Engineering Services for HMGP Flood Mitigation Scoping Study, Town of Richmond

STONE ENVIRONMENTAL

PROJECT NO.

20231145

REVIEWED BY:

CAC

PREPARED FOR:

Josh Arneson / *Town Manager*
Town of Richmond, Vermont
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SUBMITTED BY:

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October 9, 2024

Josh Arneson, Town Manager
Richmond, Vermont
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Stone Project No. 20241145
Subject: Response to Request for Proposals: Engineering Services for HMGP Flood Mitigation Scoping Study of the Winooski River and Its Tributaries

Dear Josh and Members of the Selection Committee:

Stone Environmental, Inc. (Stone) is excited to submit our proposal to the Town of Richmond to complete a Flood Mitigation Scoping Study of the Winooski River and its key tributaries.

We understand the main objective of this project is to assess current flood risks and evaluate mitigation options for reducing flood levels in future events, with the goal of preparing a full grant application for the selected project alternative to the Federal Emergency Management Agency (FEMA) Hazard Mitigation Grant Program (HMGP). To achieve this goal, our team will complete a review of existing data, hydraulic analysis of the Winooski and select tributaries, flood mitigation project alternatives analysis, conceptual (30%) designs for the selected alternative(s), and FEMA Benefit Cost Analysis (BCA) to help support development of grant applications for eligible projects. Through this process, our team will help the town assess and prioritize a wide range of flood mitigation projects. The hydraulic models and alternatives analysis matrix developed as part of the project could be used to help support future grant applications and project development outside the project scope.

Recognizing tight HMGP application deadlines and the range of eligible engineering projects, we have assembled a diverse project team to ensure our capacity and technical expertise align with the Town's needs. The Stone team is comprised of knowledgeable planners, scientists, modelers, and engineers with a history of working with Vermont communities to enhance their natural and built environments, and a focus on developing engineering and nature-based solutions for addressing challenges such as flooding. Stone has partnered with Whiteout Solutions, a geospatial technology company based in Northern Vermont, to collect topographic and bathymetric LiDAR data to support hydraulic modeling of the Winooski River. Our team also includes Stephanie Magnan of SEAM Solutions, who brings expertise in hazard mitigation planning and FEMA. The Stone team is forward-thinking, taking factors like climate change into account in hydrologic and hydraulic analyses and design and critically evaluating project alternatives early on to identify viable solutions.

Sincerely,

Meghan Arpino, PH, CFM
Project Manager, Hydrologist
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Engineering Services for HMGP Flood Mitigation Scoping Study for the Town of Richmond, Vermont

Cover Photo: Hands Mill Dam, Washington, Vermont, after breaching during the July 2023 Flood

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1. Qualifications and Experience

Stone understands that the Town of Richmond is seeking engineering services to complete a Scoping Study for the Winooski River and its tributaries related to flood resiliency and hazard mitigation. The study will include a project narrative, hydraulic analysis, conceptual designs, alternatives analysis, archaeological and historic preservation review, and benefit-cost analysis. The goal is to mitigate flood damage to private residences and town infrastructure, including water and wastewater systems. The study will provide the technical analysis needed to support HMGP application development for selected flood mitigation projects.

Stone is a 100% employee-owned environmental science and engineering firm in Montpelier, Vermont. Founded in 1992, our mission is to provide tools, information, and analyses to help our clients solve environmental challenges with integrity, expertise, and innovation. We bring together over 65 scientists, engineers, modelers, project managers, and support staff with diverse backgrounds and skills, and a shared commitment to excellence, creativity, and accountability through employee ownership. Our areas of expertise include stormwater planning and design, community wastewater planning and feasibility assessment, stream and ecological restoration design and implementation, dam removal engineering and design, aquatic organism passage (AOP) and geomorphic assessments, water quality assessment and modeling, hydrologic analyses, hydraulic modeling, environmental monitoring, geospatial analysis, data visualization, and application development.

Our project managers and staff collaborate with stakeholders—including landowners, towns, and regulatory agencies—to advance projects from early feasibility to final design, permitting, and construction. We have worked on more than two dozen projects that improve flood resilience and restore aquatic and terrestrial ecosystems. Our team of scientists and engineers specializes in balancing the elements of nature-based solutions, such as restoration of AOP, sediment transport, and other geomorphic functions, with long-term infrastructure protection and flood hazard mitigation within the built environment. We maintain collaborative working relationships with project stakeholders while advancing technical and engineering aspects of project screening, vetting, and development efforts. Most recently, our team was awarded contracts to provide technical engineering services to four Vermont communities—Ludlow, Weston, Londonderry, and Jamaica—as part of the Resilience Initiative for Vermont Empowerment and Recovery (RIVER) program. RIVER aims to provide technical assistance to support the development of FEMA HMGP applications for flood mitigation projects. Our team has participated in public meetings and brainstorming sessions, led project vetting and scoping, and begun work on developing conceptual designs and completing Benefit Cost Analysis (BCA) for selected projects.

For this project, we have teamed up with SEAM Solutions and Whiteout Solutions. We have successfully collaborated with our teaming partners on similar scoping projects. Our deep understanding of Vermont's regulatory landscape, coupled with a strong track record in securing necessary permits, positions us to navigate the complexities of this project efficiently and effectively.

1.1.1. SEAM Solutions

SEAM Solutions is a proud of its status as a certified woman-owned consulting firm that has been financially stable and able to complete all services since its inception. Seam Solutions cares about helping communities recover quickly from natural and man-made disasters. They understand the real challenges clients face when it comes to emergency management, and bring experience with FHWA, FEMA and PA policy for a wide range of recovery efforts. SEAM Solutions has the expertise necessary to work with towns to update their local hazard mitigation plans. Identifying hazards and their risk, extent, probability, and potential damage impact to life, infrastructure, and the economy within the community. They provide municipal grant management oversight for towns that include application and the administration of grants, both at the state and federal level. Calculating Benefit Cost Analysis (BCA) for grants can prove to be beneficial in demonstrating the long-term costs savings of investing in upgrading, repair, or replacement of critical municipal infrastructure.

1.1.2. Whiteout Solutions

Whiteout Solutions is a geospatial technology company based in Northern Vermont. Since 2016, they have been developing remote sensing hardware and software systems, specializing in high precision LiDAR. They work to generate high-value datasets to help solve the biggest environmental challenges. With 50 years of collective experience, their staff draws on deep knowledge and modern technology to efficiently deliver answers and insights to partners with the aim of maximizing the value of data and providing customers with the ability to collaborate with teams on analysis and share all deliverables. They have built thousands of proprietary processes and analysis tools to answer questions with geospatial data. These include tools and processes for tree species identification, tree stem detection, forestry biomass analysis, utility vegetation encroachment analysis, lithologic surface analysis, topographic and bathymetric elevation mapping, and coastal sediment elevation models.

1.2. Key Staff Roles and Bios

MEGHAN ARPINO, CFM, PH — Hydrologist & Water Resources Scientist

Project Manager and Primary Point of Contact

Meghan will serve as the project manager and primary point of contact. Meghan is a Professional Hydrologist and Certified Floodplain Manager specializing in surface water hydrology and stream and floodplain restoration. She is experienced in water-quality sampling, stream habitat assessments, geomorphic assessments, topographic and fluvial surveying, statistical hydrology, hydrologic and hydraulic (H&H) modeling, stream and floodplain restoration design support, and project management. While at Stone, Meghan has managed teams of scientists and engineers, including subconsultants, for flood resiliency, dam removal, floodplain reconnection and restoration, and water quality projects. She has presented project alternatives and deliverables to the public and project stakeholders in virtual and in-person meetings. Meghan is currently leading the Stone team that provides technical and engineering assistance for developing FEMA HMGP applications as part of the RIVER project in Ludlow, Weston, Londonderry, and Jamaica. She has a Bachelor of Science in Environmental Science from the University of Vermont and a Master of Science in Hydrology from the University of New Hampshire.

PETER LAZORCHAK, PE, LEED AP — Senior Water Resources Engineer

Senior Engineering Lead

Peter will serve as the lead senior engineer during the project vetting and design phases, providing senior-level review and quality assurance for project deliverables. Peter leads Stone's Water Resources Management group with over 25 years of experience in the consulting industry and a diverse background in environmental services, civil engineering, and construction oversight. His expertise includes stormwater management, on-site wastewater disposal, site development, and navigation of local, state, and federal permitting processes. Peter strives to provide solutions to his clients that balance natural resource protection with the built landscape by utilizing low-impact development (LID) techniques and designing green infrastructure. His current projects include developing engineering designs for gravel wetlands and upland green stormwater infrastructure in Georgia, Vermont; implementing high-priority improvements from Concord's Stormwater Master Plan; and project development and vetting for the RIVER program in Ludlow, Weston, Londonderry, and Jamaica. Peter is a Vermont Professional Engineer, a Class B Licensed Designer, and a LEED Accredited Professional. He holds a Bachelor of Science degree in Civil and Environmental Engineering from Lehigh University.

BRANDEN MARTIN, PE — Water Resources Engineer

Conceptual Design Lead

Branden will support the project vetting and design phases. He is a licensed Vermont Professional Engineer with over 10 years of experience working on stormwater, stream, and wetland restoration projects. His expertise spans stream and floodplain restoration, stormwater infrastructure and green stormwater infrastructure design, bridge and culvert design, low-impact design, hydrologic and hydraulic modeling, stormwater retrofit planning and design, coordinating with local, state, and federal permitting agencies to advance projects to construction, and construction management and oversight. At Stone, he has led the design phase for stream restoration and flood mitigation projects, including recent culvert/structure replacements in Wilmington, Dorset, Eden, and Stannard, and dam removal in Washington, Vermont. Branden has a Bachelor of Science in Civil Engineering from the University of Vermont.

JENS KIESEL, PHD — Environmental Modeler

H&H and Alternatives Analysis Review and Support

Jens will lead H&H modeling and provide review and support for the alternatives analysis for the project. Jens is an environmental modeler with over 10 years of international experience in project planning and implementation for a broad range of projects, including flood assessments. During his time 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. Prior to joining Stone, he worked on a project to assess 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 and 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.

JARED ARDMAN Staff Water Resources Engineer

Field Data Collection, Survey, and Design Support

Jared is a recent graduate of the University of Vermont with a Bachelor's Degree in environmental engineering. He is an Engineer-in-Training (EIT) focused on providing water quality modeling, engineering, and permitting support for dam removal and stream restoration projects. Jared's passion for the environment extends into his personal life, where he can often be found hiking, climbing or skiing in the Green Mountains. Since joining Stone, Jared has provided field data collection, topographic and bathymetric survey, and design drafting support for several dam removal and culvert replacement and upsizing projects with both flood hazard mitigation and aquatic ecosystem restoration goals.

1.3. Relevant Experience

The Stone team is well-versed in the technical aspects of developing HMGP projects for flood damage reduction methods and understands the need to attain consensus at critical steps in the assessment and permitting processes. Most recently, our team has been supporting five other Vermont municipalities in developing projects for FEMA funding and has successfully completed designs for two

Table 1 provides an overview of our experience, followed by detailed descriptions of selected project examples from the Stone Team.

