Pollutant Removal Credits for Buffer Restoration in MS4 Permits

Final Panel Report

June 2019

Approved by

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Table of Contents

Executive Summary

Sound management of buffer areas is an effective approach to protecting water quality in New Hampshire. However, regulators and communities lack synthesized, scientifically justified guidance on how to quantify the water quality benefits of buffers and compare them to those derived from other structural Best Management Practices (BMPs). The *Credit for Going Green* project helped address this need by using an expert panel process to develop consensus-based recommendations for pollutant load reduction performance curves for restored or constructed buffers. These curves are intended to meet in-stream pollution reduction targets in development, redevelopment, restoration, or other land use change projects. This report describes the work and findings of the project's expert panel from January 2018 to March 2019.

Going Green was inspired by an integrated policy analysis of buffer management conducted in the Great Bay Watershed from 2015 to 2018. This analysis included an assessment of community perspectives on buffers, an analysis of the regulatory context, and reviews of relevant biophysical and social science literature. It was also motivated by regional trends related to stormwater runoff and its potential impact on water quality in the Great Bay Estuary watershed, including increased population and impervious surfaces.

The project built on other initiatives as well, including the Pollution Tracking and Accounting Pilot Program (PTAPP) and the New Hampshire Association of Natural Resource Scientists Wetland Buffer Scientific Workgroup. It was modeled after a similar project that developed green infrastructure pollutant removal efficiency and runoff volume reduction curves for Chesapeake Bay. (These are now accepted by the United States Environmental Protection Agency (USEPA) and used by the bay's communities.) Both projects used a weight-of-evidence approach, based on independent peer reviews at the National Academy of Sciences, to synthesize expert opinions on a subject around which there was uncertainty due to insufficient data and data that was unattainable because of physical constraints or lack of resources.

Going Green's advisory committee included representatives of local communities, New Hampshire Department of Environmental Services (NHDES), and USEPA Region 1. The committee provided input on the panel process, literature review, and identification of panel members. The panel included experts in local and regional watershed hydrology, stormwater management, soil science, fish and stream ecology, and spatial understanding of nutrient attenuation. The panel was managed using best practices for collaboration, decision making, and transparency. Over the course of six meetings, panelists reviewed existing data and literature, identified conditions under which buffers are most effective at pollutant removal, characterized the factors that influence that effectiveness, developed pollutant load reduction

performance curves, and made recommendations for how to use these curves in models available for the Great Bay Watershed.

They summarized their findings in a technical memorandum (see Appendix 7.1). This memorandum is designed to help municipalities, engineers, and regulatory officials use the curves to quantify pollutant removal rates for buffers ranging from 20 to 100 feet in width in redevelopment, development, restoration, and other land use change projects. It includes four sets of curves that characterize the removal of total nitrogen, total suspended solids, and total phosphorus in hydrologic soil groups A, B, C, and D. These curves can also be used to allocate credit for installing buffer areas in USEPA permits and other stormwater management efforts. The memorandum summarizes the panel's key decisions to develop these curves, describes situations that curves cannot address and other caveats, and provides examples to demonstrate how the curves could be applied.

An advisory committee provided input on the utility of these curves and how best to share them with relevant audiences. Project organizers used this input to develop additional communication materialsto share these products with municipal leaders and technical assistance providers in New Hampshire, Rhode Island, Massachusetts, and at a regional conference. They also developed a roadmap that captures best practices and lessons learned about the expert panel process for others who wish to apply this approach to other management questions.

Project partners include the University of New Hampshire Stormwater Center, Great Bay National Estuarine Research Reserve, Narragansett Bay National Estuarine Research Reserve, Waquoit Bay National Estuarine Research Reserve, and Roca Communications+. *Going Green* was sponsored by the National Estuarine Research Reserve System Science Collaborative, which supports collaborative research that addresses coastal management problems important to Reserves and their communities. The Science Collaborative is funded by the National Oceanic and Atmospheric Administration and managed by the University of Michigan Water Center.

