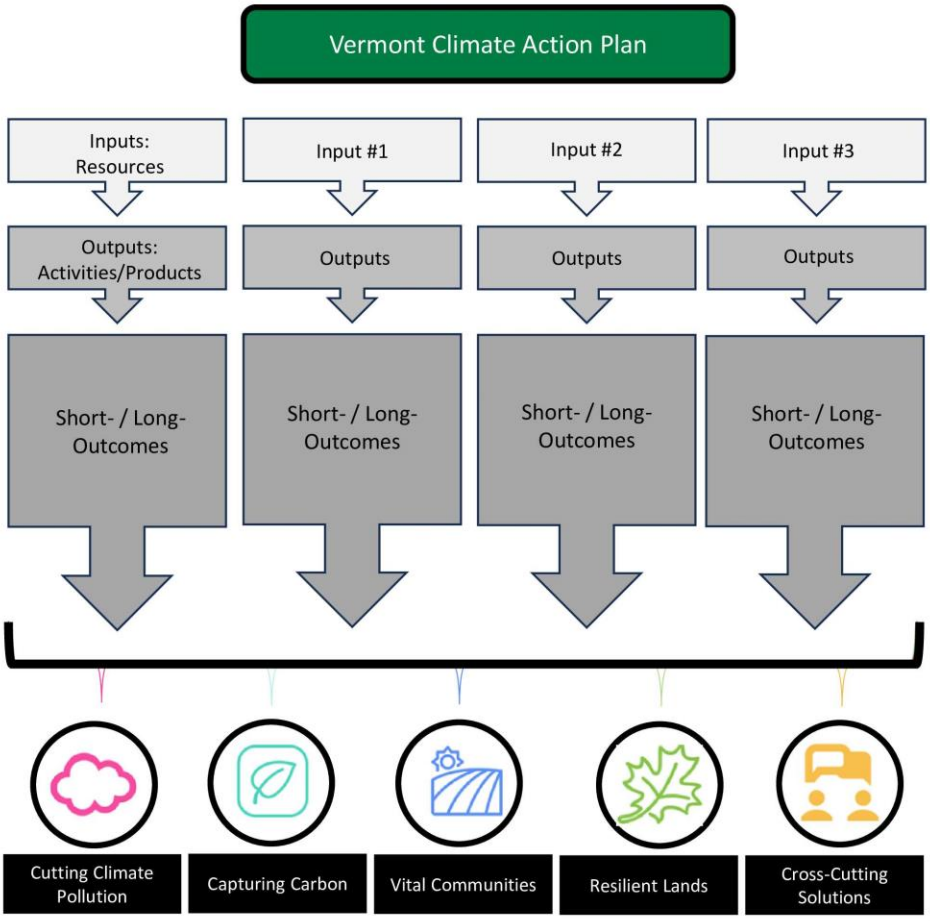
Response to Request for Proposals for Measuring and Assessing Progress of Vermont's Climate Action Plan

STONE ENVIRONMENTAL



PROJECT NO.

20231148

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November 17, 2023

Vermont Agency of Natural Resources
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Stone Project No. 20231148
Subject: Proposal for Measuring and Assessing Progress of Vermont's Climate Action Plan

Dar Jane and Members of the Selection Committee

Stone Environmental, Inc. (Stone) is excited to respond to the State of Vermont Agency of Natural Resources (ANR) Request for Proposals (RFP) to provide technical support services to ANR to develop a tool to measure and assess indicators of progress related to reducing greenhouse gas emissions and increasing resilience and adaptation to a changing climate in Vermont, as well as the implementation of action in the Climate Action Plan. Our proposed approach to the scope of work includes guiding the compilation, development, and ongoing maintenance of data; determining metrics and indicators for monitoring and assessing progress; mapping underlying data sources and critical attributes; identifying gaps in data or data requirements; and making recommendations for the successful implementation of the second phase of this effort focused on creating the tool.

Stone is a small, 100% employee-owned company based in Montpelier, Vermont with a national reputation for deep spatial and data analysis, web mapping, data visualization, and tool development that closes the gap between raw data and actionable information. For the past 20 years, we have developed and managed databases, mapping platforms, and inventories for a variety of state agencies, non-profits, and community organizations to create powerful tools that solve complex environmental problems.

Our team will work closely with the ANR and the Vermont Climate Office, the Vermont Climate Council, the Climate Action Office Director, and other stakeholders to ensure the project meets the needs outlined in this RFP. We are well qualified for this work based on a history of successful planning, database, modeling, and tool development projects with the State. We also bring significant expertise in designing and implementing solutions to address a range of relevant problems, including water quality, agriculture, transportation and infrastructure, climate change mitigation, and resiliency and adaptation.

The following proposal includes our Technical Response, Price Schedule, and required documentation. We appreciate this opportunity to submit our proposal and are available to answer any questions you have regarding our team's capabilities or experience.

Sincerely,

Jody Stryker
Senior Environmental Modeler
858.444.5790
jstryker@stone-env.com

Technical Response: Measuring and Assessing Progress of Vermont's Climate Action Plan

***Cover Photo**: Example simple schematic of logic model for Vermont Climate Action Plan.*

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1. Qualifications of the Project Team

Stone Environmental, Inc. (Stone) is invested in supporting environmental stewardship and increasing resilience to climate change in Vermont. We work with multiple state and federal agencies, the University of Vermont (UVM), and other local consultants on a wide range of projects that relate to planning, implementing, and incentivizing strategies for building resiliency and improving environmental quality across the state. For this proposal, we have assembled an interdisciplinary team to develop a framework for creating a tool for monitoring and evaluating progress on key strategies and activities intended to drive emissions reductions in line with the Global Warming Solutions Act (GWSA) requirements. Our team includes individuals with varied expertise, a diverse skillset and capacity for multi-faceted analysis, and experience working across state government sectors, making this Project Team highly qualified to contribute to all phases of developing a tool to meet the ongoing objectives and desired outcomes of Vermont's Climate Action Plan (CAP).

1.1. About Stone Environmental

Stone is a 100% employee-owned environmental science, engineering, and field services firm in Montpelier, Vermont. Founded in 1992, our mission is to provide tools, information, and analyses to help clients solve environmental challenges with integrity, expertise, and innovation. We bring together over 65 scientists, engineers, and foundation staff with diverse backgrounds and skills and a shared commitment to excellence, creativity, and accountability through employee ownership. Our expertise includes developing and applying a broad range of tools and models that address various aspects of the changing climate, such as water quality, soil health, agriculture, and conservation practices. Additionally, we have extensive experience in environmental planning and policy development, stormwater and watershed assessment, developed lands stormwater retrofit practice design and implementation, environmental monitoring, geographic information systems (GIS) spatial analysis, and application development.

Over the past three decades, Stone has worked with local, regional, and federal partners, including the Agency of Natural Resources (ANR), Vermont Agency of Agriculture, Food & Markets (VAAFM), the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), Lake Champlain Basin Program (LCBP), and the Vermont Agency of Transportation (VTrans) to develop innovative strategies and tools to address sustainability and resiliency challenges in Vermont. We have developed several web-based tools to support state programs aimed at meeting data management, water quality, stream reconnection/restoration, and resiliency goals, including the Farm-Phosphorus Reduction Planner (Farm-PREP), the Functioning Floodplain Initiative web application, Vermont Transportation Resilience Planning Tool (TRPT), and the Vermont Partners Database. In addition, we are currently working with multiple agencies and organizations across the Lake Champlain Basin to evaluate, site, design, and implement agricultural water quality improvement projects, as well as guide decision-making, program planning, and policy development to address water quality impacts associated with agriculture. Several of these tools have been specifically designed to quantify and track progress toward meeting the state's water quality and/or resiliency goals.

Table 1. Firm Profile

Stone Environmental, Inc.	
Address:	535 Stone Cutters Way, Montpelier, Vermont 05602
Structure:	100% Employee Stock Ownership Plan (ESOP), Private S-Corporation
Years in Business:	Stone was founded in July 1992 and has been in business for over 31 years. We are actively licensed to do business in the State of Vermont.
Size:	Stone is a small business. We currently employ 65 employees, including part-time and on-call staff.

1.2. Key Staff Roles and Bios

The Stone team has the capacity, knowledge, and technical/subject matter expertise to successfully complete this project within our proposed timeline. We have designated lead staff on components of this work, as well as identified supporting staff who are available to contribute time and intellect. Due to the relatively short timeline, we recognize that success will require we establish a clear and achievable scope of work and maintain open and timely communication internally at Stone and between Stone and the Climate Action Office (CAO) Director and the ANR project team. In addition to our biweekly project check-ins, our team will meet internally for regular check-ins and use project management tools described in Section 2.

The following sections provide an overview of the qualifications and experience of our key personnel. Resumes for key staff are included in Appendix A.

JODY STRYKER, PH.D. Senior Environmental Modeler

Project Management and Oversight

Jody will serve as Project Manager, responsible for the project schedule, coordination with the State, invoicing, contract requirements, and ensuring all objectives and deliverables are met. She will be the primary point of contact for the Director of the Climate Action Office. Jody has an interdisciplinary background and experience working for varied clients on a range of environmental science, modeling, and engineering projects. Her expertise includes model and methodology development, model application, report and publication writing, data visualization and presentation, and project management. As part of her doctoral research, Jody made critical contributions to building an integrated assessment model for understanding the role of climate change on nutrient and sediment fluxes in the Lake Champlain Basin. At Stone, Jody has led and supported several projects focused on measuring, modeling, and/or tracking improvements in water quality, resiliency, and ecosystem services at state and national scales. She manages Stone's role in the Vermont Functioning Floodplain Initiative (FFI) Phase 2 effort, which continues to develop an application for accessing connectivity data, identifying and prioritizing project opportunities, and tracking floodplain restoration and phosphorus loss reductions in the Lake Champlain Basin. She is also leading the ongoing development of Farm-PREP, which supports the VAAFM's Pay for Phosphorus Program by providing model-driven field and farm-specific estimates of phosphorus loss reductions based on simulated implementation of agricultural conservation practices compared to baseline management assumptions. Jody also supports collaborative research efforts with UVM and Virginia Tech, regularly collaborates with other consulting companies in Vermont, and has worked across multiple sectors of Vermont state government. She earned her Ph.D. and M.S. in Civil and Environmental Engineering from the University of Vermont and a B.S. in Environmental Science from the University of Miami.

BARBARA PATTERSON Senior Application Developer

Technical Lead – Data Governance and Data Mapping

Barb will lead the development of the data governance plan and the data mapping task. Barb has 25 years of experience in application design, application and data development, and project management. She is passionate about designing creative solutions from large disparate datasets across the environmental sciences. Her expertise includes application design, database design and development, data visualization, and project management. Barb has led and supported numerous clean energy, agriculture, transportation, climate change, and conservation projects. Her experience includes leading a multi-year effort with the Environmental Defense Fund to develop the PermianMAP web-based tool to communicate and highlight methane emissions in the Permian Basin of New Mexico and Texas to multiple stakeholders. Barb has also led the multi-year effort with VAAFM to streamline data management in a web-based GIS application for farm practices, inspections, and enforcement as part of the Vermont Partners project. She also led the database design for Stone's Farm-PREP application, integrating a user-friendly interface with the sophisticated Agricultural Policy Environmental eXtender (APEX) model. Most recently, Barb led the design and development of a web-based application for the NRCS Grazing Lands team that allows users to enter data from disparate research studies and then dynamically query and visualize the data to understand research outcomes. She holds an M.A. in Environmental Studies from the Evergreen State College and a B.A. in Mathematics and Spanish from Bucknell University.

ANNEMARIE FORTUNE, AICP Brownfields Program Manager

Technical Advisor – Stakeholder Coordination, Community Outreach, and Program Evaluation

Annemarie will serve as a technical advisor and support stakeholder coordination and community outreach to identify strategies for developing new data sources and make recommendations for metrics regarding programmatic effectiveness. Annemarie will also provide best-practice research and technical assistance related to metric identification and prioritization on topics such as community resiliency, infrastructure, and the economy. Using a systems-thinking lens, Annemarie will help lead logic model creation. Annemarie is an American Institute of Certified Planners (AICP) certified planning and public health professional committed to co-developing more resilient and equitable communities through policy, system, and environmental changes. Before joining Stone, Annemarie participated in city, regional, and state planning and policy processes in Colorado communities to advocate for environmental health, social impact, and community planning best practices on topics such as food access, air quality, climate change, transportation, and housing. Her experience included developing evaluation methods to identify opportunities for more equitable programs and policies related to resource allocation and land use policy. She holds a Master of Public Health from the Colorado School of Public Health and a Master of Urban and Regional Planning from the University of Denver College of Architecture and Planning.

JENNIFER CYPHER, Quality Assurance Manager, Corporate Health and Safety Officer

Data Governance Support

Jenn will provide support for data governance as well as maintain quality assurance for this project. Jenn has over 16 years of experience developing and maintaining rigorous quality assurance practices across various industries. Her early career was in precision manufacturing, where she implemented quality management systems to support aerospace applications, including spaceflight programs. There, Jenn managed staff training, documentation, and procedures, facilitated internal and external audits, and implemented enterprise resource planning programs. As Stone's Quality Assurance Manager, she provides quality assurance (QA) services for EPA-related environmental and agrochemical field studies, including drift, volatility, and hybrid studies. Jenn serves as Task Manager under Stone's General Services Contract for PCB Assessment in

Vermont Schools. She also oversees Stone's quality assurance (QA) programs, including Phase I and II Environmental Site Assessments, brownfield remediation projects, and water resources programs through the Lake Champlain Basin Program. She holds a Registered Quality Assurance Professional in Good Laboratory Practice (RQAP-GLP) Certification, is a certified AS9100 Lead Auditor, and is a member of the American Society for Quality. She holds a B.S. in Environmental Science and Biology from the University of Maine at Farmington.

JENS KIESEL, PHD — Environmental Modeler

Quantitative Climate Change Analyses and Metric Support

Jens will provide review and support for climate change and resiliency quantitative metrics. Jens is an environmental modeler with over ten years of international experience in project planning and implementation for a broad range of projects, including flood assessments. As a consultant, he worked on more than 30 development corporation projects in 18 countries and major river basins such as the Nile, Mekong, and Zambezi. Before joining Stone, Jens worked on a project assessing flood mitigation measures in Tbilisi, Georgia. At Stone, he uses established and custom-built models, as well as GIS tools in water-related projects investigating hydrologic processes as well as the fate and transport of nutrients and pesticides from the field up to river basin scales. Jens holds a Ph.D. in Natural Sciences from Kiel University in Germany and a diploma in Civil Engineering from the University of Technology, Darmstadt.

PAIGE GEBHARDT, GISP — GIS Specialist

Data Mapping Support

Paige will provide data mapping support for this project. Paige is a GIS Professional with six years of experience providing web mapping application development and geospatial analysis. Before joining the Stone team, she leveraged her technical expertise in data management to support natural resources, military training and readiness, and environmental data quality. At Stone, Paige manages the VT Culverts project, working with regional planning commissions to update culvert and bridge data across the state, create backups, and automatically populate fields to increase efficiency. Paige recently developed a series of maps for the Champlain Water District's Source Protection Plan, incorporating over 40 geospatial data layers from various municipal and statewide sources. She also assists the Vermont Community Broadband Board with data management, analysis, statewide broadband implementation progress summaries, and data standards. For the State of New York, Paige helped migrate the New York Geographic Information Gateway public data and website from servers to ArcGIS Online and ArcGIS Hub. She holds a B.A. in Human Geography from Michigan State University and a Geographic Information Systems Professional (GISP) Certification.

MARY HALEY — GIS Specialist

Program/Tool Review and Data Mapping Support

Mary will provide data mapping support for this project. Mary is a GIS project professional with experience leveraging advanced-level GIS services in a range of technical projects. Before joining Stone, she applied her skills at VTrans, where she administered geodatabases and mapping services with Python automation, developed ArcGIS Online web maps and tools, and led fieldwork for the terrestrial LiDAR scanning program. At Stone, Mary uses her diverse design and field experience to support application development and geospatial analysis projects. She is an Esri-certified professional in ArcGIS Desktop and is skilled in ArcGIS Online, ArcGIS Pro, ArcMAP, ArcGIS Collector, StoryMaps, Field Maps, Survey123, Experience Builder, and ArcGIS Hub. Mary's recent project experience includes developing complex datasets from State and Federal databases to visualize chemical release data and cleanup efforts; creating an automated phosphorus reduction tracking system to identify current infrastructure condition changes for Vermont swales and culverts; migrating data from existing servers and geodatabases into a platform developed for the New York

Geographic Information Gateway; and managing data services for the Vermont Community Broadband Board with automated Python scripts. She holds a B.S. in Environmental Science from Endicott College, a professional GIS certificate from Michigan State University, and a professional certification in Esri ArcGIS Desktop.

AMY MACRELLIS Senior Water Quality Specialist

Program/Tool Review and Metric Support

Amy is a Senior Water Quality Specialist with over two decades of experience in wastewater and stormwater management projects, policy development, community wastewater needs assessments and feasibility studies, and applied water quality research projects in Vermont. Her latest work is in green infrastructure implementation from policy to practice for municipalities and state agencies, including VTrans. She led the development of Phosphorus Control Plans for the Lake Champlain Basin and continues to support their implementation. Amy manages stormwater planning activities in numerous Vermont communities, ranging from Burlington to Concord, in size and complexity.

1.3. Relevant Experience Supporting the Development of Climate Action Work

Stone's team has experience in climate action work that includes projects focused on improving sustainability, resiliency, and understanding the potential impacts of climate change. Our work in this area has ranged from data management and developing data management workflows that highlight change from baseline assumptions, utilizing climate change projections in hydrological and water quality modeling, and conducting uncertainty analyses to develop combined land use and climate change scenarios. We have added climate change impact assessments into workflows for multiple projects, enabling water resources and agricultural management to adapt to and mitigate the impacts of climate change. Our experience includes applying physically based models to better understand and predict changes in environmental outcomes from climate impacts, as well as supporting program development to provide information on resiliency and progress metrics. These approaches are crucial to finding and optimizing sustainable solutions for uncertain or changing climate conditions.

Stone has supported climate change resilience and adaptation planning projects, including the Functioning Floodplain Initiative (FFI) web application and the Vermont Transportation Resilience Planning Tool (TRPT). These efforts continue supporting the State's goals to build resiliency in natural and built environments. The FFI web application uses a scientifically developed methodology to find high-priority projects that restore floodplain and river function, build capacity in our fluvial systems to improve water quality, increase resiliency to higher magnitude precipitation and flooding events, and protect critical habitats. TRPT similarly uses science and transportation factors to identify infrastructure vulnerability to damage from flooding and natural processes, provide risk estimates, and determine potential mitigation measures based on vulnerability factors (e.g., 100-year flood depth above the road, length of road in the river corridor, roadway-river relief, etc.).

Stone has also worked on large-scale state projects for Vermont and New York that establish data standards and data mapping protocols to integrate data in web applications for the public, state employees and officials, and policymakers. The New York Geographic Information Gateway project is a multi-year effort that incorporates over 700 datasets from the State of New York and is used in planning activities and as a communication tool for the public. Using Python, the Stone team published the datasets to ArcGIS Online, standardized metadata and collaborated with the Geospatial Services team at the New York State Office of Information Technology Services, Chief Data Office, to share data across state agencies. For the Vermont

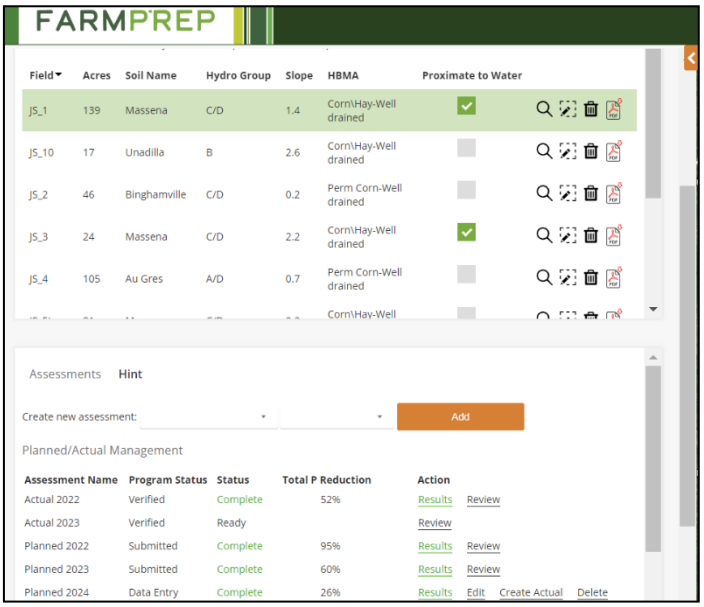
Community Broadband Board (VCBB) project, Stone similarly incorporated over 75 datasets from Vermont's E911 data, the Federal Communications Commission, and Communication Union Districts (CUDs) to create a platform to visualize broadband service status and grant funding statewide.

1.3.1. The Farm Phosphorus Reduction Planner (Farm-PREP): Continued Development of an Integrated Tool to Meet Farm and Basin Scale Water Quality and Climate Goals

Stone developed Farm-PREP to help farmers, technical crop consultants, and stakeholders evaluate the impacts of field-level best management practices on farm-scale phosphorus (P) loss reductions and identify modifications to their field operations to help achieve water quality improvement targets on the watershed-scale. Farm-PREP is an integrated web-based application that brings the power of the USDA Natural Resource Conservation Service's farm-scale water quality model, the APEX, to a much broader audience through a streamlined and user-friendly interface that evaluates thousands of farm management scenarios. The tool integrates agronomic and hydrologic science, numerical modeling, and web-based application development into a high-powered scientific modeling tool operated by an elegant and intuitive user-facing front end.

Stone's development of the Farm-PREP tool and integration with the APEX model allow for thousands of possible use cases. Stone worked closely with the University of Vermont agricultural scientists, local crop consultants, and stakeholders on developing APEX model inputs to represent thousands of possible field practice combinations representative of Vermont dairy operations. These model inputs were then built into a relational database and accessed by the Farm-PREP tool based on user input.

Stone is currently supporting the ongoing development of a version of the Farm-PREP for the VAAFM Pay for Phosphorus Program (VPFP). This program provides farmers with performance-based payments for reducing phosphorus loss based on the outcome of implementing conservation practices. The VAAFM opened applications for the program in January 2022 after receiving a $7 million grant award from the USDA Natural Resources Conservation Services (NRCS). This expansion of the APEX-based Farm-PREP tool has required substantial model testing and evaluation, including a critical review of the physical process linkages between soil carbon and nutrient dynamics, crop growth, water quality, and agronomic management decisions.



Farm-PREP has been customized to support implementation of the Pay for Phosphorus program and evaluation of the impact of agricultural conservation practices against historic baseline management (HBMA) scenarios.

We continue to work with VAAFM to evaluate a subset of greenhouse gas models that can be incorporated into the Farm-PREP tool to evaluate a farm-scale footprint more holistically for not only water quality indicators but GHG emissions and carbon sequestration. This current work aims to expand the tool's capabilities to include non-agricultural natural and working lands, model carbon emissions and carbon sequestration, and represent soil aggregate stability. The

tool framework will continue to focus on evaluating and tracking improvements and progress toward water quality and climate goals through implementing practices and changes in agricultural management.

1.3.2. Vermont Floodplain Planning and Tracking Tool for Phase 2 of the Vermont Functioning Floodplains Initiative

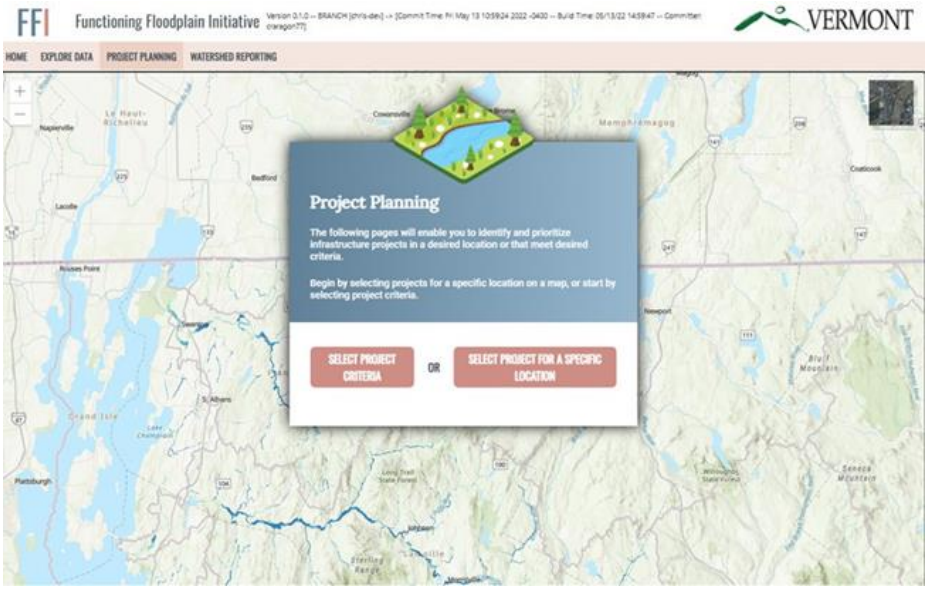
Stone is part of a collaborative effort to assist the VTDEC in establishing planning tools that promote stream and floodplain connectivity for water quality, flood resiliency, and habitat benefits. Services include data collection, development of river-floodplain connectivity departure scoring, creation of project opportunity screening approaches, development of a web-based application to house and provide user access to datasets and methodologies, as well as training and outreach materials. The project incorporates cutting-edge research into method development to inform project planning and track progress toward reconnecting Vermont's rivers and floodplains. This project has advanced our understanding of functioning floodplains by adding information in the following areas:

- The level of phosphorus deposition on connected floodplains and the cost-effectiveness of floodplain restoration to improve water quality;
- The potential resiliency benefits include cost and savings associated with reconnected floodplains; and
- Improvements to instream and riparian habitat associated with reconnected floodplains.

Stone is compiling data and methods into a public-facing web application that will be widely accessible for project planning and tracking progress towards reestablishing connected floodplains. As a part of the application development process, Stone gathered and refined user requirements, developed a set of prototypes, and completed full-scale custom web-based application development.

The Functioning Floodplain Initiative (FFI) tool will enable the user to identify potential reconnection projects and explore data describing the state and potential state of rivers and floodplains in Vermont, as well as calculate site and project-specific benefits of river reach and floodplain project implementation. The application was created to be publicly accessible by utilizing features such as an open-access platform to enable users to view maps and data, download the results of project identification workflows, estimate the impacts of potential projects on connectivity and phosphorus crediting, and export customized watershed scale summary data.

Stone is developing the application using Esri's ArcGIS Platform for map visualization and a fully custom backend database system to support calculations and tracking of reconnection progress over time. This application will serve as the interface for the State and watershed management stakeholders to support flood and erosion control strategies, water quality



Screenshot of the Functioning Floodplain Initiative interface.

objectives, sediment storage and nutrient attenuation, and habitat enhancement. We are currently developing the FFI web tool with VTDEC to create workflows and functionality that specifically supports the VTDEC to prioritize, fund, and implement restoration projects.

The FFI web application also tracks progress made towards basin-level total maximum daily load goals and progress made towards reconnecting rivers and floodplains, thereby improving resiliency to climate change and changing weather patterns.

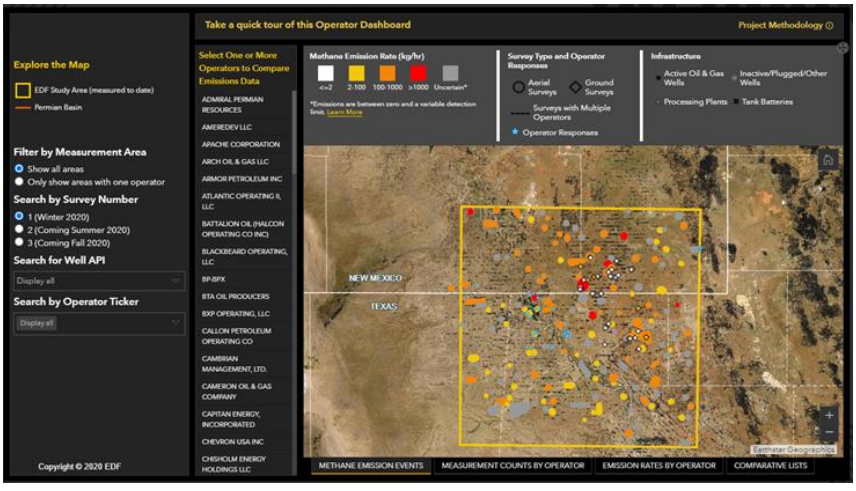
The application, which is still under development, is available here: https://ffi.stone-env.net/home.

1.3.3. PermianMAP: A Data Platform to Track Methane Emissions from Oil and Gas Drilling in the Permian Basin

Stone worked with the Environmental Defense Fund (EDF) to develop an interactive online data platform to highlight the immense volumes of climate-warming methane emitted in the Permian Basin, one of the world's largest oil and gas fields. Our team ingested, processed, and integrated data from a diverse set of scientific partners and state and federal sources to create a compelling visual story emphasizing the scale of the methane problem. The EDF's initial requirements included:

- A secure storage for raw data;
- A system for data cleaning and aggregation of data in multiple formats;
- A system that allowed for ongoing data uploads and kept operators informed of emission events;
- The ability to display aggregated data on a public-facing website that included maps and charts;
- The ability to query data for responsible operators;
- Easy data downloading; and
- The ability of the platform to scale as new data and measurement technologies are added.

Given EDF's requirements and Stone's experience developing custom web applications, our team decided that ArcGIS Online applications, including web maps, Dashboards, StoryMaps, Survey123, and Hub would best meet project needs. Our team's first task was to obtain well and operator data from New Mexico and Texas—a key dataset for determining operators responsible for the methane emissions data collected. We developed a Python script to download well data from these publicly available datasets, which standardized operator names and merged the data to create a single dataset of active wells. We further used Python to connect the well and ongoing measurement data, establishing which operators were responsible for methane emissions, and uploaded data to ArcGIS Online. Later, the project Python scripts were developed to identify the most likely operators of infrastructure closest to methane plume measurements.



Stone developed the Operator Performance dashboard as part of a larger data platform highlighting the scale of methane emissions in the Permian Basin.

This project also features a public-facing website built using Esri's Hub tool, which allows the team to use a custom domain name and embed a classic tabbed StoryMap. We primarily relied on Operations Dashboard to organize content, provide filtering functionality, and create maps of methane emission rates measured across the Permian Basin. The dashboard includes charts highlighting the total methane emissions by operator and the number of events. Users can filter results by operator and type of emission source. In the Operator Performance Dashboard, oil and gas company technicians and regulators can filter the map of detected methane leaks by company name and/or view dynamic charts of how the selected company ranks amongst its peers regarding methane emission rates. Stone has automated the identification of responsible operators with Python scripts, allowing for quick updates to the platform as new data becomes available. Technical users can access links to download data from pop-ups and the Download Dataset Tab.

