] Thus, a large percentage of known construction activity does not currently require an operational stormwater permit, meaning that post-construction stormwater management practices may not be implemented on the majority of new land development projects in the state.[23] This "unregulated development contributes to existing water quality

16. PHASE I IMPLEMENTATION PLAN, *supra* note 5, at 37.

17. *Id.*

18. *Id.*; Dutcher & Blythe, *supra* note 15.

19. VT. AGENCY OF NAT. RES., THE VERMONT STORMWATER MANAGEMENT MANUAL (2002), http://dec.vermont.gov/sites/dec/files/wsm/stormwater/docs/Resources/sw_manual-vol1.pdf [https://perma.cc/B3ZX-7ENY].

20. VT. AGENCY OF NAT. RES., REPORT ON REGULATORY THRESHOLD FOR PERMITTING STORMWATER RUNOFF FROM IMPERVIOUS SURFACES: A RECOMMENDATION ON WHETHER THE LEGISLATURE SHOULD LOWER THE REGULATORY PERMITTING THRESHOLD FOR AN OPERATING PERMIT FOR STORMWATER RUNOFF IN 10 V.S.A. § 1264, 3 (Jan. 15, 2016), http://legislature.vermont.gov/assets/Legislative-Reports/2016-Act-64-Report-on-half-acre-stormwater-threshhold-Final.pdf [https://perma.cc/GBC5-PACF] [hereinafter VERMONT IMPERVIOUS SURFACE REPORT].

21. *Id.*

22. *Id.*

23. *Id.*

impairments, including excess sediment and scour in stormwater-impaired waters, and excessive phosphorus loading in Lake Champlain."[24]

In January of 2016, ANR filed a report with the Vermont legislature recommending that the post-construction permitting threshold be reduced to half-an-acre of impervious cover from the current one acre.[25] In its report, ANR estimated that this would result in a doubling of the number of post-construction stormwater permits issued annually, requiring treatment for an additional 100 acres of new construction each year.[26] This is important because although several Vermont communities have adopted robust local permitting standards for post-construction stormwater management, many communities have been reluctant to adopt standards stricter than state requirements, fearing that they could hinder business development.[27] Thus, absent expanded state regulation, is it unlikely treatment measure would be required for development activities creating between one-half and one acre of impervious cover.

III. IMPORTANCE OF LOCAL LAND USE DECISIONS IN MANAGING STORMWATER RUNOFF

Prior to the arrival of European colonists, the Lake Champlain Watershed mainly comprised vast tracts of forested land and wetlands and a limited amount of meadows and some farmland, all of which slowed runoff and captured and absorbed sediment and nutrients. Land development has altered or eliminated many of the features that moderate stormwater runoff, exposing soil to erosion. Intensified runoff carries soil and other pollutants into streams, lakes, rivers, and estuaries. Downstream, bank erosion and flooding increase and even upstream communities begin to experience road washouts and flooded basements.[28] Instead of a valuable resource, stormwater becomes a costly and sometimes dangerous problem.[29]

Where and how communities grow has a dramatic effect on water quality. Preventing water quality impacts requires that precautions be taken before, during, and after land development. In Vermont, municipal governments have principal responsibility for controlling land use and

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24. *Id.*

25. *Id.* at 2.

26. *Id.* at 3–4.

27. TWO RIVERS OTTAUQUECHEE REGIONAL PLANNING COMMISSION, STORMWATER: THE UNSEEN THREAT TO VERMONT'S WATERS (2013), http://ecvermont.org/wp/wp-content/uploads/2013/03/Stormwater-TRORC-FINAL_7-23-13.pdf [https://perma.cc/BX87-4ML5].

28. N.Y. STATE DEP'T OF ENVTL. CONSERVATION & N.Y. STATE DEP'T OF STATE, STORMWATER MANAGEMENT GUIDANCE MANUAL FOR LOCAL OFFICIALS 1 (2004), http://www.dec.ny.gov/docs/water_pdf/localall.pdf [https://perma.cc/YPG4-YYZS].

29. *Id.*

development. Because only a small amount of development in Vermont is regulated under existing federal or state permits, municipalities are largely left to manage stormwater in a way that suits their own individual conditions. However, integrating stormwater management into local land use regulations is not straightforward. A complicated web of local codes and standards often intersects with and even conflicts with stormwater management goals, including zoning and subdivision regulations, land use policies, floodplain regulations, and public works specifications.