Table 1. Summary of Relevant Project Experience

Firm	Project Name	Location	Key Project Personnel	Project Type							Related Services					
				Dam Removal	Culvert and/or Bridge Replacement	Flood Resiliency Planning & Scoping	Channel and Floodplain Restoration	Buyout or Managed Retreat	Flood Hazard Mitigation	Stormwater	Engineering Services	Hydrologic and Hydraulic Analysis	HMGP Application Support	FEMA or FHWA BCA	Regulatory & Permitting Support	Public & Stakeholder Outreach
Stone Environmental	RIVER: Ludlow	Ludlow, VT	Meghan, Peter, Branden, Jared, SEAM Solutions			●			●		●	●	●	●	●	●
	RIVER: Weston, Londonderry, Jamaica	Weston, Londonderry, and Jamaica, VT	Meghan, Peter, Branden, Jared, SEAM Solutions			●			●		●	●	●	●	●	●
	Wardsboro Hydrologic Study	Wardsboro, VT	Meghan, Jens		●	●			●	●		●			●	●
	Town of Richmond Stormwater Master Plan	Richmond, VT	Peter, Branden			●				●	●					●
	Richmond Schools Final Stormwater Design	Richmond, VT	Peter, Branden							●	●	●				●
	Wolcott Wastewater: Feasibility Study and Village Solutions	Wolcott, VT	Peter, Branden			●					●	●			●	●
	Deer Brook Gully Restoration	Georgia, VT	Peter, Branden							●	●	●				●
	Concord Stormwater Master Plan and Folsom Ave. Stormwater Improvements	Concord, VT	Peter, Branden			●				●	●	●				●
	Johnsons Mill Dam Aquatic Organism Passage Assessment Final Design and Monitoring	Bakersfield, VT	Meghan, Branden, Peter	●			●				●	●			●	●
	Mountain School Dam Conceptual (100%) Design	Shrewsbury, VT	Meghan, Branden	●	●		●		●		●					●
	Mudd Pond Dam Removal	Hubbardton, VT	Meghan	●			●				●	●				
	Stevens River Bank Stabilization	Barnet, VT	Branden, Meghan				●		●		●	●			●	●
	Barre Dams Feasibility and 30% Design	Barre, VT	Branden, Meghan, Peter	●			●		●		●	●			●	●
	Pelletier Dam Removal and Final Engineering Design	Castleton, VT	Branden, Meghan, Peter	●			●				●	●			●	●
	Sugar House Lane Culvert Replacement	Dorset, VT	Branden, Peter		●		●				●	●			●	●
	Eden Bridge Replacements	Eden, VT	Branden, Peter		●		●				●	●			●	●
	Newbury Solar HEC-RAS Modeling	Norwich, VT	Meghan									●				
	Stannard Culvert Replacements	Stannard, VT	Branden, Peter		●		●				●	●			●	●
	Hands Mill Dam Removal, 30% and Final Engineering Design	Washington, VT	Meghan, Branden, Jared	●		●	●	●	●		●	●	●	●	●	●

Firm	Project Name	Location	Key Project Personnel	Project Type							Related Services					
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	Allen Brook Watershed Large Culverts Assessment and Project Prioritization Study	Williston, VT	Branden, Meghan		●		●		●		●	●				
	Beaver Brook Dam Removal and Culvert Upgrade Design	Wilmington, VT	Meghan, Branden, Peter	●	●		●				●	●			●	●
	Mount Sunapee Resort Stream Restoration and Streambank Stabilization - Design & Monitoring	Newbury, NH	Meghan			●	●			●	●	●			●	●
SEAM Solutions	Town of Duxbury FHWA PROTECT Grant Application	Duxbury, VT	Stephanie Magnan										●	●	●	●
	Local Hazard Mitigation Plan for Town of Morristown	Morristown, VT	Stephanie Magnan						●							●
	Local Hazard Mitigation Plan for Town of Hancock	Hancock, VT	Stephanie Magnan						●							●
	Town of Barre Emergency Action Plan	Barre, VT	Stephanie Magnan						●							●
	Ongoing Local Hazard Mitigation Plan Development for Eight Vermont Towns	Vermont	Stephanie Magnan						●							
	City of Cape Coral and Lee County Florida Hurricane Ian Response and Recovery Support	Florida	Stephanie Magnan		●	●		●	●				●	●	●	●

1.4. Project Examples

1.4.1. Resilience Initiative for Vermont Empowerment and Recovery (RIVER) Engineering Services

Stone was contracted by the Two Rivers-Ottauquechee Regional Commission (TRORC) to provide technical expertise and engineering support for the Resilience Initiative for Vermont Empowerment and Recovery (RIVER) project. The main goal of the RIVER project is to develop successful FEMA HMGP applications for priority flood mitigation projects selected by partnering with regional planning commissions (RPCs) and communities. Our team is developing engineering designs for selected dam removal, culvert and bridge upsizing, and floodplain reconnection projects in Ludlow with the Mount Ascutney Regional Commission and in Jamaica, Londonderry, and Weston with the Windham Regional Commission.

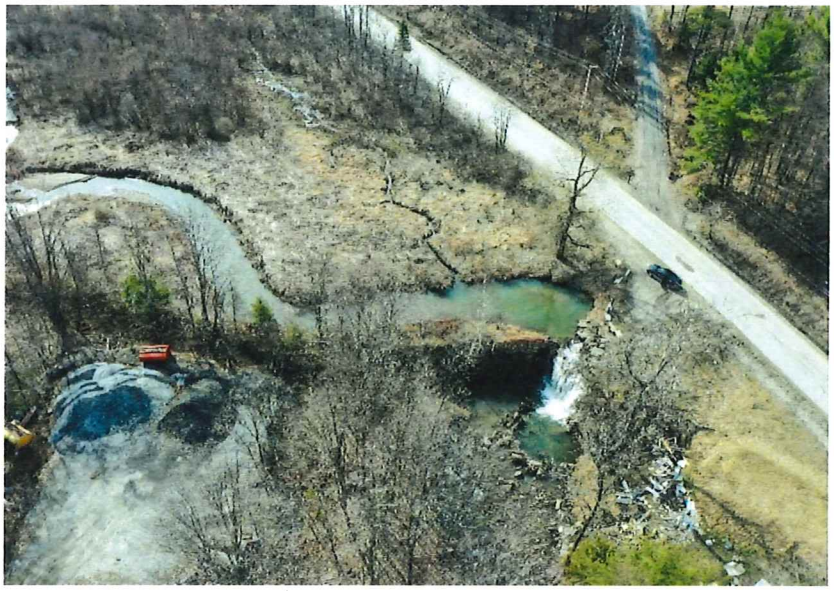
Throughout each project stage, we closely coordinated with RPCs and town personnel to scope projects with potential for reducing flood risk. This process included developing a public outreach plan, introducing the RIVER project at public meetings, holding a public brainstorming session to gain input from town residents, and creating a project alternatives analysis matrix to vet projects for feasibility, FEMA HMGP eligibility, community alignment, and cost-effectiveness. Stone recommended flood mitigation projects to progress to the conceptual design phase for pursuing FEMA HMGP funding to town officials, who selected their preferred alternative. Project concepts were also reviewed with Vermont Emergency Management. Stone's scientists and engineers are completing field investigations, hydrologic and hydraulic modeling, drafting design plans, developing final design and implementation cost estimates, completing Benefit Cost Analyses, and providing asneeded technical assistance to RPCs and towns to develop full HMGP applications for viable projects.

Initial visit to potential culvert upsizing project to be evaluated for HMGP funding. The stream crossing is located on Ball Mountain Brook, a steep tributary to the West River.

1.4.2. Preliminary Engineering through Project Implementation for Hands Mill Dam Removal and Floodplain Reconnection

Hands Mill Dam was a partially breached stone masonry and concrete dam located along the Jail Branch in Washington, Vermont. The dam was owned by the Town of Washington and classified as a Class 2 "significant hazard dam" in 2016 by the Vermont Department of Environmental Conservation (VT DEC) Dam Safety Program. The overall goals of this project were to remove the Hands Mill Dam to mitigate current flood hazards, improve aquatic organism passage (AOP), restore stream equilibrium and floodplain function, and improve water quality.

In 2020, Stone was retained by the Winooski Natural Resources Conservation District (Winooski NRCD) to complete Phase 1 of the design to remove the Hands Mill Dam. For this phase, Stone coordinated with Winooski NRCD, the Town of Washington, US Fish and Wildlife Service, Vermont Department of Fish and Wildlife, and the VT DEC to develop preliminary (30%) design plans to remove the dam. The initial scope of work included: stakeholder meetings, existing data and desktop review, field investigations, impounded sediment probing and characterization, hydrologic and hydraulic modeling, geotechnical assessment and reporting, wetland delineation, alternatives analysis, FEMA Benefit Cost Analysis (BCA) and grant application support, and the development of 30% design plans.



Aerial view of Hands Mill Dam along Jail Branch in Washington, VT prior to the July.

The Winooski NRCD retained Stone in Spring 2021 to complete Phase 2 of the project. The scope of work for this phase includes developing 100% engineering design plans, completing additional field investigations to inform final engineering design, finalizing an operations and maintenance agreement, finalizing a sediment management plan, preparing permit applications for submittal, summarizing the final design and associated efforts in a final report, developing construction specifications, and supporting the construction bidding process. Stone worked closely with project stakeholders to adapt the final designs after the dam partially breached during the July 2023 flood. The project went to construction in summer 2024, with Stone providing construction oversight and project management support.

Aerial view of the Hands Mill Dam area collected in October 2024 following dam removal and restoration.