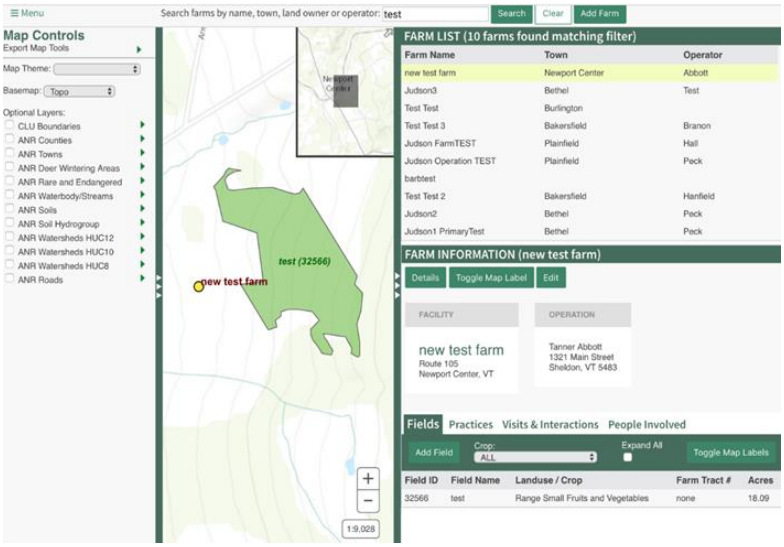
The EDF entered this project to alert operators of emissions as quickly as possible and encourage their response. Stone developed an automated process that emails operators with CSV files of identified emission sources. Operators can directly respond to these alerts through the public platform with links to Survey123 forms to respond to ownership corrections or actions taken. Responses are highlighted in a separate Dashboard contained in a StoryMap tab and in the map—highlighting which Operators had taken steps in response to emission events.

This data platform was launched in April 2020 and continues to be updated with new data collected by EDF and partners. Stone and the EDF jointly presented the PermianMAP platform at the 2022 Esri User Conference.

The completed application is available here: PermianMAP (Methane Analysis Project) | Home

1.3.4. The Vermont Partners Geospatial Database and Water Quality Mapping Application

Stone developed the Vermont Partners Database—a secure, shared, web-based mapping, database, and reporting platform for communicating, coordinating, and tracking farm conservation efforts in Vermont. The application was designed in partnership with the Vermont Agriculture Water Quality Partnership and VAAFM to improve long-range planning across and within agencies to maximize resources and improve agronomic impacts on water quality. The Partners Database provides up-to-date farm field data that helps field staff plan, coordinate, and track farm best management practice (BMP) implementation statewide.



The Vermont Partner Database application can be used to view and edit both spatial and non-spatial information within the relational database.

This single information exchange, repository, and reporting system for farm assessments, plans, and practices will greatly aid efforts to improve the efficiency and effectiveness of Vermont's agricultural water quality BMP implementation over time. The application helps to reduce redundancy and improves communication among

farm conservation planners. Authorized users can drill down to a farm field of interest, determine what activities have already been planned or implemented and what organization provided the assistance.

Using ArcGIS Server and PostGres, Stone developed a robust relational database to manage both spatial and non-spatial information associated with agricultural best management practice implementation. The database allows users to view and edit farm information, including farm fields, practices, visits & interactions, and farm contacts. Because the application contains sensitive farm data and direct communication with farmers, access to the application is available only with a secure username and password. Vermont conservation districts are provided access, and farm data is restricted based on the user's county. The relational database also allows for flexible reporting capabilities to list details of practices or a summary based on county or watershed.

In 2019, Stone worked with VAAFM's Water Quality Division to develop and integrate a new farm water quality multi-user online mapping application and spatial data management system within the Vermont Partner Database. Development of the solution has included developing separate user roles for VAAFM's water quality inspection team such that users of the system cannot access any of the Vermont Partner practice data. Similarly, the Vermont Partner's practice data users do not have access to inspection data or activities conducted by the water quality team. The solution has helped simplify the VAAFM's current workflow for mapping on-farm inspection information by providing multiple users the ability to access the application; quickly create farm inspections, add structures, fields, buffers, and other farm assets associated with the inspection; and create detailed maps of all farm data. The application also includes a custom labeling tool, allowing users to create detailed labels for inspection reports. Integrating the water quality inspection data with the Agency's farm practice data has provided the VAAFM with a more holistic picture of all activities on a farm.

In 2021 and 2022, Stone worked with VAAFM to expand the Water Quality module to include the ability to track water quality investigation requests, investigations, and enforcement actions. Using the updated module, stakeholders can use the application to track all information related to an initial complaint on a farm through the enforcement process, including creating customized and formatted PDF reports. This new functionality has significantly streamlined VAAFM's workflow and reporting process.

The Stone team continues to work with VAAFM to identify new methods for integrating the application into the Agency's workflow. We are currently working on a system to share data between Farm-PREP and the Vermont Partners system. These improvements and modifications streamline communication and coordinate an information exchange repository and reporting system to track and share all relevant farm, field, and practice data across teams.

The partner organizations involved in the direction and use of the application include VAAFM, VTDEC, NRCS, Farm Service Agency, the United States Fish and Wildlife Service (USFWS); the Vermont Association of Conservation Districts, the University of Vermont Extension Service, and the Lake Champlain Basin Program (LCBP).

The application is built using several COTS tools, including ArcGIS Server 10.3x's Javascript API, PostgreSQL, Angular JS, and CSS. In 2017, the Vermont Agency of Agriculture, Food & Markets was awarded the prestigious Special Achievement in GIS Award at the Esri 2017 International User Conference in San Diego, California.

1.3.5. Development of a Soil Health Calculator Tool to Quantify Impacts of Agricultural Management Practices on Soil Health in the Lake Champlain Basin

Stone is currently working with the Lake Champlain Basin Program to develop a soil health calculator tool to provide quantitative and field-specific information about the impact of agricultural management on key soil health indicators. The tool outputs will be based on the USDA's APEX model. The Soil Health Calculator will incentivize best management practices adoption by providing a better understanding of the relative impact of those practices and evaluating management options tailored to specific farm/field conditions.

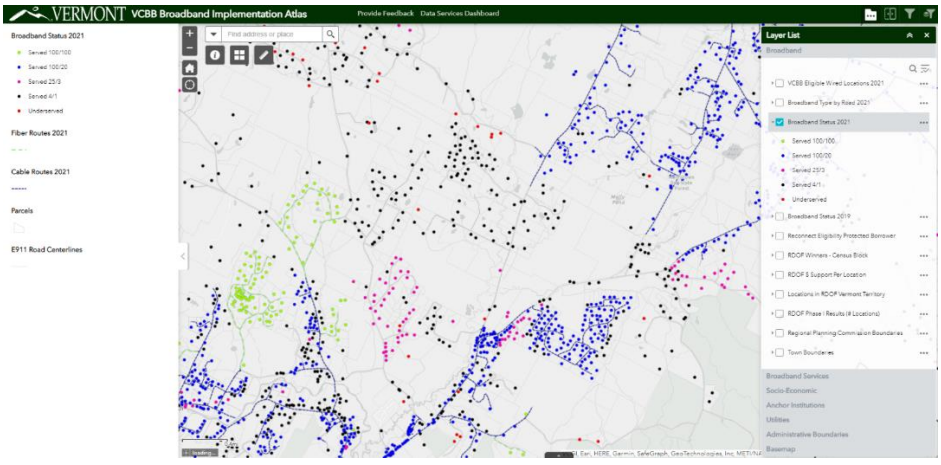
Stone is designing the tool for a broad range of stakeholders, including VAAFM, farmers, crop consultants, and researchers. The proposed Soil Health Calculator module could be an additional component of a State of Vermont system (e.g., VAAFM programs) for quantifying the benefits of environmental stewardship on agricultural lands and supporting state programs. Using APEX to simulate key soil health indicators is a consistent and scalable approach that could advance environmental stewardship goals and support an ecosystem services framework in the agricultural sector of Vermont. In future projects, this tool could be further developed and/or integrated with other models (e.g., DayCent, economics models) to create a system modeling tool and provide information on additional indicators and a larger suite of ecosystem services.

The Soil Health Calculator Tool will be easily accessible as either an independent component of Farm-PREP, or as part of an assessment that includes nutrient loss, erosion, and runoff results (current outputs of Farm-PREP). This expands the capabilities of Farm-PREP to provide information to a range of stakeholders on the integrated impacts of agricultural management on multiple ecosystem metrics.

1.3.6. The Vermont Community Broadband Implementation Atlas

Broadband has become a vital service in the United States but is essential for those living in rural states such as Vermont. The federal government prioritized expanding broadband capacity in the United States by providing the funding necessary to build broadband to underserved areas of Vermont. Because of the traditional individuality of the towns, counties, and regions in the state, the towns are organized into Communications Union Districts (CUDs) responsible for building broadband in each area while balancing the needs and interests of the member towns. Governor Phil Scott installed the VCBB in 2021 to distribute state and federal funding to the CUDs and oversee broadband expansion across the state. The VCBB required a GIS approach to track the dollar allocations related to network buildout.

Stone's history of building and using GIS and roots in Vermont made our team a natural fit for the task. Stone designed, implemented, and configured ArcGIS Online, ArcGIS Hub, ArcGIS Dashboards, and ArcGIS StoryMaps for the VCBB to capture and track data from the CUDs' implementation work. The CUDs used the same ArcGIS tools to plan their networks



The VCBB Broadband Implementation Atlas is an interactive map showing a wide variety of GIS data layers that give context to broadband, including utilities, municipalities, and transportation.

and perform outreach to their towns. As is common in Vermont, some CUDs developed their planning solutions and data management systems. Stone collaborated effectively with the CUDs and other private firms to manage the spatial data in different formats. We developed data standards and shared them with the CUDs and collaborators to ensure data could be moved from its source to the data platform. Effective communication is critical in implementing a statewide system, and Stone has played an essential role in maintaining strong communication and providing training to CUDs.

This work is ongoing as broadband implementation continues in Vermont. The VCBB requires data submittals to arrive in a specific schema to consistently track the network's progress funded by grants. Stone has further developed specifications to define the data needed to track the progress of network buildout.

1.3.7. The New York Geographic Information Gateway

Since 2005, Stone has collaborated with the New York Department of State, Office of Planning, Development & Community Infrastructure (OPDCI), formerly known as the Office of Planning and Development , to establish an effective system for distributing program data and communicating planning initiatives to a diverse range of stakeholders. Over the years, the New York Geographic Information Gateway has evolved from a simple data inventory to a fully integrated web-based mapping system with a data catalog, mapping tools, stories, and other features. The Gateway hosts over seven hundred datasets for planning activities and as a communication tool for the public.

In 2022, Stone began a two-year project to migrate the Gateway to ArcGIS Hub, which is more secure, easier to maintain, and frequently updated to meet diverse needs. The Hub site was launched in April 2023, and the team continues to add functionality. The ArcGIS Hub platform includes all existing functionality of the current Gateway, and new tools and technology allow New Yorkers to explore data relevant to their community's growth and development, recreational opportunities, immersive learning experiences, resources connecting state and national planning efforts, and unique and approachable mapping tools.

Data was hosted and managed on Amazon Web Services infrastructure. Stone migrated over 700 datasets and associated metadata to ArcGIS Online using Python and ArcGIS Notebooks. Stone introduced Web AppBuilder and ArcGIS Experience Builder as replacements for the old website's outdated tools. Since Esri's out-of-the-box tools could not perform all the functions of the old Gateway, Stone customized ArcGIS Experience Builder widgets.

In its current and future form, the Gateway serves as a "one-stop, state-of-the-art website to find data, information, tools, and expert knowledge relevant to New York's existing uses and resources." The Gateway website allows users to view datasets related to OPDCI's programs, including the Ocean & Great Lakes Program, among five others. The full site includes functionality to browse, search, download, and view datasets. Users can explore data through the web map viewer, add datasets to their own web maps, or review metadata. There is also extensive information on the various programs at the OPDCI presented as ArcGIS Story Maps.

The Gateway development process began in 2013, with a visioning session to more fully understand the purpose of the application. The visioning session involved program managers, data developers, and professionals within the OPDCI and incorporated exercises to capture the full breadth of potential scope. Following the visioning session, we worked with the OPDCI and various stakeholders to collect "user stories" to understand specific functionality that may be needed to realize the vision.

Story mapping is an integral part of the Gateway website so that the OPDCI can convey how data can inform decision-making and planning processes (https://new-york-opd-geographic-information-gateway-

nysdos.hub.arcgis.com/apps/8174c66ee307450fa392756a9918c46d/explore). One example is a story about how geospatial data can be used to understand the risks communities may face during extreme weather events and how they can implement resilience planning in their area. This story has been updated from its original release. It includes interactive maps, infographics, images, and videos to illustrate issues such as sea-level rise, flood impacts, and susceptible natural shoreline features. The story also highlights solutions and how the OPDCI works with communities to improve resilience to extreme events.

The Gateway site has been developed with the client in mind. The site's various elements, such as stories, metadata, and data records, can be added and configured by administrative users at OPDCI. Additionally, partnerships are in place so that data from outside agencies can be accessed through the Gateway and vice versa. Partners include the New York State ITS GIS Program Office (GPO) and the National Oceanic and Atmospheric Administration (NOAA). The New York Geographic Information Gateway received the GIS Spatial Application Award from the New York GIS Association in 2023, the URISA Exemplary Systems in Government Distinguished System 2017 award, 2017 NY GIS Association GIS Application Award, and the 2016 Esri Special Achievement in GIS award,. In addition, the Gateway's DOS Coastal Risk Areas map was selected for publication within Esri's Map Book (Volume 33).

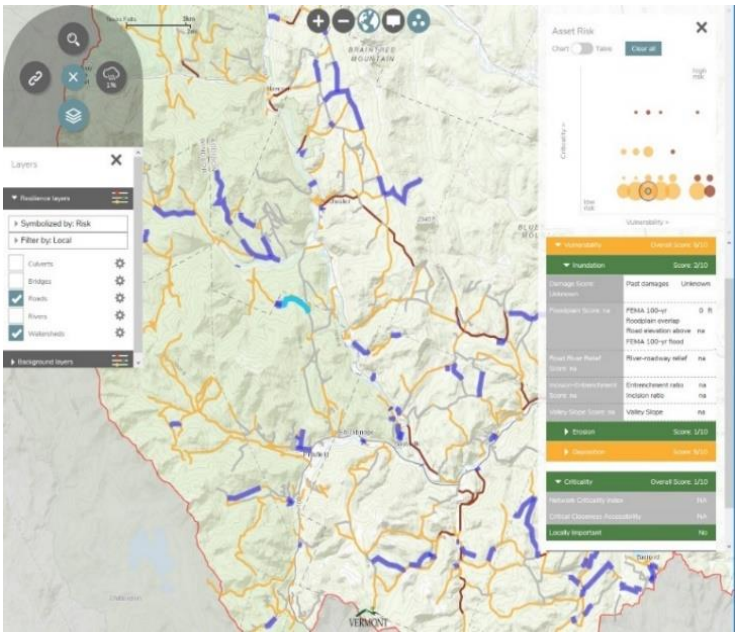
The New York Geographic Information Gateway serves as a public communication tool, offering access to over 700 datasets and information about OPD's programs, including climate change & resilience planning activities.

1.3.8. The Vermont Transportation Resilience Planning Tool: A Web Tool for Assessing Infrastructure Risk

Stone worked with VTrans, a multidisciplinary team of consultants, and a variety of local, regional, and state agency partners to develop the Vermont TRPT, a web-based dashboard designed to help integrate climate risk and transportation resiliency into VTrans' planning process and create a more resilient transportation network in Vermont. The TRPT, advanced through the Methods and Tools for Transportation Resilience Planning Project, is a publicly available tool (roadfloodresilience.vermont.gov) that combines river science, hydraulics, and transportation planning methods to help VTrans and project partners understand the vulnerability of their transportation systems and prioritize mitigation strategies to minimize the impacts of future damage in high-risk locations.

We used agile or iterative development to ensure the application would meet the expectations of the stakeholders and users. The platform has sustainability and longevity in mind, with data processing automation built in to allow VTrans and other state agencies to update and include new data within the tool. The application identifies bridges, culverts, and road embankments within a watershed vulnerable to damage from floods, estimates risk based on the vulnerability and criticality of roadway segments, and identifies potential mitigation measures based on the factors driving the vulnerability and criticality. The TRPT, which is applied at the watershed level, was developed and tested in three pilot watersheds.

The TPRT uses Esri's ArcGIS Enterprise to publish spatial datasets from the indexed database and charts to display the results of vulnerability, criticality/transportation modeling, risk, and mitigation strategies assessments in these watersheds. It allows users to review these data for three flood sizes (10-year, 50-year, and 100-year; or 10%, 2%, and 1% chance annual recurrence interval) and three processes (inundation, erosion, and deposition). Key features include a map service for viewing spatial datasets, graphical data for summary analyses, and a tabular display of mitigation alternatives for at-risk transportation assets. The app is available for anyone connected to the internet and is compatible with multiple browsers and devices. It provides a centralized repository and display for all users without requiring any specialized desktop software or internet browser plug-ins.



Within the TRPT tool, users can visualize and analyze asset risks under various scenarios using filters and queries, as well as graphs and charts.

As an extension of the project, our team developed data processing and validation tools using Python to allow regional planning commissions and VTrans to easily calculate new vulnerability, criticality and risk scores and upload data for new watersheds into the application database. These updates are immediately reflected in the front-end application. This extension also included additional background data layers and direct links to the to VTrans Route logs. Stone also provided training to teach regional planning commissions and VTrans about application functionality, data scoring, and upload tools.

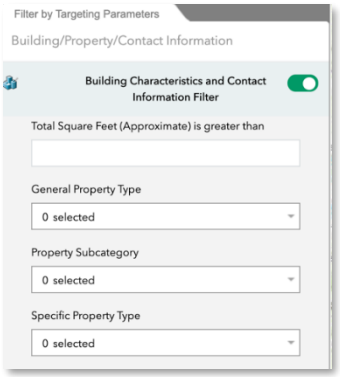
In 2018, the project and app received the Engineering Excellence Grand Award from the American Council of Engineering Companies of Vermont and the GIS & Data Science Project of the Year from the Vermont Center for Geographic Information.

1.3.9. Westchester County Customer Targeting Tool for Real time Energy Management Vendors

Stone—in conjunction with the New York State Energy Research and Development Authority (NYSERDA)—developed the Real Time Energy Management (RTEM) Customer Targeting Tool to identify businesses and residents impacted by a recent natural gas moratorium in portions of Westchester County, New York with the highest potential for gas savings.

RTEM system is a cutting-edge technology that continuously monitors real-time data of a building's energy use and transforms it into actionable information using sensors, meters, and other equipment. The data can pinpoint a building's operational inefficiencies to help identify conservation measures and justify capital improvements.

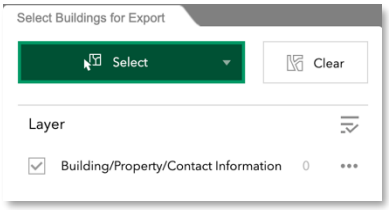
The RTEM Customer Targeting Tool provides an innovative way to identify potential candidates for RTEM system adoption by allowing vendors to locate buildings of interest using customized property information, physical building characteristics, business, and contact information. The tool also allows vendors to update the "contact status," giving all vendors information about which potential customers have been contacted and whether they have subsequently adopted an RTEM system. Every element of this targeting tool has been designed with the vendor in mind, to reduce acquisition costs and expand RTEM system implementation to promote energy efficiency and provide immediate relief for customers affected by the gas moratorium throughout Westchester County, New York.



RTEM Customer Targeting Tool Components & Processes

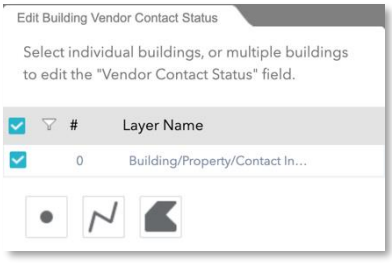
Filter Search

The filter tool drives the search functionality of the application, allowing the user to input their desired targeting parameters to include only the buildings that meet their specific criteria. Filter parameters include total square footage, property type (general, subcategory, and specific), available contact information (parcel owner name and address or building occupant name/phone/email), and vendor contact status.



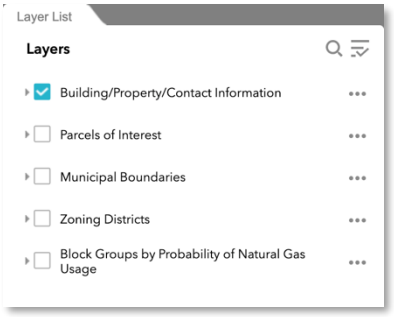
Export Data

The ability to export lists of buildings, including relevant contact information, is an important aspect of the tool. Once the user has identified a desired building or set of buildings, all information associated with those building(s) can be exported to a CSV file for vendors to use as a call and\or contact list and to further pursue the implementation of an RTEM system.



Update Vendor/Building Contact Status

To track which buildings have been contacted by other vendors, as well as tracking the status of these contacts, the tool includes functionality for the user to update the Vendor Contact Status for the buildings in which they initiate contact. This prevents multiple contacts for a single building and optimizes the chances for a successful sale for the vendors by only searching for buildings not contacted.



Toggle On/Off Map Layers

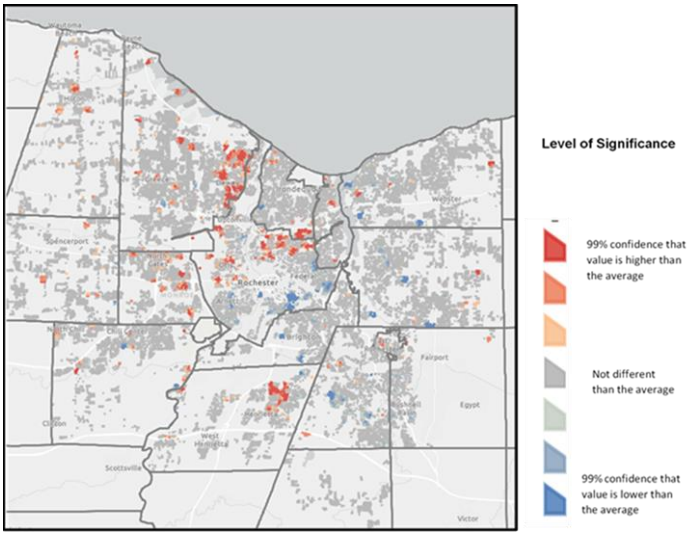
The map includes additional layers of spatial data to further inform the user on various aspects of the portions of the map they are viewing. These include parcel boundaries and data, municipal boundaries, zoning districts, and block group boundaries with estimated natural gas connectivity data.

1.3.10. Monroe County Asset Data Matching Pilot Study

Stone worked with NYSERDA in 2018 to complete an Asset Data Matching Pilot Project in Monroe County to analyze building asset data, utility usage data, and NYSERDA program data for single-family residential and small commercial buildings. The study's objective was to analyze publicly available data along with two years of utility usage data and provide information and data to the market to help lower the costs associated with adopting energy efficiency measures.

Building asset and utility data were merged to create an analysis dataset for the study. The building asset data and demographic data came from multiple sources, including utility data for Monroe County provided by Rochester Gas and Electric Corporation (RG&E) and datasets from NYSERDA's energy efficiency programs.

Stone mapped the average annual residential energy consumption and energy use intensity to better understand the distribution of energy use in Monroe County. Stone took two approaches to mapping the data. The first approach was to map actual annual averages of energy consumption and energy use intensity, and the second was to conduct a hot spot analysis.



Comparison of observed and predicted hot spots of average annual fuel consumption (MMBtu) in Monroe County, NY.

The Stone team evaluated several methods for determining the best predictor variables for energy consumption and energy use intensity. The approach identified the variables that accounted for the most variation in the data and then evaluated approaches for developing a model to predict energy consumption and energy use intensity from building asset and occupant data. Models were also developed for electric consumption and gas consumption. Regression models were developed to predict energy consumption and energy use intensity based on the building asset and occupant data. While the regression models underestimate the highest energy consumers and those with the highest use intensity (least efficient), the regression models and publicly available building asset data can be used to estimate a home's energy use and energy use intensity.

The study found the largest homes, owned by the highest income earners, have the highest total energy consumption (gas and electric). While these homes are newer and include energy-efficient building practices

leading to lower energy per square foot usage, the high consumption is driven by recreational energy use from pools, hot tubs, and gas fireplaces. The study's higher-level findings are useful for contractors looking to target homes based on easily available data such as home size and age and provide energy solution providers with more in-depth findings on energy usage. A key outcome of the study was the development of an aggregated and anonymized dataset for publication on Leveraging ArcGIS Online to Inventory Supply Side Organizations in New York State's Clean Energy Economy.

Stone worked with a consultant firm specializing in clean energy strategies to create a detailed geo-coded inventory of clean energy organizations in New York and deliver to NYSERDA a comprehensive clean energy cluster analysis for of organizations that create "value-added tradable products" for various clean energy sectors.

Stone staff developed a secure web database to streamline inventory development and sharing throughout data development, data review, and the QA/QC process. The database was pre-populated with business information provided by NYSERDA and additional, detailed information was obtained by research consultants through online research and phone calls to characterize the state's size, composition, and core competencies of clean energy organizations. This included an inventory of organizations within key sectors and segments, classification of their role within the industry, and identification of core competencies within the segments. Stone used address information within the inventory to geocode the location of each organization. The georeferenced locations were then enriched with New York State Regional Economic Development Council region codes, the metropolitan areas (Core Based Statistical Area) codes, and Census Bureau County codes, as well as other key datasets and detailed information.

Using ArcGIS Online and the geodatabase inventory, Stone developed algorithms using spatial statistics to identify clusters of clean energy activity by sector. The hot spot analysis is used to find patterns in the data that cannot be picked up by the human eye and that indicate significant geographic groupings. Comparing clusters across categories revealed compelling differences across sectors.

Stone developed a secure ArcGIS Online web mapping application for internal NYSERDA to map, explore, and visualize the results of the clean energy inventory. The inventory data was summarized by geographic regions, including counties, regional economic development council zones, and census core-based statistical areas to help visualize hot spots of renewable energy industry activity across the state. The application includes tools to query, identify, and visualize industry activity over time.

Stone's analysis of the inventory data yielded several key findings, including:

- Identification of major clean-energy clusters across the state;
- Identification of the strongest clean energy sectors, their distribution, and the ways in which they compare to other sectors;
- Identification of supply-side service providers across the state;
- Determination of the most common linkages between sectors, and their relevance to potential growth opportunities;
- Determination of links and strengths at different value-chain positions, as well as linkages between value-chain strengths and sectors; and
- Creation of a technical competency taxonomy, and initial identification of technical competencies within organizations across the state.

1.4. List of Current and Past State Projects

Table 2 provides a list of all our current and past projects with the State of Vermont over the past five years (October 1, 2018 – October 1, 2023).

