

Seth P. Brown, PE, PhD

Mr. Brown is the principal and founder of Storm and Stream Solutions, LLC with over 20 years of experience in the water resources engineering arena and 5 years covering regulatory, policy, legislative, legal and advocacy issues in the water sector. He is also the founder and Executive Director of the National Municipal Stormwater Alliance, a 501.c.3 representing 15 states and over 3,000 municipal separate storm sewer systems (MS4s) from across the U.S. He is a licensed professional engineer in Maryland, and has a Masters degree in Civil Engineering from the University of Maryland at College Park. This degree focused on fluvial geomorphology, stream restoration and watershed analyses. Mr. Brown's PhD-level research in the Civil, Environmental and Infrastructure Engineering Department at George Mason University focusing on economic behavior of green stormwater infrastructure investments. His areas of focus include stormwater management design and analysis, environmental economics, alternative project delivery for infrastructure investments, public-private partnerships, innovative funding and financing in the water sector, stream/geomorphic assessment and restoration, water resources design/analysis, sediment transport modeling, and adult education development and delivery.

EDUCATION

Ph.D. in Civil, Environmental and Infrastructure Engineering, George Mason University, Fairfax, VA, 2019

M.S. in Civil and Environmental Engineering, University of Maryland, College Park, MD, 1999.

B.S. in Civil Engineering, Christian Brothers University, Memphis, TN, 1995.

PhD Research: Agent-Based Modeling Simulation of Green Stormwater Infrastructure Adoption by Private Property Owners in the Context of an Incentive-Based Program, George Mason University, Department of Civil, Environmental and Infrastructure Engineering: Mr. Brown led a research effort focusing on an approach that uses agent-based modeling to simulate the behavior of private property owners responding to incentives to adopt onsite green stormwater infrastructure. Concepts such as small-world social networks, opinion dissemination and diffusion of innovation is used to capture dynamic social, spatial and temporal aspects of stormwater infrastructure adoption. Demographic information is integrated into modeling rules that influence simulation dynamics. Information is presented that describes how these concepts have been translated into an agent-based modeling platform, Netlogo, that provides the opportunity to explore modeling dynamics and output. A novel market-based approach used by Washington, D.C. Department of Energy and the Environment that promotes the use of tradeable stormwater retention credits is explored in the context of modeling, with this community being used as the generic template for incentive-based simulations that could be relevant to other urban landscapes facing stormwater runoff challenges on privately-held properties. Detailed information is available at: <https://fhrl.vse.gmu.edu/node/15>

Masters Thesis

Mr. Brown's thesis, titled "Prediction of Stream Channel Geometry in the Maryland Piedmont based upon Land Use and Urbanization," focused on the development of a series of models that predict stream cross-sectional geometry based upon certain watershed characteristics (i.e., drainage area, land use composition) in the Maryland Piedmont physiographic province. This research required a thorough understanding of model development. Also, as part of this research, intense field work was necessary along with an extensive amount of knowledge on topics related to cross-sectional as well as longitudinal stream geometry including effects of land use on stream geometry, geomorphology, geographic information systems, and statistics.

Special Research

Mr. Brown researched the ENSO (El Nino/Southern Oscillation) phenomenon with regards to extreme streamflow events during seminar class while pursuing Masters degree. He used statistical analysis to investigate correlations between warm and cold ENSO events and extreme streamflow events in the Western US.

LICENSES & PROFESSIONAL AFFILIATIONS AND AWARDS

Professional Engineer, Maryland (#25820)
Member of the Washington, D.C. Chapter of ASCE
Member, Water Environment Federation
Rosgen Level II certified
National Highway Institute Instructor of Excellence, 2013

Water Finance, Funding and Alternative Project Delivery; Economic Analysis; Policy Support

Development of Community-Based Public-Private Partnership Guide for Stormwater/Green Infrastructure-focused Infrastructure and Related Support Services, Environmental Protection Agency, Region 3, Philadelphia, Pennsylvania (2014-ongoing) - Mr. Brown has provided, and continues to provide a variety of support services for EPA Region 3, including:

- Lead author for a publication focusing on various aspects of public-private partnership (P3s) intended to support the investment in stormwater and green infrastructure. This publication was released in April, 2015, and is the first document outlining the nature of Community-Based P3s (CPB3) for Green Infrastructure and the many advantages of using this approach to enhance investments in stormwater management infrastructure, such as the ability to accelerate implementation of green infrastructure investments, reduce overall costs due to economies of scale as well as efficiencies gained in procurement process, and generate local, green entry-level employment opportunities.
- Development of supporting documents associated with the CBP3 model, including template documents, policy/position papers, community needs analysis, and scenario development.
- Support for an analysis of pollutant load reductions from point and nonpoint sources in the Chesapeake Bay region including documentation of investments made and impacts generated in the water quality sector. The deliverable will be a study describing the evolution of the Chesapeake Bay TMDL, how states and regions are addressing assigned wasteload and load allocations, how states and regions are faring in meeting required reductions, what technologies have helped communities and utilities achieve pollutant load reductions, and what future efforts are needed in the urban runoff and agricultural runoff sectors in the context of the Chesapeake Bay TMDL.
- Ongoing services include development of policy papers, regulatory, financial and scenario analyses, economic studies, public outreach, community engagement, and technical support for regulated entities related to the CBP3 approach as well as other innovative and sustainable approaches to stormwater management.

Green Infrastructure Incentives White Paper and Meeting Facilitation, Willamette Partnership, Portland, OR (2017): Mr. Brown assisted as a convener of a national-level workshop focusing on stormwater and green infrastructure trading, offset/mitigation and incentive-based programs, Seth authored a white paper via stakeholder input and via a survey of workshop attendees. This document scanned the country to find varying incentive-based programs, categorize these programs, and draw conclusions based upon the effectiveness of each approach as well as through input gained from workshop attendees.