Section 1: The Panel and Its Work

1.1 Panel Charge and Membership

The panel's charge was to develop consensus-based recommendations for pollutant load reduction performance curves that could be used to meet pollution reduction targets. It was anticipated that the recommendations would take the form of a removal percentage per unit area of buffer. For the panel to meet its charge, scientific, practitioner, and management communities had to agree on defensible pollutant load reductions. As a result, the panel included experts in local and regional watershed hydrology, stormwater management, soil science, fish and stream ecology, and spatial understanding of nutrient attenuation. To ensure the curves would be easy to apply and verifiable, it also included representatives of the USEPA, New Hampshire state regulatory programs, and a former private sector practitioner with extensive experience working with local communities. (See Table 1).

Table 1: Going Green Expert Panel Members	
Panelist	**Position & Affiliation**
Dr. James Houle (Chair)	Program Director, University of New Hampshire Stormwater Center
Dr. Thomas Ballestero	Director, University of New Hampshire Stormwater Center Associate Professor, Civil Engineering
Dr. Michael Dietz	Director, Connecticut Nonpoint Education for Municipal Officials (NEMO) Associate Extension Educator, University of Connecticut
Mr. Mark Voorhees	Environmental Engineer, U.S. Environmental Protection Agency Region 1
Mr. Ted Diers	Administrator, NHDES, Watershed Management Bureau
Ms. Karen Dudley	Resource Soil Scientist, USDA Natural Resources Conservation Service
Dr. Nigel Pickering	Research Associate Professor, Washington Stormwater Center (Formerly of Horsley Witten Group)
Mr. Pete Steckler	GIS & Conservation Project Manager, NH Certified Wetland Scientist, The Nature Conservancy, NH
Mr. John Magee	Certified Fisheries Professional & Fish Habitat Biologist, New Hampshire Fish and Game Department
The panel retained a consultant who had run an expert panel process to develop credits for non-structural BMPs in the Chesapeake Bay Region: Thomas Scheuler, Executive Director of the Chesapeake Stormwater Network.	

1.2 Advisory Committee Membership

The panel was supported by an advisory committee consisting of stakeholders from regulatory agencies, communities subject to municipal separate storm sewer systems (MS4) regulations, design consultants, and technical assistance providers. As the panel progressed, it became clear that more perspectives from municipalities, the private sector, and technical assistance providers were needed. Committee members who joined the group later in the process are indicated with an * in Table 2.

Table 2: Going Green Advisory Committee Members	
Committee Member	**Position & Affiliation**
Suzanne Warner	Environmental Engineer, U.S. Environmental Protection Agency
Eric Perkins	Environmental Scientist, U.S. Environmental Protection Agency, Region 1
Gretchen Young	Assistant City Engineer, City of Dover
Sally Soule	Coastal Watershed Supervisor, N.H. Department of Environmental Services
Jackie LeClair	Wetlands Protection Unit Manager, U.S. Environmental Protection Agency
*William Arcieri	Senior Water Resource Scientist, Vanasse Hangen Brustlin, Inc.
*Owen Friend-Grey	Assistant City Engineer, City of Rochester
*Abigail Lyon	Community Technical Assistance, Piscataqua Region Estuaries Partnership
Steve Miller	Coastal Training Program, Great Bay National Estuarine Research Reserve
Tonna Marie Surgeon Rogers	Coastal Training Program, Waquoit Bay National Estuarine Research Reserve
Jennifer West	Coastal Training Program, Narragansett Bay National Estuarine Research Reserve

The committee's primary role was to provide input and feedback on key decision points in the *Credit for Going Green* project, including expert panel selection, compilation of the literature review, final reporting, and the dissemination of products and outcomes. Advisory committee members assisted the expert panel as needed, but were not participants in the process to allow for the greatest autonomy of the panel.

1.3 How the Panel Collaborated

The panel used a weight-of-evidence approach based on independent peer reviews at the National Academy of Sciences, which was designed to synthesize expert opinions on a subject around which there is uncertainty due to insufficient data and data that is unattainable because of physical constraints or lack of resources. In support of an efficient and respectful process, they employed the following best practices:

A. Start with a Working Charter

The support team developed a draft charter to help clarify the panel's goal, approach, and decision making process. The panel refined this charter at the start of the process.

B. Hold Periodic Meetings

There were six meetings held between January and September 2018. The first was a four-hour face-to-face meeting. Subsequent meetings were held via web conference with some panelists meeting in person. Meetings were recorded, transcribed, and made available to the panel throughout the process.