Table 2. Projects with the State of Vermont (2018-2023)

Project Description	Client
PCB Indoor Air Testing - Camel's Hump Middle School	VTDEC Waste Management & Prevention Division
PCB Indoor Air Testing - Browns River Middle School	VTDEC Waste Management & Prevention Division
PCB Indoor Air Testing - Molly Stark School	VTDEC Waste Management & Prevention Division
PCB Indoor Air Testing - Bennington Elementary	VTDEC Waste Management & Prevention Division
VTrans/BGS Central Garage	Vermont Agency of Transportation
Bogner Manufacturing	VTDEC Waste Management & Prevention Division
FFI DEC Development	Vermont Department of Environmental Conservation
Lyndonville Army National Guard	Vermont Military Department
PCB Indoor Air Testing - St. Johnsbury School	VTDEC Waste Management & Prevention Division
115 Eastern Avenue	VTDEC Waste Management & Prevention Division
West Burke Preliminary Design Phase Svcs	Dufresne Group
Jewett Brook Treatment Train Wetlands Delineation	Vermont Department of Buildings and General Services
Rochester Tire	VTDEC Waste Management & Prevention Division
PCB Indoor Air Testing - Union Street School	VTDEC Waste Management & Prevention Division
PCB Indoor Air Testing - U32 UHS	VTDEC Waste Management & Prevention Division
PCB Indoor Air Testing - Rumney Memorial School	VTDEC Waste Management & Prevention Division
PCB Indoor Air Testing - Rochester School	VTDEC Waste Management & Prevention Division
PCB Indoor Air Testing - Riverside Middle School	VTDEC Waste Management & Prevention Division
PCB Indoor Air Testing - Fisher School	VTDEC Waste Management & Prevention Division
VAAFM Farm-Prep Application Modifications	Vermont Agency of Digital Services
105-107 Eastern Ave.	VTDEC Waste Management & Prevention Division
VAOT P Control Planning & Implementation	Vermont Agency of Transportation
PCB Indoor Air Testing - Vergennes Elementary	VTDEC Waste Management & Prevention Division
PCB Indoor Air Testing - Shaftsbury Elementary	VTDEC Waste Management & Prevention Division
PCB Indoor Air Testing - Pownal Elementary	VTDEC Waste Management & Prevention Division
PCB Indoor Air Testing - Elm Hill School	VTDEC Waste Management & Prevention Division
Hosting for the Vermont Agency of Agriculture, Food & Markets	Vermont Agency of Digital Services and Vermont Agency of Agriculture, Food & Markets
Hosting for the Vermont Department of Public Service	Vermont Department of Public Service
VTrans Route 5 WRJ	Vermont Agency of Transportation
AGR Partner Database Support	Vermont Agency of Digital Services
TLR Complex	VTDEC Waste Management & Prevention Division
PCB Indoor Air Testing - Monument Elementary	VTDEC Waste Management & Prevention Division
Central VT Montessori	VTDEC Waste Management & Prevention Division
Wolcott Community Forest	VTDEC Waste Management & Prevention Division

Project Description	Client
117 Strongs Avenue Rutland VT	Vermont Department of Buildings and General Services
South Royalton Elementary	VTDEC Waste Management & Prevention Division
Bethel Elementary School	VTDEC Waste Management & Prevention Division
VARNG Bennington Readiness Center	Vermont Military Department
Otter Creek WMA and Stone Phase I ESA	Vermont Fish and Wildlife Department
Hazen Union School Stormwater Permitting	Greenprint Partners
30 Henry Street	VTDEC Waste Management & Prevention Division
Felchville Well Location	VTDEC Waste Management & Prevention Division
Woodside UST Assessment	Vermont Department of Buildings and General Services
Wastewater Sampling at SIUs	VTDEC Water Investment Division
Agricultural Stewardship Tool Modifications	Vermont Agency of Digital Services
453 Pine Street 2022	VTDEC Waste Management & Prevention Division
159 Eastern Ave, St. Johnsbury Phase I ESA	VTDEC Waste Management & Prevention Division
Marcotte School Stormwater Permitting	Greenprint Partners
VTrans Gen. Phosphorus Control Plan	Vermont Agency of Transportation
West Burke Town Garage Site Investigation	Dufresne Group
VCBB GIS Services	Vermont Agency of Digital Services
254 Benmont Ave	VTDEC Waste Management & Prevention Division
Butterworks Farm Wastewater	Vermont Agency of Agriculture, Food & Markets
IDDE Project for Basins 1 & 12	Vermont Department of Environmental Conservation
Waterbury Dam Dewatering Well Monitoring	VTDEC Watershed Management Division
Roger's Fabricare Indoor Air Assessment	VTDEC Waste Management & Prevention Division
Center for Cartoon Studies	VTDEC Waste Management & Prevention Division
Penta/Wyman Flint Redevelopment	VTDEC Waste Management & Prevention Division
Eastern Ave Vapor Intrusion Source Investigation	VTDEC Waste Management & Prevention Division
VTDEC Soils Cleanup Approaches	VTDEC Waste Management & Prevention Division
VAAFM Farm-PREP Pay-For-Phosphorus Program	Vermont Agency of Digital Services
Ide ET &HK Corporation Phase I/Phase II Workplan	VTDEC Waste Management & Prevention Division
SFY2021 Deer Brook Gully	Friends of Northern Lake Champlain
Deering Farm	Vermont Fish and Wildlife Department and VTDEC Waste Management & Prevention Division
VAAFM Water Quality Enforcement Expansion to VT AMPITS	Vermont Agency of Digital Services
UVRLC	VTDEC Waste Management & Prevention Division
Muriel B. Harris Trust	VTDEC Waste Management & Prevention Division
Killington Resort Area PFAS Investigation	VTDEC Waste Management & Prevention Division
Edgar May Health and Recreation Center	VTDEC Waste Management & Prevention Division
Springfield Redemption Center Phase I ESA	VTDEC Waste Management & Prevention Division
Tetra Tech Rusty-Patched Bumble Bee Inventory	Tetra Tech

Project Description	Client
Flow Monitoring Feasibility Assessment for Lake Carmi Tributaries	Vermont Agency of Agriculture, Food & Markets
314 Hill Street Phase I ESA	VTDEC Waste Management & Prevention Division
VTAAFM-RSET-APEX-Comparison	Vermont Agency of Agriculture, Food & Markets
Butterworks Farm	Vermont Agency of Agriculture, Food & Markets
VAAFM Maple Process Water Study 2020	Vermont Agency of Agriculture, Food & Markets
J.P. Noonan Site Investigation	VTDEC Waste Management & Prevention Division
Operation & Maintenance Standards of Clean Water Projects in VT	Hoyle, Tanner & Associates, Inc.
Statewide IDDE Contract 4	VTDEC Watershed Management Division
NRPC Assignment 1: Young Landfill	VTDEC Waste Management & Prevention Division
Wolcott Village Wastewater Solutions Initiative - Consulting Engineer	VTDEC Watershed Management Division
DEC River and Floodplain Mapping Phase 2 Web App	SLR International Corporation
Bert White Auto Salvage	VTDEC Waste Management & Prevention Division
Analysis of Ready Health Care Data Products	Vermont Program for Quality in Health Care
L.W. Greenwood & Son	VTDEC Waste Management & Prevention Division
453 Pine Street	VTDEC Waste Management & Prevention Division
Jeffersonville Granary	VTDEC Waste Management & Prevention Division
Russels Auto	VTDEC Waste Management & Prevention Division
PFAS Contamination - Rutland Southern Vermont Regional Airport	Vermont Agency of Transportation
VAAFM Farm Quality Multi-user Online Mapping Application	Vermont Agency of Agriculture, Food & Markets
DEC Village WW Solutions Project Coordinator - Wolcott Village	Lamoille County Planning Commission
VAAFM Collection of Maple Industry Process Water Data	Vermont Agency of Agriculture, Food & Markets
IRule Feedback	VTDEC Waste Management & Prevention Division
Former Browns Salvage, Moretown	VTDEC Waste Management & Prevention Division
Long Falls Paper	VTDEC Waste Management & Prevention Division
Lynwood Crown Farm	Vermont Fish & Wildlife and VTDEC Waste Management & Prevention Division
Woodbury Country Store	VTDEC Waste Management & Prevention Division
GMCB Health Resource Allocation Plan	Green Mountain Care Board
Basin 12 IDDE	VTDEC Watershed Management Division
VTrans Resilience	SLR International Corporation
Lyndon Town Highway Garage Phase I ESA	VTDEC Waste Management & Prevention Division
Nutrient Management Planning Assessment	Vermont Agency of Agriculture, Food & Markets
74 Eastern Ave. St. Johnsbury	VTDEC Waste Management & Prevention Division
CEDF Program Evaluation	The Cadmus Group LLC

Project Description	Client
Basin 11 IDDE	VTDEC Watershed Management Division
VTrans PCIP Support	Vermont Agency of Transportation
PCP Implementation Plan	Vermont Agency of Transportation
VTrans Missisquoi Phosphorus Control Plan, Phase 1	Vermont Agency of Transportation
VTrans Generalized Phosphorus Control Plan	Vermont Agency of Transportation
Phase I ESA, 961, 977, & 963 US Route 2, Middlesex, Vermont	VTDEC Waste Management & Prevention Division
Parks and Woolson	VTDEC Waste Management & Prevention Division
GCD Blanchard Block Site Closure	VTDEC Waste Management & Prevention Division
Ottauquechee Black CT River IDDE	VTDEC Watershed Management Division
RCPCC Targeted Brownfield Assessment	VTDEC Waste Management & Prevention Division
260 River Street Supplemental Site Investigation	VTDEC Waste Management & Prevention Division
AAFM - Longway Farm	Vermont Agency of Agriculture, Food & Markets
RCPP Deer Flats Farm	VTDEC Watershed Management Division
VTrans Missisquoi Watershed P-Plan	Vermont Agency of Transportation
19 Bennett Drive Corrective Actions, Brattleboro VT	VTDEC Waste Management & Prevention Division
Montpelier IDDE	VTDEC Watershed Management Division
LUHS Water Supply Study	Lamoille North Supervisory Union
VTDEC Streamflow Monitoring for MS4 General Permits	VTDEC Watershed Management Division
VTrans Post-Irene Geomorphology Assistance	Vermont Agency of Transportation
Ernie's Garage Phase I ESA	VTDEC Waste Management & Prevention Division
SWCRPC/SRDC J&L CAP	VTDEC Waste Management & Prevention Division
AG-BMP	Vermont Agency of Agriculture, Food & Markets
IDDE Otter Creek/Poultney/Lamoille	VTDEC Watershed Management Division
Blueprint Web GIS and Database Services	Vermont Blueprint for Health

2. Approach to the Scope of Work

Stone is excited to establish a framework for a tool to measure and assess the State's GHG emissions and progress towards emission reduction goals, identify metrics to evaluate the effectiveness of initiatives, programs, and strategies outlined in Vermont's CAP, and track progress towards improving the resilience of Vermont communities, infrastructure, and economy. To do so, Stone will work with project stakeholders to determine which metrics and indicators to track, lead the development of a data governance plan, and determine data availability and sources and how to fill any data gaps for chosen metrics to build a foundation for CAP Measuring and Tracking Progress Tool (the Tool) creation in subsequent phase two.

Stone will couple our technical expertise and intimacy with Vermont datasets, our experience in developing climate change mitigation and resiliency tracking solutions, modeling best practices, and data governance abilities with a collaborative approach to leverage existing tools, subject matter experts, and lived experiences that can truly tell the story of the progress of the CAP and support long-range policy and educational goals. Through robust dialogue, project management, and facilitation of a Data Governance Team, Stone hopes to develop logic models that reflect systems thinking and visualize how social, economic, and policy factors and actions impact GHG emissions, resiliency, and equity throughout Vermont communities. This will lead to a holistic inventory of metrics, including a robust understanding of both data availability and gaps, which will be the framework for the Tool development in phase two. The Tool will support climate-related decision-making, identify additional opportunities for mitigation and adaptation, and inform the collective progress towards achieving the CAP's Just Transition Principles.

2.1. Task 0. Project Management

Successful project management will ensure the project objectives are met and deliverables are completed on time and within budget. Following contract execution, Stone will immediately begin work on a draft workplan to be presented and discussed during a project kickoff meeting (this will be provided before the meeting for review). The workplan will identify specific next steps for accomplishing the work described in this proposal. In addition to discussing any modifications to the draft workplan, we will use the kickoff meeting to establish clear process-management expectations, including the project timeline, opportunities, and mechanisms for gathering feedback, and communication channels. We will deliver a final work plan shortly following the kickoff meeting and incorporate any suggested modifications from the Project Team. We will strive to complete this task within two weeks of contracting; however, delivering the final workplan is dependent on the timely response of the external project team in both scheduling a kickoff meeting and providing feedback. Throughout the contract period, Stone will facilitate 30-minute check-in meetings twice per month with the CAO Director; these meetings will ensure an open dialogue to discuss deliverables, tasks underway, decision points, and opportunities for further input/presentations. Stone's Project Manager will be responsible for invoicing following the completion of deliverables at each project phase.

We recognize the importance of collaboration in this project as multiple stakeholders are invested in the outcome and considerable progress advancing Vermont's CAP. We will collaboratively lay out a clear framework for points of contact for various aspects of this work, the role of mentioned sub-committees (e.g., the RFP mentions both an Agency Data Team and Data Governance Team who we will coordinate with on

Task 1), and who will review intermediate project deliverables. The Stone Project Manager will work with the Climate Action Office Director to ensure subsequent tasks incorporate the appropriate level of correspondence and involvement by parties who either have been involved in aspects of this work or who would be able to significantly contribute to the success of this project as we develop a framework for the Tool that measures and assesses progress of the CAP.

For internal project management, Stone uses a suite of tools that ensure team members are aware of tasks assigned to them and can report progress and alert other team members of key decision points and dependencies. We use Ajera as project management and accounting software to provide resource planning, time recording, and invoicing. Project managers access real-time budget reports that include budgeted and actual and accrued costs, enabling them to monitor cost performance daily. Project-specific scope, schedule, and budget management protocols are in place to ensure we track project progress. We routinely use on-line collaboration tools such as Microsoft Teams, SharePoint, Asana, and Slack in our projects to maintain effective communication with team members working under remote working as well as in our central Vermont office.

Task 0 Deliverables:

- ✓ Project Kickoff Meeting delivered within two weeks after signing of contract.
- ✓ Project initiation workplan delivered within two weeks after signing of the contract.
- ✓ Ongoing project management tasks, including bi-weekly meetings and presentations delivered within six weeks after Kickoff Meeting (associated with Task 1 deliverables).
- ✓ Ongoing project management tasks, including bi-weekly meetings and presentations delivered within 18 weeks after Kickoff Meeting (associated with Task 2 deliverables).
- ✓ Ongoing project management tasks, including bi-weekly meetings and presentations delivered within 30 weeks after Kickoff Meeting (associated with Task 3 deliverables).
- ✓ Ongoing project management tasks, including bi-weekly meetings and presentations delivered within 34 weeks after Kickoff Meeting (associated with Task 4 deliverables).

2.2. Task 1. Data Governance

The objectives of Task 1 are to establish a Data Governance Team, draft a Data Governance Plan, and thoroughly review three to five existing tools relevant to Vermont, as well as existing data and ongoing programs that support the CAP. Establishing the Data Governance Team and Plan will inform the Tool's design and ensure that data is secure, accurate, available, and usable. We will coordinate with the CAO Director and Data Governance Team (as well as other subcommittees, e.g., the Science and Data subcommittee, as needed) to define and refine key content of the Data Governance Plan.

Stone recommends establishing a Data Governance Team within the first month of the project, as opposed to the two months suggested in the RFP. Early and clear communication with a Data Governance Team for the Tool is critical in this phase. We anticipate work can begin immediately on the Data Governance Plan to define key components such as specific data goals, structure, and requirements to inform the development of a data management system and identify key roles and responsibilities in the data management workflow. In this task, we will also research appropriate technical platforms for the Tool and associated processes for adding, updating, and editing data that will inform the Tool's architecture and design elements. We are aware of existing data governance plans for Vermont programs (e.g., https://education.vermont.gov/data-and-reporting/data-governance); these could form the basis for the format/structure of the Data Governance Plan for the Tool if consistency across programs is a priority.

Stone will conduct a review of existing tools and data frameworks, including three to five existing tools and/or data frameworks relevant to Vermont, as recommended by the Agency. Stone will first work with the CAO

Director and the Agency to clarify and prioritize aspects of the tools to characterize and review. It is unclear whether the tools already identified by the Agency are internal or external to Vermont, which will impact elements to include in the review. Any tools internal to Vermont should consist of an in-depth inventory of the data sources used and how these data are maintained outside or within the application to lay the foundation for subsequent tasks. Reviewing and evaluating tools external to Vermont will focus more on application features such as analysis and reporting functionality, data visualization features, usability, and data access. Stone will develop a matrix to easily compare the evaluated tools' features. Stone proposes an additional evaluation component that entails ranking the importance of functionality and whether the tool supports or does not support that functionality. Stone conducted a similar analysis for the Green Mountain Care Board, which helped them narrow down desired functionality and identify a platform that would best support their needs.

In addition to reviewing the tools, the Project Team will review the GHG Inventory, Water Quality data, and ongoing University of Vermont Extension analysis of Agricultural Policies in the CAP. The GHG Inventory Report (Hill et al., 2021) provides an overview of GHG inventory methodology, a comparison to existing guidelines for GHG inventory analysis and methodology from other key states, and identification of potential issues and recommendations for improving these methods. Galford et al. (2022) have completed a Vermont Carbon Budget and made the associated datasets available). Efforts by other consultants have also included multiple Pathways Analysis Reports that explore options and scenarios for reaching Global Warming Solutions Act (GWSA) targets. A thorough review of these documents, priority actions from the CAP, datasets, and others will inform the governance plan and design of the Tool's framework.

We propose developing a draft Data Governance Plan as part of Task 1. We envision that subsequent tasks may result in modifications that should be incorporated into a Final Governance Plan delivered at the end of Task 4. Stone has successfully prepared numerous Quality Assurance Project Plans (QAPPs), which, like a data governance plan, ensure that data used in the solution meets project requirements. We have also developed several custom data management systems and web application tools, where data structure and management were developed based on an initial phase of collecting information from stakeholders and users. For example, our work with the State of New York required compiling disparate datasets into one application to provide a fully integrated web-based mapping system with a data catalog, mapping capabilities and tools, and stories to deliver and communicate data across the state. Our work with Vermont Community Broadband involved establishing data specifications and guidelines to ensure we correctly migrated data from the Communication Union Districts to the VCBB mapping atlas and Data Dashboards. Our combined local experience and expertise in designing custom data solutions suggest we are well-suited for laying the successful groundwork for a tool that can be used long-term to measure the impacts of programs described in the CAP and progress towards Vermont's climate change and resiliency goals.

Task 1 Deliverables:

- ✓ Review of 3 to 5 existing relevant tools and/or data frameworks, as well as GHG Inventory, Water Quality, and UVM Extension data products
- ✓ Two to three Data Team scoping meetings with Agency staff.
- ✓ Two to three meetings with the Data Governance Team on developing the Data Governance Plan.
- ✓ Data Governance Plan draft.

2.3. Task 2. Logic Model Development and Metric Creation

Stone understands the foundational objectives of the Tool are to support the State and its partners in making climate policy decisions, as well as inform the public about progress towards achieving GWSA commitments and to make data readily available. The Project Team will meet with the Data Governance Team to confirm

goals and more specific objectives of this task. These specific objectives will help guide the development of the logic models, starting with the use cases, and identify and prioritize key categories for inclusion within the Tool. This is particularly important when considering climate adaptation and mitigation efforts as the topic spans sectors, local, regional, and state governments and departments, natural systems, socio-economic factors, and built environment features. Given the complexity of the topic, Stone sees the Tool and the logic model approach as an iterative process. We can ensure that the Tool is feasible and implementable by focusing on priority objectives and starting with a simple approach supported by existing resources, capacity, and systems. Over time, we can prioritize additional metrics, indicators, and outcomes as resources become available.

Stone will work with subject matter experts and stakeholders to develop logic models and rely on best practice research to identify inputs, outputs, intermediate outcomes, and long-term impacts associated with the CAP's priority goals and activities. The models will also demonstrate areas that CAP implementers have control over and how these actions lead to change. Utilizing the theory of change, we will not only depict how inputs lead to outcomes but also the interconnectedness of climate actions and outcomes. This will help illustrate the impacts various policies, programs, and strategies will have on GHG emission reductions, sequestration, community resilience, and equity. Decision-makers can use an interconnected model to better understand and communicate the impacts of investments and identify opportunities to change or modify approaches to progress towards Plan goals.

The logic models will identify key metrics and indicators that will form the basis of the Tool. Stone anticipates developing an inventory with diverse metrics and indicators based on the logic model that spans data types (e.g., qualitative/quantitative; geospatial/non-spatial). The data inventory can serve as a foundation not only for the first iteration of the Tool but can be a guide to anticipate resources, systematic needs, and programmatic approaches that can be integrated into the Tool over time.

The review of existing frameworks and tools, together with the development of logic models and metric identification, will also inform the development of baseline metrics that will be used to evaluate progress and/or change moving forward. This will be done in collaboration with the CAO Director, Data Governance Team, Science and Data Subcommittee, and other stakeholders. We understand the GHG Inventory and other programs have already developed baseline assumptions; these will be reviewed as part of Task 1 and incorporated into the framework for a new tool in Tasks 2 and 3.

Task 2 Deliverables:

- ✓ Summary of Framework use cases and categories.
- ✓ Development of logic models, including identified metrics, indicators, and data needs.
- ✓ Up to four meetings with Agency Staff, which may also include the Data Governance Team or S&D Subcommittee as necessary.

2.4. Task 3. Data Mapping

Once the data needs have been identified in Task 2, Stone, with input from the Data Governance Team and key stakeholders, will conduct a thorough data inventory, including a review of potential data sources starting with data reviewed in Task 1. This will also include data needed to analyze key metrics and indicators. This task will define data availability and the process for getting each dataset from its original source to a data structure and format that the Tool's application framework can use.

The Project Team will develop an initial data inventory based on the data needs and characterize all datasets with the following attributes: data source, data owner, data schema, accessibility, data type, key data attributes, data format, and data update frequency. This will include further review of existing and previously generated data, such as from the Department of Public Service (DPS) and Vermont's Energy Action Network (EAN).

We will provide this initial review to the Data Governance Team for review and input. The interviews with internal and external data managers, recommended by the Data Governance Team, will help fill in data gaps and determine possible additional data sources; we will also leverage these interviews to review information included in the inventory and understand current data management processes. We will explore more detailed information, such as data completeness and options for integrating data into the Tool, during the interviews.

The data mapping process will identify datasets readily available through Vermont's Open GeoData Portal, other data portals, or web or map services. The tool can easily consume this type of data. The data mapping process, however, will still need to identify critical and necessary attributes in each dataset to include, make usable, and/or visualize. It will also need to ensure data elements included in multiple datasets are only incorporated from the master or source dataset.

Many datasets and data elements will not be available through an easily accessible format and may only be maintained in a format such as Microsoft Excel or Access. Determining whether to include these data may depend on the priority of the dataset for inclusion in metrics and the Tool. Using the Data Governance Plan as the foundation for recommendations, the Project Team will work with these dataset owners to define the data mapping process to get data from its source to the Tool.

The data mapping process will help inform the short-term incorporation of specific metrics and indicators into the Tool. Based on identified gaps, Stone will recommend proxy metrics and identify longer-term recommendations for integral metrics that may require additional investment, resources, and time that are currently not supported but integral to illustrating the impacts of the CAP and its components.

Stone will develop a final data map and provide it as a deliverable to the Data Governance Team and the CAO Director to illustrate how datasets integrate with the logic models and ultimately flow into the Tool.

Task 3 Deliverables:

- ✓ Up to three working sessions with Agency staff, which may also include the Data Governance Team.
- ✓ Up to seven data manager interviews.
- ✓ Data map indicating logic model, metrics, indicators, data source, and data characteristics for Vermont's GWSA-related efforts.

2.5. Task 4. Infrastructure Recommendation

The final task in this project will synthesize information gathered and generated in Tasks 1-3 in a report that documents infrastructure recommendations that provide a clear path to develop the Tool for measuring and assessing the Vermont CAP. This will include suggestions for the Tool's infrastructure and architecture that support sustainable data management. As outlined above in Tasks 2 and 3, we anticipate this Tool to be iterative and continue growing and developing as additional resources become available. The final report will document opportunities for metric development to fill identified data gaps, including resources/systems needed to fill programmatic tracking needs, recommendations for additional community and stakeholder engagement, and innovative opportunities for non-traditional metrics such as storytelling and data crowdsourcing. Depending on the use scenarios prioritized, the report may also be appropriate for additional policy and programmatic opportunities recommendations, including best practices to support communicating the Tool to the public, programmatic capacity considerations, or other technical assistance that can help the ongoing metrics development and tracking. The Project Team will present these findings and associated recommendations to build a robust framework for long-term measurement of progress towards meeting GWSA targets. This will ultimately inform a starting place for Phase 2, where the technical build out of the Tool will begin.

In making recommendations, the Project Team will focus on the five desired outcomes of this project that ultimately support an innovative tool for long-term assessment of the Vermont CAP. We understand this tool will need to support climate policy decision-making by making the best available information accessible to those who require it. Through the Data Governance Plan and preliminary recommendations on tool design, we will ensure data is accessible and users can access public data in a format suitable for independent analysis. It will also ensure sustainable data management. The Project Team will also prioritize forward-thinking metric identification and tool design so that multiple stakeholders can readily analyze, summarize, and visualize current data and new metrics can be readily incorporated as new data becomes available. We will recommend next steps for the development of the Tool, such as determining critical design elements (e.g., how would a particular indicator identified in this work be visualized in the Tool).

We anticipate identifying key partnerships will be a key component of Phase 2 of developing the Tool to measure and assess the Vermont CAP. While we feel the Stone Project Team is qualified and capable to layout the framework for the tool as we have specified in this proposal, we acknowledge the past and ongoing efforts by Vermont agencies, consultants, research groups, and other stakeholder groups and anticipate a formal collaboration may best support build-out of the Tool in a Phase 2 effort. In this task, we will seek to identify and establish future partnerships and collaborations for a successful Phase 2 proposal to ensure project success, sustainability, and Tool adoption.

Task 4 Deliverables:

- ✓ Draft and final report to Agency staff.
- ✓ Final data governance plan.
- ✓ Presentations to Data Governance Team and to S&D Subcommittee.

3. Schedule

The Stone Project Team has thoughtfully considered the time to execute each task and produce the deliverables specified in the RFP. We propose to complete the entire scope of work in the timeline outlined in the RFP; however, we have modified timeframes and due dates for interim deliverables. Based on our experience working with diverse stakeholder groups, the level of collaboration needed to meet the objectives and produce the outcomes specified reflects an aggressive but realistic project schedule. We can be flexible to some extent with timelines and deliverables. We will discuss this schedule during the project kickoff meeting to coordinate minor changes that meet the needs of all parties involved. Please note that our proposed timeline requires timely feedback and engagement from the client and stakeholders, particularly on key decision points. Through the communication channels established during Task 0 and the project kickoff meeting, we will clearly communicate task dependencies and specific feedback needed to advance and maintain the proposed schedule. Table 3 below presents our proposed schedule for completing the scope of work.

Table 3. Proposed Schedule

Phase	Performance Measure	Deliverable	Timeframe
1	Task 0	Project Kickoff Meeting	Within two weeks after contracting
		Project initiation workplan delivered within two weeks after signing of contract	To be presented during kickoff meeting (within two weeks of signing contract)
		Ongoing project management tasks, including bi-weekly meetings delivered within two weeks after signing of contract	Ongoing project management during first 2 weeks of contract
		Final workplan (incorporating feedback from external project team)	Delivered one week after kickoff meeting/feedback received (within 3 weeks of contracting)
	Task 1	Documented review of 3-5 relevant tools and/or data frameworks, as well as GHG Inventory, Water Quality, and UVM Extension data products (in the form of a spreadsheet, database, and/or memo-style report)	Within 4 weeks of project kickoff meeting (6 weeks after contracting)
		Up to three Data Team scoping meetings with Agency staff and up to three meetings with the Data Governance Team on developing the Data Governance Plan	Within 6 weeks after kickoff meeting (8 weeks after contracting)
		Draft Data Governance Plan	Within 6 weeks after kickoff meeting (8 weeks after contracting)
2	Task 0	Ongoing project management tasks, including bi-weekly meetings and presentations	Over the 12-week period encompassing efforts associated with

Phase	Performance Measure	Deliverable	Timeframe
			Task 2 (within 18 weeks after kickoff meeting/ 20 after contracting)
	Task 2	Up to 4 meetings with Agency Staff, which may also include the S&D Subcommittee and/or Data Governance Team	Within 18 weeks after kickoff meeting (20 weeks after contracting)
		Summary of use cases and categories. Development of logic models, including identified metrics, indicators, and data needs.	Within 18 weeks after kickoff meeting (20 weeks after contracting)
3	**Task 0**	Ongoing project management tasks, including bi-weekly meetings and presentations	Over the 12-week period encompassing efforts associated with Task 3 (within 30 weeks after kickoff meeting/ 32 after contracting)
	Task 3	Up to three working sessions with Agency staff, which may also include the Data Governance Team and/or S&D Subcommittee Up to 7 data manager interviews	Within 30 weeks after kickoff meeting (32 weeks after contracting)
		Data map indicating logic model, metric, data source, and data characteristics	Within 30 weeks after kickoff meeting (32 weeks after contracting)
4	**Task 0**	Ongoing project management tasks, including bi-weekly meetings and presentations	Over the 4-week period encompassing efforts associated with Task 4 (within 34 weeks after kickoff meeting/ 36 after contracting)
	Task 4	Draft Phase 4 Report to ANR staff, presentation to Data Governance Team and to S&D Subcommittee	Within 34 weeks after kickoff meeting (36 weeks after contracting)
		Final Phase 4 Report to ANR staff, presentation to Data Governance Team and to S&D Subcommittee	Within 34 weeks after kickoff meeting (36 weeks after contracting)

4. References

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Project Reference: Vermont Functioning Floodplains Initiative

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Project Reference: Soil Health Calculator Tool to Quantify Impacts of Agricultural Management Practices on Soil Health in the Lake Champlain Basin

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Project Reference: Vermont Transportation Resilience Planning Tool

5. Reporting Requirements

We have attached a sample of reporting documentation applicable to the detailed requirements of this RFP on the following pages.

Lake Champlain Basin Phosphorus Control Implementation Plan for the Vermont Agency of Transportation, 2021-2024

STONE ENVIRONMENTAL

PROJECT NO.

18-008-C

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Acknowledgements and Disclaimer

This project was undertaken by Stone Environmental, Inc. and Hoyle, Tanner and Associates Inc. for the Vermont Agency of Transportation, with funding provided by the Agency.

The intent of this plan is to present the data collected, evaluations, analysis, designs, and cost estimates for the Vermont Agency of Transportation (VTrans). This document provides information for stormwater retrofit projects proposed to meet VTrans phosphorus management obligations in watersheds subject to a Phosphorus Control Plan (PCP) under *National Pollutant Discharge Elimination System (NPDES) General Permit 3-9007 for Stormwater Discharges form the State Transportation Separate Storm Sewer System (TS4)* (effective November 29, 2017). This plan is the regulatory document for VTrans to meet PCP obligations under General Permit 3-9007. If VTrans land is included in PCPs submitted by any Municipal Separate Storm Sewer System (MS4) permittee or by non-MS4 municipalities, the information contained in this plan should supersede that information. Retrofit projects identified in this plan have not been fully assessed for feasibility or completely designed. The work completed has been done at a planning level and will be subject to change based on site conditions, permitting, budgetary constraints, and other unforeseen issues.

The coronavirus epidemic continues to radically affect both how VTrans and Vermont Agency of Natural Resources (ANR) staff members interface, and how work is completed to advance the first four-year implementation plan. VTrans and the consultant team gratefully acknowledge the flexibility provided by the ANR Stormwater Program staff during the preparation and submittal of this Implementation Plan.

Executive Summary

The Vermont Agency of Transportation (VTrans), through its Maintenance Bureau and Pollution Prevention and Compliance Section, is committed to maintaining compliance with a swiftly evolving variety of state and federal environmental regulations. The Vermont Agency of Natural Resources (ANR) and VTrans have worked together for several years to develop and implement permitting programs, plans, policies, and designs to comply with the Lake Champlain Phosphorus Total Maximum Daily Load (TMDL), finalized by the United States Environmental Protection Agency (EPA) on June 17, 2016.

As required by Section 9.2 of *General Permit 3-9007 for Stormwater Discharges from the State Transportation Separate Storm Sewer System (TS4)*, this Phosphorus Control Implementation Plan (PCIP) documents how VTrans will work over the next four years to advance the first phase (25%, representing a phosphorus (P) load reduction of 401 kg/yr) of its work to reduce P loading from roads, rights-of-way, and facilities subject to the PCP by over 20% (or a total of 1,606 kg/yr) within the next 20 years (by June 17, 2036). It first summarizes P reduction credit documented for areas of hydrologically connected roadway drainage systems improved to current standards since 2010, existing areas of localized erosion repaired in the last seven years, and existing and planned structural stormwater treatment practices (STPs) as documented since the April 1, 2020 Generalized Plan submittal. This document then identifies a menu of necessary best management practices (BMPs) VTrans may employ to achieve its first phase target reductions, provides an implementation schedule and financial plan, and updates the implementation strategy set forth in the Generalized Plan.

Achievement of this target P load reduction may require the management of up to 950 acres of impervious surface and 1,980 acres of pervious cover on VTrans roads and facilities with structural controls, including areas of road drainage deficiencies brought up to standards, areas of localized erosion corrected with structural improvement, and structural stormwater treatment practices (STPs), as well as continued management of approximately 2,500 acres annually with non-structural controls (street sweeping and drop inlet cleaning). VTrans anticipates continued pursuit of emerging and innovative strategies, including enhanced correction of gullying or large areas of culvert outlet erosion and implementation of floodplain restoration and other natural resource restoration projects, over the term of this Implementation Plan.