Technical Support on Various Areas of Office of Wastewater Management, U.S. EPA HQ, Washington, DC (2017-ongoing): Mr. Brown has provided an array of support services for EPA's Office of Wastewater Management (OWM), including research, policy report review and development, and presentation of key findings on technical recommendations. Areas of focus has wide potential with current focus on water quality trading policies regarding technical aspects related to market-based approaches, including banking credits, spatial considerations for trading, and the universe of tradeable pollutants based upon technical basis. Additional focus is to support the efforts of the Stormwater Funding Task Force by providing research and analysis on critical topics of interest.

Technical, Policy, and Administrative Support for National Municipal Stormwater Alliance, Washington, DC (ongoing): Mr. Brown is leading multiple tasks on behalf of the National Municipal Stormwater Alliance (NMSA) via a Federal grant focusing on stormwater/MS4 issues, alternative project delivery approaches / Community-Based Public-Private Partnerships (CBP3s), and green stormwater infrastructure. Specific tasks include research and analysis to develop

white papers on issues of interest, convene and facilitate workshops and meetings centered on topics of interest, provide technical support to select communities on alternative project delivery potential, and similar topics.

Technical, Policy, and Administrative Support for Water Environment Federation, Washington, DC (ongoing): Mr. Brown acts as a Senior Stormwater Advisor to the Water Environment Federation's (WEF) Stormwater Institute (SWI). Seth provides input on technical and policy topics that intersect with stormwater and wet weather areas. Mr. Brown engages with U.S. EPA and legislators on behalf of WEF on issues of significance. Seth also leads the Stormwater Testing and Evaluation for Products and Practices (STEPP) initiative, which is an effort to develop a national-level testing and verification program for stormwater products and practices through robust and widely-accepted performance testing standards.

Technical Support on Community-Based Public-Private Partnerships (CBP3) for Large-Scale Investment in Green Infrastructure, Great Lakes Protection Fund (2016-ongoing): Mr. Brown is providing technical assistance for a series of reports focusing on the potential for alternative approaches, including the CBP3 program approach, to drive large-scale green infrastructure for select cities across the Great Lakes Region. Support includes assistance in performing research, authoring sections of reports, and report editing and finalization.

Technical Support on Various Areas of Office of Wastewater Management, U.S. EPA HQ, Washington, DC (2017-ongoing): Mr. Brown has provided an array of support services for EPA's Office of Wastewater Management (OWM), including research, policy report review and development, and presentation of key findings on technical recommendations. Areas of focus has wide potential with current focus on water quality trading policies regarding technical aspects related to market-based approaches, including banking credits, spatial considerations for trading, and the universe of tradeable pollutants based upon technical basis.

Investigation into Alternative Project Delivery Options, Market-Based Incentive Approaches, and Innovative Financing Tools for Green Stormwater Infrastructure and Beyond, Seattle Public Utilities, Seattle, Washington (2018) - Mr. Brown provided consulting services to SPU focusing on alternative project delivery options, market-based and incentive-based approaches, as well as innovative financing tools. Seth acted as project manager to develop a library of reference information on the topics of interest for SPU staff as well as the development and delivery of webcasts on the topics of interest. Mr. Brown also led the facilitation of a 2-day workshop with SPU departments ranging from financing and procurement to GSI and wastewater. The workshops included in-depth discussions on public-private partnerships, ways to improve market-based and incentive-oriented programs for GSI adoption on private properties, creative ways to forge partnerships between public departments/agencies and private sector parties on a project basis to form sound long-term policy, and consideration of creative ways to utilize low-cost public financing options, such as State Revolving Fund and Water Infrastructure Finance Innovation Act assistance, including leveraging and securitization for expanded overall investments for GSI and other infrastructure types.

Green Infrastructure Incentives White Paper and Meeting Facilitation, Willamette Partnership, Portland, OR (2017): Mr. Brown assisted as a convener of a national-level workshop focusing on stormwater and green infrastructure trading, offset/mitigation and incentive-based programs, Seth authored a white paper via stakeholder input and via a survey of workshop attendees. This document scanned the country to find varying incentive-based programs, categorize these programs, and draw conclusions based upon the effectiveness of each approach as well as through input gained from workshop attendees.

Consulting Services for Green Infrastructure Technical Assistance, Chesapeake Bay Trust, Annapolis, Maryland (2017) - Mr. Brown led an effort to develop training and public outreach materials based upon the Community-Based P3 publication soon to be released by EPA Region 3. As the project leader, Mr. Brown engaged with multiple public entities within EPA Region 3 to educate/inform on the technical aspects and advantages of using the CBP3 approach to meet stormwater requirements as well as perform feasibility analysis to ascertain and illustrate the potential advantages of utilizing the CBP3 approach to generate investment in green infrastructure.

Value Engineering Services for Green Infrastructure Program, Seattle Public Utilities, Seattle, Washington (2016) - Mr. Brown provided value engineering support services for Seattle Public Utilities (SPU), which included a comprehensive review of the technical, outreach, policy, and funding/financial aspects of SPU's green infrastructure program. Mr. Brown

worked with other national experts to develop a set of recommendations for SPU to improve the performance of SPU's green infrastructure program and enhance the overall potential for SPU to delivery significant impacts through their stormwater program projects and efforts.

Technical and Policy Support Services, Water Environment Federation (2015-ongoing) - Mr. Brown is the Director of Stormwater Programs at the Water Environment Federation (WEF) and is providing on-going support for WEF's stormwater initiatives. Services include policy and regulatory analysis, member engagement, programmatic support, and technical advisement on stormwater and wet weather issues and technologies. Specifically, Mr. Brown is the staff liaison to the National Municipal Stormwater Alliance (NMSA), which is a 501.c.3 that was developed in close partnership with WEF and is comprised of state/regional groups who represent regulated MS4 communities across the U.S.