It is not enough to implement a stormwater bylaw or ordinance, which implements standards for construction-related and/or post-construction stormwater management at the local level. While treating runoff from construction sites and newly created impervious areas is an important best practice, such measures capture only fraction, albeit a significant fraction, of stormwater runoff and its attendant pollutants.[30] Even if a development receives a stormwater permit, the permit is in effect permission to pollute and results in an additional load that the receiving water needs to bear.[31] Typical literature values for sediment removal in post-construction stormwater practices averages 80-90%, while phosphorus removal averages 40-65%.[32] Put another way, runoff from a forested acre is estimated to yield 0.10 pounds of phosphorus annually as a result of stormwater runoff, as compared to an acre in a medium density urban area which yields 2.58 pounds of phosphorus annually.[33] If stormwater management practices can reliably capture 65% of the 2.58 pounds, there is still a net increase of phosphorus loading of about 0.90 pounds per year as a result of every acre of impervious surface created.[34] As such, the most important strategies for reducing stormwater-related pollution are better planning and policies that seek to minimize site disturbance and the creation of impervious cover and preserving important site natural features.[35]

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30. APPENDIX E, *supra* note 3.

31. *See* CHESAPEAKE BAY FOUNDATION, *The Chesapeake Clean Water Blueprint* (2016) http://www.cbf.org/how-we-save-the-bay/chesapeake-clean-water-blueprint/watershed-wide-pollution-limits [https://perma.cc/H3DB-4BPA] (explaining the pollution limits Chesapeake Bay can handle in conformance with its TMDL).

32. APPENDIX E, *supra* note 3.

33. N.H. DEP'T OF ENVTL. SERVS., NEW HAMPSHIRE STORMWATER MANUAL, APPENDIX D: TYPICAL STORMWATER POLLUTANT EMCS (2008), http://des.nh.gov/organization/divisions/water/stormwater/documents/wd-08-20a_apxd.pdf [https://perma.cc/BJF8-W3VR] (the author calculated 2.58 pounds of phosphorus captured by converting milligrams per liter to pounds per liter and applying the amount of runoff over an acre of medium-development-density land in the Lake Champlain Basin (21.8 inches of runoff)).

34. *Id.*

35. N.J. DEP'T OF ENVTL. PROT., NEW JERSEY BEST MANAGEMENT PRACTICES MANUAL 2-2 to 2-6 (2004), http://www.njstormwater.org/bmp_manual/NJ_SWBMP_2%20print.pdf [https://perma.cc/F8QY-XXEA].

Factors at the site-, neighborhood- and municipal-scale can all drive the creation of unnecessary impervious cover. These factors are often embedded in a community's land use codes and policies. A comprehensive approach to stormwater management therefore must include an examination of local land development regulations, policies, and ordinances to better align with watershed- and state-level water quality goals.[36] Existing land use regulations and road ordinances can even create unintentional barriers to or disincentives for stormwater best practice—often driving the creation of additional impervious surfaces via setback requirements, minimum road widths to serve as few as two homes, and parking minimums for commercial establishments.

Most Vermont municipalities engage in stormwater management at the site level by restricting development within the riparian buffer, wetlands, or other critical natural features. However, also engaging at the neighborhood or municipal scale can have far greater water quality benefits.[37] Including specific language in town plans that supports the protection and restoration of strategic natural features, such as riparian areas, articulates a clear preference for approaches that work to manage stormwater as close to its source as possible and improves a community's resilience to climate change is a strategy that can help provide a vision for future development.

IV. APPROACHES TO STORMWATER MANAGEMENT THROUGH THE LAND DEVELOPMENT PROCESS

When a vegetated watershed is deforested and paved, its streams see significantly higher peak flows during storms and often slow to a trickle between events—impacting fish and other smaller organisms that live on or in the bottom of the stream. High flows also scour streambanks and in-stream infrastructure, such as bridge abutments. Regulators and designers alike are striving to reverse these trends through the use of better stormwater management practices and by protecting pristine watersheds through preserving forests, soils, and native bedrock structure.[38] The purpose of the construction stormwater controls is to protect water resources from sediment and other pollutants while post-construction practices also incorporate water quantity controls for both routine and

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36. *Id.*

37. *Id.* at 3-3.