With submittal of the Generalized Plan, VTrans documented that from 2010-2019, 84 acres of impervious cover, and 281 acres of pervious cover, were managed with structural stormwater practices, while approximately 2,500 acres of paved roads area was managed with non-structural practices on an annual basis since 2015. These practices were cumulatively responsible for a total P load reduction of 32.6 kg/yr.

Since that submittal, from 2010-2019 VTrans has documented a total of 181 acres of impervious cover, and 347 acres of pervious cover, managed with structural stormwater practices. These practices, added to continued management with non-structural controls, are cumulatively responsible for a total P load reduction of 93.3 kg/yr, representing 23% of the 401.5 kg/yr reduction target for this PCIP.

During development of this PCIP, a substantial field screening and verification effort was completed to verify Generalized Plan methodology, and to identify retrofits and improvement projects in support of PICP implementation. Field screening, focused in the Missisquoi Bay Lake segment along areas of roadway

identified as having road drainage deficiencies and/or structural stormwater treatment practice (STP) opportunities, sometimes documented improvements in road drainage asset conditions, resulting in some road segments achieving partial or full P reduction credit. Following documentation of the 2020 field season's improvements, accounting for major localized erosion improvements anticipated in 2020, and assuming continuation of current maintenance operations, 306 impervious acres are managed with structural controls and 171.5 kg/yr in P load reduction progress is documented as of 2020. This cumulative P load reduction represents 43% of the 401.5 kg/yr reduction target of this PCIP.

Following documentation of historic improvements and operations, an additional P load reduction of 230 kg/yr is required for achievement of the P reduction target specified for the term of this PCIP. VTrans will achieve this P load reduction through improved tracking and accounting of maintenance activities and capital projects already being developed and completed, as well as strategic implementation of combinations of some of the following:

- Continued regular maintenance activity, as documented for 2015-2019, to manage 19 acres of paved roads area and 12 kg/yr of P load reduction annually or 76 acres impervious cover and 50.4 kg/yr P reduction from 2021-2024
- Continued documentation of past structural improvements to road drainage deficiencies and areas of localized erosion, particularly those resulting from capital project construction from 2018-present
- Continued application of non-structural controls
- Structural correction of road drainage deficiencies identified during 2020 field screening: manage up to 159 additional acres of paved road area, resulting in up to 110.3 kg/yr P reduction across the LCB.
- Structural correction of road drainage deficiencies on uninspected and highly hydrologically connected road segments not meeting standards in the Missisquoi Bay Lake segment: manage up to 87 additional acres of paved road area, resulting in up to 71.4 kg/yr P reduction within the Missisquoi Bay Lake segment.
- Structural correction of major areas of localized erosion identified during 2020 field screening and advanced to concept design: The 11 priority concepts developed for this PCIP, if advanced, would not manage impervious surface and would result in a P load reduction of 44.8 kg/yr
- Continued construction of structural STPs, whether through FRP or VTrans capital project implementation, anticipated to manage up to 94 impervious acres and resulting in 34.4 kg/yr P reduction from 2021-2024
- Strategically pursue emerging and innovative strategies for achieving target P load reductions, particularly the potential for crediting floodplain restoration and other natural resource restoration work in the VTrans PCP Area or where VTrans has contributing drainage, as opportunities arise and through application of results from Vermont's Functioning Floodplains Initiative, with project outputs anticipated in 2021.

VTrans has identified a robust menu of improvements that are more than sufficient to meet the P reduction target of this PCIP. The strategies VTrans may pursue in PCIP implementation are not limited to those outlined above, but these represent 311 kg/yr of potential P load reduction – well above the additional P load reduction of 230 kg/yr needed to achieve the TS4's 25% cumulative P load reduction target by October 2024. As PCIP implementation proceeds, VTrans will work to prioritize, plan for, and implement controls including but not limited to those listed above.

Phosphorus Control Implementation Plan, Lake Champlain Basin, Vermont Agency of Transportation, 2020-2024

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1. Introduction

The Vermont Agency of Transportation (VTrans), through its Maintenance Bureau and Pollution Prevention and Compliance Section, is committed to maintaining compliance with a swiftly evolving variety of state and federal environmental regulations. The Vermont Agency of Natural Resources (ANR) and VTrans have been working together for several years to develop and implement permitting programs, plans, policies, and designs to comply with the Lake Champlain Phosphorus Total Maximum Daily Load (TMDL), finalized by the United States Environmental Protection Agency (EPA) on June 17, 2016.

Section 9.2 of the TS4 General Permit requires VTrans to develop and implement a PCP, in phases, that will identify and document a suite of best management practices (BMPs) capable of achieving required reductions in the amount of P in stormwater discharges in each of 11 Lake segments, as required by the TMDL. This Phosphorus Control Implementation Plan (PCIP) documents how VTrans will work towards achievement of the first phase (25%, representing P load reduction of 401 kg/yr) of its ultimate goal of the reduction of phosphorus (P) loading from roads, rights-of-way, and facilities under the Agency's control by over 20%, or a total of 1,606 kg/yr within the next 20 years (by June 17, 2036). Achievement of this target P load reduction will require the management of approximately 950 acres of impervious surface on VTrans roads and facilities, as well as continued management of approximately 2.500 acres annually with non-structural controls (street sweeping and drop inlet cleaning).

The P-impaired watersheds included in the VTrans PCP encompass the entirety of the LCB in Vermont, except for the Burlington Bay direct drainage. A summary of the VTrans PCP area by land cover type (Road/linear facility or Parcel-based facility) and type of land cover (Developed Impervious, Paved Road, Unpaved Road, and Developed Pervious) is provided in Table 1. The portion of the Vermont P base load (2001-2010) falling within developed lands source areas as summarized in the 2016 P TMDL[1], as compared to the portion of those developed lands owned and controlled by VTrans, is included in Table 2. The portion of VTrans-managed developed lands by Lake segment varies from 0% in the area draining to the Burlington Bay Lake segment, where VTrans has no land subject to this TMDL, to 8.6% in the watershed draining to the St. Albans Bay Lake segment.

[1] https://ofmpub.epa.gov/waters10/attains_impaired_waters.show_tmdl_document?p_tmdl_doc_blobs_id=79000

Table 1. Summary of VTrans PCP Area by Land Cover Classification (acres)

Lake Segment	Linear Facilities and Right-of-Way Areas (acres)				Parcel-Based Facility Areas (acres)				Total
	Developed Impervious	Paved Roads	Unpaved Roads	Developed Pervious	Developed Impervious	Paved Roads	Unpaved Roads	Developed Pervious	
South Lake B	16.83	481.54	0.00	775.63	3.98	1.22	0.00	9.74	1,288.94
South Lake A	1.94	69.11	0.00	61.30					132.35
Port Henry	0.75	15.29	0.00	8.10					24.14
Otter Creek	57.93	1,181.20	0.00	1,445.40	43.96	42.53	0.00	269.14	3,040.16
Main Lake	65.38	1,645.12	12.30	3,029.56	41.68	36.57	0.00	223.05	5,053.66
Shelburne Bay	10.15	163.66	0.00	189.58	0.84	2.62	0.00	11.15	378.01
Burlington Bay	--	--	--	--	--	--	--	--	--
Malletts Bay	56.67	1,013.46	0.00	1,604.31	24.13	0.99	0.00	47.44	2,747.00
Northeast Arm	5.86	159.51	0.00	164.01	1.83	0.00	0.00	2.54	333.76
St. Albans Bay	9.90	187.20	0.00	321.73	5.60	0.00	0.00	1.03	525.45
Missisquoi Bay	38.18	910.14	0.00	1,167.43	28.87	26.78	0.44	115.14	2,286.97
Isle La Motte	2.29	46.93	0.00	37.56					86.78
Total	265.89	5,873.17	12.30	8,804.61	150.89	110.71	0.44	679.22	15,897.23

Table 2. Summary of Total Developed Land and VTrans Developed Land Base P Loads

Lake Segment	Total Developed Lands Base P Load (mt/yr)	VTrans Base P Load (mt/yr)	Percent of Base P Load Within VTrans PCP Area
South Lake B	9.0	0.66	7.3%
South Lake A	2.3	0.09	3.9%
Port Henry	0.7	0.02	2.7%
Otter Creek	20.2	1.64	8.1%
Main Lake	35.1	2.24	6.4%
Shelburne Bay	3.4	0.17	4.9%
Burlington Bay	1.7	0.00	0.0%
Malletts Bay	17.2	1.19	6.9%
Northeast Arm	3.9	0.19	4.8%
St. Albans Bay	2.6	0.23	8.6%
Missisquoi Bay	17.0	1.19	7.0%
Isle LaMotte	0.9	0.06	7.0%
Total	114.0	7.7	6.7%

The developed lands portion of the P base loads, and target P reductions managed under the VTrans PCP, are summarized by Lake segment in Table 3. The cumulative P load reductions anticipated under each of the four VTrans PCIPs are summarized in Table 4.

Table 3. Phosphorus Base Loads and Reduction Targets by Lake Segment

Lake Segment	P Base Load (kg/yr)			% Reduction Needed to Meet Allocation	Target P Load Reduction (kg/yr)		
	Linear Facilities	Parcel Facilities	Total		Linear Facilities	Parcel Facilities	Total
South Lake B	646.16	8.49	654.66	21.10%	136.34	1.79	138.13
South Lake A	89.46		89.46	18.10%	16.19		16.19
Port Henry	18.69		18.69	7.60%	1.42		1.42
Otter Creek	1,472.19	163.72	1,635.91	15.00%	220.83	24.56	245.39
Main Lake	2,115.80	127.02	2,242.82	20.20%	427.39	25.66	453.05
Shelburne Bay	162.62	4.64	167.26	20.20%	32.85	0.94	33.79
Malletts Bay	1,153.92	36.20	1,190.12	20.50%	236.55	7.42	243.98
Northeast Arm	186.27	2.85	189.11	7.20%	13.41	0.21	13.62
St. Albans Bay	217.58	7.12	224.70	21.70%	47.21	1.55	48.76
Missisquoi Bay	1,101.05	85.96	1,187.02	34.20%	376.56	29.40	405.96
Isle La Motte	63.30		63.30	8.90%	5.63		5.63
Total	**7,227.04**	**436.00**	**7,663.04**		**1,514.40**	**91.52**	**1,605.91**

Table 4. Implementation Plan Schedule and Phased P Reductions

4-Year Plan Phase	Plan Due Date	Estimated Plan Completion Date	Cumulative P Reduction Anticipated by Plan End Date (kg/yr)
Phase I	October 1, 2020	September 30, 2024	401.48
Phase II	October 1, 2024	September 30, 2028	802.96
Phase II	October 1, 2028	September 30, 2032	1,204.44
Phase IV	October 1, 2032	September 30, 2036	1,605.91

2. Progress Since Generalized Plan Submittal

Since submittal of the Generalized PCP on April 1, 2020, VTrans has documented additional improvements and advanced a substantial field verification effort to identify problem areas and priority projects. Work completed in preparation of this PCIP is further documented below.

2.1. Completed Structural Stormwater Treatment Practices, Maintenance Activities and Capital Program Projects (2010-2019)

The implementation model submitted in the Generalized Plan, which summarized the analyses and findings available prior to April 2020 and provided a basis for a draft implementation schedule, was updated with results described in Appendix A. The April 1, 2020 submittal documented that from 2010-2019, VTrans had implemented structural stormwater practices managing a total of 84 acres of impervious cover and 281 acres of pervious cover. These included structural stormwater treatment practices (STPs), areas of road drainage deficiencies brought up to standards, and areas of localized erosion corrected with structural improvement. VTrans also managed approximately 2,500 acres of paved roads area with non-structural practices on an annual basis since 2015. These practices were cumulatively responsible for a total P load reduction of 32.6 kg/yr.

Since that submittal, from 2010-2019 VTrans documented an increased total of 181 acres of impervious cover, and 347 acres of pervious cover, managed with structural stormwater practices. These updates included primarily completed and planned/permitted structural STPs (Figure 1 and Appendix A, Section 1) and completed maintenance-scale corrections of roadway drainage deficiencies (Figure 2 and Appendix A, Section 2). The paved roads area managed by non-structural practices was unchanged from the April 1 submittal. These practices are now cumulatively responsible for a total P load reduction of 93.3 kg/yr, as documented in the implementation model (Appendix A, Table 14). This P load reduction represents 23% of the 401.5 kg/yr reduction target for this PCIP.

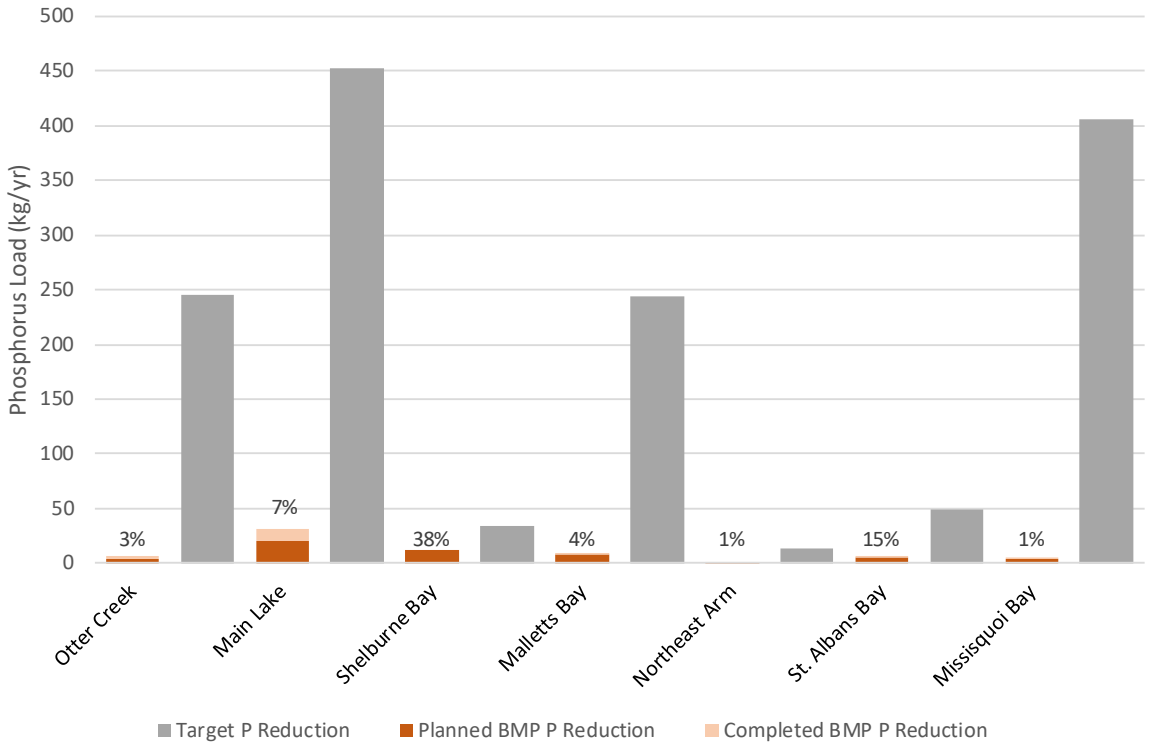

Figure 1. P load reductions creditable to existing and planned structural STPs, as of September 2020

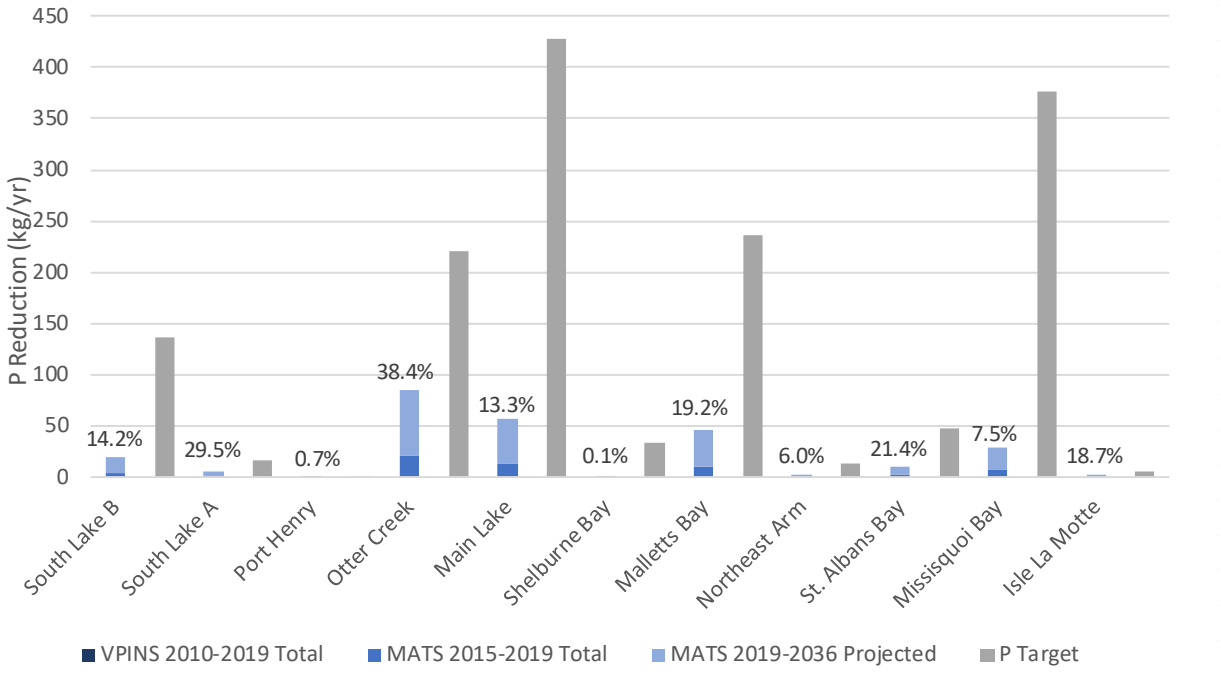

Figure 2. Total P reductions achieved from road drainage improvements documented in VPINS (2010-2019) and MATS (2015-2019) and projected using MATS annual average (2020-2036), compared to target P reductions

2.2. 2020 Field Verification and Identification of High-Priority District Maintenance Projects

During development of this PCIP, a substantial field screening and verification effort was completed to verify Generalized Plan methodology, and to identify retrofits and improvement projects in support of PICP implementation. A full description of the findings of the 2020 field season work is included in Appendix B. Field screening efforts were largely focused in the Missisquoi Bay Lake segment along areas of roadway identified as having road drainage deficiencies (per the small culvert or ditch inventory results) and/or structural STP opportunities (see Sections 2.1 and 2.2 of the Generalized Plan). At road segments where drainage deficiencies were identified, field crews inspected each asset (culverts and/or swales), reviewed corresponding asset inventory data (whether from the Small Culvert Inventory (SCI) or ditch inventory), updated data as necessary, and documented asset condition with photos. STPs along these routes were screened to determine feasibility, adjust GIS-derived polygons based on site constraints observed in the field, and document conditions such as distance from road, overhead powerlines, and environmental and other potential feasibility constraints. Areas of localized erosion were identified, and erosion volumes were documented where feasible.

Over 57 miles of roadway (over 1,280 road segments) were inspected for drainage deficiencies and localized erosion issues, encompassing 359 swales, 810 culverts, and 80 areas of localized erosion. A total of 650 conceptual STP opportunities identified in the Generalized PCP[2] were screened. Key results of the field effort are summarized below.

Field inspections sometimes documented improvements in road drainage asset conditions previously recorded in the SCI and the ditch inventory, resulting in some road segments achieving partial or full P reduction credit (see Section 3.2.1 for discussion of the P reduction crediting methodology for road drainage improvements). Of the 1,283 inspected road segments, 534 (42%) were found to be in an improved condition compared to prior asset inventories (this was largely due to vegetated swales with improved conditions). The road segments with documented improvements to drainage asset conditions constituted 97.4 acres of paved road impervious surface managed (of the 241 acres inspected) and a P base load of 80.9 kg/yr. Road segments brought up to standards following assessment for partial (40%) or full (80%) P reduction credit constituted a 54.9 kg/yr P load reduction (Table 5). This P load reduction, when added to the P load reduction documented in Section 2.1, represents a cumulative P load reduction of 148.2 kg/yr or 36% of the PCIP Phase 1 401.5 kg/yr target.

Table 5. Summary of Road Drainage Deficiency Improvements Documented, 2020 Field Screening

Lake Segment	Total Road Segments Brought Up to Standards	Paved Roads Area Managed (acres)	P Base Load, Area Managed (kg/yr)	Total P Load Reduction (kg/yr)	Target P Load Reduction*	% of Total P Reduction
Main Lake	11	2.5	2.6	1.3	427.4	0.3%
Malletts Bay	83	16.2	11.3	8.1	236.6	3.4%
Missisquoi Bay	374	66.1	56.1	38.0	376.6	10.1%
Northeast Arm	9	1.3	1.1	0.8	13.4	6.1%
Otter Creek	17	2.5	2.4	1.5	220.8	0.7%
St. Albans Bay	40	8.7	7.4	5.3	47.2	11.1%
Grand Total	534	97.4	80.9	54.9		

**Roads portion of P load only, all land covers*

[2] Stone Environmental (2020) "Lake Champlain Basin Generalized Phosphorus Control Plan for the Vermont Agency of Transportation" Submitted to VTrans and ANR April 1, 2020.

Over 80 areas of localized erosion were identified during the 2020 field screening effort, representing over 4,600 cubic yards of erosion. Two of these areas, along I-89 in Colchester, will be stabilized in the fall of 2020 as part of the VTrans-ANR research project *Quantifying Nutrient Pollution Reductions Achieved by Erosion Remediation Projects on Vermont's Roads*. While impervious surface management is not credited through localized erosion stabilization, these projects represent 534 cubic yards of erosion stabilized and a P load reduction of 8.26 kg/yr which, added to the P load reductions documented above, represents a cumulative P load reduction of 156.5 kg/yr or 39% of the 401.5 kg/yr reduction target of this PCIP. Section 3.3 presents information regarding repairs to areas of localized erosion identified during the 2020 field season, and potential P reductions using the volumetric methodology outlined in the Agency of Natural Resources' draft MRGP Tracking and Accounting SOP[3].

Over 650 STP opportunities were inspected during the 2020 field season, of which 478 (73%) were determined to be suitable. Gravel wetlands were the most common STP type identified by inspectors, followed by infiltration trenches and infiltration basins. Though the STP opportunities inspected were pre-screened for potential conflicts using the GIS methodology from the Generalized PCP, a portion of suitable STP opportunities had implementation constraints identified in the field. Between 20%-35% of the STP areas screened had at last one potential constraint. Stormwater treatment practice opportunities with low barriers to implementation are the highest priority for advancing to design stage, to the extent that structural STPs are required to meet target P reductions in any of the Lake segments. Information about the STP screening results, the potential for impervious surface management with structural STPs, concept plans for high-priority structural STPs, and adjustments to the Generalized Plan's GIS screening methodology are presented in Section 3.5.

2.3. Current Operations Projection Implementation Model Updates

Following documentation of the 2020 field season's improvements, the implementation model was further updated to assume continuation of current maintenance operations through June 17, 2036. The current level of implementation was assumed to include 2015-2019 annual average impervious acres managed, and resulting P load reductions anticipated, resulting from structural correction of maintenance-scale road drainage deficiencies and areas of localized erosion (Appendix A). Non-structural controls (street sweeping and drop inlet cleaning) were assumed to remain at the annual average frequencies documented in the Generalized Plan. Following updates to the implementation model to account for drainage deficiency improvements documented during the 2020 field season (above and Appendix B), and including VTrans capital projects anticipated to be complete in 2020, 306 impervious acres are managed and 171.5 kg/yr in P load reduction progress is documented for 2020. Continued implementation of maintenance-scale correction of road drainage deficiencies and areas of localized erosion from 2021-2024 is anticipated to manage an average of 19 impervious acres/year and to achieve a 12 kg/yr P load reduction (Figure 3).

Following documentation of historic and current improvements and operations as summarized above, an additional P load reduction of 171 kg/yr is required for achievement of the P reduction target specified for the term of this PCIP. The suite of necessary stormwater BMPs VTrans will leverage in achievement of this target reduction are provided in Section 3.

[3] https://dec.vermont.gov/sites/dec/files/wsm/stormwater/docs/MS4/FINAL%20DRAFT%20MRGP%20SOP%206-5-20.pdf

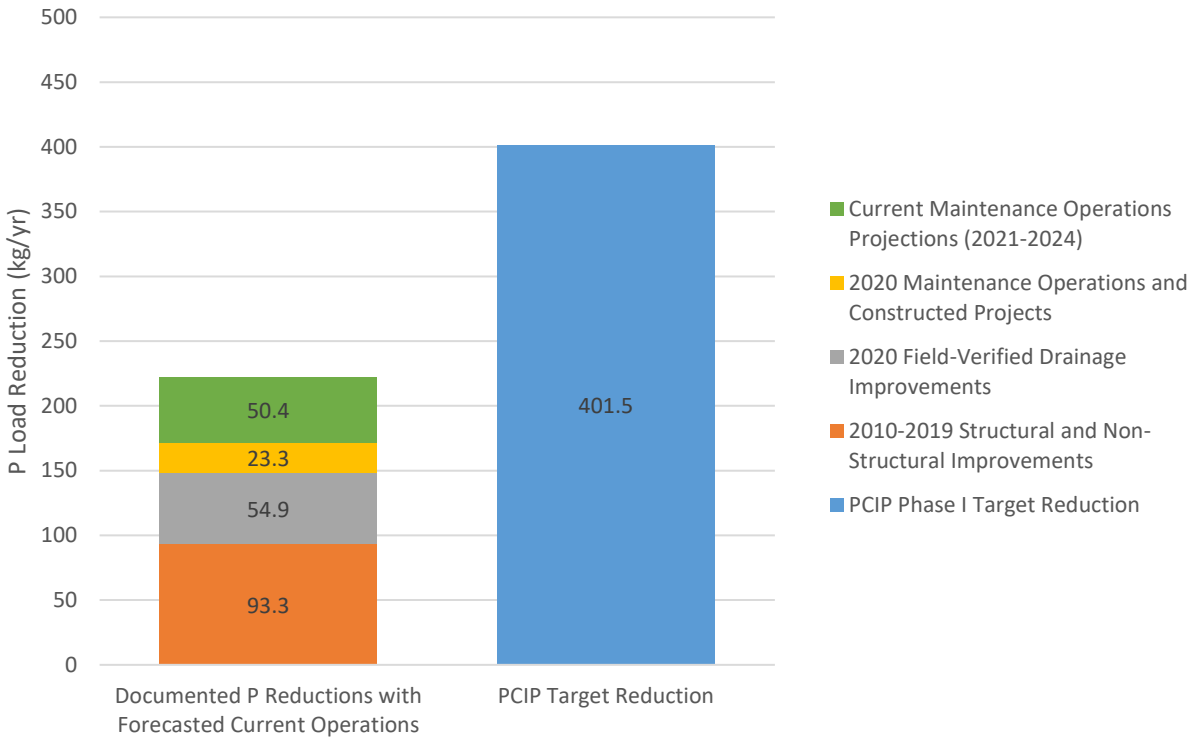

Figure 3. Progress toward target P load reduction following 2020 updates and including only current maintenance improvements projection

3. Suite of Necessary Stormwater BMPs

Implementation plans are anticipated to include combinations of implementation of localized erosion and hydrologically connected road segment drainage repairs, structural STPs (both new treatment practices and retrofits to existing structural STPs), potential enhancements to non-structural control frequencies or extents, and other projects with the highest P cost-benefit.

In developing the Generalized Plan, repairs to road drainage assets and to areas of localized erosion were found to generally be more cost-effective and to have greater co-benefits (for example, regarding flood resilience and the safety of the traveling public) compared to treatment of impervious surfaces with green stormwater infrastructure or other structural stormwater treatment practices. Natural resource restoration projects, and particularly floodplain reconnection or restoration projects, represent a critical opportunity for cost-effective P reduction and maximization of co-benefits, and remain an area of continued development for the term of this implementation plan.

The suite of stormwater best management practices (BMPs) included in this VTrans PCP Implementation Plan includes:

- Tracking and accounting
- Structural correction of road drainage deficiencies
- Structural correction of localized erosion issues
- Non-structural practices
- Structural stormwater treatment practices
- Natural resource restoration projects

Summary information regarding each class of the suite of necessary stormwater BMPs is provided in the sections below.

3.1. Tracking and Accounting

An important step following submittal of this PCIP will be to continue development of a tracking and accounting system, potentially integrating with or building from VTrans' Vermont Asset Management Information System[4] (VAMIS). The 'lessons learned' during PCIP development and suggested enhancements below may be considered as this effort is advanced.

The ditch inventory often indicated more deficient swale conditions than were observed in the 2020 field screening. If future field screening efforts also flag this issue, refinements to the ditch inventory guidance documentation may be warranted. Adding representative photographs or other visual indicators to both the SCI and ditch inventory field manuals may assist in clearer communication with field staff regarding, for instance, the difference between "poor" versus "critical" condition for a vegetated or stone-lined swale.

[4] https://vtrans.vermont.gov/sites/aot/files/documents/Research/2020_Symposium/VAMIS%20Newsletter%2008-2020.pdf

As tracking and accounting refinements are progressed during PCIP implementation, refinements to the ditch inventory should be considered. Often, a single swale asset manages runoff from several road segments over hundreds or even thousands of feet, making it difficult to pinpoint the locations of swale-related drainage deficiencies and to appropriately estimate repair costs or credit improvements. Dividing the swale assets to correspond to linear road segments would allow a more direct relationship of these assets to road segments and enable cleaner tracking and accounting, whether for improved asset management, tracking maintenance activities in MATS, or for enhanced P tracking and accounting.

Refinements to the VTrans guardrail inventory, and expansion of the suite of practices applied to correct VTrans road drainage deficiencies, may be considered during the term of this PCIP. For example, removal of sediment berms accumulating beneath guardrails and on shoulders represents a maintenance practice with distinct water quality benefits and sometimes incorporated into capital projects (Section 3.2.4). Improved location tracking for this and similar shoulder repair maintenance activities may allow VTrans to manage areas of roadway with guardrail (but without curb board) as structural disconnection STPs, resulting in cost-effective P load reduction with a low maintenance burden.

3.2. Structural Correction of Road Drainage Deficiencies

In the Generalized PCP, a method was proposed by VTrans, working in coordination with ANR, to assess roadway and drainage deficiencies, and to subsequently quantify P load reductions for improvements that are considered regular maintenance activities on VTrans paved roads. Examples include ditching, guardrail maintenance, or culvert or outfall repair/replacement, where these activities result in a demonstrable P load reduction or improvement in a road segment's condition. This approach is comparable to ANR's requirement for municipalities to complete Road Erosion Inventories (REI) of hydrologically connected road segments under the Municipal Roads General Permit (MRGP)[5] and as incorporated into the MS4 General Permit[6]. This requirement is not part of the TS4 General Permit.