- March 6th, 2018
- April 4th, 2018
- May 16th, 2018
- August 16, 2018
- September 18, 2018

C. Use Collaboration Best Practices

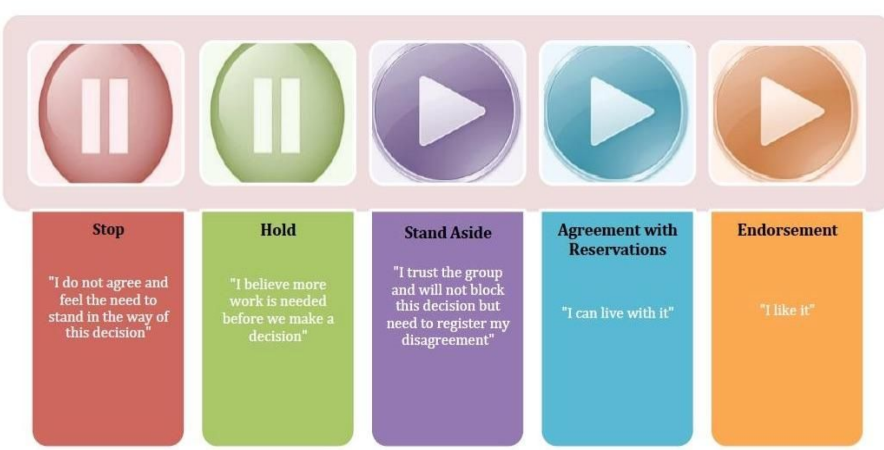
The panel agreed to the following principles of collaboration:

- Commit the time, energy, and resources needed to meet project objectives
- Recognize the validity of differing points of view
- Recognize the complexity involved in buffer-related issues
- Be prepared to listen intently to understand others' views
- Regard disagreements as problems to be solved, not battles to be won

D. Agree On a Process for Decision Making

While the panel worked toward consensus, they did not interpret it as unanimous agreement. The chair and process support person worked to ensure that opposing points of view were respectfully discussed and to identify areas of agreement. They used the continuum of consensus (Figure 1) for key decisions, which allowed panelists to endorse a recommendation, agree with reservations, disagree but stand aside, hold and demand more work, or not agree and therefore stop the decision.

Figure 1: Continuum of Consensus *Courtesy, Center for Leadership and Organizational Change*



E. Maintain Momentum Between Meetings

To encourage decision making and build cohesion among panelists, the process support team used the following techniques:

- Pre-meeting surveys: At least three weeks before each meeting, panelists received a survey that guided their preparation. The survey asked panelists to review and confirm notes from the previous meeting and provided reminders and/or guidance about "homework." The survey also asked panelists to apply the continuum of consensus to key decision points identified at the previous meeting. Survey responses helped the process support team highlight topics that required additional discussion at the next meeting; they used those to inform the next meeting's agenda.

- Meeting Prep: One week before the meeting, panelists received an agenda, support materials, survey responses, and the PowerPoint file that the chair would use to guide the meeting. The presentation included comments from the survey and identified the relevant panelist so they could speak to their rationale.

- Google Drive: The panel used a protected Google Drive folder that contained resources such as the literature review, meeting notes, agenda, and working charter. This platform supported file development, sharing, revision, and storage, and allowed for panelists to access shared literature, models, and materials.

Section 2: Glossary

2.1. Commonly Used Acronyms

- AOT - Alteration of Terrain
- BMP - Best Management Practice
- DCIA - Directly Connected Impervious Area
- EPA - United States Environmental Protection Agency
- HSG - Hydrologic Soil Group
- MS4 - Municipal Separate Storm Sewer System
- PLER - Pollutant Load Export Rate
- TN - Total Nitrogen
- TP - Total Phosphorus
- TSS - Total Suspended Solids

2.2 Commonly Used Terms

- **Buffer**: An upland area adjacent to wetlands and surface waters (the panel used New Hampshire state definitions for *wetlands* and *surface waters*).

- **Contributing Area:** The amount of land that could generate runoff to the buffer.

- **Credit***:* The estimated pollutant load reduction given for the use of buffers in regulatory permits issued for development, redevelopment, restoration, and other land use change projects under the NPDES Stormwater Permit Program and other efforts to manage stormwater.