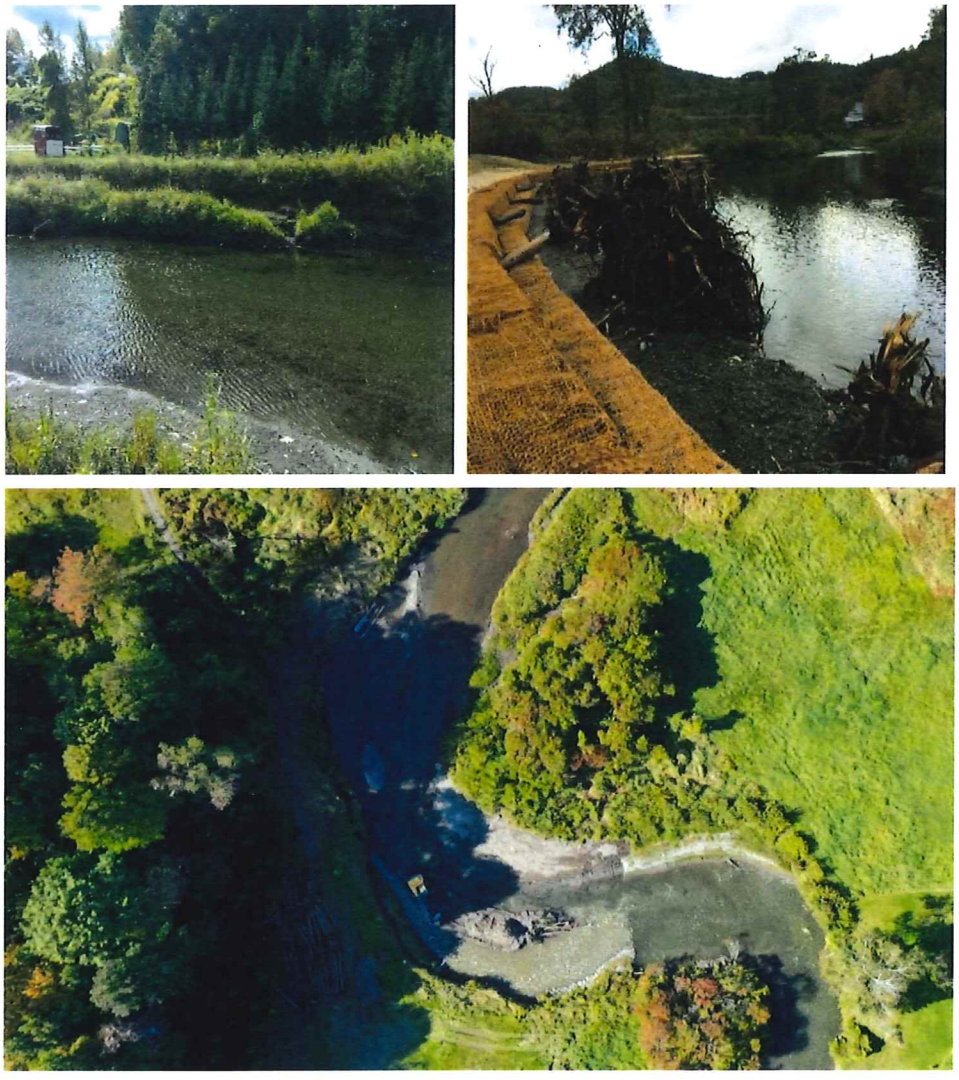
Information on this project is available at http://winooskinrcd.org/handsmilldam/

1.4.3. Stevens River Bank Stabilization

The Connecticut River Conservancy hired Stone to provide engineering design and construction management services for a bank stabilization project along a portion of the Stevens River in Barnet, Vermont. The project area included an incised meander bend migrating toward a residential property, threatening to cut off access to a portion of the property used as horse pasture. Stone performed a geomorphic assessment to determine the source of the issue and concluded that the replacement of approximately 200 feet of stream channel with a concrete culvert and associated channel straightening upstream of the project area had added excess energy in the system, accelerating bank erosion and lateral migration of the meander bend.

To ensure the proposed work did not raise the 100-year flood water surface elevation, Stone developed a HEC-RAS model that tied into the Base Flood Elevations of the FEMA Flood Insurance Rate Maps and submitted a No-Rise certification. Stone used model outputs to create flood inundation maps for the pre-project and post-project conditions. Model results indicated the project would not raise the 100-year flood water surface elevation.

The bank stabilization design plans included a large wood structure with over 50 pieces of wood and a toe reinforced with a large stone. Channel and floodplain elevations were modified to mimic reference conditions. The top of the bank was set at an elevation such that flood events beyond the 1.6- to 2-year recurrence interval will engage the floodplain, restoring floodplain connection and function. Erosion prevention measures, such as fabric-encapsulated soil lifts and native shrubs, were installed in the newly graded floodplain. As evaluated through hydraulic modeling, the large wood structure was designed to resist buoyancy, momentum, and drag forces associated with large flood events.



Clockwise from top left: Eroding bank along meander bend of Stevens River adjacent to private property and horse farm. The same meander bend following construction of bank stabilization measures. During the construction of stream bank stabilization measures along the Stevens River in 2018 we used a drone to inspect and document progress.

1.4.4. Stormwater Master Planning, Conceptual Design, and Final Design in the Town of Richmond

In 2017, Stone worked with the Chittenden County Regional Planning Commission and project stakeholders to develop a stormwater master plan for the Town of Richmond, Vermont. As part of this effort, we reviewed existing watershed-based assessment data and performed field screenings to identify and evaluate stormwater problem areas and strategic retrofit opportunities. Among the 22 stormwater management opportunities identified, 10 were advanced to conceptual design following a detailed examination and prioritization process involving potential stakeholders. Stone prepared conceptual design plans for the stormwater improvement areas and incorporated information from existing plans and datasets to create a single, town-specific resource to guide future stormwater management activities.

Stone worked with the Friends of the Winooski River to advance three high-priority projects at the Camels Hump Middle School and Richmond Elementary School campus identified in Richmond's Stormwater Master Plan through final design and implementation. The designs included two gravel wetlands to treat stormwater from the school driveway, parking lot, rooftop, and interstate; and the stabilization of a severely eroded gully threatening a portion of the schools' parking lot. The gully stabilization design incorporates a series of steps and pools to stabilize the gully banks and provide energy dissipation that works in conjunction with stormwater velocity reduction provided by the gravel wetlands near the gully head.

Stone worked with partners to finalize designs for restoring this gully at the elementary school campus.

As the design progressed, the property became subject to the requirements of the Stormwater General Permit 3-9050 (GP 3-9050). Stone completed the application and secured the necessary permit, submitted an Act 250 permit amendment and State of Vermont State Highway Access and Work Permit, and obtained zoning permits to facilitate the construction of the two gravel wetlands. Once constructed, these projects will provide peak flow control of stormwater runoff, dramatically reduce sediment and nutrient transport, provide long-term stability to the schools' property, and facilitate GP 3-9050 compliance with state regulations.

1.4.5. Concord Stormwater Master Plan and Folsom Avenue Stormwater Improvements

Stone and the Essex County Natural Resources Conservation District (ECNRCD) worked with the Town of Concord, Vermont, to develop a Stormwater Master Plan. The plan identified 20 areas for improvement, including sites with drainage problems and strategic retrofit opportunities. A major erosion and sediment issue on a steep portion of Folsom Avenue was ranked the highest priority stormwater issue in the village. Stone completed preliminary designs with cost estimates for the two highest-priority projects and then helped the town and conservation district secure funding to advance the Folsom Avenue project. Stone then advanced that design, producing construction-ready drawings and an opinion of probable cost for: 1) Construction of an infiltration basin; 2) subsurface infiltrating chambers; 3) a new closed-drainage system and improvements to best practices for managing stormwater; 4) site-wide regrading and paving, and 5) replacement of concrete curb and sidewalk. Stone then secured the necessary permitting to advance the project to the construction phase.

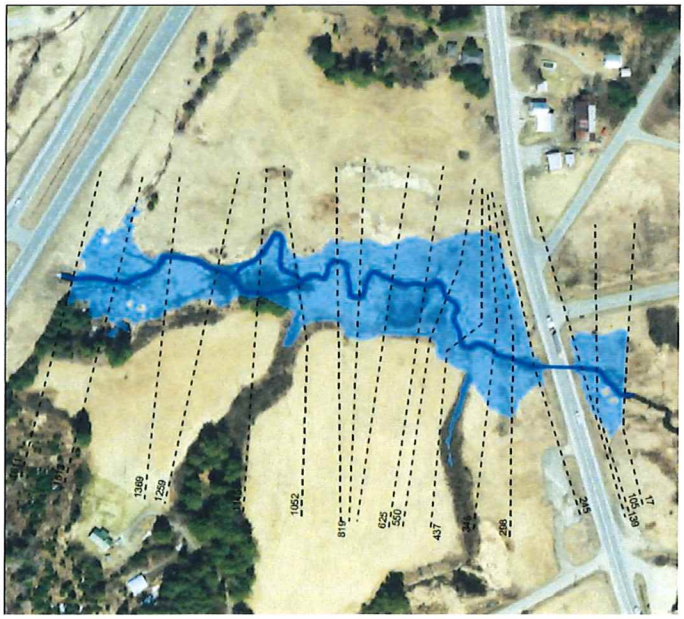
Left: Looking uphill on Folsom Avenue prior to construction. Note failed, undersized culvert to right of sidewalk. Right: Looking downhill on Folsom Avenue during construction. Infiltration basin is north of High Street.

In 2023, Stone revised the existing plans, secured a State of Vermont State Highway Access and Work Permit, managed the construction bidding and contractor selection processes, and provided construction oversight for the Folsom Avenue stormwater system. As built, the Folsom Avenue improvements promote stormwater infiltration, eliminating storm pipe outlets and roadside erosion.

1.4.6. Based Flood Elevation Estimate for Solar Site

Stone completed hydraulic modeling to estimate the base flood elevation (BFE) at the Norwich Solar Technologies, Inc. (Norwich) Newbury Leighton Hill Solar site. The site was located within a flood hazard zone without a defined BFE.

Stone used the US Army Corps of Engineers (USACE) Hydrologic Engineering Center's River Analysis System model (HEC-RAS) to develop a one-dimensional, steady flow hydraulic model of the Wells River Tributary flowing through the Newbury Leighton Hill Solar site. The model was used to simulate peak flow for the 100-yr (1% annual exceedance probability, AEP) flood and determine the base flood elevation (BFE).



Base flood inundation extent at Newbury Leighton Hill Solar site determined using 1D HEC-RAS model.

US Geological Survey (USGS) StreamStats software was used to calculate the drainage area and provide peak flows for the site. Stone developed the terrain model in HEC-RAS RASMapper using the 2016 hydro flattened DEM derived from Lidar data available through the Vermont Center for Geographic Information VT Lidar Finder. Downstream culvert dimensions and data from the Vermont Agency of Transportation (VTrans) Structure Inspection Report were used to include the culvert located under US Route 302. The vertical datum and horizontal coordinate system for the terrain and model results are NAVD88 (US feet) and NAD83 Vermont State Plane (US feet), respectively. The results of this modeling effort supported refined flood inundation extent estimates for this reach.

1.4.7. Culvert Replacements in Stannard, Vermont

Stone provided preliminary and final engineering and design services to re-engineer two road crossings on and near Stannard Mountain Road to accommodate bankfull (and larger) flow events, correct structural deficiencies in existing crossing infrastructure and stream efficiency, and facilitate eastern brook trout and general aquatic organism passage.

Tasks included topographic surveys and site investigations, hydrology and hydraulic modeling, and the development of preliminary engineering designs. Preliminary designs included the identification of temporary crossing alternatives. Under this contract, we advanced final engineering designs for one of the stream-road crossings (including permitting support, final design plans, technical specifications, and bid administration).

Precast footers, abutments, U-wall wingwalls, and precast concrete deck installation at Hutchins Farm Road.

Our staff also assisted with contractor selection and provided construction engineering and oversight for the project, which was constructed in September and October 2023.

1.4.8. Friends of the Mad River Project Development

The Friends of the Mad River (FMR) obtained a Project Development Subgrant to develop water quality improvement projects in the Mad River Valley. FMR hired Stone to assess existing Stormwater Master Plans and River Corridor Plans for the Mad River Valley to identify the most appropriate projects to advance and perform outreach to stakeholders. Together, Stone and FMR targeted three stormwater management projects: The Moretown Town Garage and Sand Storage, the Waitsfield Bridge Street and Main Street commercial area, and the Warren Lodge. The team also identified three river and floodplain restoration projects: Doctors Brook floodplain restoration, Doctors Brook small bridge replacement, and Dowsville Brook floodplain restoration.