38. *Maintaining Pre-Development Hydrology: The Eight Hydrologic Functions of Forests and Trees*, DEEPROOT: GREEN INFRASTRUCTURE FOR YOUR COMMUNITY (Sept. 19, 2011), http://www.deeproot.com/blog/blog-entries/maintaining-pre-development-hydrology-the-eight-hydrologic-functions-of-forests-and-trees [https://perma.cc/9R3K-24HX].

extreme storm events. Effective stormwater management once construction is complete must include both water quality and water quantity controls.[39]

A. Construction Stormwater Management

When stormwater drains off a construction site, it carries sediment and other pollutants that harm lakes, streams, and wetlands. EPA estimates that 20 to 150 tons of soil per acre are lost every year to stormwater runoff from construction sites.[40] Preventing erosion can significantly reduce the amount of sediment and other pollutants transported by runoff from construction sites. For projects that will disturb more than one acre of land (e.g., involving clearing, grading, and excavating activities), site owners must obtain a permit from ANR. The permit requires implementation of a suite of sediment control, erosion, and pollution prevention measures. Since 2006, planned NPDES-permitted construction disturbance has averaged 1,500 acres per year.[41] There are no estimates available as to the number of acres per year of sub-jurisdictional construction activities, meaning projects that disturb less than one acre and therefore do not trigger state-level regulatory oversight in Vermont, but it is understood to be significantly more than the area of permitted construction disturbance[42].

"Uncontrolled runoff from construction sites is a water quality concern because of the devastating effects that sedimentation can have on local waterbodies."[43] In addition to concerns related to sediment pollution (because phosphorus tends to cling to soil particles), exposed soils at construction sites can result in large flushes of phosphorus to nearby receiving waters.[44] Numerous studies have shown that the amount of sediment—and attendant phosphorus—transported by stormwater runoff from construction sites with no controls is significantly greater than from sites with controls. During storms, construction sites may be the source of sediment-laden runoff, which can overwhelm a small stream channel's

39. VERMONT STORMWATER MANUAL, *supra* note 2, at 1-1.

40. U.S. ENVTL. PROT. AGENCY, REPORT TO CONGRESS ON THE PHASE II STORM WATER REGULATIONS I-4 (1999), http://yosemite.epa.gov/ee/epa/ria.nsf/vwAN/W999C.pdf/$file/W999C.pdf [https://perma.cc/SQE4-4MNM].

41. VT. AGENCY OF NAT. RES. & VT. AGENCY OF AGRIC., FOOD & MKTS., VERMONT ECOSYSTEM RESTORATION PROGRAM: 2011 ANNUAL REPORT 37 (2012), http://www.leg.state.vt.us/reports/2012ExternalReports/276255.pdf [https://perma.cc/65HL-AVFX].

42. Personal communication with Kari Dolan, Ecosystem Restoration Program Manager, Vt. Dep't of Envtl. Conservation.

43. U.S. ENVTL. PROT. AGENCY, FACT SHEET 1.0 – STORMWATER PHASE II FINAL RULE: AN OVERVIEW 2 (2005), https://www.epa.gov/sites/production/files/2015-11/documents/fact1-0.pdf [https://perma.cc/P7ZT-6NS5].

44. VT. DEP'T OF ENVTL. CONSERVATION & N.Y. STATE DEP'T OF ENVTL. CONSERVATION, LAKE CHAMPLAIN PHOSPHORUS TMDL 65 (2002), http://www.dec.ny.gov/docs/water_pdf/champlain_final_tmdl.pdf [https://perma.cc/CDQ6-XA7J].

capacity, resulting in streambed scour, streambank erosion, and destruction of near-stream vegetative cover. Where left uncontrolled, sediment-laden runoff has been shown to result in the loss of in-stream habitat for fish and other aquatic species, an increased difficulty in filtering drinking water, the loss of drinking water reservoir storage capacity, and negative impacts on the navigational capacity of waterways.

B. Post-Construction Stormwater Management

The intent of post-construction management is to ensure that stormwater runoff from developed land does not negatively impact receiving waters either through hydrologic impacts or pollutant discharges. Hydrologic impacts coupled with the increased concentration of pollutants contained in stormwater runoff from developed lands result in degradation of the water resources to which the stormwater is discharged. The smaller the receiving stream, the greater the importance of controlling the hydrologic and subsequent hydraulic impacts of the construction project and its resultant impervious surfaces. Since 2006, Vermont has permitted an additional 233 acres of impervious surface each year,[45]—issuing more than 1,900 permits for post-construction stormwater management.[46] The state has also estimated that there is more than 100 acres of sub-jurisdictional impervious surface constructed each year, meaning the impervious surface is constructed on projects that are too small to trigger state regulatory oversight[47]; EPA has estimated the annual increase sub-jurisdictional impervious surface to be equal to the change in jurisdictional impervious.[48]