VTrans continues to work with ANR to define standards and criteria for hydrologically connected road segments within the TS4, where an approach similar to the MRGP standards may be applied. VTrans asset inventories were combined with a GIS inventory of paved road areas, P loading factors, and resulting P base loads to create a desktop inventory of areas located within highly hydrologically connected (HHC) and moderately hydrologically connected (MHC) paved road segments that, based on existing conditions reflected in VTrans asset inventories, may be "brought up to standards" and thus be eligible for P reduction credit throughout the VTrans PCP Area.

The scoring system below (Table 6), developed from key conditions in the VTrans Small Culverts Inventory (SCI) and the TS4 Drainage Inventory (Swale/Ditch), was applied in the Generalized Plan to create a unified condition assessment across various asset inventory data fields. The scoring categorized condition assessments so that segments could be identified as Meeting Standards or Not Meeting Standards based upon a standardized set of scoring criteria.

[5] https://dec.vermont.gov/sites/dec/files/wsm/stormwater/docs/Permitinformation/MunicipalRoads/sw_MRGP_RoadErosionInventory.pdf
[6] https://dec.vermont.gov/watershed/stormwater/permit-information-applications-fees/ms4-permit

Table 6. Scoring System for Determining Whether Roadway Drainage Infrastructure Meets Drainage Standards

Score	Culvert Condition	Culvert Erosion	Culvert Sediment	Culvert Sink Hole	Road Settling	Swale Condition
5	Critical	Severe	Plugged	Severe	Grade	Critical
4	Poor	Moderate	Heavy	Major	--	Poor
3	Fair	Light	Moderate	Moderate	Repair	Fair
2	--	--	Light	Minor	--	Good
1	Good	None	None	None	None	Excellent
0	Unknown/Null	Unknown/Null	Unknown/Null	Unknown/Null	Unknown/Null	Unknown/Null

An overall road segment score was assigned using the worst ranking of any of the above conditions found within that road segment. The resulting data and scoring outputs were uploaded to a web map[7] where users may filter and export the results for road segments with drainage deficiencies by Lake segment, maintenance district, VTrans route name, inspection status, and other criteria. These outputs may be imported into an Excel spreadsheet and further tabulated for prioritization and implementation.

The evaluation and methodology described in the Generalized PCP (Section 2.2.1 of that Plan) was piloted during the 2020 summer field inventory work (Section 2.2 and Appendix B), and was determined to be sound following field screening and confirmation. Adjustments to the evaluation methodology are not warranted at this time. Adjustments to the P crediting methodology were completed during development of this PCIP, following consultation with ANR (Appendix A). A road segment was considered to fully meet standards post-construction and receive 80% P reduction credit if all assets (culverts and ditches) within the road segment met standards following completion of an activity or repair. If any remaining assets associated with the road segment still did not meet standards following repair activity, a partial 40% credit was applied.

3.2.1. VTrans Roadway Drainage Standards Crediting Adjustments, Standard Details, and Cost Basis for Maintenance-Scale Improvements

A draft set of VTrans roadway drainage standards is now in development, which tailors the MRGP Road Drainage Standards to the conditions of the VTrans road network and to VTrans roadway and design standards as applicable. A final draft of this document is anticipated to be available approximately six months after submittal of this PCIP.

The VTrans road drainage standards document, when available, will be further supported by standard details developed during PCIP preparation. The best management practices (BMPs) selected for standard detail development and cost estimation were the most common fixes identified during the 2020 field season (Appendix B) and those classified from MATS records during development of the Generalized Plan (Section 2.2). The standard detail sheets illustrate common roadway drainage asset improvements and localized erosion fixes (Appendix C) that may be applied to bring deficient drainage assets and road segments up to the anticipated standards, and to repair areas of localized erosion. Supporting implementation unit cost information for the repairs most frequently identified during inspections were also prepared (Appendix C). The drainage deficiency details establish a common basis for improvement of a culvert's condition to benefit water quality (Table 7), while localized erosion details include stabilization techniques for areas of erosion commonly found in swales, road shoulders, and channels beyond culvert outlets (Table 8). Unit cost ranges

[7] https://stone-env.maps.arcgis.com/apps/webappviewer/index.html?id=f762ae432a69427eb2d05d65b26b26d8

were estimated for each detail based on asset size, material quantities, and related construction activities such as excavation.

Table 7. Summary of Drainage Deficiency Improvement Standard Details and Unit Costs

No.	Detail	Cost Range (based on culvert size/depth)
1	Dry Laid Field Stone Header	$3,640 - $25,970 (EA)
2	Culvert Replacement	$520 - $2,420/lf
3	Plunge Pool	$3,740 - $6,590 (EA)
4	Outlet Protection (No Defined Channel)	$220 - $1,260 (EA)
5	Upsize Culvert	$520 - $2,420/lf
6	Partial Culvert Replacement	$370 - 560/lf
7	Rock Step and Riffle	$1,560 (EA)

Table 8. Summary of Localized Erosion Standard Details and Unit Costs

No.	Detail	Cost Range (based on regrading and slope)
1	Guidelines, Seed and Mulch	N/A
2	Stone Check Dam	$160/lf
3	Stone-Lined Ditch	$70 - $120/lf
4	Grass-Lined Ditch	$20 - $70/lf
5	Riprap Slope Protection	$220 - $610/lf
6	Armored Shoulder Protection	$140/lf
7	Clearing Debris/Clogging	$10 - $60/lf

3.2.2. VTrans Roadway Drainage Improvements – Maintenance-Scale Priority Projects

Road drainage deficiencies identified in the Generalized PCP and in the 2020 field screening were often associated with maintenance-scale repair and improvement activities that may be completed using VTrans District resources or District contract vehicles. The field inventory and resulting road drainage asset improvement identification was first applied to determine costs and cost-benefit summaries at the road segment level, with the intent of creating a summary list of high-priority road segments for implementation planning. At present, while the swale inventory has been related to the road segment inventory, swale improvement costs are estimated at the asset level rather than the road segment level—resulting in over-estimation of swale improvement costs at the individual road segment level. As the PCIP is implemented, further refinement of per-asset or per-road-segment costs for correcting swale deficiencies is warranted.

A draft VTrans Road Drainage Standards implementation table was developed for 2020 field-inspected road segments that did not meet the proposed VTrans road drainage standards (Appendix D). This implementation table provides an example, detailed list of maintenance-scale improvements by Lake Segment, Maintenance District, VTrans route, and Town. The tables are prioritized for future implementation by VTrans based on the system outlined in the Generalized Plan, where hydrologically connected road segments with road slope >10% are the highest priority for repair. Road segments identified in

the implementation tables may be located, and further details gathered, from a related web mapping application[8].

The draft implementation tables presented in Appendix D, and the spatial data contained in the web map, are intended to facilitate targeting of maintenance activity in support of District priorities and to be used in concert with planning and development of VTrans projects. In the first year of PCIP implementation, VTrans will consider use and expansion of the web mapping and datasets developed to date for VTrans project planning. As the PCIP is implemented, VTrans will also consider refinements to the implementation table system, including moving tracking of improvements online and integrating with the existing on-line drainage asset inventories.

Table 9 summarizes the paved road acres, P base load, and P reduction credit that may be attained through completion of these road drainage asset repairs detailed in Appendix D. If the 2020 field-verified road drainage deficiencies on 811 road segments were all repaired, VTrans would manage a total of 159 additional acres of paved road area, resulting in up to 110.3 kg/yr P reduction across the LCB (Figure 4).

Table 9. Summary of Impervious Acres and P Load Potentially Managed, Road Drainage Improvements for 2020-Field-Inspected Road Segments

Lake Segment	Total Inspected Road Segments with Drainage Deficiencies	Paved Roads Area Inspected with Drainage Deficiencies (acres)	Road Segment Base P Load (kg/yr)	Estimated P Load Reduction (kg/yr)*
Missisquoi Bay	562	108.57	93.07	74.46
St. Albans Bay	64	13.88	12.02	9.62
Northeast Arm	10	2.16	1.80	1.44
Malletts Bay	95	20.94	17.30	13.84
Main Lake	49	8.53	8.41	6.73
Otter Creek	29	4.87	5.01	4.01
South Lake A	1	0.10	0.11	0.09
South Lake B	1	0.17	0.11	0.09
Total	811	159.21	137.84	110.27

** assumes all identified drainage deficiencies are corrected along the inspected road segments (80% reduction from base P load)*

[8] https://stone-env.maps.arcgis.com/apps/webappviewer/index.html?id=f762ae432a69427eb2d05d65b26b26d8

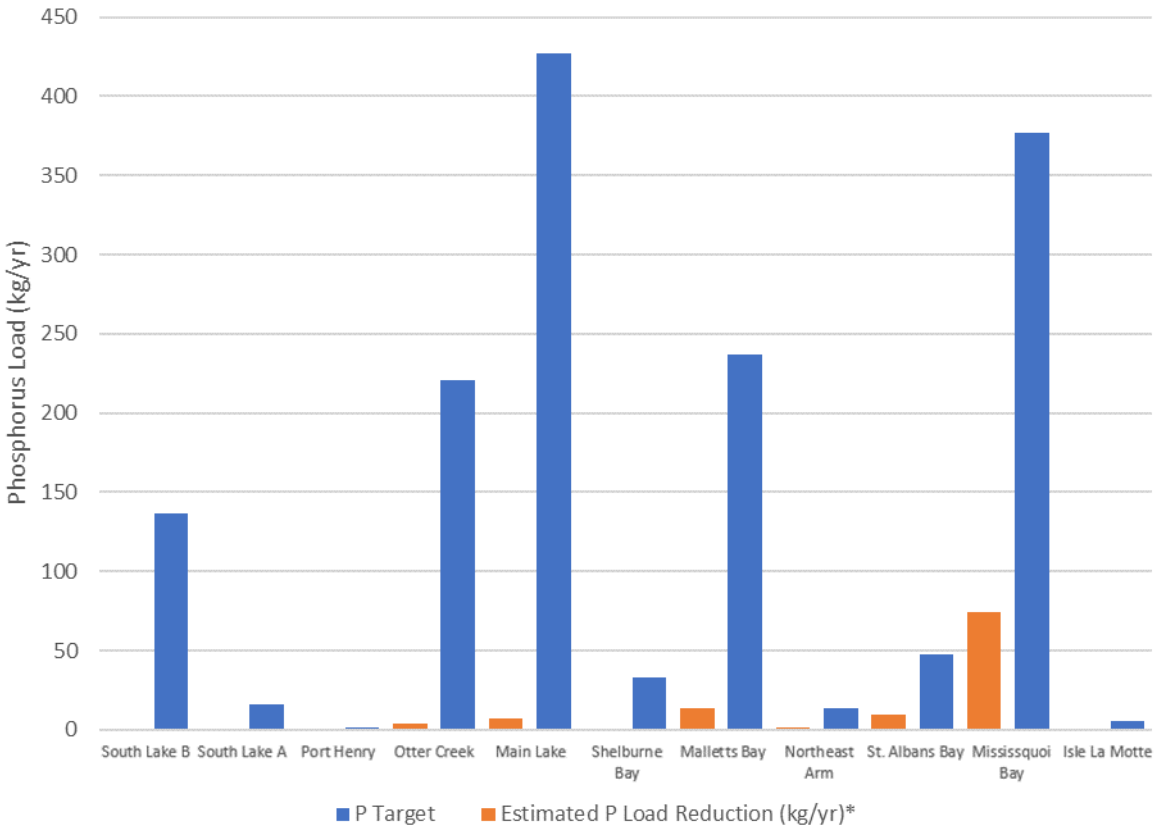

Figure 4. Estimated P Reduction from Improving 2020 Field-Inspected Road Segments with Drainage Deficiencies (kg/yr)

3.2.3. District Data Collection

Over the summer of 2020, VTrans District 5, 8, and 9 personnel documented and shared priority water quality issues they observed in the field. Staff reported 27 problem areas within the LCB, including erosion and sediment buildup issues from 18.1 acres of paved roads area (Table 10). The most common BMPs identified to improve these issues were ditching, stabilization with Type II stone, and swale profile restoration, usually requiring district forces to install the BMPs. If all district-identified BMP opportunities were considered as road drainage deficiencies, their potential P load reduction would range from 5.3-10.7 kg/yr, depending on whether road segments were partially (40% P credit) or fully (80% P credit) brought up to standards. Details regarding these District-identified problem areas are included in Appendix B and should be reviewed for priority completion as PCIP implementation proceeds.

Table 10. Summary of Priority Drainage Deficiency Improvements Identified by District staff within LCB

Lake Segment	Total Projects Identified	Potential Area Managed (acres)	Potential P Load Managed (kg/yr)
Missisquoi Bay	6	1.1	1.0
St. Albans Bay	3	0.5	0.4
Malletts Bay	8	1.7	1.4
Main Lake	8	12.0	8.2
Shelburne Bay	2	2.8	2.3
Total	27	18.1	13.4

Additionally, a District Needs Map is under development by VTrans and is anticipated in 2021. As this resource comes online and is populated by District personnel, the identified needs described above, and others, can be spatially assessed in comparison to the online road drainage standards inventory, as well as VTrans corridor plans and capital projects in development. The District Needs Map will represent a valuable resource for use in executing the PCIP, particularly in prioritizing and addressing road drainage improvements and localized erosion fixes that can be completed by the Districts and that have distinct and creditable water quality benefits.

The 2020 field season's effort to identify priority road drainage deficiency improvements inspected over 1,280 inspected road segments. While this work resulted in a list of priority maintenance improvements for targeted implementation, the effort inspected only 27% of the 4,760 highly and moderately hydrologically connected road segments in the Missisquoi Bay Lake segment. A companion VTrans Road Drainage Standards implementation table was developed to identify and prioritize potential improvements to road drainage assets only for uninspected and highly hydrologically connected road segments not meeting standards in the Missisquoi Bay Lake segment, with highest priority for implementation on road segments with slope >10% (Appendix D). The road drainage deficiencies on highly hydrologically connected road segments (all slope classes) not inspected in Missisquoi Bay lake segment, if also brought up to standards, represent 87 acres of impervious managed and could result in up to 71.4 kg/yr P reduction within the Missisquoi Bay Lake segment (Table 11).

Ultimately, bringing all hydrologically connected road segments up to standards in any Lake segment will not be feasible or cost-effective. Further prioritization, and development of projects that combine drainage deficiency improvements with those for localized erosion and water quality treatment, is warranted in the first 1-2 years of the implementation phase of this PCIP.

Table 11. Summary of Impervious Acres and P Load Potentially Managed, Road Drainage Improvements for Un-inspected and High HC Road Segments, Missisquoi Bay Lake segment

	Highly Hydrologically Connected Road Segments, All Slope Classes			
Drainage Area, Missisquoi Bay Lake Segment	Total Un-Inspected Road Segments with Drainage Deficiencies	Paved Roads Area with Drainage Deficiencies (acres)	Road Segment Base P Load (kg/yr)	Estimated P Load Reduction (kg/yr)*
Missisquoi Bay - DD	44	6.23	6.51	5.21
Missisquoi River	428	80.14	82.79	66.23
Total	472	86.37	89.30	71.44

** assumes all identified drainage deficiencies are corrected (80% reduction from base P load)*

3.2.4. VTrans Roadway Drainage Improvements – Priorities for Incorporation into Capital Projects

The VTrans Transportation Program[9] includes a range of capital projects that presently address drainage deficiency improvements, as well as repairs to areas of localized erosion and construction of structural STPs. Table 12 summarizes areas of the present and historic VTrans Transportation Program that address drainage and stormwater improvements and provides a partial list of representative improvements often included in VTrans capital projects.

Table 12. Summary of VTrans Transportation Program Project Types Addressing Road Drainage Deficiencies and Other Stormwater Concerns

Program	Project Class	Representative Improvements
Traffic & Safety	Hazard Elimination (HES)	Roadway and intersection reconstruction, including roadway and drainage.
Paving	National Highway System (NH)	Reconstruction, including roadway and drainage. Resurfacing, ditching details, limited drainage improvements.
	Surface Transportation Program (STP)	Reclaiming, resurfacing, guardrail and drainage improvements. Substantial variability in incidental drainage/ditching work, particularly prior to 2018.
	Resurfacing (PS)	Resurfacing and guardrail improvements. Little drainage work, but shoulder berm removal sometimes included
	Resurfacing (SURF)	Resurfacing; shoulder berm removal sometimes included
Roadway Projects	Emergency Relief (ER)	Culvert replacements; slope stabilization; correction of major erosion areas usually following major storm events
	Federal-Aid Primary – Economic Growth Center (FEGC)	Reconstruction, including roadway and drainage.
	STP - Culvert Repl. (CULV)	Culvert replacements and headwalls; small structures (>6 ft. diameter) or replacement of multiple small culverts
	STP - Culvert Rehab. (SCRP)	Culvert rehabilitation - lining, headwalls, primarily small structures (culverts >6 ft. diameter)
	Stormwater Retrofit - Flow Restoration (SWFR)	Structural stormwater treatment practices for Flow Restoration Plan implementation

VTrans capital program projects completed between 2010 and 2019 were reviewed to assess improvements made to drainage assets and related roadways through these projects, and to document P reductions creditable for road drainage deficiency corrections where applicable (Appendix A). Of the 214 projects documented in VTrans' archived projects database as completed between 2010 and 2019, 90 appeared likely to contain some level of creditable activity. Once the database filtered only to capital projects that were likely to encompass creditable road drainage asset improvements, a total of 280 miles of roadway were potentially improved between 2010 and 2018 (Table 13). This translates to approximately 30 miles/year, or approximately 128 acres/year, of paved road area with some potential for drainage deficiency improvement. When this review was completed, in early July 2020, capital projects with construction completed in 2019 were not archived and as-built plans were not available for review. Capital projects closed out and archived should be assessed, and creditable improvements documented and incorporated into the implementation model, on an annual basis.

[9] https://vtrans.vermont.gov/about/capital-programs

Table 13. Summary of VTrans Road Miles in LCB Potentially Improved Through Capital Projects with Drainage Improvements, 2010-2018

	Miles of VTrans Roadway Improved by Project Type							
Year	Emergency Relief (ER)	Federal-Aid Primary – Economic Growth Center (FEGC)	Hazard Elimination (HES)	National Highway System (NH)	Surface Transportation Program (STP)	STP - Culvert Repl. (CULV)	STP - Culvert Rehab. (SCRP)	Total
2010			0.29	0.33	30.51			31.13
2011				1.85	24.12			25.97
2012	0.08		0.43	4.22	24.60			29.32
2013	0.07	1.97		3.10	51.62	2.40		59.17
2014				7.11	41.77	0.05	0.04	48.96
2015	0.26			2.03	21.18	0.01		23.48
2016					10.94			10.94
2017	0.02			7.77	20.77			28.55
2018	3.67			8.73	9.62		0.04	22.06
Total	4.09	1.97	0.72	35.13	235.13	2.46	0.08	279.58

VTrans capital program projects in construction and planned for future implementation between 2020 and 2027 were similarly reviewed to assess improvements planned for drainage assets and related roadways, and to estimate P reductions creditable for road drainage deficiency corrections. VTrans' current and future project summary information was accessed through the VTransparency website[10] in July 2020. Of the 283 projects in construction or planned, 44 appear likely to contain some creditable activity. Once the database was filtered to those potentially creditable projects, a total of 84 road miles (309 acres) of paved roads in the PCP Area are being improved or are planned for improvement (Table 14 and Table 15). In 2020-2022, approximately 20 miles/year or 70 acres/year of paved roads area are expected to be improved. While projected road miles improved, and thus paved roads acres and resulting P load potentially managed through improvements to road drainage conditions, decrease in 2023-2027, this is consistent with the VTrans project development process.

[10] https://vtrans.vermont.gov/vtransparency

Table 14. Summary of VTrans Road Miles in LCB Potentially Improved Through Capital Projects with Drainage Improvements, 2020-2027

	Miles of VTrans Roadway To Be Improved by Project Type								
Year	Emergency Relief (ER)	Federal-Aid Primary – Economic Growth Center (FEGC)	Interstate Maint. (IM)	National Highway System (NH)	Surface Transp. Program (STP)	Culvert Repl. (CULV)	Culvert Rehab. (SCRP)	Flow Restoration (SWFR)	Total
2020	0.11		0.06		3.23				3.40
2021	1.99			2.82	23.15	13.28	0.02		41.26
2022					11.76		0.01	2.68	14.44
2023	0.02				10.12	0.01			10.15
2024	0.01			0.89	0.34		0.01		1.25
2025		1.28		1.66					2.94
2026				5.89					5.89
2027				1.56	3.22				4.78
Total	2.13	1.28	0.06	12.82	51.82	13.29	0.04	2.68	84.11

Table 15. Summary of VTrans Paved Roads Area in LCB Potentially Improved Through Capital Projects with Drainage Improvements, 2020-2027

	Estimated Paved Roads Area (acres) To Be Improved by Project Type								
Year	Emergency Relief (ER)	Federal-Aid Primary – Economic Growth Center (FEGC)	Interstate Maint. (IM)	National Highway System (NH)	Surface Transp. Program (STP)	Culvert Repl. (CULV)	Culvert Rehab. (SCRP)	Flow Restoration (SWFR)	Total
2020	0.40		0.06		20.40				20.86
2021	3.20			5.82	59.48	55.26	0.31		124.08
2022					50.92		0.16	12.70	63.79
2023	0.54				39.32	0.19			40.05
2024	0.23			6.43	1.98		0.22		8.87
2025		2.22		6.63					8.85
2026				24.19					24.19
2027				6.85	11.67				18.53
Total	4.37	2.22	0.06	49.93	183.79	55.45	0.70	12.70	309.23

Review of VTrans capital program projects completed between 2010 and approximately 2017 documented few creditable improvements to road drainage conditions (Appendix B). While the historic project review did not yield enough information to project future drainage deficiency improvement and associated P load reduction, capital projects that began construction in approximately 2017-18, as reviewed during the summer of 2020 in desktop and field work, demonstrated marked and encouraging improvements. Table 16 provides examples of the paved road areas managed and P load reductions anticipated for projects now in development or

construction, based on plans and information provided by VTrans Project Managers during PCIP preparation. The information in this table has been included in the implementation model and schedule (Section 4). As PCIP implementation proceeds, further review of VTrans projects in development and construction, identification of creditable improvements being implemented, and incorporation of impervious acres managed and P load reductions credited into the implementation model or tracking system should be completed on an annual basis or as VTrans projects are closed out.

Table 16. Examples of VTrans Projects in Construction and Development and Potential for Drainage Deficiency Improvements

Project No.	New Haven HES-032-1(8)	Jericho STP HES 030-1(21)	Bridport-Cornwall STP CULV(75)	Richford-Jay STP 2914(1)
Lake Segment	Otter Creek	Malletts Bay	Otter Creek	Missisquoi Bay
Description	REALIGNMENT OF THE VT17/EAST ST. (TH22 & TH18) INTERSECTION IN NEW HAVEN, AND ELIMINATION OF THE VT17/TH19 INTERSECTION.	INSTALLATION OF A LEFT-TURN LANE ON VT15 WESTBOUND IN JERICHO, AT THE INTERSECTION OF TH1 (BROWNS TRACE RD.). ALSO INCLUDES INSTALLATION OF A NEW TRAFFIC SIGNAL.	Replace 4 culverts, PID 558, 549, 545, 570	RESURFACE VT105 IN RICHFORD AND JAY, BEGINNING 2.529 MILES EAST OF THE BERKSHIRE-RICHFORD TOWN LINE AND EXTENDING EASTERLY 7.381 MILES. Replacement and maintenance of existing guardrail runs, culvert replacements, ditching.
Estimated Completion Year	2023	2020	2021	2021
Total Road Segments	9	12	4	196
Road Segments Not Meeting Standards (2020)	5	5	4	76
Paved Roads Acres (total)	1.28	1.72	0.42	22.59
Paved Roads Base P Load (total)	1.31	1.38	0.37	18.86
Paved Roads Acres Not Meeting Standards	0.86	0.7	0.42	7.8
P Base Load for Road Segments Not Meeting Standards	1	0.61	0.37	6.32
P Load Reduction (kg/yr)*	0.8	0.488	0.296	5.056
Comments	Operational permit for 1.77 acres redeveloped/expanded impervious	Operational permit 6947-INDS.A for 0.39 acres new impervious, site balancing applied, grass channels and disconnection STPs		Contract plans indicate all or nearly all culvert and swale deficiencies will be addressed through this project. Localized erosion past culvert outlets will not be addressed.

** assumes 80% P load reduction for fully meeting road drainage standards*

VTrans capital projects in construction and development where creditable drainage deficiency improvements are anticipated to occur, and including the paved roads acres and P load potentially managed through these projects, are listed in Appendix E. This list is a resource for targeting road segments within project limits where drainage deficiency improvements may be enhanced, particularly for paving and roadway projects that

are in the preliminary design stage. It should be reviewed and expanded in the fall of each year, following approval of State Transportation Program[11] funding and the close of each construction season.

As this PCIP is implemented, VTrans may consider further assessment of the potential to accrue P load reductions through implementation of bridge replacement projects. Where bridge replacements result in increased clear spans for river crossings, or other design aspects that reduce infrastructure vulnerability and increase flood resilience, such improvements may be partially creditable for their natural resource restoration benefits (Section 3.6).

3.3. Structural Correction of Localized Erosion Issues

Stabilization and treatment of areas of localized erosion caused by roadway runoff provides P reduction benefits while protecting VTrans infrastructure. Specific crediting mechanisms were not well-established for these and similar transportation-related improvements when the Generalized Plan was completed. While this PCIP was in development, a draft volumetric methodology was outlined in the ANR draft MRGP Tracking and Accounting SOP[12]. This draft methodology will be further informed by the progress and findings of the VTrans and ANR research project *Quantifying Nutrient Pollution Reductions Achieved by Erosion Remediation Projects on Vermont's Roads,* which is now underway and will be completed in 2021. The draft ANR methodology is applied in this PCIP to estimate P reduction credit for proposed localized erosion repairs.

Opportunities for correction of minor areas of localized erosion were conservatively estimated in the Generalized Plan (Section 2.3) by excluding road segments with drainage deficiencies from consideration of opportunities for localized erosion repairs. The summer 2020 field verification effort demonstrated that this assumption is conservative; minor localized erosion on road shoulders was regularly encountered in association with culvert or swale drainage deficiencies (Appendix B). In the Generalized Plan, a conceptual 50% P reduction credit was assumed for correction of minor areas of localized erosion, following confirmation of the appropriateness of the assumption by ANR in March 2020. While adjustments to the implementation model's assumptions regarding minor areas of localized erosion are not warranted (see discussion below of 2020 field season findings), the P reductions assumed may be revisited during the term of this PCIP as improved information becomes available.

Correction of gullying and large areas of active erosion, as well as corrections at stormwater system outlets, remain areas of active investigation across multiple State agencies, Regional Planning Commissions and municipalities, watershed stewardship organizations, and other partners. VTrans expects that major upgrades to road embankments and culverts where improvements would address both existing drainage issues and reduce vulnerability to damage from floods, where risk, vulnerability, or criticality have been identified in VTrans's Transportation Resilience Planning Tool[13] will become a possibly substantial factor in prioritization and completion of improvements (when and as data become available in the LCB).

Over 80 areas of localized erosion were identified during the 2020 field screening effort, representing over 4,600 cubic yards of erosion (Table 17 and Appendix B). If these areas of localized erosion were rehabilitated and credited using the volumetric methodology outlined in the Agency of Natural Resources' draft MRGP Tracking and Accounting SOP[12], up to 71.4 kg/yr of P load reduction may be achieved (Table 17 and Figure

[11] https://vtrans.vermont.gov/about/capital-programs
[12] https://dec.vermont.gov/sites/dec/files/wsm/stormwater/docs/MS4/FINAL%20DRAFT%20MRGP%20SOP%206-5-20.pdf
[13] https://vtrans.vermont.gov/planning/transportation-resilience

5). An implementation table summarizing the areas of localized erosion identified, erosion volumes, and P reduction calculations is included in Appendix F.

Table 17. Summary of Potential P Load Reduction from Repairing Inspected Localized Erosion Areas

Lake Segment	Erosion Volume (yd^3)	Potential P Load Reduction (kg/yr)	Target P Load Reduction (kg/yr)*	% of Target P Load Reduction
Main Lake	18.6	0.3	427.4	0.1%
Malletts Bay	1,681.4	26.0	236.6	11.0%
Missisquoi Bay	2,372.3	36.7	376.6	9.7%
Otter Creek	501.1	7.7	220.8	3.5%
South Lake B	17.8	0.3	136.3	0.2%
St. Albans Bay	27.8	0.4	47.2	0.9%
Grand Total	4,619	71.4		

**Roads portion of P load only, all land covers*

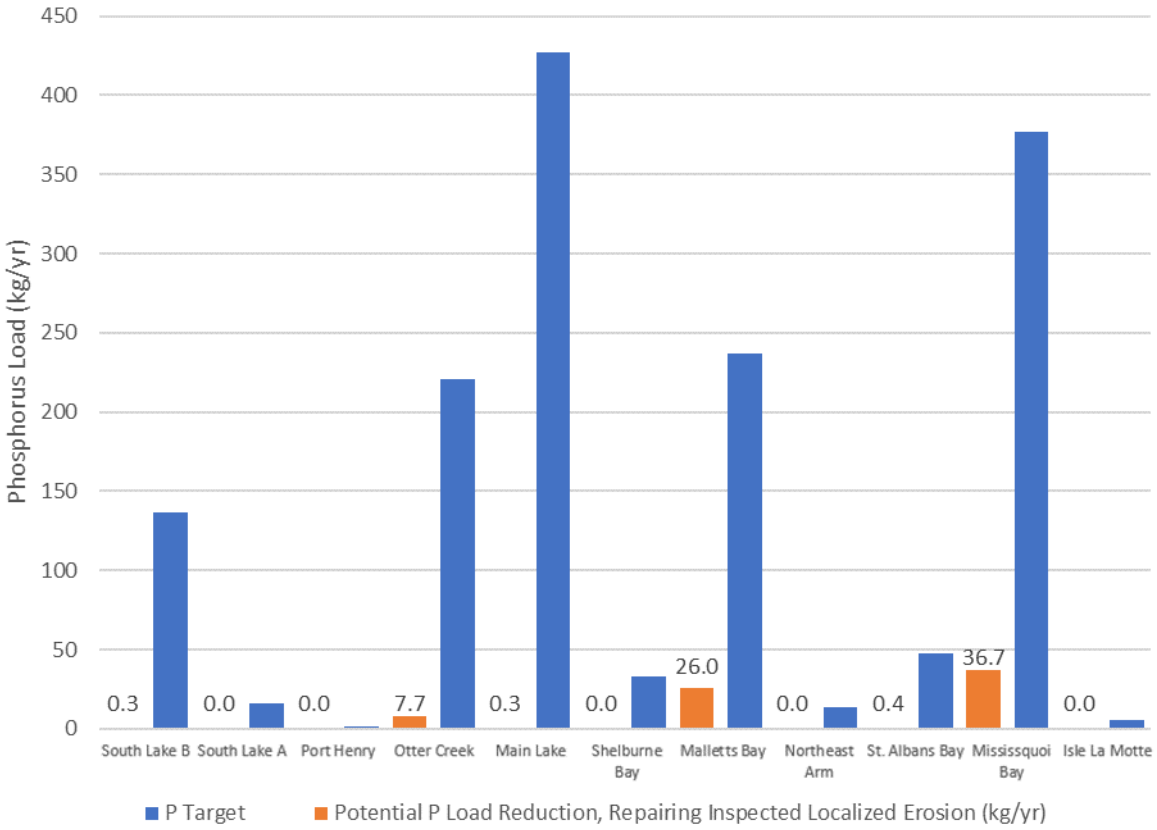

Figure 5. Summary of Potential P Load Reduction from Repairing 2020-Inspected Areas of Localized Erosion

Roughly a third (27 of 80) inspected areas of localized erosion were on road segments or in rights-of-way that were identified as having one or more of the localized erosion risk factors described in Section 2.3.1 of the Generalized PCP. This aligns closely with field evaluations completed for areas of localized erosion in 2017 and 2019, and with the 30% factor applied to pervious ROW areas with one or more risk factors for localized erosion in the Generalized PCP (Section 2.3.1). Adjustments to the prior analyses are not warranted at this time. Expansion of field screening for improvements at culvert outlets, however, is warranted during the term of this PCIP. The 2020 field screening effort strategically focused culvert inspection first in the Missisquoi Bay Lake segment, and later where the SCI identified severe culvert outlet erosion and where desktop evaluation of the terrain downslope from the culvert outlet indicated that gullying was likely present. An additional 713 culverts throughout the LCB with moderate outlet erosion have yet to be re-inspected.