We met with stakeholders to re-engage them with the project, developing task lists, partner lists, and timelines for each project. We engaged with the Vermont Department of Environment and Conservation and the Agency of Transportation to identify pain points and funding sources for projects. We kept detailed records of outreach and progress for future reference in project development.

2. Scope of Work

We understand the importance of supporting Vermont communities in their flood recovery efforts. Our team's role in the Richmond Scoping Study is to complete a hydraulic study for the Winooski River and key tributaries that contribute to flooding in Richmond in order to inform identification and prioritization of flood mitigation projects. Following an alternatives analysis, viable projects will be selected by the Town to progress to the conceptual (30%) design phase. At this point, our team will complete a Benefit Cost Analysis (BCA) in accordance with FEMA guidelines. This analysis will be used to assess eligibility for HMGP funding and develop HMGP applications for those projects. While this study will primarily focus on developing one or more flood mitigation projects for FEMA HMGP funding, the study will provide an understanding of current flood risks and potential flood mitigation projects to pursue through alternate funding sources in the future.

We are familiar with Vermont's flood history, the interdisciplinary nature of flood mitigation projects, and the importance of community involvement during the project identification and scoping process. Stone's Water Resources Management team has decades of experience working with towns to develop stormwater, village wastewater, water quality, and stream restoration projects with direct and indirect benefits related to improving flood resiliency. We have included partner firms with expertise in flood hazard planning at the municipal level and high-resolution topographic and bathymetric data collection to inform hydraulic modeling to support this effort. SEAM Solutions will provide BCA and FEMA HMGP guidance support during project identification, conceptual design, and benefit cost analysis tasks, and Whiteout Solutions will provide geospatial data collection and processing to support high-resolution two-dimensional hydraulic modeling of the Winooski River.

Stone staff, along with our partnering firms, have the capacity to complete the following scope of work in the proposed timeline, which assumes that a six-month extension request is granted to Vermont Emergency Management's (VEM) current FEMA HMGP deadline. Should that extension be denied, our team will work with the Town to develop an acceptable timeline. Our proposed approach, presented below, is informed by the Town's RFP and our familiarity with FEMA's HMGP guidelines. This approach prioritizes projects that have a high potential to reduce flood damages, are cost-effective, have community support, or already have completed conceptual or preliminary design work and are seeking implementation funding. Should FEMA grant Vermont additional deadline extensions, the Stone team anticipates maintaining the same scope of work and approach, but we will coordinate with the Town to adjust the number of projects selected to progress to the full application stage if the project budget, timeline, and availability of viable projects within the community allow.

2.1. Task 1: Project Kick-Off Meeting

Stone recognizes the importance of clear communication with project partners from the start. Our team will attend a project kickoff meeting with the Town Manager, project stakeholders, and the public to introduce the scoping study goals, scope, and timeline. Stone staff will be available in person at this kickoff meeting to answer questions about the project and listen to concerns and project ideas from the public, but no engineering will have been completed prior to this meeting. Stone will record meeting minutes and share

them with meeting attendees. Ideas and concerns raised in this first meeting will be considered throughout the hydraulic study, alternatives analysis, and conceptual design process. Concurrently to the kickoff meeting, we will work with the Town to solicit input from residents living along Snipe Island and Jones Mill brooks at a minimum via a targeted email or other communication. Our team will continue to share project updates, challenges, and milestones to the Town throughout each task.

Task 1: Project Kickoff

- ✓ *Public kickoff meeting attendance and meeting minutes*
- ✓ *Communication with residents along tributaries to introduce project and solicit input*
- ✓ *Open communication and coordination with the Town through each task*

2.2. Task 2: Existing Data and Desktop Review

Stone will begin the project with a desktop review of existing data and relevant records. This review will guide field data collection, hydrologic and hydraulic modeling, project identification and alternatives analysis, cost estimates, and conceptual design development. Our team is familiar with local hazard mitigation plans, stormwater master plans, river corridor plans, effective and preliminary modeling for FEMA flood insurance rate maps, and engineering projects throughout the Winooski River watershed, and will leverage that experience to establish a strong understanding of current conditions and risks related to flooding. Studies and data sources mentioned during the project kickoff will be included in this initial review. Aerial imagery and high-water mark data collected during the July 2023 and July 2024 flood events will also be reviewed at this time.

In addition to the materials and documents mentioned above, Stone staff will use current web-based project screening tools for initial project identification. Specifically, we propose to complete a detailed review of the project area using the Functioning Floodplains Initiative (FFI) Explorer Tool (https://ffi.stone-env.net/home) and the Transportation Resilience Planning Tool (TRPT) (https://roadfloodresilience.vermont.gov/#/map). Stone's team of data scientists and modelers led the web-based application development phase for both tools, and engineering staff are well-versed in applying these tools to project screening and scoping. VTrans developed the TRPT tool following Tropical Storm Irene and funded it through the FEMA HMGP. The FFI Explorer Tool is designed to build on river corridor planning in Vermont by providing a web-based application for identifying river reaches with little lateral, vertical, or longitudinal connectivity and recommending potential projects for restoring stream and floodplain connectivity along that reach. Enhanced floodplain connectivity can restore natural stream and floodplain processes related to flood water storage, sediment transport, nutrient uptake, and habitat uplift. Within the context of this scoping study, the FFI tool can be used to identify reaches that are both poorly connected to their adjacent floodplain, and meet project selection criteria (i.e., eligible for FEMA funding, within the project area, or cost-effective). Examples of the types of projects identified in the FFI tool include dam removal, buffer planting, bank stabilization, floodplain restoration, planting, and easements. The Stone team will also review and take into consideration planning and assessment tools available through FEMA, such as the Risk MAP products (https://www.fema.gov/flood-maps/tools-resources/risk-map/products), which are non-regulatory materials that supplement regulatory FIRMs.

Work completed in this step will set the groundwork for subsequent hydraulic studies, alternatives analysis, and conceptual designs. Summaries of relevant information from these reviews will be included in the Scoping Study Final Report and/or visually in project maps and figures.

Task 2: Existing Data and Desktop Review

✓ *Relevant summaries, figures, maps, and background data incorporated into scoping study narratives*

2.3. Task 3: Hydraulic Study – Winooski River

The Stone team will complete a hydraulic study for the Winooski River through Richmond. The main components of this study will include:

- Aerial topographic and bathymetric survey
- River corridor assessment and field data collection
- Winooski River hydraulic model development
- Hydraulic study report

The model will be used to evaluate current conditions and potential future benefits of flood mitigation projects included in the alternatives analysis.

2.3.1. Aerial Topographic and Bathymetric Survey

Stone has partnered with Whiteout Solutions to obtain high-resolution elevation data to develop a two-dimensional hydraulic model of the Winooski River through Richmond. Whiteout Solutions specializes in high-precision LiDAR collection systems and data processes. Their team will use a topobathymetric system mounted to an Unmanned Aerial Vehicle to collect topographic and bathymetric (streambed elevation below the water surface) data along the main stem of the Winooski River from Jonesville to downstream of Interstate 89, an area of approximately 42 acres. Following the kickoff meeting and discussions with the Town, this area could be downsized as needed. The LiDAR system produces 200+ points per square meet and 3cm of vertical accuracy with ground control. The 532-nanometer wavelength photon or green laser used in the topobathymetric sensor can collect elevation data up to 15 meters below the water surface–2.5 times the Secchi depth–which is influenced by water clarity. The aerial survey will be completed over two days, a much shorter timeframe than traditional total station surveying. After the data collection process is complete, Whiteout Solutions will process the data into useable geospatial formats. Key environmental features will be identified, including vegetation, bathymetry elevation, water surface, road surface, buildings, bridges, and ground. Deliverables will include elevation contours, Digital Surface Models and Digital Terrain Models projected in Vermont State Plane coordinated and vertical datum NAVD88, unless otherwise noted. These datasets will be made available to the Town for future modeling and design efforts.

2.3.2. River Survey and Supplemental Field Data Collection

To complement the aerial topographic and bathymetric survey, Stone staff will complete a river corridor walk to collect supplemental field data as needed. During this walk, we will collect data on stream bed sediment size and type, bank conditions, culvert and bridge dimensions and conditions, and location data for potential flood mitigation projects. This field data will be used to refine the hydraulic model and inform subsequent alternatives analysis.

2.3.3. Hydraulic Model Development

The Stone team will complete hydrologic analyses and hydraulic modeling for the project extent. We propose that a coupled 1D/2D hydraulic model will be developed using the United States Army Corps of Engineers (USACE) Hydrologic Engineering Center's River Analysis System (HEC-RAS). A coupled 1D/2D hydraulic model provides flexibility to model high-priority or complex areas in two dimensions, while a one-dimensional approach can be used in simpler reaches, balancing computational requirements with project goals. Our scientists, modelers, and engineers are well-versed in hydraulic model development.

The hydraulic model will be used to simulate flooding under existing conditions. Model inputs will include channel and floodplain geometry, bridges and other infrastructure, peak discharges (or streamflow), channel and overbank roughness parameters, and boundary conditions. The model extent ranges from upstream of Jonesville to approximately one mile downstream of where Interstate 89 crosses the Winooski River. This extent may be adjusted in coordination with the Town and will be set to ensure that the model boundary conditions do not influence model results in areas of interest and are sufficiently reasonable to evaluate flood mitigation measures that would benefit Richmond. The model geometry will be developed from the aerial topobathymetric survey data, field data, and publicly available geospatial data layers. Model roughness parameters assigned to the main channel and each overbank based on professional judgment based on-site visits and/or aerial imagery. Boundary conditions will be set at the upstream and downstream extent of the model and junctions with tributaries.

The model will be used to simulate peak discharges, or flood flows. A hydrologic analysis will be completed to determine the most appropriate flood flow values to model. Stone will develop hydrology for the site by utilizing gage transfer and statistical analysis techniques. Our team will perform a review of USGS stream gages along the Winooski River. We will process data from the selected gage(s) and develop estimates of peak flow for the 2-, 5-, 10-, 25-, 50-, and 100-year recurrence interval flood events, using the Log-Pearson Type III Distribution flood frequency analysis technique. We will then perform the gage transfer technique to develop similar peak flow estimates for the hydraulic model extent through Richmond. These values will be compared to peak flow estimates calculated using USGS StreamStats and effective peak flows from the FEMA FIS for the Winooski to select the most appropriate peak flows for the model simulations.

High-water mark data from the July 2023 flood is available through the United States Geologic Survey (USGS) Flood Event Viewer. This data will be used to validate the model. Model results will include flood inundation maps and estimates of water velocity, shear stress, and stream power. The model will be reviewed in accordance with Stone's standard hydraulic model review procedures to ensure accuracy of inputs and flood scenario results.

2.3.4. Hydraulic Study Report – Winooski River

Stone will prepare a hydraulic study report summarizing field data collection, model inputs, model validation, and model results. The report will include a summary of how the model may be used to assess potential flood inundation and impacts associated with different peak flows and to simulate potential flood reductions associated with specific flood mitigation projects. A map of flood inundation extent and longitudinal profile of the Winooski River depicting flood levels will be provided. The hydraulic report will be included as an appendix to the Scoping Study Report.

Stone will share a final draft of the report with the Town for comment and review. One round of revisions will be completed to address the Town's comments prior to the alternatives analysis interim meeting described in Task 5.