C. Municipal Separate Storm Sewer Systems ("MS4s")

In Vermont, there are currently twelve communities and three non-traditional entities (the Vermont Agency of Transportation, the University of Vermont, and the Burlington International Airport) designated as Municipal Separate Storm Sewer System ("MS4") permit holders. Under the federal MS4 permitting program, permittees must develop a stormwater management program that includes six Minimum Control Measures ("MCMs") designed to reduce the potential for pollutants to enter the MS4

45. U.S. ENVTL. PROT. AGENCY, TOTAL MAXIMUM DAILY LOAD DOCUMENT AND APPENDICES FOR VERMONT SEGMENT OF LAKE CHAMPLAIN, APPENDIX A: FUTURE GROWTH FROM DEVELOPED LANDS IN THE LAKE CHAMPLAIN BASIN 1 (2015), https://www.epa.gov/sites/production/files/2015-09/documents/appendix-a-future-growth.pdf [https://perma.cc/X5RG-N8B7] [hereinafter APPENDIX A].

46. Personal communication with Kari Dolan, *supra* 42.

47. VERMONT IMPERVIOUS SURFACE REPORT, *supra* note 20, at 4.

48. Personal communication with Kari Dolan, *supra* 42.

and discharge to surface waters. The MCMs include public education and outreach, public participation/involvement, illicit discharge detection and elimination, construction site runoff control, post-construction runoff control, and pollution prevention/good housekeeping. The regulated MS4s permit holders submit annual reports detailing their progress on MCM implementation.

In addition, fourteen of the fifteen regulated MS4s discharge to receiving waters that have been identified as stormwater impaired and, as such, are required to develop Flow Restoration Plans ("FRPs") to reduce peak flows that reach the receiving waters during storms.[49] It is anticipated that the deployment of stormwater management infrastructure in implementing the FRPs will also contribute substantially to phosphorus reduction in Lake Champlain.[50] Regulated MS4 municipalities are required to track phosphorus reductions associated with these projects.[51]

D. Stormwater Discharges Associated with Industrial Activities

Vermont's Multi - Sector General Permit ("MSGP") addresses stormwater runoff associated with most industrial facilities. All permittees are required to implement best management practices ("BMPs"), such as good housekeeping, erosion prevention, and minimizing exposure, all of which serve to reduce potential pollutant discharges. Facilities manufacturing agricultural chemicals are required to monitor specifically for phosphorus in their stormwater discharges. If monitoring results are above the level set in the permit, the facilities must modify their plans to reduce the phosphorus discharge.

E. Stormwater Retrofits

In Vermont, a significant amount of impervious surface is not governed by a stormwater permit—by some estimates as much as ninety percent of all the impervious surface that currently exists statewide.[52] Many of these existing untreated or inadequately treated surfaces will require retrofits as part of an overall strategy to reduce nutrient and sediment loads in order to meet pollutant reduction targets for existing developed lands under the Lake Champlain Phosphorus TMDL.[53] "Stormwater retrofits are a diverse group of projects that provide nutrient and sediment reduction on existing

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49. PHASE I IMPLEMENTATION PLAN, *supra* note 5, at 33.
50. *Id.*
51. *Id.*
52. *Id.* at 36.
53. *Id.* at 39.

development that is currently untreated by any BMP or is inadequately treated by an existing BMP."[54]

The primary challenges with stormwater retrofits are that most of Vermont's core developed areas are characterized by highly connected impervious surfaces, aging infrastructure, and limited pervious or open areas where retrofits can be successfully sited. These challenges are often compounded when the open space that is available is not particularly suitable for stormwater management. In these high-traffic areas, acceptance by the people who use the spaces where the controls are located is vitally important. Public perceptions and concerns about hydrologic performance (soil characteristics, standing water, and public health issues), safety, construction-related inconveniences, and maintenance needs are challenges to overcome for community acceptance and implementation of stormwater retrofits.[55]

F. Low Impact Development and Green Stormwater Infrastructure

Urbanization and development typically alter the landscape's hydraulic and hydrologic regimes—but this is not inevitable. Through the use of a combination of

> structural, nonstructural, and institutional practices, functional, environmentally friendly, sustainable, and beautiful living environments can be created. Surface and stormwater management play a large role in this movement.
>
> There have been many popularly named approaches that address some or all of these elements, including Low Impact Development (LID), Green [Stormwater] Infrastructure [("GSI")], Better Site Design, and Conservation Development . . . .[56]