Technical and Policy Support Services, National Municipal Stormwater Alliance (2015-ongoing) - Mr. Brown is the staff liaison to the National Municipal Stormwater Alliance (NMSA), which is a 501.c.3 that was developed in close partnership with WEF and is comprised of state/regional groups who represent regulated MS4 communities across the U.S. In this role, Seth supports members on a variety of fronts, such as coordinates events and meetings, leads discussions on policy and outreach efforts, and represents NMSA at high-level policy and technical meetings focusing on the MS4 program, and coordinates and authors policy advocacy submission and publications.

Investigation of Stakeholder Decision-Making in the Washington, D.C. Stormwater Retention Credit Trading Program, University of the District of Columbia (2015) - Mr. Brown received grant funding to study the dynamics of the Washington, D.C. Stormwater Retention Credit trading program. As Co-PI, Mr. Brown engaged in stakeholder interviews to understand the decision-making dynamics of market participants. This information informed the development of an agent-based model that will simulate the SRC program market under varying policy assumptions and financial conditions. The investigation was performed in coordination with the University of the District of Columbia with the hope of providing aid to stakeholders in their decision-making efforts when considering the option to invest in retention-based practices on-site.

Consulting Services to Support White Paper on Economic Value of Green Infrastructure, Horinko Group, Washington, D.C. (2015) - Mr. Brown provided technical support in an ongoing effort to craft a policy paper related to the economic benefits of urban, coastal and watershed-based green infrastructure. This document synthesized existing literature on the costs and benefits of green infrastructure in financial as well as ecosystem services contexts and provided policy recommendations to encourage and catalyze more green infrastructure implementation in the U.S.

Investigation of the Impacts of the Washington, D.C. Stormwater Retention Credit Trading Program (2014-2015) - Mr. Brown provided support services to a team investigating the impacts of the Washington, D.C. Stormwater Retention Credit (SRC) trading program on various D.C. stakeholders. In the capacity of team member, Mr. Brown led an effort to interview leading design consultants and land developers to understand the key factors associated with SRC credit generation. Further, Mr. Brown assisted the team in developing policy recommendations on the SRC program based upon insights gained from interviews and through policy analysis.

Training Development and Delivery

Certified Instructor by the National Highway Institute

Development and Delivery of Water Quality Management Course, National Highway Institute, Arlington, Virginia (2004-2015): Mr. Brown constructed 2-day technical training course for the National Highway Institute (NHI) on water quality management, as well as taught the course on to several States across the Country. The course covered the basics of water quality sources, impacts and dynamics. Other aspects of water quality management were introduced, such as regulatory procedures, and effective design of treatment facilities as related to linear construction and maintenance. Concepts included water quality and quantity treatment and Low-Impact Development (LID) design and implementation. Mr. Brown led the delivery of the course in numerous States and Federal agencies.

Development and Delivery of Erosion and Sediment Control Training Course (2004-2015): Mr. Brown assisted in the development of an adult-targeted erosion and sediment control course for the National Highway Institute (NHI), which is the training wing of the Federal Highway Administration. This course focused on erosion and sediment control in highway construction. The nation-wide target audience is highway construction professionals who design, construct, inspect and maintain highway construction projects. Adult-education techniques were used in the development of materials and examples in the course. Mr. Brown was the lead instructor for this course.

Great Lakes Water Quality Workshop, Federal Highway Administration, Washington, DC (2006): Mr. Brown developed materials and assisted in moderating a regional conference on water quality issues. His duties included collecting information related to water quality and roadway impacts on the Great Lakes states and assisting in the presentation of information related to this topic at a 1-day workshop.

Loudoun County Stormwater Management Training (2003): Mr. Brown aided in the development of a 2-day course on the topic of stormwater management for engineers and maintenance on the County staff. This course was developed to help Loudoun County meet their VPDES permit requirements.

Watershed Planning

Reston Watershed Plan (2001/02). Mr. Brown managed several tasks involved with the development of a watershed plan for Reston, Virginia. Tasks in this project include an intensive public outreach effort, physical and biological assessments of targeted streams, hydrologic and hydraulic modeling, GIS support (in the ArcView environment), and the development of conceptual designs for potential projects to aid in the improvement of water quality. Stream assessments utilized protocols such as the EPA Rapid Bioassessment for habitat assessment and the Bank Erosion Hazard Index (BEHI) for physical assessment. H&H modeling will be developed in the GIS environment using HEC-GeoHMS (for hydrological modeling) and HEC-GeoRAS (for hydraulic modeling).

Lower Gunpowder Watershed Management Study (1999/2000): Mr. Brown played a significant role in the development of a highly-detailed water quality management study for the Lower Gunpowder Watershed. In the field component of the study, he aided in Level III Rosgen field assessments through out the watershed. These assessments provided crucial geomorphic information which aided in the understanding of the fluvial geomorphic patterns in the watershed and the relative stability of streams draining it. For the office component, Mr. Brown utilized a commercial Geographical Information Systems package, ArcView, to map the results of his field investigation.

Stream Assessment and Restoration/Stabilization Design

Stream Assessment and Restoration, City of Fairfax, Virginia (2010): Mr. Brown was involved with stream assessment (BEHI) and prioritization of potential stream projects for several miles of impacted stream in City of Fairfax area. He led an effort to produce a comprehensive report on the physical condition of the streams in Fairfax City and two five-year plans to stabilize and restore the most impacted stream segments. Prioritization schemes were developed using parameters such as feasibility, location, access, impacts to utilities and costs.

Stream Assessment and Prioritization Plan, Burke Centre HOA, Burke, Virginia (2006): Mr. Brown led an effort to assess several miles of stream using the Bank Hazard Erosion Index protocol (BEHI) in order to develop prioritization plan for potential stream restoration and stabilization projects for Burke Centre. He authored a report detailing the assessment efforts and results of the analysis, and presented this information to the community.

Reedy Creek Channel Improvement Monitoring, Richmond, VA (2010): Task leader responsible for mitigation compliance for a stream restoration project associated with a flood control enhancement of Reedy Creek. He is currently providing in-field and in-office support to engineering and environmental science staff. In this role, he has reviewed documents, such as the 30-day post-construction monitoring report and coordinated field efforts to collect additional stream cross-section data. Mr. Brown will also be involved in the review of the six-month and annual monitoring reports, which will

entail benthic collection, fish sampling, vegetative surveys, stream stability assessment, photographic documentation, and habitat assessment using the EPA RBP method.