Task 3: Existing Data and Desktop Review

- ✓ *Digital Surface Model (DSM), Digital Terrain Model (DTM), and elevation contours developed from the aerial topographic and bathymetric survey.*
- ✓ *Coupled 1D/2D Winooski River Hydraulic Model*
- ✓ *Hydraulic Study Report included as an appendix to the Scoping Study Report and presented at the alternatives analysis interim meeting.*

2.4. Task 4: Hydraulic Study – Jones Mill Brook, Snipe Island Brook, Huntington River

In addition to flooding along the main stem of the Winooski, increases in water depth and stream velocities associated with flood events present a hazard to infrastructure and homes along tributaries to the Winooski. The Town has identified three tributaries to examine further as part of this effort. These include Jones Mill Brook, Snipe Island Brook, and the Huntington River. Stone will complete a hydraulic study for these three tributaries, including incorporating their confluences with the Winooski in the Winooski River hydraulic model to gain a better understanding of water depths and velocity contributing to flood hazards. The scale of the hydraulic studies on the three tributaries will align with the overall flood mitigation goals of reducing flood impacts in Richmond with a focus on town-owned infrastructure, roadways, and residences along the tributaries. The main components of the Winooski River Tributaries Hydraulics Study include:

- Supplemental field data collection and survey
- One-dimensional hydraulic model development
- Hydraulic study report

2.4.1. Supplemental Field Data Collection and Survey

Stone staff will collect limited topographic, bathymetric, and stream geomorphic data to supplement existing geospatial and geomorphic data. Our proposed scope includes one day of field work for two Stone staff along each tributary. Field data collection will be completed using a survey-grade GPS Base Station and Rover. Field notes will be recorded using electronic or paper field forms. Location data will be recorded for potential flood mitigation projects. Field data collection locations and extents will be informed and refined based on information learned during the project kickoff meeting, existing data review, and desktop analysis. We anticipate that data collection will focus on the most vulnerable reaches of these tributaries.

2.4.2. Hydraulic Model Development

The Stone team will complete hydrologic analyses and hydraulic modeling for each of the three tributaries. The hydraulic models will be used to simulate flooding under existing conditions. If available, effective FEMA models used to develop FIRMs will be used as a starting point and modified to reflect current conditions. In some cases, this can reduce time spent on model development. The scope and budget presented here assume that a recent effective model is not available from FEMA. Model inputs will include channel and floodplain geometry, bridges and other infrastructure, peak discharges (or streamflow), channel and overbank roughness parameters, and boundary conditions. The model extents will be determined in coordination with the Town and are anticipated to extend upstream from the confluence of each tributary with the Winooski River. Based on information from the project site visit and RFP Question and Answers, it is assumed that Snipe Island Brook and Jones Mill Brook will be studied from the Richmond town line to their confluence with the Winooski River, and the Huntington River hydraulic analysis will extend far enough upstream to ensure that the model boundary conditions do not influence model results in areas of interest. The model geometry will be developed using terrestrial LiDAR data available through the Vermont Center for Geographic Information (VCGI), supplemental survey data, field data, and bridge and culvert dimension data available via state records. Model roughness parameters assigned to the main channel and each overbank are based on professional judgment from site visits and aerial imagery. Boundary conditions will be set at the upstream and downstream extent of the model.

The model will be used to simulate peak discharges or flood flows. A hydrologic analysis will be completed to determine the most appropriate flood flow values to model following the same methods described in section 2.3.3. If available, high-water mark data from the July 2023 flood is available through the USGS Flood Event

Viewer, or other sources will be used to validate the models. Model results will include flood inundation maps and estimates of water velocity, shear stresses, and stream power.

2.4.3. Hydraulic Study Report - Tributaries

Stone will prepare a hydraulic study report summarizing field data collection, model inputs, model validation, and model results for Jones Mill Brook, Snipe Island Brook, and the Huntington River. The report will include a summary of how the models may be used as tools to assess potential flooding associated with different peak flows and to simulate potential flood reductions associated with specific flood mitigation projects. Maps and figures depicting the model results will be included in the report. The hydraulic report will be included as an appendix to the Scoping Study Report.

Stone will share a final draft of the report with the Town for comment and review alongside the Winooski River Hydraulic Study Report. One round of revisions will be completed to address the Town's comments following the interim meeting described in Section 2.3.4.

Task 4: Hydraulic Study – Jones Mill Brook, Snipe Island Brook, and Huntington River

- ✓ *Hydraulic models for Jones Mill Brook, Snipe Island Brook, and the Huntington River within project extents.*
- ✓ *Hydraulic Study Report included as an appendix to the Scoping Study Report and presented at the alternatives analysis interim meeting.*

2.5. Task 5: Alternatives Analysis

Following the hydraulic studies, Stone's team will identify and vet potential flood mitigation projects to progress to the conceptual design phase and eventually into HMGP funding applications. Project concepts to be considered will include both targeted, immediate potential solutions to flooding challenges, and broader, more holistic projects that incorporate multiple approaches or types of engineering and nature-based solutions (i.e., buyout [or managed retreat] combined with floodplain reconnection and restoration, or projects involving multiple parcels and stream crossings along the same reach) to address long-term and repeated damages, as appropriate. The Stone team will maintain an open mind at the project identification and vetting stage, pulling from experience and expertise, knowledge of the FEMA HMGP, and familiarity with Richmond and the Winooski River watershed. Projects will be prioritized based on their assumed effectiveness in lessening future flood damage.

From the geospatial desktop analysis, hydraulic modeling, and field visits, project ideas will be entered into an alternatives analysis matrix. The matrix will include key project identification information along with an initial evaluation of the project relative to screening criteria. Stone will work with the Town to ensure that project criteria align with the project's goals. Projects in the matrix will be evaluated in a community-driven process based on criteria developed by the Stone team in coordination with the Town and informed by the HMGP requirements for eligibility. The ideal project will be cost-effective, impactful, and supported by landowners and key stakeholders.

We anticipate that the alternatives analysis matrix will include the following criteria or project attributes:

- Project identification information:
  - Name
  - Location
  - Type of project
- Eligibility – Does the project fall into at least one of the HMGP eligible categories?

- Feasibility – How constructable is this project? Are there any major potential challenges?
- Permitting Ease/Constraints – What level of permitting will be required?
- Flood Mitigation Potential - Will this project have immediate flood-reduction benefits? Will it contribute to long-term flood resiliency?
- Community Alignment – Has the community already expressed interest in or concern about this type of project, or this specific project?
- Cost-effectiveness – Is the anticipated cost of the project relative to its benefits likely to be cost-effective for HMGP funding?

During this alternatives analysis, projects will be assigned preliminary numerical scores (i.e., a score of 1 to 3 for low to high cost-effectiveness) for feasibility, permitting ease/constraints, flood mitigation potential, community alignment, and cost-effectiveness. This scoring framework will streamline project comparisons, providing a defensible and less biased comparison across projects where possible. Limitations and assumptions of the numerical scoring will be acknowledged in the project matrix and alternatives analysis process. SEAM Solutions will review and provide input on the draft project map and matrix, paying specific attention to each alternative's likelihood of passing the benefit cost analysis.

Our proposed approach to flood mitigation projects presented here focuses on the following types of projects eligible for HMGP funding:

- Infrastructure projects such as culvert and bridge upsizing
- Roadway relocation, elevation, or soil stabilization projects to address reoccurring washouts
- Floodproofing of commercial and/or municipal buildings
- Natural resources projects including dam removals and floodplain reconnection
- Structural elevation
- Buyouts

In addition to these example project types, our team will evaluate options for projects that mitigate flood impacts for private residences, Volunteers' Green, the Town water system and water system well, a pump station for the Town sewer system, the Town offices, and the Town Wastewater Treatment Facility. Stone has extensive experience with village wastewater feasibility assessments through engineering design support, and is currently helping communities like Wolcott, Vermont, design and implement village wastewater projects with flood resiliency in mind. This includes exploring options like relocation in addition to floodproofing and/or elevating infrastructure such as tanks or electrical components. We will leverage this past experience, along with our strong understanding of natural resource, roadway, and culvert and bridge project design and implementation, to develop viable alternatives for the Town.

Stone will then meet with the Town to review and discuss the results of the alternatives analysis. During this meeting, Stone will review the project evaluations, hydraulic studies, alternatives analysis matrix development, and recommendations for projects to progress to the conceptual design phase. Preliminary cost estimates and timelines will be provided at this stage for the conceptual (30%) design phase to help determine which projects are able to progress to the HMGP application stage within this project's scope and timeline. The goal of this meeting will be to select one or more projects to progress to conceptual (30%) design. Details related to criteria like cost will be refined for projects selected to move forward.

Task 5: Alternatives Analysis

- ✓ *Alternatives analysis matrix with supporting documentation included as an appendix to the Scoping Study Report.*
- ✓ *Presentation of the alternatives analysis and recommendations at an interim public meeting.*

2.6. Task 6: Conceptual (30%) Designs

We understand that this task aims to complete conceptual-level engineering to further develop and evaluate the selected alternatives for full HMGP application development. The potential scope and efficacy of the flood mitigation alternatives range from targeted solutions like single bridge upsizing or floodproofing of a single historical structure to more holistic, large-scale projects combining multiple buyouts, floodplain reconnection, and stream restoration. Depending on the scale and scope of the preferred alternatives, our team anticipates completing conceptual designs to the 30% level for up to two selected alternatives. Our team will also be realistic about the number and scope of projects to develop conceptual preliminary engineering designs under the Scoping Study project due to funding application deadlines, and whether VEM is granted extensions. While project feasibility and potential impact will be prioritized, the project team will consider the ability to develop effective, accurate, and sound engineering designs to support a successful HMGP application in the given timeframe.

Stone will begin the conceptual design phase by identifying data gaps that need to be filled at the conceptual engineering stage and anticipating potential future project challenges. Our proposed scope of work allocates time for additional field data collection, including site-specific topographic and bathymetric survey and identification of trees and vegetation that may need to be removed for construction. The presence of wetlands, natural resources, and threatened and endangered species will be mapped using available geospatial data as needed to inform additional field investigations that may be necessary during the final (100%) design stage. The models developed during the hydraulic studies will be updated to simulate proposed project conditions and quantify potential flood reductions. These model simulations will be used to quantify how the selected flood mitigation measure impacts the mapped flood zone area in Richmond. This data will be incorporated into the Benefit Cost Analysis (BCA).

We anticipate the preliminary design plans will include, at a minimum:

- Cover sheet,
- Notes sheet,
- Existing conditions site plan sheet(s),
- Proposed conditions site plan sheet(s), including proposed access and construction sequence,
- Longitudinal profile sheets,
- Typical cross sections sheets, and
- Details sheets.

Stone will identify and summarize all necessary permits and regulatory applications. Our team has experience obtaining Construction General Permits, Stormwater Permits, Army Corps of Engineers permits, Stream Alteration Permits, Wetlands Permits, Stormwater Construction General Permits, and archeological and historic preservation review for the State Historic Preservation Office (SHPO); and will coordinate with all necessary parties to identify the specific needs for each project. A Vermont State Historic Preservation Project Review Form will be completed and submitted to SHPO for the selected alternative. Since the selected alternative project site is not yet known, this scope of work does not include time or budget for an archeological resource assessment or subsequent investigations should they be required following SHPO's review. Those costs will be included in the opinion of probable cost for the final (100%) design and implementation phase.