These approaches to stormwater management are a significant shift from traditional gray infrastructure approaches that have been widely-used in Vermont and throughout the country because they are intrinsically

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54. Tom Schueler & Ceclia Lane, *Recommendations of the Expert Panel To Define Removal Rates for Urban Stormwater Retrofit Projects*, CHESAPEAKE STORMWATER NETWORK 4 (Jan. 20, 2015), http://chesapeakestormwater.net/wp-content/uploads/dlm_uploads/2012/10/Final-CBP-Approved-Expert-Panel-Report-on-Stormwater-Retrofits-short_012015.pdf [https://perma.cc/QNC9-SV9Z].

55. *Using Rainwater To Grow Livable Communities: Sustainable Stormwater Best Management Practices*, WATER ENV'T RES. FOUND. (2009), https://www.werf.org/liveablecommunities/toolbox/retrofit_chal.htm [https://perma.cc/4VPY-PPZS].

56. THOMAS N. DEBO & ANDREW J. REESE, MUNICIPAL STORMWATER MANAGEMENT 9 (2d ed. 2003).

decentralized, requiring a network of site-scale practices. Fundamentally, each of these approaches seeks to:

- Mimic[] acceptable hydrology . . .
- Balanc[e] ecological preservation and conservation with economic growth and development
- Build[] systems that are sustainable and maintainable
- Work[] at a small, integrated scale with accumulated results
- Deal[] with stormwater as a valuable resource.[57]

Vermont's Green Infrastructure ("GI") Initiative is a statewide effort that seeks to increase the adoption of LID principles and implementation of GSI practices. The Initiative works to implement strategies identified within the GI Strategic Plan. The Strategic Plan is supported by Executive Order 06-12 ("EO"), signed in March of 2012.[58] The EO calls for the creation of an Interagency Green Infrastructure Council, which includes the secretaries of the agencies of Natural Resources, Transportation, Commerce and Community Development and the Commissioner of Buildings and General Services or their designees.[59] The Council is tasked with identifying opportunities for integration of GSI practices in existing programs, initiating a process for developing GSI technical guidance, establishing a plan for implementing GSI on state properties and projects, identifying agency liaisons, identifying and undertaking GSI research and monitoring, and identifying sustainable funding sources.[60] Members of the Council are also tasked with developing a GSI Implementation Work Plan for their respective agency or department.[61] Work plans were completed on July 1, 2013 and the EO is in effect until January 1, 2017.[62] From 2009 until 2015, ANR staffed a GI coordinator position that led this initiative.[63] In August of

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57. *Id.*

58. Exec. Order No. 06-12, STATE OF VT. EXEC. DEP'T (Mar. 7, 2012), http://governor.vermont.gov/sites/shumlin/files/documents/EO%2006-12%20Interagency%20Green%20Infrastructure%20Council.pdf [https://perma.cc/5AHT-7ZK9].

59. *Id.*

60. *Id.*

61. *Id.*

62. *Id.*; AGENCY OF ADMIN. ET AL., STATE OF VERMONT GREEN STORMWATER INFRASTRUCTURE AGENCY WORK PLANS (2013), http://bgs.vermont.gov/sites/bgs/files/pdfs/GSI_Work_Plan_Final.pdf [https://perma.cc/K5Q3-YWJ8] [hereinafter WORK PLANS].

63. WORK PLANS, *supra* note 62, at 16.

2015, lead responsibility for the Initiative was transferred to the Lake Champlain Sea Grant.[64]

Municipalities can incorporate LID and GSI into bylaws and ordinances in a variety of areas, including zoning districts, subdivision regulations, planned unit developments, dimensional requirements, stormwater management standards, erosion prevention and sediment control standards, river corridor and floodplain management regulations, flood and erosion hazard area bylaws, wetland regulations, riparian buffer or setback ordinances, habitat protection standards, transfer of development rights, building codes, and public works specifications.[65] The Vermont League of Cities and Towns recently introduced a Green Stormwater Infrastructure Toolbox, which includes both a model LID/GSI stormwater management bylaw and a spreadsheet-based tool to aid in the design of GSI practices for small sites.[66] In addition, also in 2015, the Vermont Association for Planning and Development Agencies ("VAPDA") published a Green Infrastructure Toolkit for Municipalities.[67] The toolkit is intended to serve as a clearinghouse of information for Vermont municipalities seeking to further investigate GSI policies and practices.[68]

V. VERMONT-SPECIFIC STORMWATER MANAGEMENT CHALLENGES

There are a number of challenges—perceived and real—related to on-going efforts to improve stormwater management in Vermont in order to reduce the impacts of the developed landscape on nearby receiving waters and the ultimate receiving water: Lake Champlain. These include designing GSI practices that are able to achieve water quality targets not only during the growing season, but during colder weather and that recognize and effectively address the limited infiltration capacity of many Vermont soils.