- **Directly Connected Impervious Area (DCIA)**: The portion of impervious area with a direct hydraulic connection to the MS4 or a waterbody via continuous paved surfaces, gutters, drain pipes, or other conventional conveyance and detention structures that do not reduce runoff volume (EPA Region 1 MS4 Guidance).

- **Denitrificatio**n: Process by which bacteria remove nitrogen from the soil that results in nitrogen release to the atmosphere as a gas.

- **Expert Panel Process:** An approach to synthesizing the opinions of authorities on a particular subject around which there is uncertainty due to insufficient data or data that is unattainable because of physical constraints or lack of resources.

- **Hydrologic Flow Path:** The pathways surface and subsurface water follow in a given groundwater velocity field.

- **Hydrologic Soil Group (HSG):** Based on the premise that soils found within a climatic region that are similar in depth to a restrictive layer or water table, the transmission rate of water, texture, structure, and degree of swelling when saturated will have similar runoff responses. Determined by the water transmitting soil layer with the lowest saturated hydraulic conductivity and depth to any layer that is more or less water impermeable (such as hardpan or bedrock) or depth to a water table (if present).

- **Infiltration:** The downward entry of water into the soil or rock.

- **Optimal buffer condition**: As defined by this panel, a forested buffer with a width of 100 feet capable of achieving the maximum removal efficiency values described in Table 1 in the technical memo (see Appendix 7.1). This defines the upper boundary of pollutant removal performance for these curves. Deviations from this condition result in penalties that reflect lower performance expectations.

- **Performance:** A buffer's ability to function and remove Total Nitrogen (TN), Total Suspended Solids (TSS), and/or Total Phosphorus (TP).

- **Penalty:** Reduction in credit from the total possible; reflects the impact of different, less optimal conditions on the buffer's ability to remove TN, TSS, and/or TP.

- **Pervious Land:** Areas of land that allow infiltration and groundwater recharge, excluding impervious surfaces such as pavement, concrete, and rooftops, among others.

- **Pollutant Load Export Rate (PLER):** Rate of total pollutant load exported from a unit area watershed, typically based on land use category on an annual basis (e.g. pounds of nitrogen per acre per year (lb-TN/acre/year).

- **Removal Credit or Removal Efficiency**: A buffer's capacity to remove TN, TSS, and TP.

- **Runoff Loading:** Total volume of water divided by the area of the buffer.

- **Surface waters:** Perennial and seasonal streams, lakes, ponds, and tidal waters within the jurisdiction of the state, including all streams, lakes, or ponds bordering on the state, marshes, water courses, and other bodies of water, natural or artificial (485-A:2 Definitions. – XIV).

- **Turf** (aka lawns, turf grass, turf cover): Pervious areas managed for dense grass cover, which may involve one or more of the following practices: fertilization, irrigation, and weed control.

- **Wetlands:** Areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support (and that under normal conditions do support) a prevalence of vegetation typically adapted for life in saturated soil conditions (482-A:2 Definitions).

- **Wetland Functions:** Practical, measurable values of wetlands. The 12 primary wetland functions recognized in New Hampshire are ecological integrity, wetland-dependent wildlife habitat, fish and aquatic life habitat, scenic quality, educational potential, wetland-based recreation, flood storage, groundwater recharge, sediment trapping, nutrient trapping, retention, or transformation, shoreline anchoring, and noteworthiness (482-A:2 Definitions).

Section 3: Background on Buffer Conditions in the Great Bay Watershed

3.1 Environmental Conditions Requiring Increased Buffer Management

In 2008, the Great Bay was placed on the New Hampshire Department of Environmental Services (NHDES) Section 303(d) list for Threatened and Impaired Waters. Great Bay is impaired for aquatic life due to declining eelgrass coverage caused by reduced water clarity, which is caused in part by phytoplankton abundance due to excessive nitrogen levels. Many of these impairments remain today and the methodology for their determination is described in the NHDES Consolidated Assessment and Listing Methodology (CALM). The eelgrass loss trend that was documented in 2008 has continued to worsen and remains a serious concern. In 2014, NHDES released the final report of the Great Bay Nitrogen Nonpoint Source Study (GBNNPSS). This estimated stormwater as the source of 34% of the nitrogen loads to Great Bay.