The majority of inspected localized erosion areas were gullies that could be rehabilitated using maintenance-scale BMPs and District forces. Project-scale repairs for substantial localized erosion problems, however, provide the largest P reduction benefits – 52.1 kg/yr, or 73% of the total P reduction credit identified during the field screening effort (Appendix B). Conceptual plans and implementation cost estimates were developed for 11 areas of localized erosion (Appendix F). Projects were chosen for advancement that represented the range of conditions encountered during the field season, while selecting those that may be feasibly advanced by VTrans in the term of this PCIP (located partially or fully in the VTrans ROW and with limited utility, natural resource, or access constraints, etc.). Table 18 summarizes the concepts advanced.

The two areas of localized erosion associated with the VTRC 19(2) research project are expected to be repaired in the fall of 2020 and monitored following construction; these were included in the implementation model. The remaining priority concepts, if advanced in the term of this PCIP, would generally not manage additional impervious surface and would result in a P load reduction of 36.5 kg/yr (Table 18).

Table 18. Summary of Priority Localized Erosion Repairs Advanced to Concept Design

ID	Concept No.	Lake Segment	Location	Concept Description	Erosion Volume (yd^3)	Potential P Load Reduction (kg/yr)	Project Cost ($2020)	$/kg P managed
LE_16	1	Missisquoi Bay	VT Rte 36 Fairfield	Stabilize with Type I stone, check dams, plunge pools	66.7	1.03	$50,900	$49,500
LE_28	2	Missisquoi Bay	VT Rte 105 Richford	Stabilize two culvert outlets with Type II stone, plunge pools, rock steps.	518.5	8.02	$106,400	$13,300
LE_43	3	Missisquoi Bay	VT Rte 105 Jay	Stabilize culvert outlet with rock step and riffle, provide limited water quality treatment with regenerative conveyance, stabilize downslope gully channel with Type I stone.	130.4	2.02	$80,100	$39,700
LE_47	4	Missisquoi Bay	VT Rte 78 Highgate	Repair slope above culvert outlet with riprap; construct culvert endwall; stabilize outlet with Type I stone	29.6	0.46	$102,600	$223,100
LE_48	5	Missisquoi Bay	VT Rte 78 Highgate	Repair slope above culvert outlet with riprap; construct culvert endwall; stabilize outlet with Type I stone	37	0.57	$77,900	$136,700
LE_52	6	Missisquoi Bay	I89 SB Highgate	Construct culvert endwall; stabilize outlet with plunge pool; stabilize downslope gully channel with Type I stone	865.9	13.4	$123,700	$9,300
LE_53	7	Missisquoi Bay	I89 SB Highgate	Construct culvert endwall; stabilize outlet with plunge pool; stabilize downslope gully channel with Type I stone	166.7	2.58	$80,000	$31,100
LE_56	8	Missisquoi Bay	VT Rte 36 Fairfield	Replace cross culvert (18"RCP); construct headwall and endwall; stabilize outlet and downslope area with Type I stone	11.1	0.17	$82,000	$476,800
LE_57	9	Malletts Bay	VT Rte 118 Eden	Armored shoulder protection	370.4	5.73	$65,600	$11,500
LE_59	10	Missisquoi Bay	VT Rte 242 Jay	Armored shoulder protection	41.7	0.64	$147,800	$229,600
LE_65	11	Malletts Bay	I89 Exit 18 SB off-ramp	Repair trench above culvert outlet; replace culvert; construct endwall; stabilize downslope erosion with Type I stone	123.3	1.91	$79,000	$41,400
LE_2	VTRC 19(2)	Malletts Bay	I89 NB, MM 97.0	Stabilize gully with Type I stone for VTrans - DEC research project	206.4	3.19	$25,000	$7,900
LE_3	VTRC 19(2)	Main Lake	I89 SB, MM 92.6	Stabilize gully with Type I stone for VTrans - DEC research project	327.8	5.07	$25,000	$5,000
TOTAL					2,895.5	44.8	$1,046,000	$23,400

3.4. Non-Structural Controls

Drop inlet (DI) or catch basin cleaning and street sweeping both result in the removal of sediment and P from impervious surfaces. As documented in the Generalized Plan (Section 2.5), VTrans has committed to conduct street sweeping on 2,000 lane miles of VTrans roads annually, conduct storm drain inspections on 20% of VTrans roads annually, and to properly dispose of materials collected per ANR guidelines per the Stormwater Management Program[14]. Phosphorus reductions calculated based on the DEC P crediting methodology for non-structural controls indicate that street sweeping and DI cleaning have a modest P reduction benefit (1-2% of annual VTrans P target reductions) with an estimated average annual unit cost of $32,000/kg/yr and $12,000/kg for street sweeping and DI cleaning, respectively.

Increasing the extent or frequency of non-structural control, or changing the sweeping equipment used to complete sweeping operations, presently offers incremental increases in P reductions (Table 19). Results of ongoing research by USGS and others[15] evaluating reductions in nutrient and sediment loads from current street cleaning and leaf litter collection practices, and evaluating P reductions and crediting for current practice and potential enhancements, will further influence decision making regarding VTrans' street sweeping program once those findings are available in 2020. This study is focused on the performance of sweeping and DI cleaning on municipal streets with curb and gutter drainage, and applicability of the results to the VTrans highway system is not clear. Substantial changes to the implementation of non-structural controls are not anticipated in the term of this PCIP. Annual lane miles swept and DIs cleaned will be summarized by Lake segment annually for TS4 reporting and incorporation into the implementation model and tracking system. VTrans may also consider innovative options for enhancements to non-structural controls, such as piloting an approach to translate enhanced pollution reduction through public outreach and education into impervious acres managed and P load reduction credit for the TS4[16][17].

Table 19. Non-Structural Controls P Reduction Factors[18]

STREET SWEEPING				
	Frequency			
Sweeping Equipment Type	2/year (spring and fall)	Monthly	Weekly	4X in the fall
Mechanical Broom	1%	3%	5%	
Vacuum Assisted	2%	4%	8%	
High Efficiency Regenerative Air-Vacuum	2%	8%	10%	
Any technology on streets with ≥17% tree cover				17%
DI CLEANING				
A two percent (2%) credit can be applied to the road load if catch basins have material removed annually.				

[14] https://anrweb.vt.gov/PubDocs/DEC/Stormwater/PublicNotice/7892-9007/VTrans%20Final%20SWMP%20-%20December%205%202017.pdf
[15] https://www.ccrpcvt.org/wp-content/uploads/2018/12/CleanStreetsSweepingStudy_Sept4_update.pdf
[16] https://www.capitalgazette.com/news/ac-cn-education-pilot-program-0426-20200429-t2phb2glyzajpm7br63mckygiu-story.html
[17] https://www.roads.maryland.gov/mdotsha/pages/index.aspx?pageid=336
[18] https://dec.vermont.gov/sites/dec/files/wsm/stormwater/docs/MS4/FINAL%20DRAFT%20Stormwater%20SOP%206-5-20.pdf

3.5. Structural Stormwater Treatment Practices

Structural stormwater treatment practices (STPs) are one of the measures available to VTrans to meet P reduction targets in accordance with the TS4 General Permit. Structural treatment practices are intended to detain, treat, and better manage runoff from well-defined areas of impervious surface, such as roads, parking lots, or rooftops. These treatment practices range from older detention ponds managing only peak flows to dry swales, gravel wetlands, and other green stormwater infrastructure. Structural stormwater treatment practices historically have been incorporated into VTrans' asset portfolio as transportation projects improving roads and facilities implemented to comply with regulatory requirements.

In developing the Generalized Plan and this PCIP, enhancements to maintenance activities already being performed by VTrans that have quantifiable P reduction benefits were typically preferred over construction of new structural STPs. Recognizing that these improvements alone may not be sufficient to achieve the required target P reductions in all Lake segments, structural STP opportunities were further evaluated in developing this PCIP to allow for adaptive management during the development and execution of the four-year implementation plans.

Information about existing and planned structural STPs throughout the TS4 presented in the Generalized Plan (Section 2.1.1) was updated in the TS4's BMP Tracking Table and in the implementation model (Appendix A). A total of 160 structural STPs exist and another 102 are planned. These practices will manage stormwater from 274 acres of impervious area and 1,060 acres of pervious area within the VTrans PCP Area over the term of the PCP.

One of the most cost-effective structural STPs available to VTrans is the retrofit of replacement of existing guardrails, where removal of timber curb effectively disconnects runoff from adjacent paved roads areas, allowing unconcentrated flow of runoff into the pervious right-of-way (ROW). Several such disconnections are included in VTrans' BMP tracking table for 'structural' STPs. Where conditions are right (relatively gentle slopes and sufficient pervious area width available in the ROW), the guardrail and timber crib removal may be completed by VTrans personnel, and operation/maintenance of the resulting disconnection practice consists primarily of maintaining the guardrail (if only timber curb is removed and guardrail remains) and mowing – all of which is part of normal VTrans operations. Continued screening of opportunities for implementing disconnections through timber curb removal is warranted as the first four-year implementation plan is progressed.

3.5.1. Updates to the Analysis of Treatment Potential using Structural STPs

In the Generalized Plan, a screening analysis was conducted to determine the potential for successfully siting and implementing structural STPs to manage runoff from linear facilities within the VTrans PCP Area. Areas of developed pervious land within the VTrans right-of-way were identified using a desktop GIS analysis, and the drainage areas directing runoff to each pervious area were delineated. Suitable structural STP types were assigned to each pervious potential STP area based on physical and feasibility constraints, as well as cost considerations. Conceptual structural STP were identified by targeting pervious right-of-way areas in proximity to and downslope of large areas of VTrans paved road impervious cover.

The results of the screening analysis, even as refined during development of this PCIP, are intended to be used only for planning purposes. Further refinement of structural STP siting and sizing, and careful evaluation of feasibility constraints and permitting needs, will be necessary prior to implementation.

The conceptual STP selection workflow developed in the Generalized Plan to preferentially select high-performing, low-cost STPs that align with VTrans' needs and operation/maintenance preferences was

updated during the 2020 field season (Figure 6). Several adjustments were made to the GIS analysis as the 2020 field screening progressed:

- The conceptual STP selection decision logic applied in the Generalized PCP (Section 2.1.2) was adjusted to remove HSG C soils from consideration for infiltrating STPS. During field screening, the HSG C soils encountered were generally not suitable for infiltrating STPs, though opportunities with HSG C soils were often confirmed as suitable for gravel wetlands, under-drained bioretention, or other filtering STPs.
- Conceptual STP areas that intersected with a water body of floodplain were considered as potential floodplain reconnection projects in the Generalized PCP (Section 2.1.2). However, field screening indicated that the waterbody intersection criterion was not an accurate screening measure, and that this opportunity should be limited to VTrans pervious ROW areas identified within mapped floodplains or river corridors.
- Areas identified as potential wetland restoration projects were not screened during the 2020 field season, so no adjustment to that portion of the STP opportunities dataset is warranted.

The adjustments made to the structural STP selection decision logic will be applied to the implementation model and to projections of the acres of impervious surface potentially managed, P reductions that may be achieved, and implementation costs considered in the PCIP.

Over 4,000 conceptual structural STPs were identified following refinement of the analysis and filtering for feasibility constraints. Together these STPs have the potential capacity to manage stormwater from 1,841 acres of paved roads area and 3,373 acres of developed pervious area within the VTrans PCP Area (Table 20). The majority of conceptual structural STPs identified remain infiltration trenches and gravel wetlands. The conceptual structural STPs have the cumulative potential to result in 1,302 kg/yr in P load reduction (Table 21 and Figure 7).

Table 20. VTrans Impervious Areas Potentially Managed by Conceptual Structural STPs

	VTrans Impervious Acres Potentially Managed by Conceptual STP Type						
Lake Segment	Bioretention (w/ underdrain)	Disconnection	Dry Swale (w/ underdrain)	Gravel Wetland	Infiltration Trench	Wet pond/ Created Wetland	Total
Isle LaMotte			0.36	5.39	1.02		6.76
Missisquoi Bay	4.12	48.40	4.79	115.67	66.32	25.49	264.79
St. Albans Bay				40.73	22.01	12.15	74.89
Northeast Arm			4.23	33.74	3.58	2.11	43.65
Malletts Bay			1.30	157.45	182.90	33.37	375.03
Shelburne Bay				22.37	15.66	3.00	41.04
Main Lake	0.45		2.91	259.83	214.54	79.71	557.43
Otter Creek			7.95	172.70	104.77	67.32	352.74
South Lake A			0.25	6.08	0.60		6.92
South Lake B				42.50	64.77	10.15	117.42
Isle LaMotte			0.36	5.39	1.02		6.76
Total	4.56	48.40	21.79	856.46	676.16	233.31	1,840.67

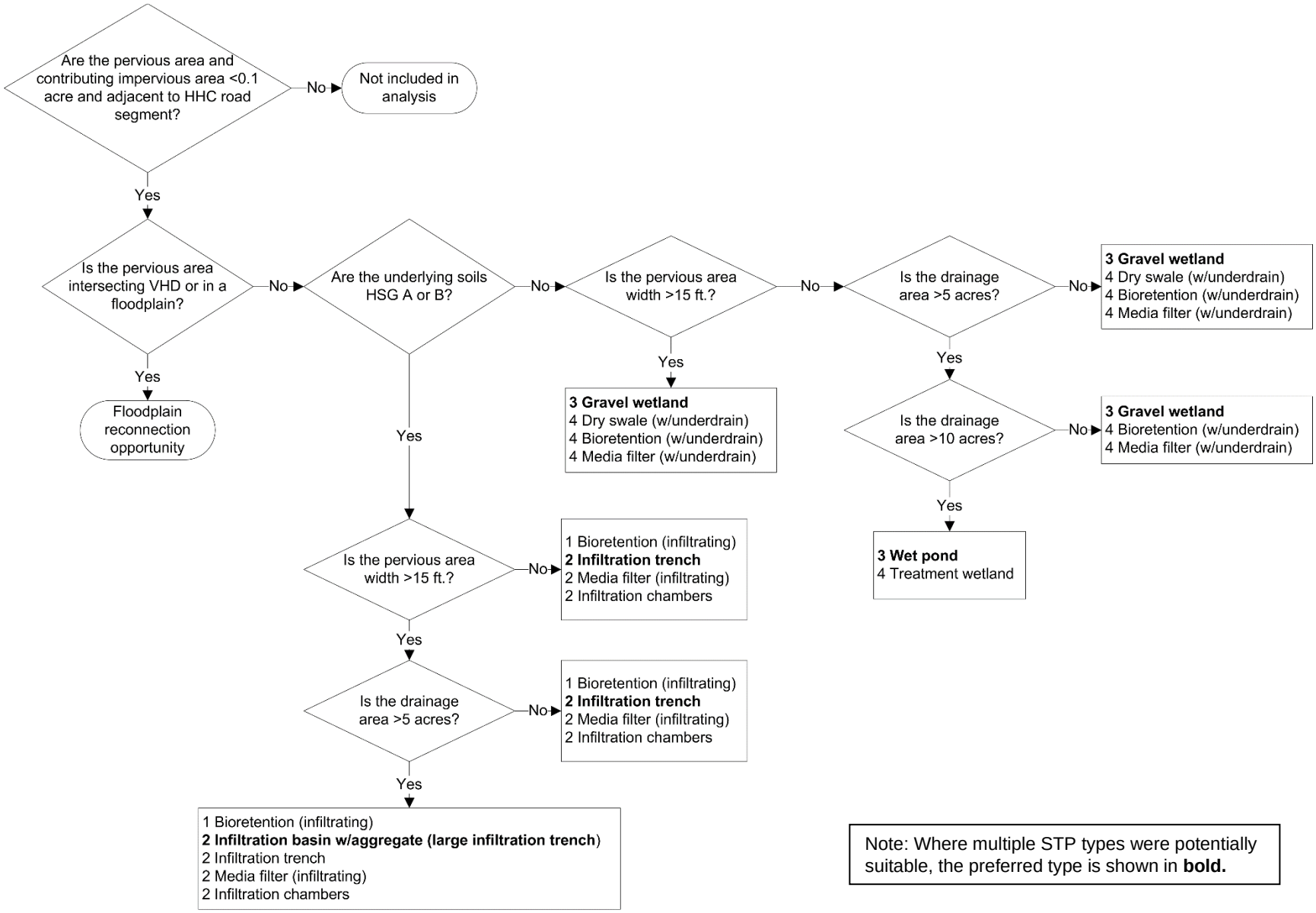

Figure 6. Conceptual STP Selection Decision Logic Flowchart

Table 21. Summary of P Load Reduction Potential for Conceptual Structural STPs

Lake Segment	P Load Reduction Potential by Conceptual STP Type (kg/yr)						Total
	Bioretention (w/ underdrain)	Disconnection	Dry Swale (w/ underdrain)	Gravel Wetland	Infiltration Trench	Wet pond/ Created Wetland	
Isle LaMotte			0.09	2.34	0.59		3.02
Missisquoi Bay	2.18	31.17	2.08	66.92	67.74	12.82	182.91
St. Albans Bay				21.39	18.72	6.13	46.25
Northeast Arm			1.81	17.81	3.57	0.88	24.08
Malletts Bay			0.52	81.58	165.23	14.12	261.45
Shelburne Bay				10.21	13.15	1.24	24.60
Main Lake	0.24		1.07	145.91	211.27	44.04	402.54
Otter Creek			3.60	102.37	107.35	39.99	253.31
South Lake A			0.11	3.65	0.60		4.36
South Lake B				26.60	67.33	5.76	99.69
Total	2.42	31.17	9.29	478.79	655.55	124.99	1,302.21

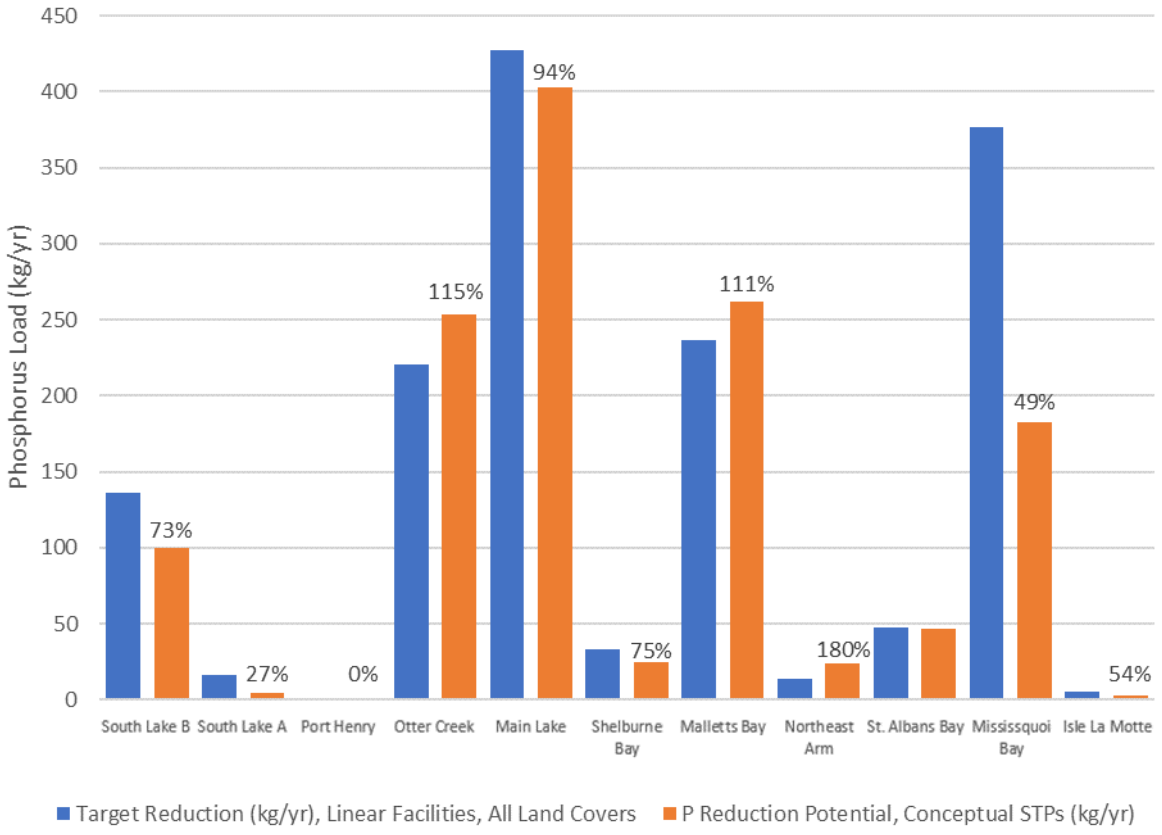

Figure 7. Potential for P Load Reductions with Conceptual Strucutal STPs by Lake Segment

Following completion of the 2020 field verification effort, ten inspected structural STP opportunities were selected to advance to concept design (Appendix G). The conceptual STPs were selected to provide examples of a range of STP types, to be among the largest opportunities to manage VTrans paved roads area, yet to be

representative of the range of site conditions likely to be encountered if structural STP projects are necessary or desired. Table 22 summarizes the key characteristics of the structural STPs advanced.

Table 22. Summary of Inspected Structural STPs Advanced to Concept Design

Unique ID	Lake Segment	VTrans Drainage Area (ac)	VTrans Impervious Area (ac)	VTrans Pervious Area (ac)	STP Type	Storage Volume (cf)	P Load Reduction (kg/yr)	Cost (2020$)
STP_3932	Missisquoi Bay	1.71	0.34	1.38	Infiltration Trench	7373	0.69	$216,800
STP_3822	St. Albans Bay	2.36	1.88	0.48	Gravel Wetland	20280	1.24	$104,300
STP_3005	Missisquoi Bay	7.50	1.68	5.82	Gravel Wetland	98817	2.37	$509,400
STP_3786	Missisquoi River	23.90	6.62	17.28	Gravel Wetland	17796	3.19	$230,000
STP_385	Missisquoi Bay	4.47	1.30	3.17	Infiltration Trench	37454	1.73	$287,200
STP_378	Missisquoi Bay	9.17	1.42	7.75	Infiltration Trench	30569	2.87	$235,100
STP_3790	Missisquoi River	2.59	0.76	1.84	Gravel Wetland	34496	0.83	$151,600
STP_3918	Missisquoi Bay	4.91	1.00	3.91	Gravel Wetland	31082	1.61	$278,400
STP_1943	Missisquoi Bay	2.49	1.09	1.41	Infiltration trench	45740	1.20	$399,400
STP_374	Missisquoi Bay	3.92	0.45	3.47	Infiltration Trench	14477	1.18	$140,800
STP_3896	Missisquoi Bay	1.07	0.27	0.80	Infiltration Basin	2330	0.41	$80,400

Finally, a series of detail sheets are provided for a suite of 46 inspected and suitable structural STP opportunities located in the I-89 right-of-way in the Missisquoi Bay Lake segment (Appendix H). These summary pages are generated from the online dataset for conceptual structural STPS, and so as PCIP implementation proceeds or as VTrans capital projects proceed through planning, summaries may be quickly generated upon request.

3.6. Natural Resource Restoration Projects

Natural resource restoration projects, and particularly floodplain reconnection projects, may be credited as a stormwater treatment practice in the context of the VTrans PCP if some portion of the floodplain area to be reconnected is also connected to a TS4 roadway or parcel-based "developed lands" contributing drainage. A potential crediting methodology and test case completed by ANR, using a floodplain reconnection project completed in the Lamoille River watershed in 2007-2008, was discussed in the Generalized Plan stream (Section 2.4 and Appendix G of that Plan).

VTrans is aware of at least two potential floodplain reconnection projects that will continue to be evaluated as the first four-year implementation plan is executed. A series of floodplain reconnection alternatives for a portion of the Lamoille Valley Rail Trail located along VT Route 36 in Fairfield in the Black Creek floodplain were evaluated through the VTrans-funded project *Evaluating Effectiveness of Floodplain Reconnection Sites along the Lamoille Valley Rail Trail: A Blueprint for Future Rail/River Projects,* with results provided in August-September 2020. Although the potential for floodplain reconnection associated with rail trail construction or berm lowering may be limited in the future, application of that project's findings to developing

a draft P crediting SOP is now underway, with results anticipated by the end of 2020. A preliminary evaluation of the potential for floodplain reconnection in the Potash Brook watershed was conducted by the South Burlington MS4 in February 2020, identifying a potential reconnection opportunity near the I-89/I-189 interchange. An opportunity for riverbank stabilization near the crossing of Mill Brook and VT Route 117 in Jericho represents a small-scale project, but one that may be more representative of restoration projects typically encountered within the TS4 right-of-way.

As discussed in the Generalized Plan, VTrans also anticipates further investigation of floodplain reconnection where VTrans roads and facilities contribute runoff upstream of the restoration practice through coordination with and application of results from Vermont's Functioning Floodplains Initiative[19]. While the project outputs will not be complete until 2021, the initiative will develop and apply methodologies for evaluating river reach and watershed-scale restoration of stream, riparian, wetland, and floodplain function. The initiative seeks to garner local community support by tracking and publicizing the accumulation of the natural and socio-economic assets derived from connected and naturally functioning floodplains and wetlands, including fish and wildlife habitat, water quality, avoided damage from floods and fluvial erosion, and the storage of carbon affecting the earth's climate.

[19] http://www.vermontbusinessregistry.com/bidAttachments/37484/Vermont Functioning Floodplains Initiative White: Paper.pdf

6. Price Schedule

Table 4, below, presents our proposed price schedule for this project.

Table 4. Proposed Price Schedule

Task Number/Name		Deliverable	Unit Rate	Unit	Units	Amount
Phase 1 Task 0 - Project Management		**Project Kickoff Meeting, Workplan and Ongoing Project Management**				**$8,608.00**
Professional Services					**48**	**$8,608.00**
	Project Manager	Senior Modeler	$178.00	Hours	32	**$5,696.00**
	Lead Stakeholder Outreach and Program Evaluation	Senior Scientist	$169.00	Hours	8	**$1,352.00**
	Lead Data Governance and Mapping	Senior App Developer	$195.00	Hours	8	**$1,560.00**
Phase 1 Task 1 - Data Governance		**Establish Data Governance Draft Plan Work with Digital Governance Committee**				**$22,750.00**
Professional Services					**134**	**$22,750.00**
	Project Manager	Senior Modeler	$178.00	Hours	32	**$5,696.00**
	Lead Stakeholder Outreach and Program Evaluation	Senior Scientist	$169.00	Hours	12	**$2,028.00**
	Lead Data Governance and Mapping	Senior App Developer	$195.00	Hours	36	**$7,020.00**
	Data Governance Support	Senior Professional	$169.00	Hours	14	**$2,366.00**
	Program/Tool Review	Project Professional	$141.00	Hours	40	**$5,640.00**
Phase 2 Task 0 - Project Management		**Bi-weekly Meetings for First 2 Months - Internal and with CAP, Additional Bi-weekly For Project Manager with Director**				**$4,854.00**
Professional Services					**27**	**$4,854.00**
	Project Manager	Senior Modeler	$178.00	Hours	15	**$2,670.00**
	Lead Stakeholder Outreach and Program Evaluation	Senior Scientist	$169.00	Hours	6	**$1,014.00**
	Lead Data Governance and Mapping	Senior App Developer	$195.00	Hours	6	**$1,170.00**

Task Number/Name		Deliverable	Unit Rate	Unit	Units	Amount
Phase 2 Task 2 -Logic Models		**Develop Logic Models, Decide on Metrics, Identify Data and Gaps**				**$37,460.00**
Professional Services					**220**	**$37,460.00**
	Project Manager	Senior Modeler	$178.00	Hours	40	**$7,120.00**
	Lead Stakeholder Outreach and Program Evaluation	Senior Scientist	$169.00	Hours	100	**$16,900.00**
	Lead Data Governance and Mapping	Senior App Developer	$195.00	Hours	40	**$7,800.00**
	Data Metrics Support	Project Professional	$141.00	Hours	40	**$5,640.00**
Phase 3 Task 0 - Project Management		**Project Management and Bi-weekly Meetings Or 4 Months**				**$12,944.00**
Professional Services					**72**	**$12,944.00**
	Project Manager	Senior Modeler	$178.00	Hours	40	**$7,120.00**
	Lead Stakeholder Outreach and Program Evaluation	Senior Scientist	$169.00	Hours	16	**$2,704.00**
	Lead Data Governance and Mapping	Senior App Developer	$195.00	Hours	16	**$3,120.00**
Phase 3 Task 3 - Data Mapping		**Develop Data Mapping**				**$26,776.00**
Professional Services					**164**	**$26,776.00**
	Project Manager	Senior Modeler	$178.00	Hours	40	**$7,120.00**
	Lead Stakeholder Outreach and Program Evaluation	Senior Scientist	$169.00	Hours	24	**$4,056.00**
	Lead Data Governance and Mapping	Senior App Developer	$195.00	Hours	40	**$7,800.00**
	Data Mapping Support	Project Professional	$130.00	Hours	60	**$7,800.00**
Phase 4 Task 0 - Project Management		**Project Management and Bi-Weekly Meetings**				**$11,488.00**
Professional Services					**64**	**$11,488.00**
	Project Manager	Senior Modeler	$178.00	Hours	40	**$7,120.00**
	Lead Stakeholder Outreach and Program Evaluation	Senior Scientist	$169.00	Hours	12	**$2,028.00**
	Lead Data Governance and Mapping	Senior App Developer	$195.00	Hours	12	**$2,340.00**
Phase 4 Task 4 - Infrastructure Recommendations		**Draft and Final Memo and Presentations**				**$20,120.00**
Professional					**112**	**$20,120.00**

Task Number/Name		Deliverable	Unit Rate	Unit	Units	Amount
Services	Project Manager	Senior Modeler	$178.00	Hours	40	**$7,120.00**
	Lead Stakeholder Outreach and Program Evaluation	Senior Scientist	$169.00	Hours	40	**$6,760.00**
	Lead Data Governance and Mapping	Senior App Developer	$195.00	Hours	32	**$6,240.00**
GRAND TOTAL						**$145,000.00**

7. Certificate of Compliance

CERTIFICATE OF COMPLIANCE

For a bid to be considered valid, this form must be completed in its entirety, executed by a duly authorized representative of the bidder, and submitted as part of the response to the proposal.