64. *Green Infrastructure Collaborative by DEC and UVM*, FLOW: ANRWSMDBLOG (Aug. 19, 2015), http://vtwatershedblog.com/2015/08/19/green-infrastructure-collaborative/ [https://perma.cc/U6J3-MZ3X].

65. VT. DEP'T OF ENVTL. CONSERVATION, LOW IMPACT DEVELOPMENT GUIDE FOR RESIDENTIAL SMALL SITES (2010) http://www.watershedmanagement.vt.gov/stormwater/htm/sw_gi_lid.htm [https://perma.cc/EKQ7-BGJP].

66. FACT SHEET NO. 1, *supra* note 8, at 1.

67. *Green Infrastructure Toolkit for Vermont Municipalities*, VT. PLANNING INFO. CTR., http://www.vpic.info/GreenInfrastructureToolkit.html [https://perma.cc/8SRU-4G9P (last visited April 9, 2016).

68. *Id.*

A. Cold Climate Considerations

Stormwater management practice designs in Vermont must consider the impacts of snowmelt.

> The heart of the problem with [runoff from] snowmelt is that water volume in the form of snow and ice builds for several months and suddenly releases with the advent of warm weather in the spring or during short interim periods all winter long. The interim melts generally do not contribute a significant volume of runoff when compared to the large spring melt. [While] snowmelt peaks are substantially less than those from rainfall, [] the total event volume of a snowmelt, although it occurs over a much longer period, can be substantially more. Ignoring the contribution of these large, spring melts to the annual runoff and pollution loading analysis could be a major omission in a watershed analysis. This type of comparison also shows why facility design is critical to the proper quantity and quality management of this meltwater.
>
> The water quality problems associated with [snowmelt] occur because the large volume of water released during melt and rain-on-snow events not only carries with it the material accumulated in the snowpack all winter, but also material it picks up as it flows over the land's surface. The winter accumulation can occur directly on a standing snowpack or on the side of a roadway where it is plowed. In either case, the material builds for several months prior to wash-off. Since snow is a very effective scavenger of atmospheric pollutants, [nearly] any airborne material present in a snow catchment will show up in meltwater when it runs off. Add to this the material applied to, or deposited on the land surface, for example to melt snow or prevent cars from sliding, and the wide range of potential pollutants becomes apparent. As with the volume of meltwater, a major portion of annual pollutant loading can be associated with spring melt events.
>
> The conventional pollutants of concern for most urban runoff situations are supplemented in meltwater runoff by additional contaminants added during the winter. The solids, nutrients, and metals present during the summer are joined by . . . salt and increased solids from [winter road treatments]. . . . Pesticide and fertilizer runoff and organic debris (leaves, grass clippings, seeds) are less of a concern during the winter.
>
> Part of the severity of the water quality problem associated with [snowmelt] is that it occurs when [many stormwater practices and

> receiving waters are] least able to deal with it. Routine assumptions on biological activity, aeration, settling, and pollutant degradation are altered by the cold temperatures, cold water and ice covered conditions that [in Vermont] prevail for many months. [A late winter] rain-on-snow event often presents the worst-case scenario when rain falls onto a deep, possibly saturated snowpack. The movement of a well-defined, rapidly moving wetted front through the snowpack results in the mobilization of soluble constituents, plus the energy associated with the rainfall is sufficient to mobilize the fine-grained or possibly larger solids and associated contaminants. This wave of melt also washes over urban surfaces and picks up material that has been deposited on these surfaces all winter.[69]

B. Soil Infiltration Capacity

Immediately after the last ice age, forty percent of Vermont was underwater, including much of the Champlain Valley.[70] The soils underlying this previously flooded land are rich in fine-grained clays and silts and these soils hold moisture better, are less acidic, and are more fertile than unflooded soils.[71] These fine-grained soils are often thought of as a challenge for stormwater management in that infiltration rates are minimal and therefore stormwater management BMPs are often thought to be limited to store-and-release practices such as ponds. On the contrary,

> There are many stormwater management practices that are appropriate on sites with low . . . . permeability soils.[72] The final selection of practices [depends] on many other factors including space availability, site topography, aesthetics, cost, maintenance, pollutant removal goals, and stormwater design criteria.[73]

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69. *Minnesota Stormwater Manual: Cold Climate Impact on Runoff Management*, MINN. POLLUTION CONTROL AGENCY, http://stormwater.pca.state.mn.us/index.php/Cold_climate_impact_on_runoff_management [https://perma.cc/8RBZ-W3MY] (last modified Dec. 2, 2015).