Several trends related to stormwater runoff and its potential impact on the Bay's water quality have been tracked in recent decades and are summarized in the 2018 State of Our Estuaries Report (2018 SOOE). Between 1990 and 2015, the population of the 52 Maine and New Hampshire towns in the Piscataqua Region watershed grew by 38%. There were 19,483 new multi- and single-family housing permits issued in the New Hampshire towns from 2000 to 2015. Between 1990 and 2010, impervious surfaces in the Great Bay Estuary watershed increased by 120% and have continued to increase over the last five years.

Combined with changes in precipitation, population, and development, these impervious surfaces are sending more contaminants, including nutrients, into the bay and its tributaries. At the same time, total nitrogen loading to the Great Bay Estuary from 2012 to 2016 was 26% percent lower than 2009 to 2011 levels. Low rainfall and corresponding streamflow during this period, as well as significant reductions in nitrogen loading at municipal wastewater treatment facilities, are the primary reasons for this decrease. Most of the variability relates to nitrogen from nonpoint sources from stormwater runoff and groundwater contributions. These sources accounted for 606.6 tons per year or 67% of the nitrogen load for 2012 to 2016.

Buffers are a well-established, scientifically justified method to maintain and mitigate water quality threats and promote habitat, biodiversity, and concomitant ecosystem service functionality that benefits ecosystems and societies alike. Changes in estimated pollutant loads to water bodies from overland flow can occur in three fundamental ways: 1) A change in the land use condition (e.g. residential home development replacing forest land) 2) Inadequate assessment of natural landscape capacity (e.g. buffers) to attenuate or remove increased pollutant loads 3) a reduction or adjustment of pollutant loads based on estimated effectiveness and scale of application of best management practices, including buffers.

3.2 Buffer Options for the Bay: An Integrated Policy Analysis

Buffer Options for the Bay (BOB) was an integrated policy analysis conducted from 2015 to 2018 to support policy and land use decisions involving buffers in New Hampshire's Great Bay region. BOB generated ten biophysical and social science publications and reports focused on buffers in Great Bay and beyond, including a Community Assessment, Synthesis of Policy Options, and a Coastal Science Literature Review. These studies helped identify the need for this expert panel process and have been a resource for its design and implementation.

BOB was created through a collaboration of public, academic, private, and nonprofit organizations dedicated to leveraging the capacity of buffers to protect water quality, guard against storm surge and sea level rise, and sustain fish and wildlife in the region. BOB was sponsored by the National Estuarine Research Reserve System Science Collaborative, which supports collaborative research that addresses coastal management problems important to Reserves and their communities. The Science Collaborative is funded by the National Oceanic and Atmospheric Administration and managed by the University of Michigan Water Center.

3.3 Current Buffer Policy

New Hampshire was one of the first states to regulate the protection of wetlands. Jurisdiction for tidal wetlands began in 1967 and for nontidal wetlands in 1969. Today, management of buffer areas is governed by a combination of federal, state, and local policy. State and federal buffer regulations are administered by the New Hampshire Department of Environmental Services (NHDES). These regulations restrict certain land use activities within shoreland and wetland areas. Their extension to buffer areas is limited to water bodies defined under the New Hampshire Shoreland Water Quality Protection Act (SWQPA) and the Prime Wetlands list.

Such decentralized shoreland and wetland policies allow for flexibility at the community level, giving municipalities the opportunity to apply local knowledge and control to their regulations. Many municipalities can and do enact more restrictive buffer regulations to protect valued water bodies. Yet, this flexibility comes at the price of consistent enforcement and protection across the state. Buffer width size regulations vary widely, with some towns having no regulations at all. This inconsistency leaves many smaller shorelands and undesignated wetlands beyond state jurisdiction, without protection, and at risk for degradation as New Hampshire communities continue to grow and develop. This risk is compounded by insufficient understanding of policy options, inadequate access to related resources, and confusion over terminology among stakeholders.