Stone has vast experience in cost estimating and construction sequencing and will prepare opinions of probable cost to the conceptual (30%) design level for final (100%) design, construction, and construction engineering and oversight. Our engineers will clearly outline a preliminary construction sequencing.

Opinions of Probable Cost for construction will be informed by the most recent VTrans item unit cost data (2-year and 5-year averages) and the experience Stone has gained with similar projects, with contingencies included for individual project area constraints. This cost estimate will be used to determine cost-effectiveness in the Benefit Cost Analysis (BCA).

Task 6: Conceptual (30%) Design(s)

- ✓ *Conceptual (30%) design plans, OPC, and permitting needs for the selected alternative(s)*
- ✓ *Summary of the basis of design and conceptual (30%) design plans included in the final Scoping Study Report.*
- ✓ *Presentation of the conceptual (30%) designs at a public meeting*

2.7. Task 7: Benefit Cost Analysis (BCA)

The Stone team will complete a BCA for the selected alternative(s) using FEMA's BCA Toolkit and following FEMA BCA guidance. SEAM Solutions will lead with review and support from Stone. Input required for this analysis includes data on proposed project costs and benefits along with data on past damages or estimated damages based on professional opinion. Given the extent of flooding that Richmond has experienced in recent years, our team recommends using data from past damages wherever possible to strengthen and improve the accuracy of the BCA analysis. We will work with the Town to obtain past damages data to complete the BCA analysis. Data on proposed project costs, flood mitigation benefits, and co-benefits (i.e., ecosystem restoration, social benefits) will be developed from the conceptual (30%) design and hydraulic analysis phases. Projects must be cost-effective, with a Benefit-Cost Ratio greater than 1, to be eligible for FEMA HMGP funding. Multiple project types can be combined into the same BCA analysis, sometimes increasing the benefits compared to the costs.

Deliverables for this task will include a report generated from the BCA Toolkit along with a narrative to support the BCA results. These materials will be used to support the HMGP application.

Task 7: Benefit Cost Analysis (BCA)

- ✓ *BCA Toolkit Report and supporting narrative for HMGP application for selected alternative(s)*

2.8. Task 8: Scoping Study Final Report & HMGP Application Materials

The Stone team will summarize the existing data reviewed, field instigations completed, hydraulic modeling and other analyses, conceptual designs, and preliminary BCA results in a final scoping study report for the Town to review. The report will include the following appendices:

- Hydraulic Study Report – Winooski River
- Hydraulic Study Report - Jones Mill Brook, Snipe Island Brook, Huntington River
- Alternatives Analysis Matrix
- Conceptual (30%) Design Plans for Selected Alternative(s)
- Project Location Maps

In addition, the report will include a summary of the basis of design for the selected alternative(s) and potential flood mitigation benefits, BCA narratives to accompany the BCA Toolkit Report, and recommendations for progressing viable alternatives that were not selected for this round of HMGP funding. A draft report will be provided to the Town for review and comment. Following the Town's review of the report and conceptual designs, Stone will complete one round of revisions and finalize technical materials

needed to support a full HMGP application. Our proposed scope for this task includes technical assistance for developing a full HMGP grant application for the selected alternative(s). Our team has experience providing technical assistance for FEMA, EPA Brownfields, and state-level grant programs.

In addition to the alternative selected for the current round of HMGP funding, project deliverables–including the high-resolution topobathymetric datasets, hydraulic models, and alternatives analysis–will be available for the Town to use to develop projects for future rounds of HMGP funding, other hazard mitigation grant programs such as the Building Resilient Infrastructure and Communities (BRIC) and Flood Mitigation Assistance (FMA), or non-hazard mitigation funding for projects with ecosystem, water quality, or other co-benefits that make the project eligible for alternate funding sources.

Task 8: Scoping Study Report & HMGP Application Technical Support

- ✓ *Scoping study report describing work completed in Task 1 through 7 with hydraulic studies, alternatives analysis matrix, and conceptual design plans included as appendices.*
- ✓ *HMGP technical support as needed for the selected alternative(s)*

3. Proposed Schedule

The table below outlines Stone's proposed schedule for this study. Tasks will be performed during the period illustrated by shaded blocks. Our team understands that the current FEMA HMGP deadline requires applications be submitted to Vermont Emergency Management (VEM) by November 18, 2024. VEM has requested an extension to the current FEMA HMGP application deadline for Major Disaster Declaration FEMA-4720-4R. Our proposed timeline assumes that this six-month extension request is granted, with work being completed in October 2024 through June 2025. If the extension request is not granted, we will work closely with the Town to refine the scope to meet a tighter timeline. One option in this scenario could be developing an application for a phased project, rather than final design and implementation funding, and completing the hydraulic analysis at a later date to support applications for future rounds of HMGP or other hazard mitigation funding.

Table 2. Proposed Project Schedule

Task	2024			2025					
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Task 1 – Project Kickoff Meeting									
Task 2 – Existing Data and Desktop Review									
Task 3 – Hydraulic Study – Winooski River									
Task 4 – Hydraulic Study – Jones Mill, Snipe Island, and Huntington									
Task 5: Alternatives Analysis									
Task 6: Conceptual (30%) Designs									
Task 7: Benefit Cost Analysis (BCA)									
Task 8: Scoping Study Final Report & HMGP Application									

4. Proposed Budget

The table below outlines Stone's proposed budget for this project.

Table 3. Proposed project budget by task.

Task	Professional Services	Sub-Consultant	Expenses	Total
Task 1 – Project Kickoff Meeting	$1,392	$0	$40	$1,432
Task 2 – Existing Data and Desktop Review	$2,219	$0	$0	$2,219
Task 3 – Hydraulic Study – Winooski River	$16,783	$28,050	$180	$45,013
Task 4 – Hydraulic Study – Jones Mill Brook, Snipe Island Brook, and Huntington River	$17,246	$0	$1,221	$18,467
Task 5: Alternatives Analysis	$14,062	$748	$40	$14,850
Task 6: Conceptual (30%) Designs	$25,824	$0	$0	$25,824
Task 7: Benefit Cost Analysis (BCA)	$2,952	$4,488	$0	$7,440
Task 8: Scoping Study Final Report & HMGP Application	$9,521	$0	$0	$9,521
TOTAL	**$89,998**	**$33,286**	**$1,481**	**$124,766**

Meghan Arpino, PH, CFM / *Project Hydrologist*

Meghan has an extensive background in the environmental field, specializing in water resources and surface water hydrology. Her expertise includes geomorphic and stream habitat assessments, water-quality sampling and analysis, topographic and fluvial surveying, statistical hydrology, hydrologic and hydraulic (H&H) modeling, and stream and floodplain restoration design. As a certified Professional Hydrologist (PH) accredited by the American Institute of Hydrology and a Certified Floodplain Manager (CFM), Meghan leverages her expertise on stream and floodplain restoration projects in Vermont and New Hampshire.

Years of Experience / 10

Years of Experience at Stone / 8

Education
Master of Science, Hydrology, 2016, University of New Hampshire

Bachelor of Science, Environmental Science, 2012, University of Vermont. Minor: Chemistry

Professional Certifications
Professional Hydrologist, American Institute of Hydrology, Current

Certified Floodplain Manager, Association of State Floodplain Managers, Current

Skills
Hydrologic and Hydraulic Modeling

Stream Geomorphic Assessments

Spatial Analysis and Mapping

Water Quality Monitoring

Field Data Collection

Statistical Analysis

Good Laboratory Practices (GLP)

Software: ESRI GIS Products, R, HEC-RAS, HEC-HMS, MS Office Suite

Honors and Awards
Dingman Scholarship for proposed research and academic performance (UNH)

Honors College Scholar (UVM)

Related Project Experience

Resiliency Initiative for Vermont Empowerment and Recovery (RIVER) / 2024 - Present / Multiple Towns, Vermont

Project manager and primary point of contact for Stone's two RIVER project contracts. Currently leading Stone's team of engineers and scientists in public outreach, stakeholder engagement, project scoping, alternatives analysis, hydrologic and hydraulic modeling, field data investigations, benefit cost analysis, and conceptual design development for preferred flood mitigation projects. Work to be completed over the coming months includes providing additional as needed technical assistance to RPCs and Towns to develop full HMGP grant applications for eligible flood mitigation projects.

Wardsboro Hydrologic Study / 2024 – Present / Wardsboro, Vermont

Providing project management and technical expertise for a hydrologic study in Wardsboro through the Municipal Technical Assistance Program (MTAP). The hydrologic study will assess rainfall, runoff, and streamflow along rivers and stream in Wardsboro to inform an action plan for improving flood resiliency, with special attention to culverts, bridges, and roads.

Mountain School Dam and Culvert Removal / Vermont Natural Resources Council / 2023 - Present / Shrewsbury, Vermont

Providing project management, including fieldwork and initial conceptual design development for removing a dam and replacing a culvert in Shrewsbury, Vermont.

Stevens River Bank Stabilization / Connecticut River Conservancy / 2018–2020 / Barnet, Vermont

Performed a desktop assessment of existing data, supported a survey-level field geomorphic assessment., and conducted hydrologic and hydraulic modeling using HEC-RAS for a river bank stabilization project on the Stevens River in Barnet, Vermont to improve aquatic organism passage, reduce sediment transport, and achieve overall stream equilibrium.

Hands Mill Dam Removal / Winooski Natural Resources Conservation District / 2020–Present / Town of Washington, Vermont

Project Manager for removal of a stone masonry and concrete dam along the Jail Branch in Washington, Vermont. Currently leading a team of scientists and engineers in the development of 100% design plans, along with related permits and construction bidding documents for dam removal and restoration. This project includes additional scoping work to identify opportunities for floodplain reconnection and stream crossing improvements in the vicinity of the Hands Mill Dam following the July 2023 Flood in Vermont, during which

the Hands Mill Dam breached. Provided field support and led the hydrology and hydraulics analysis during the preliminary design and feasibility study phases. Field work included sediment probing and sampling, pebble counts to characterize the stream bed material, and stream geomorphic assessments of the impounded and reference reaches.

Pelletier Dam Removal and Engineering Design / Vermont Natural Resources Council / 2018–2021 / Castleton, Vermont

Performed sediment sampling analysis and survey-level field geomorphic assessment and conducted hydrology and hydraulic modeling to evaluate dam removal scenarios in achieving the project goals of improved geomorphic continuity (reconnecting channel to adjacent floodplain), fish passage, and flood resiliency along North Bretton Brook in Castleton, Vermont. Major components of the H&H study included: delineating the watershed draining to the Pelletier Dam and characterizing flows for standard recurrence interval storm events; utilizing topographic survey information of the stream channel, floodplains, dam, and other features to develop existing and proposed hydraulic models of the river system throughout the project area; and evaluating existing conditions and two removal scenarios.

Lake Carmi Tributary Gauging Assessment / Vermont Agency of Agriculture / 2020 - 2021 / Franklin, Vermont

Led the streamflow gauging site assessment and contributed to the technical advisory committee presentations and final report writing. Provided support for determining equipment needs and costs for streamflow monitoring at proposed gauging locations.