70. Chuck Wooster, *Vermont & New Hampshire: There's Something in the Soil*, N. WOODLANDS (Mar. 17, 2002), http://northernwoodlands.org/outside_story/article/vermont-new-hampshire-theres-something-in-the-soil [https://perma.cc/EKB3-3ZPW].

71. *Id.*

72. GREEN INFRASTRUCTURE CMTY. PARTNER & PITTSBURG UNITED, CLAY SOILS: GREEN INFRASTRUCTURE: OPPORTUNITIES FOR PITTSBURGH 1 (2013), http://www.3riverswetweather.org/sites/default/files/Clay%20Soils%20White%20Paper.pdf [https://perma.cc/K6ZL-HSK5].

73. *Id.*

C. Technical Capacity

In addition to the climate and landscape factors identified above, which present challenges in managing stormwater—and in particular in deploying GSI techniques—there is also a perceived lack of clarity in how GSI could be successfully employed to meet site needs and regulatory requirements and, in particular, compliance with the Vermont Stormwater Management Manual.[74] Vermont has worked to increase technical capacity within the design community over the past five years through its Green Infrastructure Initiative, but much work remains to be done in order for GSI techniques to become the preferred stormwater management approach.[75] It is anticipated that forthcoming revisions to the Vermont Stormwater Management Manual will help clarify how GSI techniques can be used to comply with Vermont's stormwater regulations.

D. Role of Stormwater Management in the Lake Champlain TMDL

Stormwater management is essential to achieving many of Vermont's water quality goals, including the successful implementation of the Lake Champlain TMDL. While other sources of phosphorus pollution within the basin are unlikely to see significant increases in the future, land development will continue as will attendant increases in stormwater runoff from those newly developed lands. EPA acknowledges this by assigning an allocation for future growth only to loads for stormwater runoff from developed lands in its draft revised Lake Champlain Phosphorus TMDL.[76]

The Lake Champlain Watershed's land area currently includes 3% impervious surface, which translates to roughly 140,000 acres of impervious surface in the Vermont portion of the basin.[77] Only 6% of Vermont's impervious surface area in the Lake Champlain Basin is currently subject to regulation under a state operational stormwater permit and an additional 12% of the impervious area is covered by the MS4

74. VT. DEP'T OF ENVTL. CONSERVATION, THE VERMONT GREEN INFRASTRUCTURE INITIATIVE STRATEGIC PLAN: 2011-2013 (2011), http://dec.vermont.gov/sites/dec/files/wsm/erp/docs/sw_greeninfrastructureSP11-13.pdf [https://perma.cc/W7ZM-HZ4S].

75. *Id.*

76. U.S. ENVTL. PROT. AGENCY, PHOSPHORUS TMDLS FOR VERMONT SEGMENTS OF LAKE CHAMPLAIN 37 (2016).

77. Ryan Knox, Vt. Agency of Nat. Res., Lake Champlain NDVI Impervious Surface Project: Impervious Surface Layer for the Lake Champlain Basin (2012), http://anrmaps.vermont.gov/websites/vgisdata/layers_anr/metadata/LandLandcov_IMPERVLCB08.txt [https://perma.cc/FF4Z-JTBF].

permit.[78] This leaves approximately 115,000 acres of impervious surface that are not currently subject to any regulatory requirements for stormwater management. Runoff from impervious surfaces contributes nearly 20% of the total phosphorus delivered to Lake Champlain annually and the draft Lake Champlain Phosphorus TMDL will require the overall contribution from existing developed lands to be reduced by more than one-fifth (20.9%). In order to achieve this level of treatment, a significant number of impervious acres will need to be retrofitted with stormwater management practices.[79] The exact form these retrofits will take is not settled. While traditional stormwater management designs have provided treatment for both water quality and water quantity, there are newer approaches to stormwater management that may achieve a high level of nutrient reduction while providing little in the way of quantity management. Although space- and cost-effective for reducing nutrient loads, it is less clear if these approaches will be successful in achieving the ultimate water quality goals that have been established for Lake Champlain.