A. **NON COLLUSION:** Bidder hereby certifies that the prices quoted have been arrived at without collusion and that no prior information concerning these prices has been received from or given to a competitive company. If there is sufficient evidence to warrant investigation of the bid/contract process by the Office of the Attorney General, bidder understands that this paragraph might be used as a basis for litigation.

B. **CONTRACT TERMS:** Bidder hereby acknowledges that is has read, understands and agrees to the terms of this RFP, including Attachment C: Standard State Contract Provisions, and any other contract attachments included with this RFP.

C. **WORKER CLASSIFICATION COMPLIANCE REQUIREMENT:** In accordance with Section 32 of The Vermont Recovery and Reinvestment Act of 2009 (Act No. 54), the following provisions and requirements apply to Bidder when the amount of its bid exceeds $250,000.00.

Self-Reporting. Bidder hereby self-reports the following information relating to past violations, convictions, suspensions, and any other information related to past performance relative to coding and classification of workers, that occurred in the previous 12 months.

Summary of Detailed Information	Date of Notification	Outcome

Subcontractor Reporting. Bidder hereby acknowledges and agrees that if it is a successful bidder, prior to execution of any contract resulting from this RFP, Bidder will provide to the State a list of all proposed subcontractors and subcontractors' subcontractors, together with the identity of those subcontractors' workers compensation insurance providers, and additional required or requested information, as applicable, in accordance with Section 32 of The Vermont Recovery and Reinvestment Act of 2009 (Act No. 54), and Bidder will provide any update of such list to the State as additional subcontractors are hired. Bidder further acknowledges and agrees that the failure to submit subcontractor reporting in accordance with Section 32 of The Vermont Recovery and Reinvestment Act of 2009 (Act No. 54) will constitute non-compliance and may result in cancellation of contract and/or restriction from bidding on future state contracts.

D. **Executive Order 05 – 16: Climate Change Considerations in State Procurements Certification**

Bidder certifies to the following (Bidder may attach any desired explanation or substantiation. Please also note that Bidder may be asked to provide documentation for any applicable claims):

1. Bidder owns, leases or utilizes, for business purposes, space that has received:
   - ❑ Energy Star® Certification
   - ❑ LEED®, Green Globes®, or Living Buildings Challenge℠ Certification
   - ❑ Other internationally recognized building certification:

_____

2. Bidder has received incentives or rebates from an Energy Efficiency Utility or Energy Efficiency Program in the last five years for energy efficient improvements made at bidder's place of business. Please explain:

In September 2019, we worked with our building's landlord to install solar panels on our rooftop to partially power our business operations. To date, we have saved over 404,000 pounds in CO2 emissions.

3. Please Check all that apply:
   - ☑ Bidder can claim on-site renewable power or anaerobic-digester power ("cow-power"). Or bidder consumes renewable electricity through voluntary purchase or offset, provided no such claimed power can be double-claimed by another party.
   - ❑ Bidder uses renewable biomass or bio-fuel for the purposes of thermal (heat) energy at its place of business.
   - ☑ Bidder's heating system has modern, high-efficiency units (boilers, furnaces, stoves, etc.), having reduced emissions of particulate matter and other air pollutants.
   - ☑ Bidder tracks its energy consumption and harmful greenhouse gas emissions. What tool is used to do this? _____
   - ☑ Bidder promotes the use of plug-in electric vehicles by providing electric vehicle charging, electric fleet vehicles, preferred parking, designated parking, purchase or lease incentives, etc..
   - ☑ Bidder offers employees an option for a fossil fuel divestment retirement account.
   - ☑ Bidder offers products or services that reduce waste, conserve water, or promote energy efficiency and conservation. Please explain:

We provide clients with scientific tools, information, and analysis to help solve environmental challenges. Our areas of expertise include environmental assessment and remediation; environmental planning and policy development; environmental monitoring and modeling; the evaluation, siting, and design of agricultural, developed lands, forest land, and natural resource water quality projects and practices; stream and ecological restoration; and geospatial and data analysis, visualization, and application development. In Vermont much of our work focuses on understanding and addressing the impacts of Vermontâ€™s land use on the natural environment, strengthening ecosystem and community resilience to climate change, and promoting sustainable development and site reuse.

4. Please list any additional practices that promote clean energy and take action to address climate change

Good business practices and environmental stewardship go together. We consider it our duty to promote, preserve, and protect the environment in both our day-to-day operations and as part of our long-term business model. We actively support a wide range of organizations and networks across Vermont through direct financial support (via memberships, sponsorships, and donations), as well as volunteering time and resources. Stone has a dedicated team that meets regularly to ensure we're doing our part as environmental stewards. We promote the use of recycled and environmentally friendly products and practices as often as possible, provide composting and recycling services, and offer flexibility for staff to work remotely. Our office currently provides and is expanding the number of charging stations for staff using electric and hybrid vehicles. As a corporate sponsor of the ESSEX Plan, Stone is actively working to adopt policies and practices for reducing greenhouse gases emissions and our overall impact on climate change.

E. **Executive Order 02 – 22: Solidarity with the Ukrainian People**

☑ By checking this box, Bidder certifies that none of the goods, products, or materials offered in response to this solicitation are Russian-sourced goods or produced by Russian entities. If Bidder is unable to check the box, it shall indicate in the table below which of the applicable offerings are Russian-sourced goods and/or which are produced by Russian entities. An additional column is provided for any note or comment that you may have.

Provided Equipment or Product	Note or Comment

Bidder Name: Stone Environmental, Inc. Contact Name: Jody Stryker

Address: 535 Stone Cutters Way Fax Number: 802.444.5790

Montpelier, Vermont, 05602 Telephone: 802.229.5417

E-Mail: jstryker@stone-env.com

By: _____ Name: Michael Winchell

Signature of Bidder (or Representative) (Type or Print)

END OF CERTIFICATE OF COMPLIANCE

Appendix A. Key Staff Resumes

Jody Stryker, Ph.D. / *Senior Environmental Modeler*

Jody has interdisciplinary training in environmental sciences and engineering, with a concentration on hydrological processes and sediment transport. At Stone, she conducts research using a broad range of model applications and data analysis techniques, ranging from site specific field-scale APEX modeling of nutrient loss to evaluation of off-site pesticide transport for national scale risk assessment. She seeks collaborative, innovative, and intentional solutions to environmental challenges. Jody currently manages several projects with objectives that aim to increase sustainability and resilience of our environmental and agricultural systems, including the development of data-driven web application tools to incentivize agricultural conservation practices and high priority floodplain and river reconnection projects.

Years of Experience / 12

Years of Experience at Stone / 7

Education

Ph.D., Civil and Environmental Engineering, 2016, University of Vermont – "Sediment Mobilization from Streambank Failures: Model Development and Climate Impact Studies"

Master of Science, Civil and Environmental Engineering, 2012, University of Vermont

Bachelor of Science, Environmental Science, 2004, University of Miami

Skills

Environmental Modeling Applications Including APEX, PRZM, PWC, DHSVM, BSTEM, HEC-RAS, SWAT, AERMOD, and others

Programming in Python, C, Visual Basic, Fortran, R, Postgres, and others

Database Management and Development, Application Development

Data Analysis and Statistics

ArcGIS and Spatial Analysis

Development and Assessment of Methodologies

Writing, Editing, Presenting, and Professional Communication Skills

Project Management

Related Project Experience

Functioning Floodplains Initiative (FFI) Web Tool Development / 2023–Present / 20231098

Project manager and technical advisor on continued development of the Functioning Floodplains Initiative (FFI) Web Tool. This scope of work will provide the state with development services to enhance functionality of the tool (including a user management system, build out of a system for recalling user specific project calculations), will provide hosting support and maintenance services for both a production and development versions of the tool, and will improve connections between the Watershed Project Database and the FFI Web Tool.

Development of a Soil Health Calculator Tool to Quantify Impacts of Agricultural Management Practices on Soil Health in the Lake Champlain Basin / 2023–Present / 20211251

Project manager and technical advisor on developing a soil health calculator tool that provides quantitative and field-specific information about the impact of agricultural management on key soil health indicators. This is based on a modeling approach using the United States Department of Agriculture (USDA) Agricultural Policy Environmental eXtender model (APEX). The objective is that the tool can be used by a broad range of stakeholders, with farmers and agricultural/crop consultants as the primary user groups, to support adoption of conservation practices by providing a better understanding of the relative impact of those practices and evaluating management options tailored to specific farm/field conditions.

Farm-PREP Climate Modifications / 2023–Present / 20231024

Project manager and technical advisor on enhancing the Farm-PREP tool with respect to agricultural health and climate resiliency indicators. Modifications will enable the state to evaluate the benefits of modified management practices on improving water quality, enhancing soil health, reducing carbon emissions, and mitigating climate change in Vermont. This project includes a comparison of greenhouse gas (GHG) models including APEX, COMET, DayCENT, and DNDC, as well as APEX/Farm-PREP modeling of 1) carbon emissions and sinks on cropland, 2) carbon emissions and sinks on pasture, and 3) soil aggregate stability. The objective is to identify and incorporate an approach that can be implemented in the Farm-PREP tool and that is best suited to represent GHG and carbon sequestration on Vermont farms.

Agricultural Stewardship Tool Modifications / 2022–Present / 20221078

Leads continuing development of Stone's web-based tool, the Farm Phosphorus Reduction Planner (Farm-PREP), to meet the needs of the Vermont Agency of Agriculture, Food and Markets. This will add functionality to the tool for simulating pasture/grazing and associated management options.

Farm-PREP Modification / 2021–Present / 20-121

Leads ongoing development of Stone's web-based tool, the Farm Phosphorus Reduction Planner (Farm-PREP), to meet the needs of the Vermont Agency of Agriculture, Food and Markets. This includes modifications to the application workflow to support the State's innovative Pay for Phosphorus programs, as well as development of additional requested functionality. This work includes changing the baseline phosphorus runoff to be based on assumptions from Vermont's Lake Champlain Total Maximum Daily Loads (TMDLs) and assignment of baseline management to represent similar assumptions as were assumed in the TMDL SWAT modeling conducted by EPA.

Phase 2 of the Vermont Functioning Floodplain Initiative: Functioning Floodplain Assessment, Mapping, Valuation, and Tracking to Support Floodplain Restoration and Protection in the Lake Champlain Basin / 2019–Present / 19-120

Manages Stone's role within an interdisciplinary team working to expand Phase 1 FFI methods to enhance departure analysis of the connection status of Vermont rivers and floodplains and expand valuation metrics and tools to engage stakeholders. Assists with design of a web-based tool to prioritize and visualize implemented reconnection projects to track progress towards implementing the Lake Champlain TMDL and naturalize river-floodplain interactions.

Comparison of Stewardship Evaluation Tools for the Vermont Environmental Stewardship Program / 2019–2021 / 19-173

Is project manager and technical lead in evaluating and comparing outputs from two different USDA stewardship models/tools (APEX and RSET). Led development of field-scale APEX models for over 50 fields and multiple usage scenarios. Automated processing of simulation results and comparison with RSET outputs. Preparation of reports and project deliverables.

Enhancement of APEX Farm and Field-Scale Modeling to Simulate the Impacts of Manure Processing Technologies / 2018–2019 / 18-126

Model development/enhancement to include the impact of alternative manure processing technologies on field and farm-scale phosphorus loading. Also assisted in incorporation of these technologies in the web-based application for optimization of practices (Farm-PREP). Responsibilities included model development and back-end programming, client communication, preparation of memos and progress/project reports.

Development of Global Parameter Set and Calibration/Validation of APEX Models using Edge of Field and Tile Monitoring Data / NEWTRIENT and Lake Champlain Basin Program / 2018–2019 / 18-134

Calibrated and validated APEX models to edge of field and tile drain monitoring data in Vermont and New York. Development of a global parameter site for incorporation into the web-based application (FarmPREP) for optimization of farm management practices and aiding in reaching phosphorus loading goals (TMDLs) in the Lake Champlain Basin is ongoing. This involves multi-parameter optimization with respect to flow, sediment, and nutrient loading, as well as visualization and reporting of results.

Farm-Scale Optimization of the Farm Phosphorus Reduction Planner Tool (Farm-PREP) / Lake Champlain Basin Program / 2017–2018 / 17-054

Contributed to development of farm-scale phosphorus targets, development of web-based APEX tool for predicting and optimizing phosphorus loss, and well as model implementation and testing. Also assisted in preparing project related proposal, QMP, QAPP and progress report documents.

VTrans Missisquoi Phosphorus Control Plan / 2018

Determined drainage basin level phosphorus loading rates as part of methodology development to prioritize and credit implementation projects to aid in meeting TMDL requirements for paved roads. Loading rates were distributed among road slope classes to meet DEC TS4 loads for paved roads. Loading multipliers were also calculated based on hydro-connectivity scoring of roads in each slope class to further explore ways of prioritizing road segments for phosphorus control projects.

Barbara Patterson / *Senior Database Applications Developer*

Barb has over 25 years of database and application design experience. At Stone, she works with clients to design and implement data-driven solutions to inform and enhance decision-making, support long-term program planning, and communicate and track progress towards local, regional, and statewide initiatives. Barb's recent work includes the development and integration of web-based tools like the Vermont Partners database and the Farm Phosphorus Reduction Planner (Farm-PREP) aimed at reducing agriculture's impact on water quality, as well as a variety of data management and visualization platforms designed to address climate change and strengthen resilience.

Years of Experience / 26

Years of Experience at Stone / 24

Education

Master of Science, Environmental Studies, 1994, The Evergreen State College

Bachelor of Arts, Mathematics and Spanish, 1988, Bucknell University

Skills

Project Management

Data Management Strategies

Database and Application Development

GIS Analysis

Model Interface Development

Programming Experience: PostgreSQL, PostGIS, MS SQL, Python, Visual Basic

Scientific Software: ArcGIS, ArcGIS Server, Access, Excel

Professional and Community Activities

Northeast Arc Users Group

Town of Calais: Conservation Commission member

Related Project Experience

Development of the Vermont Transportation Resilience Planning Tool (TRPT) / Vermont Agency of Transportation / 2015–Present / Vermont / 15-131,18-111

Lead back-end developer for development of the TRPT application for Phases I through III, including initial pilot watershed work and expansion of the application statewide. The custom web application allows users to view the results of multi-variate models to assign risk, vulnerability and criticality of road networks. Developed a custom python tools for use by Regional Planning Commissions to validate data and calculate 10, 50, and 100-year flood scores for vulnerability, calculate criticality scores, and prepare data for upload to the TRPT database. A separate python tool was developed that allows VTrans to easily import RPC data to the TRPT database.

Phase I of Development of the Vermont Transportation Resilience Planning Tool (TRPT) / Vermont Agency of Transportation / 2015–2018 / Vermont / 15-131

Lead database developer for a custom web mapping application that views the results of multi-variate models to assign risk, vulnerability and criticality of road networks for given pilot watersheds. The database utilizes ArcSDE and Microsoft SQL Server. Model data were first aggregated by road and structure featured and stored as json strings to simplify the front-end development.

Phase II of Development: Vermont Transportation Resilience Planning Tool (TRPT) / Vermont Agency of Transportation / 2018–2020 / Vermont / 15-131, 18-111

Project manager and lead back-end developer for Phase II development of the TRPT application aimed at expanding the application of the tool to new watersheds and users. Developed a custom python tools for use by Regional Planning Commissions to validate data and calculate 10, 50, and 100-year flood scores for vulnerability, calculate criticality scores, and prepare data for upload to the VTrans TRPT application. A separate python tool was developed that allows VTrans to easily import RPC data to the TRPT database.

Phase III of Development: Vermont Transportation Resilience Planning Tool (TRPT) / Vermont Agency of Transportation / 2020–Present / Vermont / 18-111

Project manager and lead back-end developer for Phase III development of the TRPT application to provide continued support and improvements to the TRPT application and data validation and import tools.

City of Malibu Integrated Wastewater Information System (IWIMS) Version 2.0 / City of Malibu / 2016–Present / Malibu, California / 16-099

Project manager and lead database developer for the migration of the City of Malibu's online web database for management of on-site wastewater system and permit information. The enhanced IWIMS 2.0 enables for efficient data entry, reporting, and dashboard notifications. The backend PostgreSQL database handles user management, data validation, and reporting logic. Integrated the application with Google Docs to provide the City with a way of integrating the application's data with editable letter templates.

Functioning Floodplain Assessment, Mapping, Valuation, and Tracking to Support Floodplain Restoration and Protection in the Champlain Basin (Phase II) / Vermont Agency of Natural Resources, Department of Environmental Conservation Water Investment Division / 2019–Present / Vermont / 19-120

Technical lead for developing a web application to view floodplain connectivity data, support decision-making on floodplain and wetland restoration prioritization, and track project implementation. Stone has gathered and refined user requirements from the stakeholders for the application. A custom database and front-end application will be comprised of two separate front-end interfaces integrated with a common back-end database. The application will be available to the public for viewing potential projects and anticipated benefits for a specific floodplain, and for regulators to enter permanent data for implemented projects.

PermianMAP: Mapping and Measuring Oil and Methane Gas Emissions in the Permian Basin / Environmental Defense Fund / 2019–Present / 19-119

Project manager for the design and development of an ArcGIS Online platform that provides both technical and educational contents on oil and gas methane emission data in a public-facing interface. The online platform includes a site for sharing general information related to the initiative with the public, as well as an interface with maps, tools, and dashboards for visualizing, querying, filtering, analyzing, and downloading data for regulators, scientists, researchers, and technical-minded reporters. You can view the Operators Dashboard: https://data.permianmap.org/pages/operators

Integrated Water Quality Mapping Application with the Vermont Partners Database / Vermont Agency of Agriculture Food and Markets, Water Quality Division / 2019–Present / Vermont / 19-039

Project manager for the development and integration of a new farm water quality multi-user online mapping application and spatial data management system within the Vermont Partner Database. Development of the solution has included developing separate user roles for VAAFM's water quality inspection team such that users of the system do not have access to any of the VT Partner practice data. The solution has helped simplify the VAAFM's current workflow for mapping on-farm inspection information by providing multiple users the ability to access the application; quickly create farm inspections, add structures, fields, buffers, and other farm assets associated with the inspection; and create detailed maps of all farm data. The application also includes a custom labeling tool allowing the users to create detailed labels needed for the inspection reports. Ultimately, the integration of the water quality inspection data with the Agency's farm practice data will provide the VAAFM with a more holistic picture of all activities on a farm.

Vermont Agricultural Best Management Practice Multi-Partner Geospatial Database (Vermont Partners Database) / Vermont Agency of Agriculture Food and Markets / 2014–2020 / Vermont / 14-243

Lead database developer and project manager for a web-based mapping application that allows the Vermont Agency of Agriculture and its partners to easily enter, track, and report on farm field best management practices. The backend ArcSDE/PostgreSQL/ PostGIS database handles spatial processing to determine field slope and soils, manages role-based users in the application and row level security. The database also manages the application reporting so that users can generate aggregate reports of practices and generate custom exports of practices and associated geometry in Esri compatible format.

Farm Phosphorus Management Optimization Tool (Farm-PREP) / Lake Champlain Basin Program / 2017–2018 / Vermont / 17-054 and 18-013

Lead overall development for the Farm-PREP tool, an integrated web-based application developed to help farmers, technical crop consultants, and stakeholders easily evaluate the impacts of field-level best management practices on farm scale phosphorus loss reductions and identify modifications to their field operations to help achieve water quality improvement targets on the watershed-scale. Modified the existing Rich Internet Application to make the APEX model by NRCS easy enough for all its field staff in Vermont to use the tool to compare BMPs. Key technology: ArcGIS Server, ArcSDE, C# .Net, WCF .NET, Silverlight, XAML. For more info about Farm-PREP, visit: https://farm-prep.net/info/#text-1

Annemarie Fortune, AICP / *Brownfields Program Manager*

Annemarie is an experienced planning professional committed to co-developing more resilient and equitable communities through policy, system, and environmental changes. Before joining Stone, she collaborated with stakeholders in local and state government, the development community, and community-based organizations in Colorado to advocate for innovative, place-based solutions to complex environmental health challenges. As the Brownfields Program Manager, Annemarie expedites projects' progress from environmental due diligence through remediation and closure by advocating on behalf of the client, engaging the local community, and addressing the barriers and challenges to brownfield redevelopment.

Years of Experience / 11

Years of Experience at Stone / 2

Education

Master of Urban and Regional Planning, 2016, University of Denver College of Architecture and Planning

Master of Public Health, 2016, Colorado School of Public Health

Bachelor of Arts, Biology and Environmental Studies, 2012, Colgate University

Professional Certifications

American Institute of Certified Planners (AICP)

Skills

Brownfield Redevelopment

Local and Regional Planning

Stakeholder Engagement and Facilitation

Partnership Development

Policy Analysis and Advocacy

Regulatory Coordination and Permitting

Grant Management

ArcGIS and Data Analysis

Honors and Awards

Robert Giltner Memorial Scholarship

Dean's Scholarship

Related Project Experience

30 Henry Street / Bellows Falls Community Bike Share / 2022–Present / Bellows Falls, Vermont / 20221158

Project management including site access, subcontractor coordination, and ensuring project deadlines and budgets are met. Navigating client through brownfield regulatory processes including assisting the client in BRELLA enrollment. Identifying resources to support site assessment and remediation, and compiling funding applications to regional and state funding sources. Participating in stakeholder meetings to minimize uncertainty and ensure the client is well-versed in the redevelopment process.

Edgar May Health and Recreation Center Brownfield Redevelopment / NorthStar Health / 2022–Present / Springfield, Vermont / 20-069

Exploring funding opportunities to support site remediation and redevelopment including leading efforts to apply for EPA FY24 Brownfield Cleanup funding. Identifying environmental, social, and health data to develop a compelling story articulating the benefits of site revitalization to community well-being. Supporting the client in stakeholder and community engagement ensures programming, site design, and redevelopment vision align with community needs to build project support. Developed a resource roadmap to support client in prioritizing and identifying applicable funding resources for their redevelopment. Created a project briefing sheet to build support for the project, highlight project milestones, and craft an articulate ask of potential partners,

Jeffersonville Granary / Lamoille County Planning Commission / 2022–Present / Jeffersonville, Vermont / 19-089

Identified funding opportunities for remediation and redevelopment and providing technical assistance in developing funding applications and potential funding stacks to ensure project success. Tracking due diligence requirements and ensuring all necessary steps are taken to avoid future challenges and barriers with the project. Coordinating stakeholders across State and regional agencies to leverage support for the project.

Benn Hi Environmental Due Diligence / Hale Resources, LLC / 2023–Present / Bennington, Vermont / 20231034

Supporting the client in navigating environmental liability and due diligence. Identifying funding opportunities for environmental assessment, remediation, and redevelopment. Enrolled the client in BRELLA. Coordinating essential stakeholders to build a coalition of support for the project to ensure its success.

TLR Complex & Penta Wyman Flint / Sustainable Valley Group / 2022–Present / Barre City, Vermont / 20221270 & 20201002

Supported client in BRELLA enrollment for both sites. Identified and leveraged regional and state funding to support the Phase II ESA and data gap analysis for both properties. Assisting client in understanding how environmental concerns impact development potential. Providing technical assistance to support path forward, including potential funding, community outreach, and planning needs.

Turning Point Center / Turning Point Center of Central Vermont / 2023–Present / Barre City, Vermont / 20211145

Assisting client in the identification and acquisition of remediation funding to support the expansion of a recovery facility. Developed a $500,000 grant request for brownfield cleanup funding with a request to waive the 10% match requirement. Built support for the project through stakeholder coordination and introductions.

Greater Rockingham Area Services Environmental Review / Greater Rockingham Area Services / 2023–Present / Bellows Falls, Vermont / 20221281

Completing the environmental review as part of the National Environmental Policy Act (NEPA) including analyzing a variety of environmental impacts and coordination across State and federal agencies. Leading Act 250 permitting process to support the replacement of an antiquated heating system with a more energy efficient, renewable biomass boiler.

105-107 Eastern Avenue & 115 Eastern Avenue / Catamount Arts / 2023–Present / St. Johnsbury, Vermont / 20231018 & 20231062

Led BRELLA enrollment process for both properties to ensure liability protections and enable access to public funding. Stakeholder coordination across the Vermont Department of Environmental Conservation, Agency of Commerce and Community Development, Northeastern Development Association, and Catamount Arts to expedite the projects through environmental due diligence, including securing project funding.

Greater Rockingham Area Services Environmental Review / Greater Rockingham Area Services / 2023–Present / Bellows Falls, Vermont / 20221281

Completing the environmental review as part of the National Environmental Policy Act (NEPA) including analyzing a variety of environmental impacts and coordination across State and federal agencies. Leading Act 250 permitting process to support the replacement of an antiquated heating system with a more energy efficient, renewable biomass boiler.

56 Main Street & 202 Bay Street / Zion Growers / 2023–Present / Proctor and St. Johnsbury Vermont / 20221236 & 20-117

Funding navigation services for both environmental due diligence and corrective action plan implementation equating to nearly $300,000 in pending grant funding. Support with project coordination across state agencies including the State Historic Preservation Office, Brownfield Revitalization Fund, and VT DEC as well as local partners including the Town of St. Johnsbury, NVDA, and RRPC.

Publications and Presentations

Ghose, Seve & Fortune, Annemarie. 2020. “Love My Air: Exploring Air Quality Opportunities Through Parks and Recreation Programming”. Presented at the Public Health Parks and Recreation (PHPR) Summit: Community Resilience thru Public Health, Parks and Recreation. February 26, 2021.

Weakley, Michael & Fortune (Heinrich), Annemarie. 2019. “Bald Mountain Estates: Well Variances”. Presented at the Colorado Environmental Health Association (CEHA) Annual Education Conference. September 2019.

Fortune (Heinrich), Annemarie. 2016. “Private Well Contamination: User Demographics and Land Use Implications”. Presented at the Colorado School of Public Health. December 2016.

Jens Kiesel, Ph.D. / *Environmental Modeler*

Dr. Kiesel is an environmental modeler and hydrologist with more than 10 years of international experience in project planning and implementation. He has experience ranging from the local scale up to transboundary river basins in Europe, Africa, and Asia. He mainly works on the prediction of natural and anthropogenic impacts on water resources and agriculture, including climate change, sediment transport, nutrient- and chemical fate as well as water quality processes. Jens specialized in tailored software solutions to enable automated workflows, big data processing and comprehensive uncertainty analyses in the fields of hydrology, landscape modelling and spatial analysis.

Years of Experience / 14

Years of Experience at Stone / 2

Education

PhD, Natural Sciences, 2014, Kiel University (Germany). Dissertation Title: Ecohydrologic and hydraulic stream modelling to describe aquatic habitats.

Diploma in Civil Engineering, 2006, University of Technology, Darmstadt (Germany).

Diploma Thesis in hydrologic modelling at Addis Ababa University, 2005, Ethiopia

Honors Thesis in Urban Stormwater Drainage Modelling, 2004, University of New South Wales, Sydney, Australia

Skills

Hydrologic and hydraulic modeling, Environmental flows, GIS, climate change impact and adaptation, erosion and sediment transport, field assessments, training

Spatial Data Analysis: QGIS & PyQGIS, ArcGIS & ArcObjects, GDAL

Hydrologic Modelling: SWAT, HEC-HMS, Talsim, MikeHydro, SWMM

Hydraulic Modelling: HEC-RAS, AdH

Programming Skills: Python, R, C++, Fortran

Employment History

Stone Environmental, Inc. / Bartholomäberg, Austria
Environmental Modeler / September 2021–Present

At Stone, Jens utilizes established watershed models, custom-built models and software as well as geo-spatial analyses tools in a wide range of water-related projects. His responsibilities include the investigation of hydrologic processes and climate change impacts as well as the fate and transport of nutrients and pesticides from the field scale up to the river basin scale.

Kiel University / Kiel, Germany
Post-Doctoral Research Associate / March 2021–Present

Jens works in the German Research Foundation funded Collaborative Research Center RESIST, in which experiments, field studies and modelling are combined to disentangle the response of aquatic organisms to multiple stressors. Jens is using the SWAT+ model to simulate hydrology and water quality processes to provide information on temperature, oxygen, nitrogen components and salinity for ecological assessments. He works together with the SWAT+ development team on improving and testing model algorithms. His work also includes the supervision of Master and PhD students.

Freelance Consultant / Germany
Principal Engineer / 2008–August 2021

During his time as a freelance consultant, Jens has worked in more than 30 development cooperation projects in 18 countries and major river basins such as the Nile, Mekong and Zambezi. The projects included a wide range of water engineering, hydrologic and hydraulic topics such as water scarcity, flooding, forecasting, impact of dams, sediment transport, wetland processes and climate change. The common challenge in most of these projects were the need to provide a basis for informed decisions under scarce data availability and high uncertainties.

Leibniz Institute of Freshwater Ecology (IGB) / Berlin, Germany
Post-Doctoral Research Associate / 2014–March 2021

Jens held a post-doc position in the Department of Ecosystem Research where he investigated hydrological and hydraulic processes under current and future conditions. His activities included the coordination of field teams, SWAT model applications, environmental flow assessments with hydrological indicators, climate change impact and uncertainty assessments, working together with ecologists to assess impact of environmental flow changes on species assemblage under uncertain predictions. During his time at IGB, he also contributed to the global analysis of the link between hydrology and freshwater biodiversity.