Cameron Run Ecological Restoration, Alexandria, Virginia (2007/08): Mr. Brown acted as the project manager for conceptual design (35%) of 4 miles of ecological restoration of Cameron Run, a severely impacted urban riverine system that drains approximately 40 sq. mi. of developed area. Efforts include Rosgen Level II assessment of entire design reach, identification of critical areas of impact on stream ecosystem, opportunities for wetland and other water quality features (e.g., vernal pools, etc.), and 10% and 35% conceptual designs of a naturally self-maintaining system using natural channel design concepts.

Four Mile Run Stream Corridor Restoration, Arlington County/Alexandria, VA (2010): Task manager responsible for coordinating stream restoration design services to develop a stream corridor restoration design intended to transform an urban flood control channel with reduced environmental amenities to a more natural and self-maintaining river system. Restoration efforts will focus on use of natural channel design paradigm when developing stream designs which will minimize erosive conditions as well as provide the cross-sectional and longitudinal geometry required to maintain a stable river system.

NCHRP Study on Stream Restoration Protocols (2006): Mr. Brown led an effort to conduct an email survey of all State DOT's to collect information on stream restoration monitoring programs and existing methods on assessing performance of stream restoration projects. The results of this survey were compiled along with information on protocols commonly used by resource and regulatory agencies in the collection performance data on stream restoration projects. Also, an extensive literature search was performed to find information related to the use of stream restoration as a stormwater best management practice. The results of the study provide information on current stream monitoring protocols used by States throughout the Country along with detailed case studies to highlight these protocols. Also, technical recommendations and guidance are provided on future protocol development and the programmatic aspects of monitoring plans.

Cardinal Glen Stream Restoration Study (2004/05): Mr. Brown provided key expertise in evaluating a stream restoration project that had been designed and constructed previously by another party. This evaluation included a review of the design as well as in-field assessment of the construction work performed. Also, several key fixes were proposed by Mr. Brown to minimize further problems with this project. This evaluation took the form of a comprehensive report. The work is on-going, and will involve future evaluations of the system.

Upper Snakeden Branch Stream Restoration (2003/04): Mr. Brown acted as project manager for a stream restoration design in Reston, Virginia. Mr. Brown performed a Level II Rosgen assessment of the existing planform and cross-sectional stream geometry. A one-dimensional hydraulic model was developed for the existing conditions using HEC-RAS to determine areas of critical in-stream velocity and shear stress. Using this model as a guide, a proposed geometry was designed using sound geomorphic principles, and a proposed hydraulic model was developed. Also, Mr. Brown proposed the use of in-stream rock structures such as rock and cross vanes, and imbricated rock walls, as well as more "natural" solutions, such as log vanes and coir biologs. Along with these structures, Mr. Brown developed a comprehensive planting plan and schedule.

Redhouse Run Tributary "C" Stream Restoration (1999/2000): Mr. Brown was the lead project engineer and designer for the restoration of Redhouse Run Tributary C. The stream was in need of restoration and had been severely damaged due in part to the increased urbanization of the watershed as well as a trend of upstream-moving headcuts. The soils throughout the watershed are highly erodible, so the increased stress placed upon the streambanks due to higher and more frequent flooding discharges introduced a large amount of suspended sediments to downstream areas. The restoration required an intense field component, which was necessary to fully understand the dynamics of the geomorphology for the impaired stream. Mr. Brown aided in Rosgen Level III assessments for all reaches in the study. To fully understand the impacts on the system, it was necessary to determine the hydrology for the watershed. This was determined using GISHydro2000, a customized GIS application working within the ArcView environment. This application automates the process required to delineate a watershed and quantify the watershed characteristics needed for a TR-20 analysis. After investigating the geomorphology and hydrology of the watershed, a design was proposed to restore the stream and minimize the impact of urbanization. This design relied heavily on CADD software to visualize as well as

determine the proposed geometry. The final plan called for stream geometry modifications as well as bioengineered in-stream structures to reduce the amount of bank stress and therefore reduce the amount of suspended sediment leaving the system.

Germantown/Lateral C Stream Restoration and Stabilization (1997): Mr. Brown was the lead project engineer and designer for a stream restoration/stabilization. Lateral C, a tributary of the Wolf River, had become severely eroded and entrenched due to intense urbanization within its watershed. He developed a HEC-2 model to simulate various peak events in a tributary of the Wolf River in the Germantown, Tennessee area, which were determined by the development of a HEC-1 model for the area. Using the output from the HEC-2 model, a stream restoration/stabilization plan was produced which included the use of a CADD package to develop plans for the construction of the river alignment and retaining walls used in project.

Pond and Lake Management and Dredging Efforts

Burke Centre Pond Inventory and Management Study, Burke, VA (2006): Mr. Brown led the field and office efforts to investigate the condition of several streams in the Burke Centre area and develop recommendations based upon this data. Bathymetric surveys were performed for all of Burke Centre's ponds to verify recent engineering reports on the condition of the ponds. These surveys were compared with historic bathymetric mapping and original design documents to estimate sediment delivery rates. A prioritization plan was developed using this data providing recommendations of pond improvements based upon available budget funds. Innovative techniques, such as bio-dredging, were investigated for use in the plan.

Lake Caroline Bathymetric Survey and Assessment, Lake Caroline HOA, Caroline County, VA (2005): Mr. Brown led an effort to collect bathymetric data on a 277-acre man-made lake in order to aid in the determination of sedimentation rates of the impoundment facility. Several weeks of field work was performed using HYPACK, the state of the art software for bathymetric surveying. This data was compiled and analyzed in order to develop a bathymetric map of the entire lake bottom. This data was compared with historic mapping to determine areas of sedimentation and estimated rates of sediment build-up. This information, along with recommendations for future actions, was presented to the community.