Many LID and GSI approaches have significant co-benefits, particularly in facing the challenges posed by climate change. Increasingly, climate models suggest Vermont's future will include more frequent and intense storm events, more precipitation as rain, and less snow in the winter[80]. More frequent and intense storm events in the future could lead to higher runoff volumes and more pollutants entering our waterways.[81]

In light of a changing climate, sound stormwater management adaptation strategies can preserve and strengthen the health of Lake Champlain and its watershed. More precipitation is expected, but the timing of precipitation events is less clear.[82] Though GSI techniques tend to have lower capacities for flood control, they can be effective in managing stormwater during small to moderate storm events. For larger events, LID principles including floodplain and wetland protection play an important role in reducing the impacts of increased high flows on the built and natural environments.

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78. STATE OF VT., VERMONT'S CLEAN WATER INITIATIVE 14 (2014), http://legislature.vermont.gov/assets/Legislative-Reports/303279.pdf [https://perma.cc/RT8P-6JTX].

79. APPENDIX A, *supra* note 45, at 8.

80. PETER C. FRUMHOFF ET AL., CONFRONTING CLIMATE CHANGE IN THE U.S. NORTHEAST: SCIENCE, IMPACTS, AND SOLUTIONS 8, 10, 31, 82 (2007), http://www.ucsusa.org/sites/default/files/legacy/assets/documents/global_warming/pdf/confronting-climate-change-in-the-u-s-northeast.pdf [https://perma.cc/D9YL-43F9].

81. MARIKA DALTON, STEPHANIE CASTLE & ERIC HOWE, CLIMATE CHANGE AND STORMWATER MANAGEMENT IN THE LAKE CHAMPLAIN BASIN: AN ADAPTATION PLAN FOR MANAGERS 6 (2015), http://www.lcbp.org/wp-content/uploads/2013/03/80_LCBP_ClimateChange_StormwaterMangement.pdf [https://perma.cc/EXW6-7MUR].

82. *Id.* at 17, 19.

Building properly sized stormwater infrastructure throughout the landscape can help spread out runoff, improving the quality and reducing the quantity of runoff that reaches receiving waters. Getting technical and financial assistance to towns and stormwater managers and helping them identify the most important areas to protect are another way to reduce the risk of overwhelming stormwater infrastructure. Reducing stormwater runoff through the implementation of GSI practices may help limit the anticipated impacts of flooding resulting from potential climate change. Though individual GSI practices tend to have lower individual runoff detention capacities, they can be effective when dispersed throughout the landscape close to where that runoff is generated. These strategies can all help reduce the volume of untreated stormwater that flows into waterways during small to moderate storm events. For larger events, LID techniques, including floodplain and wetland protection, coupled with consistent permitting guidelines, relocation of existing infrastructure outside flood hazard areas, and properly-sized, well-maintained stormwater drainage networks will reduce the impacts of increased high flows on the built environment and Lake Champlain.

CONCLUSION

Site-scale stormwater management will play an integral role in achieving Vermont's ultimate water quality goals for Lake Champlain, but encouraging the widespread adoption of LID techniques and GSI retrofits remains challenging. This adoption requires fundamental and widespread changes in how we approach land use, development, and the centuries-old paradigm of moving stormwater away as quickly as possible in order to address a source of pollution that has produced huge chronic effects in Lake Champlain, but often less dramatic acute effects. "Therein lies the rub, or part of it, for stormwater [management]: as a species we seem hardwired to guard against the immediate, visible, localized threat, but we also seem wired to discount or even dismiss the longer term, less visible, generalized threat, even if it's ultimately [] substantial . . . ."[83] Ultimately, the stormwater management effort we must now engage is concerned with these longer-term, less-visible, generalized threats. Achieving the phosphorus load reduction for developed lands will be one of the more difficult and challenging aspects of implementation of the Lake Champlain Phosphorus TMDL.

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83. Richard B. Whisnant, *How Did Stormwater Control Get so Complicated? The Coastal Stormwater Chapter, Part 2*, U.N.C. SCH. GOV'T ENVTL. L. IN CONTEXT (Feb. 16, 2015), http://elinc.sog.unc.edu/how-did-stormwater-control-get-so-complicated-the-coastal-stormwater-chapter-part-2/ [https://perma.cc/MN8D-R693].