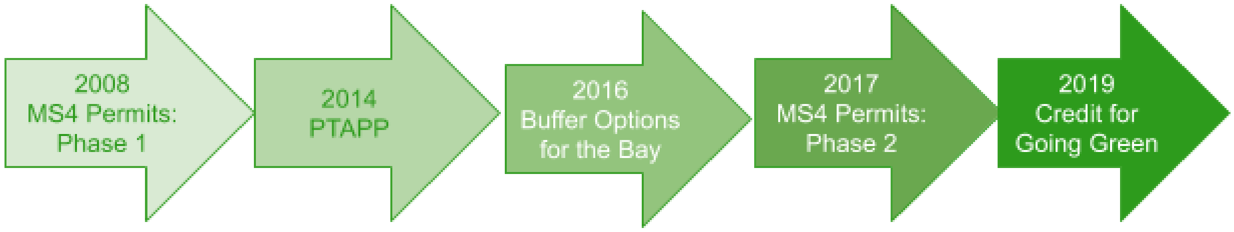
The existing framework of laws and programs is complex and at times confusing, presenting many challenges for municipalities and landowners. As a result, organizations like the New Hampshire Department of Environmental Services, the University of New Hampshire Stormwater Center, the Great Bay National Estuarine Research Reserve, and the Piscataqua Region Estuaries Partnership are focused on providing assistance—like the *Going Green* project—to support communities as they seek to manage these resources more effectively.

3.4 Community Perspectives on Buffers

The opportunity to strengthen buffer regulations for the smaller streams and undesignated wetlands lies with the state's municipalities. **BOB's assessment of community perspectives in the Exeter-Squamscott subwatershed** identified several common values and perspectives among decision-makers and other stakeholders related to buffers. Through 38 interviews with stakeholders in four watershed communities, the analysis identified a fundamental need to quantify the direct benefits of buffers and buffer restoration in terms of pollutant load reduction estimates. While perspectives on buffer value among individuals varied, there were commonly held values that relate to efforts to conserve, restore, or manage buffers.

3.5 Past Efforts Related to Buffer Pollutant Load Reduction Rates

In the last ten years, the research, government agency, technical assistance, and consultant communities have strived to help municipalities address pollution in their waterways and meet emerging federal permits related to stormwater and wastewater. The *Credit for Going Green* project builds on the work of the Pollution Tracking and Accounting Pilot Program (PTAPP) and the Buffer Options for the Bay (BOB) projects, both of which seek to meet scientific and socio-political needs related to buffer management in New Hampshire. The following diagram tracks the initiation of these projects in the context of regulatory requirements.



EPA Region 1 Municipal Separate Storm Sewer System (MS4) Permit: The National Pollutant Discharge Elimination System (NPDES) General Permit for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems (MS4s) in New Hampshire was released in January 2017 with an effective date of July 1, 2018. The final New Hampshire Small MS4 general permit establishes Notice of Intent (NOI) requirements, prohibitions, and management practices for stormwater discharges from small MS4s in New Hampshire. The permit applies to 30 out of the 42 Great Bay Estuary communities. The permit focuses on sixMinimum Control Measures (MCMs) that include:

1. Public Education and Outreach
2. Public Involvement and Participation
3. Illicit Discharge Detection and Elimination (IDDE)
4. Construction Site Stormwater Runoff Control
5. Post Construction Stormwater Management in New Development and Redevelopment
6. Pollution Prevention and Municipal Good Housekeeping

Pollution Tracking and Accounting Pilot Program (PTAPP): Tracking and accounting for pollutant load reductions achieved through various stormwater and nonpoint source control projects is challenging. Some communities have initiated steps to develop tracking systems; however, regional consensus has not been reached on accounting or tracking methods. Communities agree that regional coordination on tracking and accounting is needed and would be beneficial, however, implementation resources are limited.

To help municipalities meet the more rigorous MS4 permit requirements, the University of New Hampshire Stormwater Center and NHDES worked with municipal officials, public works departments, and engineering consultants to create the PTAPP tracking and accounting database. They also developed guidelines and recommendations for tracking and accounting systems and identified potential tools to enable municipalities to perform a quantitative assessment of pollutant load reductions associated with stormwater and nonpoint source management activities in the Great Bay region. The project has also launched a pilot PTAPP database for communities to test.

NH Association Of Natural Resource Scientists Wetland Buffer Scientific Workgroup: In March 2015, the Board of Directors of the NH Association of Natural Resource Scientists (NHANRS) authorized its Legislative Committee to form a Wetland Buffer Scientific Work Group to investigate the scientific basis for establishing protective buffers to jurisdictional wetlands in New Hampshire. The purpose was to provide science for use in future discussions regarding the need to advance wetland protection and to what extent. The workgroup published their findings in a report in June 2017.