Aquia Harbour Dredging Plan, Aquia Harbour HOA, Stafford County, VA (2004): Mr. Brown assisted in the development of a dredging plan used to obtain requisite permits for dredging activities. He assisted in the collection of bathymetric data over a two-mile tidal riverine system and led the mapping efforts to support permitting efforts.

Design and Review (Drainage, Stormwater, Coastal)

Fairfax County Stormwater Management Retrofit Design, Fairfax, VA (2010): Mr. Brown is responsible for conceptual as well final design and specifications for stormwater management facility retrofit in order to adhere to current code for water quality treatment. Tasks include conceptual planning and design, involvement in public meetings, developing final plans, specifications and estimates to describe proposed work and erosion and sediment control plan, details and specifications.

City of Alexandria Basic Order Agreement, Alexandria, Virginia (2010): Mr. Brown is currently a task leader for the **Windmill Hill Shoreline Stabilization** project, overseeing the scour analysis and stabilization of a segment of tidally-influence Potomac shoreline. The analysis requires an in-depth wave-fetch analysis to determine wave-action impacts on local conditions as well as storm surge heights. The deliverable will include a detailed scour report along with design support for a section of vertical piling, a section of sloped rock revetment, and a natural shoreline area. He is also a task leader for **George Mason Elementary School** Drainage Improvements, responsible for analysis of a hydraulically-undersized closed-drainage system in order to develop several alternatives for proposed improvements to the drainage system. Water quality mitigation efforts will be required in order to remain in compliance with Chesapeake Bay standards, and the alternatives will have to conform with planned changes to school layout and nearby park improvements.

- **Windmill Hill Shoreline Stabilization, Alexandria, VA (2010):** Mr. Brown is currently the task leader overseeing the scour analysis and stabilization of a segment of tidally-influence Potomac shoreline located in the City of Alexandria. The analysis requires an in-depth wave-fetch analysis to determine wave-action impacts on local

conditions as well as storm surge heights. The deliverable will include a detailed scour report along with design support for a section of vertical piling, a section of sloped rock revetment, and a natural shoreline area.

- **George Mason Elementary School Drainage Improvements, Alexandria, VA (2009):** Mr. Brown is the task leader to analyze a hydraulically-undersized closed-drainage system in order to develop several alternatives for proposed improvements to the drainage system. Water quality mitigation efforts will be required in order to remain in compliance with Chesapeake Bay standards, and the alternatives will have to conform with planned changes to school layout and nearby park improvements.

VDOT Location and Design Engineering Services Contract for Region IV-Northern VA (2010): Task manager responsible for hydrologic/hydraulic modeling/design and stormwater and drainage design services. He has overseen the application of standard H&H software to develop design solutions, such as water crossing improvements to reduce frequent flooding situations, and the development of cost-effective storm drainage design alternatives. Mr. Brown has overseen scour analysis required by VDOT for projects involving major stream crossings.

Route 234 / University Blvd Intersection Improvement, VDOT (2009): Mr. Brown is currently the lead H&H design engineer responsible for storm drainage layout and stormwater management related to an interchange improvement in Prince William County, Virginia. A left-turn lane is being added to Route 234 with associated widening to occur on University Boulevard. Mr. Brown is overseeing the design of all inlets and pipes, as well as ensuring that VDOT water quality and quantity requirements are met.

VDOT Lucasville Road Hydraulic Crossing Improvement (2008/09): Mr. Brown is the lead engineer overseeing the hydraulic design associated with a proposed roadway improvement along Lucasville Road in Prince William County, Virginia. The existing pipe crossing at a local sag point in the study area is hydraulically deficient which had led to frequent roadway overtopping. Mr. Brown is leading an effort to design an improved hydraulic crossing to reduce flood potential as well as respecting roadway geometry constraints. Stormwater and storm drain design needs are associated with the project as well as stream channel improvements in the vicinity of the crossing.

Chester Stadium and Redevelopment Project in PA (2009): Task Manager responsible for providing technical support associated with water resources. Technical areas covered include erosion and sediment control, stormwater management and shoreline protection. Shoreline scour potential was analyzed by considering wave fetch, boat wake, riverine flows and ice floats. This analysis was performed to determine the relative stability of existing, and proposed, river bank slopes on site. The culmination of analyses associated with these technical areas was summarized in a water resources compendium, which was submitted to regulatory authorities.

Civil Engineering Services, Fairfax, VA (2008/09): Mr. Brown is currently leading several design efforts to aid the City of Fairfax's Public Works Department as they address multiple localized flooding and pedestrian improvement projects. His role as task manager to act as the primary client contact, lead and coordinate design efforts and provide public relations services when required. Currently, two small drainage designs as well as one pedestrian walkway improvement is ongoing.

Georgetown Waterfront Park Wall Design, Washington, D.C. (2006): Mr. Brown led the design efforts for a tidally-influence portion of the Potomac River as part of the Georgetown Waterfront Park design. The design efforts melded natural systems, a vegetated reinforced soil slope (VRSS), with harder engineered systems to enhance the aesthetic and naturalistic aspects of the interface between the park promenade and the Potomac River.

Loudoun County Stormwater Design for Loudoun County, VA (2005/06): Mr. Brown served as project manager for several stormwater design efforts to alleviate localized flooding concerns. Designs were developed using CADD and other tools to provide conceptual-level plans for homeowner and County approval. Project management tasks included overseeing subconsultants for various services, including surveying and geotechnical support.

Environmental Plan Review, Stafford County, VA (2005): Mr. Brown assisted in the review of erosion and sediment as well as stormwater management plans submitted to Stafford County. The effort consisted of reviews of reports and other design documents related to water resources topics to ensure plans were compliant with County and State regulations.

Floodplain reviews were occasionally included in these reviews. The reviews focused on quality control related to report calculations and assumptions as well plan documents.