VTrans Phosphorus Control Plan / Vermont Agency of Transportation / 2020–Present / Vermont

Assisted in developing a phosphorus reduction crediting process for stream restoration projects, starting with a floodplain reconnection demonstration site. This work was in support of the VTrans Generalized Phosphorus Control Plan and Phase 1 implementation plan. Primarily responsible for the hydrology and hydraulics analysis portion of this project.

Monitoring Precipitation and Flow in Vermont's Stormwater-Impaired Watersheds and MS4 Communities / Vermont DEC / 2020–2022/ Vermont

Assisting with a comprehensive stream flow and precipitation monitoring program, with continuous, real-time data acquisition and web display, for 11 stormwater-impaired streams in Chittenden and Franklin Counties. Responsible for managing stage, discharge, and precipitation data for this project, as well as providing maintenance and troubleshooting of monitoring instruments and technical writing support. Stage-discharge relations are being developed to derive continuous streamflow records from the 5-minute stage measurements.

Mudd Pond Dam Removal Feasibility / The Nature Conservancy / 2023 / Williston, Vermont

Providing project management, field support, data processing, and technical writing support for dam removal feasibility study.

Mount Sunapee Ski Resort Streambank Stabilization and Stormwater Treatment / Lake Sunapee Protective Association & Vail Resorts / 2022 – Present / Newbury, New Hampshire

Managing multi-year monitoring after completion of a bank stabilization and stormwater treatment project at Mount Sunapee Ski Resort. Monitoring includes annual topographic and geomorphic surveys to collect stream and habitat data to assess project success and evaluate need for adaptive measures.

Efficacy of the 2017 Vermont Stormwater Management Manual Bioretention Soil Specification in Removing Pollutants and Supporting Plant Health / Lake Champlain Basin Program / 2020–2023 / Vermont

Project manager for a study evaluating the performance of four types of bioretention system media relevant to the VSMM bioretention system design standard. Bioretention soil media are being evaluated based on the media's ability to remove sediment, nutrients, and heavy metals while supporting plant health.

Evaluating Performance of Media Filters to Remove Phosphorus in Stormwater Pond Outflow / Lake Champlain Basin Program / 2023 / South Burlington, Vermont

Completed statistical analysis and provided report writing support for a study involving design, construction, and evaluation of P filters to treat outflow from a stormwater pond in South Burlington, Vermont. The effectiveness of the four filters was evaluated using non-parametric and parametric statistics as appropriate.

Peter Lazorchak, PE, LEED AP / *Director of Water Resources Management / Senior Engineer*

Peter leads Stone's Water Resources team. He is a civil and environmental engineer with more than 25 years' experience and a diverse background in environmental services, civil engineering, and construction oversight. Peter's expertise include stormwater management, on-site wastewater disposal, site development, and navigating local, state, and federal permitting processes. He strives to provide solutions to his clients that balance natural resource protection with the built landscape by utilizing low impact development techniques and designing green infrastructure.

Years of Experience / 27

Years of Experience at Stone / 5

Education
Bachelor of Science., Civil & Environmental Engineering, 1997, Lehigh University

Professional Certifications
Professional Engineer, State of Vermont #8930

Certified Site Technician (Level B), State of Vermont #456

LEED Accredited Professional

Skills
Engineering & Design for Water Quality Improvement Projects

Stormwater Management

Low Impact Development Techniques

Green Stormwater Infrastructure

Erosion Prevention and Sediment Control

On-Site Wastewater Disposal

Site Development

Environmental Permitting

AutoCad Civil 3D, HydroCAD, ArcGIS, Microsoft Access

Professional and Community Activities
Town of Waitsfield Water Commission

Valley Futures Network – Citizen Group Promoting New Initiatives (Mad River Valley)

Related Project Experience

Resiliency Initiative for Vermont Empowerment and Recovery (RIVER) / 2024 - Present / Multiple Towns, Vermont

Senior engineer for Stone's two RIVER project contracts, providing oversight for Stone's team of engineers and scientists in public outreach, stakeholder engagement, project scoping, alternatives analysis, hydrologic and hydraulic modeling, field data investigations, benefit cost analysis, and conceptual design development for preferred flood mitigation projects. Work to be completed over the coming months includes providing additional as-needed technical assistance to RPCs and Towns to develop full HMGP grant applications for eligible flood mitigation projects.

Wolcott Village Wastewater Solutions Initiative / Lamoille County Planning Commission / 2019–Present / Town of Wolcott

Lead engineer for a feasibility study and Preliminary Engineering Report (PER) for the Village of Wolcott. Peter is assisting our project partner the Lamoille County Planning Commission (LCPC) and the Town of Wolcott to identify and evaluate possible sites for a soil-based community wastewater projects. The evaluation includes considering systems of varying sizes and retrofitting existing systems for increased capacity. The village is challenged with steep valley walls, flood prone areas, and abundant bedrock.

Deer Brook Gully Restoration / Northwest Regional Planning Commission / 2019–Present / Georgia, Vermont

Developed engineering designs for four gravel wetlands and other upland green stormwater infrastructure stormwater practices to treat and reduce stormwater flows to the head of a deteriorating gully during storm events. The project included gully channel restoration design, including a drop manhole approach and incorporation of downed trees to stabilize stream and gully banks, and reduce erosion via energy dissipation. Peter supported the Friends of Northern Lake Champlain in advancing the final designs through Phase 1 construction in 2022. Supported development of successful funding applications to the Missisquoi CWSP for Phase 2 construction in early 2024.

Folsom Avenue Stormwater Improvements / Essex County Natural Resources Conservation District / 2019-2023 / Concord, Vermont

Project manager and senior review engineer on a stormwater upgrade of a steep village street with significant erosion and sediment transport to the Moose River. The project was initially identified during the development of the Concord Stormwater Master Plan. The design included an upgraded stone line ditch on the upper portions of the road, an infiltration basin on private property, a closed drainage network with deep sump catch basins, and an

underground infiltration gallery located in the village park. The project ties into VTrans infrastructure located along VT Route 2. Stone led the bid administration, contractor selection, and construction oversight for the project. Construction was completed in 2023.

Camels Hump Middle School and Richmond Elementary Stormwater Improvements / Friends of the Winooski River / 2019-Present / Richmond, Vermont

Project manager and lead design engineer for the upgrade of the stormwater management system at Camels Hump Middle School and Richmond Elementary School. Stone identified and advanced this project in developing the Richmond Stormwater Master Plan. The existing storm sewer system outfall, fed by runoff from I-89 and the developed lands of the school campus, caused a severely incised and actively eroding gully. Designs include two gravel wetlands to mitigate peak flows and a gully stabilization plan, including a plunge pool at the pipe outfall and a mixed wood and rock step-pool system incorporating local wood and more permanent stone structures.

Burlington Right of Way Condition Inventory and Stormwater Scoping / Chittenden Country Regional Planning Commission / 2019-Present / Burlington, Vermont

Project manager leading characterization of soils in the City's right of way in Burlington. The project is providing the City with a web map tool that shows soil boring locations with links to the associated boring logs. Where soils are favorable, infiltration testing was performed. The condition inventory was piloted in Wards 5 & 6 in the southern portion of the City and expanded north to include Wards 2 &3, and most recently Wards 4, 8, and 9. The condition inventory provides the City with valuable knowledge when planning stormwater STPs or retrofits in the future.

Friends of the Mad River Project Development / Friends of the Mad River / 2022–2023 / Mad River Valley, Vermont

Led the assessment of existing stormwater master plans and river corridor plans to identify key water quality improvement projects. Provided engineering expertise for project planning and development, identifying three possible stormwater management projects and three river and floodplain restoration projects. Coordinated with stakeholders and developed task lists, partner lists, and timelines. Engaged with the Vermont Department of Environmental Conservation and the Agency of Transportation to identify project funding sources.

Lake Watershed Action Plan for Maidstone Lake / Essex County Natural Resources Conservation / 2022–2023 / Maidstone, Vermont

Provided senior oversight for the project, review of the prioritization matrix, and scoring of potential phosphorus-contributing problem area solutions. Assisted in conceptual plan development and final report review.

Hazen Union High School Stormwater Retrofit Practice / Caledonia County Natural Resources Conservation District / 2019–2020 / Hardwick, Vermont

Project manager and lead engineer for a stormwater retrofit at the Hazen Union High School complex. The design includes a gravel wetland to treat stormwater runoff from the school's main parking lot, about an acre of impervious cover. The site design was challenging to fit the best management practice (BMP) into the site without impacting existing facilities. Oversaw the final design, provided bid document and bid process support, and managed construction oversight, assuring on-time and on-budget completion in late 2019. Now assisting the school with 3-9050 Stormwater General Permitting, as the school was designated a "3-acre site" and is participating in the VTDEC Green Schools Initiative.

Final Design and Construction Oversight for Pine Grove Terrace Pond Improvements in the Morehouse Brook / Chittenden County Regional Planning Commission / 2019–2020 / Winooski, Vermont

Project manager and lead engineer for the expansion of an existing stormwater pond, which is undersized for the watershed it serves. The project also includes the design of curb extension bioretention areas to improve water quality treatment in the contributing watershed, in anticipation of the City's Phosphorus Control Planning obligations. Design plans included data acquisition, site survey, HydroCAD modeling to analyze storm flows and inform the required pond size and outlet structure design, site grading, and quantity and construction estimates. The pond and outlet structure will manage the 100-year storm and reduce peak flows, helping to address the high flow target established in the Morehouse Brook stormwater flow TMDL.

Branden Martin, PE / *Project Water Resources Engineer*

Branden is a licensed Vermont Professional Engineer with over 10 years of experience working on stormwater, stream, and floodplain restoration projects. His expertise spans stream and floodplain restoration, stormwater infrastructure and green stormwater infrastructure design, geomorphic compatible bridge and culvert design, and low-impact design. As an experienced project manager, Branden is well-versed in coordinating with local, state, and federal permitting agencies to advance projects from planning and design and through construction.

Years of Experience / 11

Years of Experience at Stone / 7

Education
Bachelor of Science, Civil Engineering, 2012, The University of Vermont

Professional Certifications
Professional Engineer, State of Vermont #134591

Skills
Stormwater Management

Green Stormwater Infrastructure

Low Impact Development

Environmental Permitting

AutoCAD Civil 3D, HydroCAD, MicroStation, PCSWMM, EDM Total Stations, GPS, Microsoft Office

Professional and Community Activities
2019 Vermont Young Engineer of the Year

Vermont Society of Engineers – Member and Past President of the Board of Directors

American Society of Civil Engineers – Member, Past President and former New England Council Delegate

Report Card for Vermont's Infrastructure – Vice Chair of the committee (2019) and co-author of the stormwater section (2019, 2022)

Hinesburg Development Review Board – Member

Lotus Lake Corporation – Member and Clerk of the Board of Directors

Related Project Experience

Resiliency Initiative for Vermont Empowerment and Recovery (RIVER) / 2024 - Present / Multiple Towns, Vermont

Water resources engineer for Stone's two RIVER project contracts, assisting Stone's team of engineers and scientists in public outreach, stakeholder engagement, project scoping, alternatives analysis, hydrologic and hydraulic modeling, field data investigations, benefit cost analysis, and conceptual design development for preferred flood mitigation projects. Work to be completed over the coming months includes providing additional as-needed technical assistance to RPCs and Towns to develop full HMGP grant applications for eligible flood mitigation projects.