The group agreed it would be beneficial to develop a simplified approach to siting and implementing protective wetland buffers. They developed criteria for High Value Wetlands (HVWs) to be used in this approach. One critical concept behind this approach is to allow an applicant, landowner, or natural resource professional to determine whether a wetland would be subject to a buffer based on a relatively short list of science-based criteria. Through various meetings, the group arrived at a consensus-based list of potential criteria for the HVW designation.

Section 4: Review of Available Science

At the start of the *Going Green* project, the panel chair worked with the advisory committee to identify the following literature reviews of science relevant to buffer management in New Hampshire:

- Recommendations of the Expert Panel to Reassess Removal Rates for Riparian Forest and Grass Buffers Best Management Practices, submitted to the Chesapeake Bay Program, October 2014

- Draft annotated bibliography of sources that the Environmental Law Institute (ELI) consulted for the draft report, submitted to the RI DEM, undated, received December 2017

- Key Findings from Available Literature from the Buffers Options for the Bay, project managed by the Great Bay National Estuarine Research Reserve completed by the Nature Conservancy, Roca Communications+, and GBNERR. Undated, received December 2017

- Riparian Buffers: A summary of nutrient reduction values reported in the literature May 22, 2017 Draft Prepared for the Vermont Agricultural BMP Expert Panel.

The chair conducted a meta-analysis that led to a composite outline of relevant literature that the panel reviewed prior to the first meeting. This informed their preliminary discussion of key issues including buffer width, soil type, land use, slope, type (grassed, vegetated, or forested), pollutants (TSS, TP, TN), habitat, water temperature, biodiversity, carbon sequestration, flood resilience, flow path, surface and subsurface flow, longevity, operation and maintenance, performance, and lag time. The panel agreed the outline provided an adequate foundation, but that they would add resources as needed.

Midway through the process, panelist Karen Dudley (USDA Natural Resource Conservation Service) compiled 82 additional references to help the panel reach a consensual definition of buffers and agree on the conditions that would influence the performance curves. Through this review, Dudley identified the following conditions as key to a buffer's capacity to remove pollutants from runoff:

- ***Soil type*** strongly influences infiltration and denitrification. Infiltration is determined by soil structure and consistency. HSG A (sandy or gravelly soils) have desirable high infiltration rates, but do not remove all pollutants effectively especially those in dissolved form.

- ***Denitrification*** is facilitated by wetter soils with higher water tables and organic material. HSG D was considered optimal for denitrification.

- ***Historically forested soils*** with limited compaction and those with ample organic matter and an undulating topography were the closest thing to being wet without actually being hydric soil.

- ***Hydrologic flow path*** is driven by landscape and soil. Optimal treatment of runoff occurs in wetlands or areas with a high water table that increase hydraulic residence time.

- ***Slope*** was noted in a 2010 study which indicated that buffer slopes less than 10% are good for sediment removal, but slopes greater than 10% have negative impact. NRCS staff with significant experience with erosion work concurred that < 10% was optimal and that 15–20% slopes had negative impacts.

- ***Land use intensity*** of the area draining into buffer and buffer itself influenced performance.

- ***Buffer health and longevity*** is optimal in highly vegetated, diverse buffers, which are more effective at removing pollutants but may require maintenance. Buffers that become forested or diverse over time are expected to become more effective.

Section 5: About the Panel's Decisions

To meet its charge, the panel identified a set of optimal conditions for a buffer that served as the foundation for four sets of performance curves. They set a 100% credit for an "optimal buffer" and then calculated reductions (penalties) for suboptimal buffer conditions on each performance curve. The curves, optimal conditions, and the decisions that underpin them are captured in the technical memo in Appendix 7.1. In the making of these decisions, the panelists considered the following key questions and relevant, available science:

- How do you define buffers for the purpose of developing performance curves?
- Which types of land use should be allowed for accounting, e.g. urban or non-urban?
- How do you define optimal buffer conditions for pollutant reduction given available science and data?
- How do you aggregate and incorporate different types of buffers into curve development?

- How can findings and results from the Chesapeake Bay model be used to develop curves for New Hampshire?
- What is the relationship between buffer performance over time and credit allowed by the curves?
- Which scenario for curve development is the most practical and accurate given available information and intended use of the curves?

Section 7: Appendices

7.1 Final Technical Memo