Modeling (H&H, Sediment Transport, Water Quality, Floodplain)

South Wilmington Wetland Park, Wilmington, DE (2010): Task Manager responsible for H&H modeling and site plan development associated with the restoration and stormwater enhancement of 27 acres of historic marsh that is currently an impacted brownfield site. Mr. Brown developed a grading and stormwater plan using complex two-dimensional hydraulic modeling (SWMM) to optimize the ecological, water quality treatment and aesthetic functions of the wetland. In his capacity as technical task leader, he provided oversight of the integration of soil remediation information in order to minimize costs associated with disturbance of pollutant hot spot locations. Also, Mr. Brown developed a 10% design plan that integrated several hydraulic elements and connections to produce a well-functioning urban constructed/enhanced wetland.

Cameron Run Sediment Study, Alexandria, Virginia (2007/08): Mr. Brown led an effort to describe sediment transport properties of Cameron Run system. The study aims to provide technical assistance for on-going design alternative efforts by the USACE to prevent/mitigate flooding in the Huntington area along Lower Cameron Run. This area experience major flooding in response to a near 12-inch rain event in late June, 2006. The final deliverable will include a report that provides a proposed schedule and estimated volume of required dredge removal in order to mitigate for water surface rises due to a proposed levee to protect nearby homeowners.

Kesyer-McCool Bridge Replacement – WVDOH (2008): Mr. Brown oversaw efforts related to H&H analysis as well as storm drain design associated with the replacement of a 3,900 bridge on Route 220 spanning the Upper Branch of the Potomac River which connects communities in Maryland and West Virginia. Design activities for this project include H&H modeling and analysis of temporary and permanent impacts due to the proposed bridge in the Potomac River system, scour potential analysis, and bridge drainage design. HEC-RAS modeling was developed to reflect existing, temporary, and post-project hydraulic conditions. HEC-18 procedures were followed to estimate scour of three (3) large piers located within the 100-year flow limits. Rock outcroppings are common in this area, so rock core samples were provided along with particle size distribution to accurately analyze and determine predicted scour depths.

Kenmore Watershed Storm Sewer Study (2003/04): Mr. Brown led the development of a model to analyze a commonly flooded area in the City of Fredericksburg to provide guidance for capitol improvements for the City. The model utilized in this study is XPSWMM, which can simulate the impact of not only peak flow events on a system, but dynamic events as well. XPSWMM is a commercially packaged version of the EPA-developed public-domain software package SWMM (StormWater Management Model). The objective of the project was to determine the causes of, and solutions to, flooding problems which plague a section of the City of Fredericksburg known as the Kenmore Watershed. A major impetus for the study was severe flooding during the summer of 2000 that resulted in waist-deep water in sections of the City. Mr. Brown was responsible for developing a computer model of the stormwater drainage system using XP-SWMM. The system is a complex network of inlets, culverts, storm drains, ponds, two major box flumes, a canal, and discharges to the Rappahannock River. Mr. Brown modeled the existing stormwater infrastructure under various hydrologic scenarios to determine flood risk associated with different return period events. Mr. Brown developed and evaluated potential solutions to the flooding problems.

Falls Church Stormwater System Modeling (2002/03): Mr. Brown led an effort to model critical portions of the Falls Church stormwater system. This effort utilized the XPSWMM modeling system, which allows for dynamic hydraulic modeling of storm sewer systems. Field efforts were performed to locate all of the drainage structures in the system and this data was fed into a Geographic Information System (GIS) platform where it was integrated into the hydraulic model to ensure maximum accuracy of storm sewer locations and properties. The analysis focused on located the sources and extents of localized flooding areas and proposed solutions were developed using this same software. The results of the analysis were fed into a capital improvement plan in order to more easily facilitate the updates for this aging and complex hydraulic system.

Storm Sewer Infrastructure Mapping (2002/0): Mr. Brown acted project manager to comprehensively map the entire storm sewer system for the City of Falls Church. In this project, survey data in a database format was converted into GIS

data, which aided the City in mapping their system as well as providing a tool to quickly and accurately manage their storm sewer system.

Falls Church Flood Insurance Study for Tripps Run (2002/03): Mr. Brown assisted in the development of H&H modeling for a detailed flood insurance study for the City of Falls Church, Virginia, to update Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRMs) in the area. To accurately and efficiently model the 1.5 miles of Tripps Run in this study, GIS data was utilized whenever possible. Mr. Brown helped to collect and assemble GIS data from two sources and prepare the data for analysis. One part of this analysis was the development of hydrologic modeling, which requires an analysis of land use and zoning data to determine existing and future runoff. HEC-GeoRAS, an automated GIS tool, was utilized to increase the efficiency and accuracy of the hydraulic model development process.

SmartGrowth Policy Analysis, Environmental Protection Administration (2003): Mr Brown led the development and implementation of an analysis to investigate the water quality impacts of varying land use patterns for multiple sites across the Country. This effort was performed to support the SmartGrowth initiative based in the EPA's Office of Policy. Geographic Information Systems coverages were provided and analyzed to determine proportional land coverage for various sites using different growth patterns. Water pollutant loadings were assigned to land usages to determine total and relative impacts and changes in water quality impacts for the varying development patterns.

Flood Study Review for FEMA FIS Program (2001): Mr. Brown provided review support for flood studies submitted to the Federal Emergency Management Agency (FEMA) for their Flood Insurance Study (FIS) program. This project consisted of technically reviewing hydraulic models, such as HEC-2 and HEC-RAS models, as well as various hydrologic models (i.e., HEC-1, HEC-HMS, SWMM, etc.) submitted by communities and private developers when their development impacts areas within the 100-year floodplain, thus affecting flood insurance rates.

Thumb Run Fecal Coliform TMDL (2000): Mr. Brown provided GIS support for the Thumb Run TMDL development project. He used BASINS to perform watershed delineations to analyze land use and USGS RCH3 stream network data within the Thumb Run watershed. This model is being used to identify the prime locations for BMP implementation and to set a fecal coliform total maximum daily load, TMDL, for Thumb Run.