Camels Hump Middle School and Richmond Elementary School Stormwater Improvements / Friends of the Winooski River / 2020–Present / Richmond, Vermont

Working with fellow staff to design two gravel wetlands and stabilize an eroding gully on the campus of Camels Hump Middle School and Richmond Elementary School. The two gravel wetlands will provide water quality treatment for much of the school drive, the school parking lot impervious recreational areas, a section of Interstate 89, and a portion of rooftop runoff. The design and construction of this project will position the schools to gain permit coverage under Vermont Stormwater General Permit 3-9050.

Deer Brook Gully Restoration / Friends of Northern Lake Champlain / Georgia, Vermont / 2017–2019

Served as Water Resources Engineer for restoration design of a gully where deteriorating conditions have led to significant sediment loads being discharged to nearby Deer Brook. The addition of impervious flows over recent decades has led to mass soil failure, loss of root structure, and significant erosion in the gully and intermittent stream. Work completed includes watershed delineation upland hydrology and hydraulic calculations using PCSWMM. Results were used to evaluate potential upland BMPs that will reduce inflows into the gully. Design tasks included channel restoration incorporating the design of energy-dissipating stone step-pools and in-channel log jam grade control, slope stability analysis, design of constructed gravel wetlands in upland drainage areas, design of closed drainage infrastructure including deep sump catch basins and deep manholes, and design of bank stabilization measures which included incorporation of downed trees to stabilize stream and gully banks.

In 2021, the project entered the bidding and construction phase, provided edits to final construction plans, coordinated with VTrans and additional stakeholders, secured VTrans S.1111 permit, prepared bidding documents and

project specifications, led and oversaw the bid advertisement and bidding phase, and assisted in bid analysis and contractor selection. Conducted construction oversight in the fall of 2022. Supported a successful funding application to the Missisquoi BWQC for construction of Phase 2.

Richmond Stormwater Master Plan / Chittenden County Regional Planning Commission / Richmond, Vermont

Assisted in data collection, field assessment, problem area data sheet creation, and prioritization and implementation matrices. Led the effort to complete a series of concept designs that address high-priority stormwater problem areas within the Town of Richmond.

Concord Folsom Avenue / Essex County Natural Resources Conservation District / 2019–2023 / Concord, Vermont

Led the design to establish an infiltration basin, closed drainage network, and an underground infiltration gallery – replacing a failed culvert at a steep intersection in Concord's village that was a major erosion and sedimentation problem impacting local roads and the Moose River. Led the bid administration, contractor selection, and construction oversight for the project that provides stormwater infiltration, sediment retention, and peak stormflow mitigation.

NRCS Practice 578 - Stream Crossings / VT DEC Watershed Management / Richmond and Hinesburg, Vermont / 2017

Assisted in the collection of existing data and field data, conducted a topographical survey of the crossing location and stream profile, and assisted with the completion of hydraulic and watershed calculations with the use of HydroCAD to determine storm flow velocities and bankfull width at five different stream crossing locations. Assisted with the site grading and layout plan sets to support the installation of three (NRCS) standard portable skidder bridges (heavy duty) with 14' clear spans and two ford crossings. One of the Fords is in design, and it is anticipated that the design and construction will be complete by 2018. Work on this project was and is being completed as a project engineer.

UVM Horticultural Farm Stormwater Design / City of South Burlington / South Burlington, Vermont / 2020–Present

Leading design of two stormwater ponds, a gravel wetland, and closed drainage infrastructure. The project manages nearly 44.5 acres of drainage, including 4.2 acres of untreated impervious cover, and will help the City meet high flow targets established in the Bartlett Brook Flow Restoration Plan while also providing stormwater treatment and storage for irrigation water.

Irish Farm Stormwater Improvements / City of South Burlington / South Burlington, Vermont / 2021–Present

Leading design of three gravel wetland retrofits of existing stormwater dry detention ponds. The project manages over 47.5 acres of drainage, including at least 9.31 acres of impervious cover currently not being treated to the standards outlined in the 2017 Vermont Stormwater Management Manual. Construction of the gravel wetlands will help the City meet high flow targets established in the Bartlett Brook Flow Restoration Plan while providing water quality treatment.

Hazen Union High School Stormwater Retrofit Practice / Caledonia County Natural Resources Conservation District / Hardwick, Vermont / 2018–2019

Served as Water Resources Engineer for a stormwater retrofit project at the Hazen Union High School complex. The design included a gravel wetland to treat stormwater runoff from a drainage area that includes a parking area, tennis court, and access drive—over an acre of impervious cover. Supported final design and the construction bid process and provided construction oversight for the gravel wetland when it was completed in 2019.

Chestnut Hill Stormwater Mitigation Design / Friends of the Winooski River / Montpelier, Vermont / 2018–2019

Supported engineering and design efforts to stabilize an eroding gully near Chestnut Hill in Montpelier, VT. Collected topographic survey, created a project basemap, and designed an improved channel that incorporates properly sized closed drainage infrastructure in the upland watershed and a series of steps and pools within the channel to dissipate energy and discourage erosion and sediment transport.

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

Dr. Kiesel is an environmental modeler and hydrologist with 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, machine learning, landscape modelling and spatial analysis.

Years of Experience / 15

Years of Experience at Stone / 3

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, machine learning, 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, LSTM, Talsim, MikeHydro, SWMM

Hydraulic Modelling: HEC-RAS, AdH

Programming Skills: Python, R, Fortran

Employment History

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

At Stone, Jens utilizes established watershed models, custom-built models, software, and geospatial analysis tools in various water-related projects. His responsibilities include investigating 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 modeling 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 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 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

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.

Selected Project Experience

Climate Change Impact Assessment in Somaliland / CES / 2023 / Somaliland

CMIP6 data acquisition, bias correction, and precipitation analyses, potential evapotranspiration, and wind projections under climate change scenarios. Field investigations, impact assessment on growing seasons, and climate change data provision for hydrologic modeling.

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

Streamflow data analyses, model development, and application of a Random Forest machine learning model to calculate representative nationwide streamflow values for New Zealand's grape-growing regions.

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

Fieldwork to observe hydrological and hydraulic parameters, diatom distribution, and high-resolution temperature mapping using Distributed Temperature Sensing. SWAT+ model application and code improvements to simulate oxygen, temperature, and salinity in high spatio-temporal resolution. Analyzing C-Q relationships and hysteresis effects in high-frequency water quality monitoring data

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

The Rogun Dam reservoir, once the world's highest, faces severe sedimentation. Using SWAT and GIS-based erosion models, evaluated the total sediment input from landslides, gully erosion, screes, sheet, and rill, as well as channel erosion on ecosystem services. Worked with the project team to develop and test BMPs in the modeling framework.

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

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

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

Assessed the complex water balances of the Machar Marshes using remote sensing products, hydrologic modeling of the inflows from the Ethiopian escarpments, and detailed hydraulic modeling of the Baro spilling region and the Machar Marshes with Mike11 and Mike SHE, providing inputs to e-flows assessments.

Nile Basin Wetlands Of Transboundary Significance: Inventory, Baseline Study And Framework Management Plan With A Nested Case Study On The Sudd / Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Nile Basin Initiative (NBI), HYDROC / 2018–2020 / Nile Basin

Led modeling of the Nile Basin's major wetlands, focusing on the Sudd. Designed modeling approach, conducted impact studies, and assessed climate and development scenarios. Managed hydrologic simulations, hydraulic modeling, and coordination with ecosystem services and environmental flows assessments. Integrated models into NileDSS and provided workshops, capacity building, and training.

Assessment of Suitable Flood Mitigation Measures in Tbilisi, Georgia / Climate Technology Centre and Network (CTCN) of UN Industrial Development Organization, HYDROC / 2017–2018 / Georgia

Flash flood modeling under current and climate change conditions with HEC-HMS using temporally downscaled gauge data based on radar- and climate change data. Detailed uncertainty assessment under data-scarce conditions. Conceptualization of a flash flood early warning system, detailed technology and knowledge transfer to the National Environmental Agency in a ten-day workshop.

Computer Modeling and Complementary Engineering Assessment of Sediment Development and Hydrology of AkSu- and Khojibakirgan Watershed / ACTED, HYDROC / 2014–2015 / Tajikistan, Kyrgyzstan

Methodological and model development for assessing the spatial distribution of runoff, field erosion, and sedimentation in the stream network and the stormwater drainages of the major villages in the catchments. Investigating impacts of single events as well as climate change and land-use change on peak discharges and sedimentation using the SWAT model.

Jared Ardman, EIT / *Staff Water Resources Engineer*

Jared is a recent graduate of the University of Vermont with a bachelor of science degree in environmental engineering. He is an Engineer-in-Training (EIT) focused on providing water quality modeling, engineering, and permitting support for stormwater, culvert and bridge upsizing, dam removal and stream restoration projects. Jared's passion for the environment extends into his personal life, where he can often be found hiking, climbing or skiing in the Green Mountains.

Years of Experience / 1

Years of Experience at Stone / <1

Education
Bachelor of Science, Environmental Engineering, 2024, University of Vermont

Professional Certifications
Engineer in Training (EIT), Vermont

Skills
AutoCAD, Civil 3D & SOLIDWORKS

Topographic and Bathymetric Surveying using Total Station or GPS Base Station and Rover systems

COMSOL, MAGNET & SEEP/W

Python

Professional and Community Activities
President, Fundraising and Project Director – UVM's Engineers Without Borders

Employment History

Stone Environmental, Inc. / Montpelier, Vermont
Staff Water Resources Engineer / September 2024 - Present
Jared's work focuses on water resources engineering support for flood mitigation, stormwater, and stream restoration projects using tools such as AutoCAD and ArcGIS. He models hydraulic and hydrological systems using HydroCAD. Jared also assists with local, state, and federal permitting applications.

Engineering Ventures / Burlington, Vermont
Intern / 2022
Drafted in Civil 3D from survey data. Surveyed with total stations and GPS equipment at field sites. Computed water and wastewater flow estimates.

Related Project Experience

Hands Mill Dam Removal Implementation Phase / 2024 / Washington, Vermont
Provided construction oversight and as-built survey support.

Memphremagog Watershed Association Culvert Engineering Services / 2024 – Present / Holland and Morgan, Vermont
Providing design support including hydrologic analysis and drafting.

Chimney Hill Dam Removal / 2024 – Present / Wilmington, Vermont
Provided topographic and bathymetric survey support using a GPS Base Station and Rover along with general engineering and design support.

UVM Capstone Design Project / Stowe Electric Department (SED) / Spring 2024 / Moscow, Vermont
Completed runoff calculations, stormwater sizing, and permitting associated with the SED lot redesign. The final product included an optimized parking lot, bio infiltration basin, steel parking deck design, and general site improvements regarding ADA accessibility standards.

Professional and Community Activities

President (2023), Project Director (2024), Fundraising Director (2022), UVM's Engineers Without Borders
Volunteered in Arusha, Tanzania, for an international project, finishing work on a solar lighting system.