Related Project Experience

Higher Tier Waterbody Analysis For Grape Growing Regions / 2021–2022 / New Zealand

Streamflow data analyses, model development and application to calculate representative streamflow values for New Zealand's major grape-growing regions.

SWAT + Modeling In An Agricultural Catchment / 2021 / Belgium

Multi-objective calibration of SWAT+ for hydrology, pesticide, and metabolites using the newly developed pesticide routing and metabolite formation functionalities in SWAT+.

Estimating Buffer Distances To Wetlands For Mitigating Concentrated Flow From Herbicide-treated Soybeans / 2021 / USA

Complex GIS analyses and spatial programming to develop a tool that calculates high resolution interception distances and dilution factors of concentrated flow originating from treated agricultural fields across whole federal states.

Multilevel Response to Stressor Increase and Release in Stream Ecosystems (RESIST) / German Research Foundation / 2021–Present / Germany

Field work to observe hydrological and hydraulic parameters, diatom distribution, high-resolution temperature mapping using Distributed Temperature Sensing and infrared technologies. SWAT+ model application and code improvements to simulate oxygen, temperature, salinity, and nitrogen components in a rural and urban catchment in high spatio-temporal resolution.

Mapping and Valuing Ecosystems Services, and Prioritizing Investments in Select Watersheds in Tajikistan to support Sustainable Hydropower / HYDROC, Worldbank / 2020–July 2022

The reservoir of Rogun Dam, once completed the highest dam in the World, is subject to severe sedimentation. SWAT is therefore coupled with GIS-based erosion models to assess the total sediment input from landslides, gully erosion, screes, sheet and rill as well as channel erosion. Worked with the project team and stakeholders to develop BMPs and testing these in the modelling framework. Providing input and model results to an ecosystem services valuation.

Short Term Contribution to Global Freshwater Biodiversity Research / IGB Berlin / 2020–2021 / Germany

Application of the machine learning method "LSTM" using different datasets and time steps for the CAMELS dataset. Comparison of model performance for different datasets to assess usability of the dataset for global applications.

High Resolution SWAT Modeling for a Mesoscale Catchment / Stone Environmental / 2020–2021 / Germany

SWAT model hydrological and pesticide calibration, complex land use and management parameterization, Monte Carlo simulations for uncertainty assessments.

Annual Mekong Flood and Drought Reports (AMFDR) / Mekong River Commission / 2017–2019 / Mekong

Compiled data and summarized national reports for the development of AMFDRs. Analysis of remote sensing data of flood extent and soil moisture to assess the flood and drought situation; review of the flood and flash flood forecasting system, describing emerging technologies to cope with floods and droughts.

Study for the Machar Marshes Eco-Hydrology Assessment / HYDROC, Eastern Nile Regional Technical Office (ENTRO) / 2019–2020 / Ethiopia, South Sudan

Assessment of the complex water balances of the Machar Marshes utilizing remote sensing products (actual evapotranspiration, soil moisture, NDVI, rainfall), hydrologic modeling of the inflows from the Ethiopian escarpments, detailed hydraulic modeling of the Baro spilling region using commercial DEMs, hydraulic modeling of the Machar Marshes with Mike11 and Mike SHE, linking of results for e-flows assessments and NileDSS integration, analyzing scenarios.

Supervision and Advice on Sediment Transport Modelling for the Chorokhi River, Georgia / HYDROC, Struijk Georgia / 2018–2020 / Georgia

Support and advice to national consultants and Struijk Georgia in sediment transport modeling in the Chorokhi River including data assessment and data collection recommendations, setup, and model tuning as well as data analysis and results in presentation.

Jennifer Cypher / *Quality Assurance Manager*

Jenn has nearly 20 years of experience developing and maintaining rigorous quality management systems (QMS). She has a background in precision manufacturing where she implemented QMS to support aerospace applications. At Stone, she manages QAU services for US EPA-regulated environmental and agrochemical field studies. Jenn is a Registered Quality Assurance Professional (RQAP-GLP), a certified AS9100 Lead Auditor, and a member of the American Society for Quality (ASQ), the Society for Quality Assurance (SQA), the National Alliance of Independent Crop Consultants (NAICC), the American Chemical Society (ACS), and the Research Quality Association (RQA).

Years of Experience / 20

Years of Experience at Stone / 2

Education
Bachelor of Science, Environmental Science/Biology, 2004, University of Maine at Farmington

Professional Certifications
Certified AS9100 Lead Auditor

RQAP-GLP

Skills
Good Laboratory Practice (GLP) Standards Training (40 CFR Part 160)

Quality System Design and Implementation

Internal Audit Management

Inspection Document and Process Control Plan Development

Employee Training

Technical Writing

Database Design and Development

Continuous Improvement

Professional and Community Activities
Member, American Society for Quality

Member, Society for Quality Assurance

Member, National Alliance of Independent Crop Consultants

Member, American Chemical Society

Member, Research Quality Association

Additional Education
Environmental Policy and Planning

Employment History

Stone Environmental Inc. / Montpelier, Vermont
Quality Assurance Manager / H&S Officer / November 2020–Present
Responsible for ownership and administration of the quality management system outlined in the Quality Management Plan. Responsible for reviewing outgoing protocols/reports and conducting critical phase inspections for GLP-compliant projects. Responsible for developing and implementing quality systems for company processes both project and non-project related. Approves Site Specific and Generic Quality Assurance Project Plans (QAPPs). Administers the Corporate Health and Safety Management Program; acts as a resource for employees of the company and manages the Safety Committee. Reviews and approves project-specific site Health and Safety Plans for field investigations.

Concepts NREC / White River Junction, Vermont
Quality and Continuous Improvement Manager / November 2018–2020
Responsible for ownership and administration of quality management system for AS9100-certified turbomachinery design, engineering, and manufacturing firm. Managed internal audit program to ensure compliance to corporate, regulatory and contractual requirements. Led corrective/preventative action process and root cause analysis. Managed employee training and prepared, revised, and distributed quality assurance documents including work instructions, forms, manuals, and test procedures. Prepared inspection documents, process control plans, and failure analysis for aerospace customers. Managed supply chain, performed supplier audits and implemented new enterprise resource planning (ERP) software.

Creare, LLC / Hanover, New Hampshire
Configuration Control Manager, Fabrication Manager / 2004–2018
Manager of precision machine shop and engineering fabrication department, production manager for key fabrication programs, including spaceflight projects. Prepared process control plans, final acceptance documentation. Prepared and implemented Quality Assurance Procedures and managed employee training.

State of Maine / Augusta, Maine
Pesticide Control Technician, Board of Pesticides Control / 2002
Created reference material for inspectors and informational pamphlets for public outreach. Performed various types of inspections including dealer, restricted use, application, and storage facilities. Developed and implemented protocol for pesticide spray drift monitoring program.

Related Project Experience

Volatility Studies (Multiple) / Confidential Clients / 2022–Present / Minnesota, North Dakota / Stone Project 20221117, 20221120

Served as assigned Quality Assurance Unit (QAU) for multiple volatility studies in Minnesota and North Dakota. Specific phase inspections included field phases, field notebooks, raw data and final reports.

PCBs in Schools Inventory and Air Sampling / State of VT Department of Environmental Conservation / 2022–Present / Vermont / Stone Project (Multiple)

Performed building inventory and air sampling tasks in multiple schools in support of VT Act 74 requirement for all schools built or renovated prior to 1980 to test their indoor air for PCBs. Project Manager Jan 2023 to present.

Drift Deposition Studies (Multiple) / Confidential Clients / 2021–Present / Missouri, Illinois, Texas / Stone Project 20211114, 20211115, 20211116, 20211117, 20211118, 20211119, 20221198

Served as assigned Quality Assurance Unit (QAU) for multiple drift deposition studies in the Midwest and Texas. Specific phase inspections included field phases, plant effects, field notebooks, raw data and final reports.

Off-Target Deposition of Spray Solutions / Confidential Client / 2021 / Texas / Stone Project 20-093

Performed QAU duties and phase inspections of raw data, field notebook and final report.

Development of ISO 14064 Quality Management System / Confidential Client / 2020–2021 / Montpelier, Vermont / Stone Project 20-080

Developed guidance document and toolkit for use in implementing an ISO-14064 compliant Quality Management System. Provide ongoing consulting support for implementation activities.

Vegetative Filter Strip (VFS) Impact on Runoff Transport and Fate / Confidential Client / 2020–2021 / Georgia / Stone Project 16-097

Performed QAU duties and phase inspections of raw data, field notebook and final report.

Sampling for Possible Gaseous Field Loss After Application of a Commercial Herbicide with a Tank Mix Partner / Confidential Client / 2020–2021 / Iowa / Stone Project 18-010

Performed QAU duties and phase inspections of raw data, field notebook and final report.

Off-target Movement Assessment of a Spray Solution / Confidential Client / 2020–Present / Stone Project 20-042

Performed QAU duties and phase inspections of raw data, field notebook and field sub-report.

AS9100 Internal, Supplier Audits / Concepts NREC / 2018-2020 / White River Junction, Vermont

Executed internal audits and supplier compliance audits for AS9100 certified engineering firm. Audit design/planning, execution, report writing and corrective action follow-up.

Wide Range Vacuum Pumps for the SAM Instrument on the MSL Curiosity Rover / NASA / 2011 / Hanover, New Hampshire

Managed fabrication schedule, configuration control, documentation, and compliance activities for complex spaceflight program. This project produced two of the smallest available miniature vacuum pumps which were subsequently integrated into the MSL SAM Instrument Suite on the Curiosity Rover, launched aboard an Atlas V rocket in 2011, landed on Mars in August 2012, and has worked successfully for more than eight years (2000+ Martian sols).

Publications and Presentations

Cypher, Jennifer. 2022, Herding Cats: SOP Management for the Small CRO, National Alliance of Independent Crop Consultants, 2022 Annual Meeting

Cypher, Jennifer. 2022, Quality Culture: Incorporating Quality Principles Across Your Organization, American Chemical Society (Agro Division), 2022 Fall Meeting and Expo

Cypher, Jennifer. 2023, Field Faux Pas: Common Field Findings and How to Avoid Them, National Alliance of Independent Crop Consultants, 2023 Annual Meeting

Amy Macrellis / *Senior Water Quality Specialist*

Amy has over 20 years of experience providing technical leadership for water quality assessments, stormwater treatment system and policy evaluations, wastewater planning and feasibility studies for unsewered communities, and research projects. Her recent work implements wastewater and green stormwater infrastructure in policy and practice for municipalities and for regional and state agencies, including leading development of the Lake Champlain basin-wide Phosphorus Control Plan for VTrans. She also completes site, soil, and hydrogeologic evaluations in preparation for design and construction of stormwater BMPs and community wastewater systems.

Years of Experience / 24

Years of Experience at Stone / 22

Education
Master of Science, Environmental Geoscience, 1999, Michigan State University

Bachelor of Arts, Geological Sciences (Environmental Science concentration), 1997, Albion College

Professional Certifications
Vermont Natural Shoreland Erosion Control Certification

40-Hour OSHA HAZWOPER and 8-Hour HAZWOPER Annual Refresher, Current

Honors and Awards
Alpha Lambda Delta, Omicron Delta Kappa, Phi Beta Kappa, Sigma Gamma Epsilon, Sigma Xi

Professional and Community Activities
Green Mountain Water Environment Association (Secretary, Board of Directors)

Vermont Planners Association

Geological Society of America

Capital City Farmers Market (Community Representative, Board of Directors)

Additional Education
Discharges from Breweries and Similar Industries to Your WWTF. Vermont Rural Water Association, Essex Junction, Vermont. October 2016.

Applied Green Infrastructure Design. Cornell University Cooperative Extension, New York. February 2013.

Related Project Experience

Stormwater Master Planning and Implementation / 2011–Present / Vermont
Supports several organizations and a wide variety of stakeholders in developing stormwater management plans on municipal, regional, and watershed scales, including data compilation and analysis, site characterization, stormwater problem area identification and prioritization, Best Management Practice (BMP) design, stakeholder engagement, and community outreach and education. Provides ongoing collaboration with municipal staff, regulatory agencies, watershed stewardship organizations, Natural Resource Conservation District staff, and other key stakeholders to bring high priority retrofits identified in these plans through final design and construction. Many of the recent municipal Stormwater Master Plans focus on developed lands P reduction benefits, including calculation of P reduction benefits consistent with Vermont Department of Conservation's (VT DEC) P crediting framework. Previous projects include the development of stormwater master plans in the Flower Brook watershed, 12 towns in Franklin County, Town of St. Johnsbury, City of Montpelier, Town of Williston, Town of Hardwick, Town of Richmond, and Town of Concord.

Stormwater Best Management Practices (BMPs) & Retrofit Design / Multiple Clients / 2011-Present / Vermont
Oversaw the planning, design, and implementation of over 20 stormwater retrofits focused on reducing stormwater runoff volume and pollutant loading to Vermont's streams, ponds, and lakes using use site-specific BMPs, green stormwater infrastructure, and low impact development tools. Practices implemented included infiltration trenches, bioswales, rain gardens, gravel wetlands, bioretention areas, and nutrient treatment systems. Work performed included soil characterization and infiltration testing at proposed BMP sites and design and construction oversight.

Technical Review and Recommendations for Stormwater Mitigation at Rick Marcotte School / South Burlington School District / 2019 / South Burlington, Vermont / 19-030
Completed a technical review of a stormwater mitigation project proposed by the City of Burlington Department of Public Works (DPW) on the Rick Marcotte School campus. School District personnel desired an independent evaluation of the value of the proposed stormwater practice to the District, particularly considering treatment standards for the forthcoming "3-acre" permit. Confirmed the City's characterization of the proposed conditions for redeveloped and new impervious areas, including treatment volumes and the real estate footprint required to site stormwater retrofit practices that would meet the School's obligations under the "3-acre" permit, operational

stormwater permitting for anticipated expansion of the School's parking lot, and Flow Restoration Plans for Centennial and Potash Brooks. Determined that following completion, the 35% phosphorus load reduction target required under the "3-acre" permit would likely be exceeded for the entire school parcel, and that the project could manage more than 60% of the Water Quality Volume and thus be potentially eligible for receipt of impact fees. Determined the project would fully meet any obligations the School District may have to comply with requirements of the stormwater flow total maximum daily load (TMDL) for Potash Brook.

Decentralized Wastewater Feasibility Study / Lamoille County Planning Commission / 2003–2005 and 2019–Present / Wolcott, Vermont / Stone Project 19-029 and 031435-W

Supported the completion of a decentralized wastewater feasibility study for the Wolcott and North Wolcott Village areas. Collected needs analysis data, created and distributed surveys to property owners, entered and summarized survey results, conducted permit reviews, wrote introductory sections of report, compiled draft and final reports, and participated in site visits and meetings. Currently part of the Wolcott Wastewater Coordinator Team with Lamoille County Planning Commission and Birchline Planning, supporting the local committee as they work towards formulating affordable and implementable wastewater solutions for properties in Wolcott Village.

Deer Brook Gully Restoration Feasibility and Design Services / Friends of Northern Lake Champlain, Northwest Regional Planning Commission / 2006–Present / Georgia, Vermont / 06-1829, 17-084, 20-116

In 2006-7, completed site evaluation visits, developed design alternatives for areas within gully where groundwater seepage was a primary issue, and reviewed the final feasibility report and design plans. Beginning in 2017, led evaluation of stormwater mitigation options for areas contributing flow to the substantial gully located near the intersection of Vermont Route 104A and U.S. Route 7 in Georgia. Facilitated stakeholder meetings and supported development and review of engineering designs. Final designs include upland stormwater mitigation to detain and treat runoff flowing to the gully, a drop manhole and stable outlet for closed drainage, and incorporation of downed trees to stabilize gully banks. Following completion of the designs in 2019, continued to work with FNLC to build landowner support for the project's implementation and to secure funding for construction, which was awarded in December 2020 and is now underway with completion anticipated in 2022.

Municipal Roads Grants-In-Aid Pilot Project Technical Support / Northwest Regional Planning Commission / 2017–Present / Franklin and Grand Isle Counties, Vermont / 17-079-A

As part of the NRPC's Municipal Grants-in Aid Pilot Project (MRGP), provides technical assistance to municipalities to improve select road segments in order to meet MRGP standards. To date, has provided stakeholder coordination and project oversight on projects for Swanton Village and North Hero aimed at identifying and prioritizing potential stormwater and drainage improvements.

Town of Richmond Stormwater Master Planning / Chittenden County Regional Planning Commission and Town of Richmond / 2017–2018 / Richmond, Vermont / 17-061-A, 20-027

Project manager leading a broad stakeholder group to complete a stormwater master plan for Richmond's village area and the Richmond Elementary / Camel's Hump Middle School campus. Created watershed maps and led field characterization of potential stormwater problem areas. Led problem area prioritization, concept design and restoration plan development, and writing the final stormwater master plan report. Following completion of the Stormwater Master Plan, supported Friends of the Winooski River in submitting successful grant applications for final design of high-priority stormwater management improvements on the School campus, which is a "3-acre" site and so must meet the requirements of the 3-9050 General Permit.

Policy Development and Training Session for Vermont Stormwater Management Manual / Vermont Agency of Transportation / 2016–2017 / Montpelier, Vermont / 17-039

Assisted an engineering partner in reviewing the draft VSMM, originally developed by a Stone-led team, from a transportation perspective. Co-facilitated meetings with VTrans and VT DEC and assisted in preparation of a new VSMM chapter addressing the unique challenges of public transportation projects. Worked closely with our partner and VTrans to prepare guidance for obtaining operational permit coverage using the new "Public Transportation Projects" subchapter and assisted in developing and presenting a two-hour training session for the engineering and consulting community.

Mary Haley / *GIS Specialist*

Mary is a GIS professional with five years of experience leveraging advanced level GIS services to a range of technical projects. Prior to joining Stone, she applied her skills to the Vermont Agency of Transportation, where she administered geodatabases and mapping services with python automation, developed ArcGIS Online web maps and tools, and led field work for the terrestrial LiDAR scanning program. At Stone, she draws on her diverse design and field experience to support application development and geospatial analysis projects.

Years of Experience / 5

Years of Experience at Stone / 1

Education
Professional GIS Certificate, 2018, Michigan State University

Bachelor of Science, Environmental Science, 2016, Endicott College

Professional Certifications
Esri ArcGIS Desktop Professional Certification (EADP19-001), 2023

Skills
Geospatial & data analysis,

Application Development

Mobile Data Solutions

Data Inventory/Compilation

Metadata Development

Geodatabase Creation and Development

Data Visualization

Data Collection

ArcGIS Online, ArcGIS Pro, ArcMAP, ArcGIS Collector, StoryMaps, Field Maps, Survey123, ArcGIS Experience Builder, ArcGIS Hub, Feature Manipulation Engine

Static Terrestrial LiDAR Data Collection

Python Programming

Employment History

Stone Environmental, Inc. / Montpelier, Vermont
GIS Specialist / May 2022–Present

Supports application development projects related to a variety of GIS and data management efforts as a member of the Geospatial and Data Services team. Utilizes ArcGIS Online and ArcGIS Pro to manage geospatial data, create informative maps and applications, and perform advanced spatial analysis. Develops Python programming scripts to assist with the automation of data validation, management, and development. Collaborates with and supports team members to complete projects.

Vermont Agency of Transportation / Barre City, Vermont
GIS Professional IV / 2019–2022

Provided advanced-level GIS services to multiple business units within the Project Delivery Bureau and trained and supported other GIS staff within the section. Administered the Right of Way section's enterprise geodatabase and mapping services through complex Python scripting language data processing scripts. Built and maintained ArcOnline web maps, tools, and applications for field data collection while using complex Arcade expressions for custom configuration. Developed expertise in using and configuring ArcOnline StoryMaps and dashboards, Collector App, Field Maps App, and Survey123 forms. Acted as team lead for the static terrestrial LiDAR scanning program. Coordinated fieldwork and processed point cloud data to set standards and performed analyses for project requests. Managed large GIS projects/programs including defining the needs, requirements, and specifications that leveraged spatial data or GIS technology (i.e Right of Way Spatial Data Hub, Vermont Land Inventory, Survey Photo Monument Inventory, Vermont GPS on Benchmarks Web Application). Administered and provided user support for the VT CORS Network and VECTOR website. Serviced the complex infrastructure for the 18 reference stations including the specialized software that digests, monitors, and relays RTN/VRS and single base solutions. Submitted work order requests and reviewed proposals for consultant projects and reviewed project deliverables to ensure deliverables met standards. Assisted with the development, expenditure planning, and justification for relevant work programs.

Vermont Agency of Transportation / Barre City, Vermont
GIS Professional II / 2019

Provided intermediate-level GIS services for the Right of Way and Survey Units. Worked closely with the Land Survey Manager to interpret property deeds, surveys, and related documents for cataloging in the section's database to be displayed in the various web applications. Conducted static 3D terrestrial

LiDAR scans for numerous project types including asset monitoring, material volume calculations, pavement analysis, historical preservation, and as-built structures. Performed standard processing procedures to produce deliverables from the LiDAR scan project and developed methods for various in-house analyses. Updated documentation and metadata for GIS datasets and services. Utilized Python, HTML, ESRI Arcade, and SQL scripting languages to develop and maintain complex processing automation scripts for CADD to GIS data conversion and web application display. Developed the protocols and data collection maps used in the Survey Photo Monument Inventory.

Vermont Agency of Transportation / Barre City, Vermont
GIS Professional II (Temporary) / 2018–2019

Provided basic-level GIS services and assistance to the Right of Way and Survey units. Fulfilled CADD to GIS data conversions, survey and right-of-way plan georeferencing, and right-of-way digitization requests. Utilized basic Python and ESRI Arcade scripting languages to create and update data processes and web map pop-ups. Supported senior staff with static 3D Terrestrial LiDAR field scans.

Related Project Experience

Vermont Community Broadband Board GIS Services / Vermont Community Broadband Board / 2022–Present / 20211239

Provides GIS counsel and support for numerous requests ranging from broadband deployment analysis to web application and data systems development. Created scheduled data transfers using Microsoft Power Automate flows, translating data from internal documents to ArcGIS Online feature services to use in mapping efforts. Developed Python automation scripts to better track and manage the data services being displayed in the ArcGIS Hub site developed for Board and public use. Assisted in the initial analysis for the Federal Communications Commission (FCC) Broadband Availability Challenge efforts to secure federal funding for broadband deployment.

New York Geographic Information Gateway / New York State Department of State, Office of Planning & Development / 2022–Present / 20211241

Assisted with migrating data from existing servers and geodatabases into the ArcOnline platform. Developed Python automation scripts to catalog and validate existing metadata and ArcOnline tags to streamline future user interaction in ArGIS Open Data Portal. Improved existing automation employed to upload datasets to ArcOnline while ensuring appropriate data properties are preserved. Supported staff in developing user feedback surveys to improve the design and experience of users with the new ArcGIS Hub site. Assisted in the development and design of the ArcGIS Hub site pages, which included custom coding for various web page elements to meet the design requests of the client.

Phosphorus Control Plans for the Vermont Lake Champlain Basin / Vermont Agency of Transportation / 2022–Present / 18-008-D, E

Developed an automated phosphorus reduction tracking system to identify current infrastructure condition changes over time for swales and culverts. Provided support for ArcGIS FieldMaps data collection apps used by VTrans fieldworkers in addition to updating and developing ArcGIS StoryMaps and Dashboards. The latter applications are used to visualize phosphorus reduction progress and provide an interactive and informative display of steps taken by VTrans to meet phosphorus reduction targets.

Champlain Water District Source Protection Plan Update / Champlain Water District / 2022-2023 / 20221155

Acquired and compiled 40+ requested datasets and associated metadata from several municipal, state, and federal organizations used to update data source and create mapping deliverables. Performed complex analysis of chemical release inventory data to better visualize chemical spill volumes and quantities as well as clean-up efforts in the project area. Developed a Python automation script to clean up and attribute agricultural farming datasets for the map series. Assisted with the ArcPro Project and final Map Series development and acted as the primary contact for project management and communication.

Publications and Presentations

Co-Presenter, FHWA GIS in Transportation, Leveraging GIS for Right of Way: Vermont State Property Parcel Map Presentation / 2021

Co-Presenter, Vermont Agency of Transportation & National Geodetic Survey, GPS on Benchmarks Workshop Webinar / 2021

Paige Gebhardt, GISP / *GIS Specialist*

Paige is a certified Geographic Information Systems Professional with seven years of experience providing web mapping application development and geospatial analysis. Before joining the Stone team, she leveraged her technical expertise in GIS to support natural resource management, wildfire suppression, military readiness, and environmental data quality. At Stone, she draws on her experience to create intuitive applications and mapping solutions that facilitate problem solving, relationship building, and collaboration.

Years of Experience / 7

Years of Experience at Stone / 1

Education
Bachelor of Arts, Human Geography, 2016, Michigan State University

Professional Certifications
Geographic Information Systems Professional Certification (GISP)

Esri ArcGIS Pro Associate Technical Certification

Skills
Geospatial and Data Solutions

GIS Application Development

ArcGIS Pro, ArcGIS Online, ArcGIS for Desktop, Microsoft Office, Adobe Illustrator, Arcade, Python 3

Project Management

Honors and Awards
E. James Potchen Award in Geography, Undergraduate Student of the Year, 2016

Professional and Community Activities
Michigan State University Department of Geography, Environment and Spatial Sciences Alumni Advisory Board Member, 2019-2023

Employment History

Stone Environmental, Inc. / Montpelier, Vermont
GIS Specialist / February 2022–Present
Utilizes comprehensive knowledge of ArcGIS software and technology to provide a wide range of GIS support, including the design and development of web mapping solutions. Conducts advanced geospatial analysis to develop and manipulate data. Leads the administration of ArcGIS Online members and content. As a member of the Geospatial and Data Services team, demonstrates appropriate, professional communication and interpersonal skills to foster productive, effective in-person and remote working relationships with team members and clients. Uses critical thinking to find solutions to complex problems. Manages Stone's Esri Silver Partnership and serves as Stone's Culture Committee Chairperson.

Center for Environmental Management of Military Lands / San Antonio, Texas / GIS Program Analyst / 2021
Acted as a liaison between Colorado State University and the United States Air Force Civil Engineer Center to improve the environmental management of Air Force installations around the world. Provided GIS support including map production, web mapping application development, and geospatial analysis. Facilitated virtual meetings with Air Force leadership to present information and solicit approval for initiatives. Led 15 analysts on a project to update technical documentation for 73 environmental GIS data layers following Department of Defense standards, performed quality assurance and quality control.

Michigan Department of Natural Resources / Lansing, Michigan
GIS Analyst / 2017–2021
Planned, designed, and implemented GIS projects, performed spatial analysis and interpreted results to provide maps and report products for natural resource decision-makers. Produced over 20 creative story maps, web applications, and static maps for internal and public clients. Designed and created 11 story maps for the landscape assessment portion of the 2020 Michigan Forest Action Plan. Administered an ArcGIS Online organization of 530 members and provided ArcGIS software support to staff. Traveled to field offices around the state to facilitate relationship-building, problem-solving, and collaboration. Deployed on two wildfire incidents in 2020 as a GIS Specialist Trainee on incident management teams; efficiently created and managed content in ArcGIS Online and ArcGIS Pro, produced informative maps, and incorporated ArcGIS StoryMaps as a public information tool.

Michigan Department of Environmental Quality (DEQ) / Lansing, Michigan / Intern / 2016

Completed nine projects over three months including assisting with quality control checks of oil well geospatial data and completing i-Tree reports for urban forestry research. Used project management and teamwork skills to collaborate effectively with peers and professionals to accomplish goals for multiple state agencies, set up and staffed the GIS Day booth, fielded questions from visitors, and demonstrated DEQ GIS projects, tools, and capabilities such as 3D modeling of geologic features.

Related Project Experience

Vermont Community Broadband Board GIS Services / Vermont Community Broadband Board / 2022–Present / 20211241

Designed a multi-purpose ArcGIS Hub site to meet the needs of a wide range of audiences. Assisted in the development of data standards for submissions from Communications Union Districts around the state of Vermont. Created a PDF, spreadsheet and geodatabase as data standard resources and shared on an ArcGIS Hub site. Communicated clearly and effectively with the clients in meetings and trainings. Maintained Web AppBuilder web applications, web maps and an ArcGIS Hub site for Board review, then public use. Developed documentation including a web application user guide. Managed data and developed an ArcGIS Notebooks script to compile data from various sources and calculate new fields.

New York Geographic Information Gateway / New York State Department of State, Office of Planning & Development / 2022–Present / 20211241

Designed an ArcGIS Hub initiative and pages to replace the existing website. Reimagined narratives using ArcGIS StoryMaps to update stories about the work of the New York Office of Planning and Development's work to make the stories more engaging and mobile-friendly. Led the development of an educational website focused on expanding the geo-literacy of children in grades 3-6. Conducted a focus group and two workshops with stakeholders to build user stories for website development. Followed web accessibility best practices and State of New York web design standards. Maintained a spreadsheet of over 700 datasets and used queries in Microsoft Excel to consolidate feature information. Published authoritative data from ArcGIS Pro, established and documented a workflow for a team member to automate for efficiency and accuracy.

Vermont Culverts / Chittenden County Regional Planning Commission / 2022–Present / 2021115

Worked directly with regional planning commissions to update culvert and bridge data across Vermont, create backups and automatically populate fields to increase efficiency. Assisted with the development of a Web AppBuilder web application and Field Maps for Regional Planning Commissions and municipality leadership to edit culvert and bridge inventory information. Tested functionality based on the user experience and made updates to the tool and map visualization to better meet the user's needs. Gathered feedback from a working group of users and efficiently incorporated suggested changes to map symbology and widget functionality. Assisted in the design of an ArcGIS Hub site and interactive map for the public to access information easily. Presented on the project with the client at the Esri User Conference in San Diego, California, on July 13, 2022.

PermianMAP / Environmental Defense Fund / 2022–Present / 19-119

Configured ArcGIS Dashboard applications to clearly communicate and provide interactive data visualizations. Utilized HTML to create responsive text and a link to project methodology documentation. Updated mobile version of dashboards to enable users to view the information either on a PC or on a mobile device. Edited fields of hosted feature layers and views to standardize multiple public downloadable datasets. Used the Arcade scripting language to efficiently calculate values.

Champlain Water District Source Protection Plan Map Update / Champlain Water District / 2022 / 20221155

Developed a series of PDF maps in ArcGIS Pro for the Champlain Water District's Source Protection Plan. Used the maps from the last update in 2004 as a guide to format symbology and map layouts. Incorporated over 40 geospatial data layers from various municipal and statewide sources. Maintained a detailed inventory of data layer sources. Contacted local municipalities to coordinate transfer of information and geospatial data to ensure that the project used the most up-to-date data possible. Maintained processing documentation, metadata, and an ArcGIS Pro project with data connections, maps and layouts and included the project package as a deliverable.