South Branch Patapsco River Hydrologic Study (1999): Mr. Brown performed in-depth hydrologic study of the South Branch Patapsco River in the Sykesville, Maryland area. Due to increased traffic demands, Maryland State Route 32 required widening. This action demanded the construction of a new crossing of the South Branch of the Patapsco River. A customized Geographical Information System (GISHYDRO) was used to obtain information on soil data as well as existing and future land use information. A TR-20 model was developed that utilized this information to produce a series of predicted peak discharges. Other methods of determining peak discharge include Log-Pearson Type III analysis, USGS Regression equations, and a thorough analysis of nearby USGS stream gauge information. The results of this study were used to determine the critical discharges needed to design the proposed structure spanning the South Branch Patapsco River.

Ken Branch Culvert Analysis (1999): Mr. Brown worked as part of a team that analyzed a culvert system for the Ken Branch crossing of Maryland State Route 191. The culvert system has historically been hydraulically inadequate which has caused a hazard to automobile traffic in the area. Through the analysis of the system using HEC-RAS software, the team suggested improvements to the system to alleviate the flooding.

Meridian Municipal Airport Drainage Retrofit (1997): Mr. Brown performed a detailed hydrologic and hydraulic study of the Meridian Municipal Airport in Meridian, Mississippi to determine actions required by the airport to become FAA compliant with regards to drainage conditions. The hydrology of the site was determined through the employment of the HEC-1 computer program. Hydraulics for the site were assessed through the use of FAA and locally-accepted methods for culvert analysis and design. An extensive field inspection was performed to identify drainage lines that did not meet the proper FAA requirements. Finally, several retrofit plan alternatives were considered, with budget constraints, before the adoption of a suggested plan of action.

FHWA National Bridge Scour Program, Tennessee Department of Transportation (1997): Mr. Brown was intensely involved in predicting bridge scour for rural bridges in Western Tennessee to comply with the National Bridge Scour Program. He was involved in all phases of the program, which included in-field bridge inspection as well as WSPRO model development (Water Surface PROfile). Taking information produced by the WSPRO model, the Army Corps of Engineers

program, HEC-18, was employed to predict scour depths at bridge piers and abutments. Using the scour predictions produced by HEC-18, a detailed structural analysis was performed to determine the relative structural bridge stability.

Relevant Publications/Periodicals:

Contributing author to *Advances in Water Quality Trading as a Flexible Compliance Tool*, Water Environment Federation, July, 2015

Public-Private Partnerships Beneficial for Implementing Green Infrastructure, Bloomberg BNA Water Law & Policy Monitor, July, 2015

Accelerating Sustainable Stormwater Infrastructure Investments, American Infrastructure, July, 2015

Major contributor in EPA Region III report, *Community Based Public-Private Partnerships (CBP3s) and Alternative Market-Based Tools for Integrated Green Stormwater Infrastructure*, April, 2015

The Rising Challenge of Stormwater, World Water: Stormwater Management, Vol. 2, Issue 2, February/March, 2015

Why Worry About the Rain?, The Freshwater Trust Magazine, Portland, Oregon, October 2014

Quoted in: *With Data and Resolve, Tacoma Fights Pollution – NY Times*, Environment Section, June 13, 2014

Agent-Based Modeling of Green Infrastructure Investment, ALAM CIPTA, International Journal of Sustainable Tropical Design Research and Practice, Vol. 6, No. 2, December, 2013, Selangor, Malaysia

Breaking Down Barriers to Innovation through Testing and Evaluation, World Water: Stormwater Management, Vol. 1, Issue 2, December, 2013

Residual Designated Authority – Friend or Foe to the Public Sector?, Feature: The Stormwater Report, December, 2013

Stormwater: Paying the Bill, World Water: Stormwater Management, Vol. 1, Issue 1, September, 2013

What Is the Future of Flow-Based Regulations? Feature: The Stormwater Report, Water Environment Federation, February, 2013

Square Peg in a Round Hole: Are Flow-Based TMDLs the Right Approach?, Bloomberg News, Environment Report, February, 2013

Calming the Storm: Managing Stormwater Runoff the Green Way Makes Sense for Both the Environment and the Bottom Line. The Parking Professional, Environmental Issue, The International Parking Institute, December, 2012

Green Infrastructure Alternatives, Utility Infrastructure, “How to” Issue, October, 2012

Stormwater as a Resource, Australian Stormwater Industry Association Bulletin, August, 2012

Banking on Green: And Economic Guide to Green Infrastructure, Self-Published, May, 2012

Economic Incentives for Stormwater Control, Feature: The Stormwater Report, Water Environment Federation, April, 2012

Developing Performance Data Collection Protocol for Stream Restoration Prepared for the National Cooperative Highway Research Program, Task 8, Transportation Research Board. Prepared by GKY & Associates, Inc. and ICF Consulting. March, 2006

Other Media:

Quoted in Water Online article titled, *“EPA Stormwater Ruling: How Will It Impact Utilities?”* focusing on the impacts of recent Residual Designation Authority (RDA) petitions. January 21, 2014.

Conference / Event Presentations:

2015 (23)

Pennsylvania Leadership Forum, *Panel Discussion on Community-Based Public-Private Partnerships for Green Infrastructure*, Harrisburg, PA, October, 2015

California Stormwater Quality Association Annual Conference, two presentations, (1) *To Green or Not to Green: Modeling Incentive-based Programs for Green Infrastructure Investment on Private Properties*, (2) *Community-Based Public-Private Partnerships for Green Stormwater Infrastructure*, Monterey, CA, October, 2015

Association of Clean Water Administrators, Stormwater Workshop, *Updates on the WEF Stormwater Testing and Evaluation of Products and Practices*, Philadelphia, PA, October, 2015

Green City, Clean Water Green Infrastructure Practitioners Conference, *Panel Discussion on Community-Based Public-Private Partnerships for Green Infrastructure*, September, 2015

U.S. Water Alliance One Water Leaders Conference, *Panel Discussion on Community-Based Public-Private Partnerships for Green Infrastructure*, San Francisco, August, 2015

StormCON, *Updates on the WEF Stormwater Testing and Evaluation of Products and Practices*, August, TX August, 2015

Kentucky Stormwater Conference, Innovations, Policy Updates and Tipping Points in Stormwater, Lexington, KY, July, 2015

NCPPP, *Panel Discussion on Community-Based Public-Private Partnerships for Green Infrastructure*, July, 2015

North Carolina Green Industry Council Annual Water Symposium, *Creatively Incenting and Financing Green Infrastructure Implementation*, June, 2015

Indiana MS4 Conference, two presentations, (1) *The Significance of Stormwater: Policies, Trends, and Tipping Points*, (2) *Community-Based Public-Private Partnerships*, Indianapolis, IN, May, 2015

VA MS4 Forum, *Stormwater Utilities and Funding/Financing*, Richmond, VA, May, 2015

TRIECA Annual Conference, *Exploring the Need for a National Stormwater BMP Testing and Verification Program*, Toronto, OR, March, 2015

Virginia Lakes and Watershed Association, *To Green or Not to Green: Modeling Incentive-based Programs for Green Infrastructure Investment on Private Properties*, Richmond, VA, March, 2015

Ohio Water Environment Federation Watershed Workshop, Innovations, Policy Updates and Tipping Points in Stormwater, Columbus, OH, October 2014

Low Impact Development Symposium, *Updates on the WEF Stormwater Testing and Evaluation of Products and Practices*, Houston, TX, January, 2015

AWRA National Capital, *To Green or Not to Green: Modeling Incentive-based Programs for Green Infrastructure Investment on Private Properties*, April 2015

Great Rivers Conference, CWA Then and Now: Funding Needs and Mechanisms and Incentives for Stormwater, Lincoln, NE, March 2015

Water Environment Federation webcast, *Overview of the Community-Based Public-Private Partnership Approach*, May, 2015

Mapistry, Inc. webcast series, *Overview of the 2015 Multi-Sector General Permit*, June, 2015

Water Environment Federation webcast, *The Future of Water Quality Trading*, July, 2015

Chesapeake Bay Program Scientific and Technical Advisory Committee meeting, *Exploring the Need for a National Stormwater BMP Testing and Verification Program*, Fairfax, VA, March, 2015

PaveDrain Annual Sales Event, *Updates in Stormwater*, Orlando, FL, January, 2015

2014 (16)

Puerto Rico Water Environment Federation, Stormwater Workshop, Caguas, PR, November 2014.

Ohio Water Environment Association Watershed Workshop, Innovations, Policy Updates and Tipping Points in Stormwater, Columbus, OH, October 2014.

ACODAL Annual Conference, Stormwater and Green Infrastructure Seminar, Santa Marta, Colombia, September 2014.

Pennsylvania Water Environment Association Stormwater Seminar, WEF Activities and Stormwater Policy Updates, Harrisburg, PA, September 2014.

StormCON, Updates on the WEF Stormwater Testing and Evaluation of Products and Practices, Portland, OR, August, 2014.

Nevada Water Environment Association Annual Conference, Overview of Stormwater Policy Updates, Reno, NV, May 2014.

Great Connections Stormwater Conference, Keynote address: Innovations, Policy Updates and Tipping Points in Stormwater, Davenport, IA, May 2014.

Great Plains Stormwater Conference, Keynote address: Innovations, Policy Updates and Tipping Points in Stormwater, Tulsa, OK, April 2014.

Virginia Lakes and Watershed Association, Stormwater Policy Updates, Richmond, VA, March, 2014.

National Association of Counties Annual Fly-in Event, Presentation to Environment Committee on Stormwater Policy Updates, Washington, DC, March 2014.

International Erosion Control Association Annual Conference (2 presentations), (1) Workshop on Innovations in Stormwater, (2) Panelist on Expert Panel on Stormwater Policy, February 2014.

Ohio Stormwater Conference, Keynote address: Innovations, Policy Updates and Tipping Points in Stormwater, Akron, Ohio, June 2014.

University of South Florida / U.S. Forest Service Green Infrastructure and Water Management in Growing Metropolitan Areas Conference (2 presentations), (1) *Keynote address: Intersection of Policy and Green Infrastructure*, (2) *Panel Discussion on Barriers to Implementation of Green Infrastructure*, Tampa, FL, January, 2014

PaveDrain Annual Sales Event, *Outlook on Stormwater*, Baltimore, MD, January, 2014

2013 (8)

Think Blue: Maine Stormwater Conference, *Policy Panel*, November, 2013

American Bar Association, Environmental Conference, *Accotink Creek Flow-based TMDL Ruling / The Future of Stormwater Management*, Baltimore, MD, October, 2013

Missouri Water Environment Association Annual Stormwater Conference, *Technological and Financial Innovations in Stormwater*, Columbia, MO, September, 2013

International LID Symposium (2 presentations), (1) *Investigation of a National Stormwater Products Testing and Evaluation Program*; (2) *Stormwater Policy/Legal Updates and Innovations in Finance*, August, 2013

EPA Region 6 MS4 Conference, *Innovation Barriers & Solutions in Stormwater Sector*, New Orleans, LA, July, 2013

Potomac Conservancy, *Overview of Stormwater Sector*, Washington, DC, May, 2013

Washington Council of Governments (WashCOG) Water Resources Committee Meeting, *Updates on Stormwater Issues and Activities*, Washington, DC, May, 2013

South Carolina Water Environment Association Annual Conference, *1-Day Stormwater Seminar*, Myrtle Beach, SC, March, 2013

2012 (5)

StormCON (2 presentations), (1) *Mainstream the Green: Barriers (and Solutions) to Large-Scale Implementation of Green Infrastructure*; (2) *Banking on Green*, Denver, CO, August, 2012

Association of General Contractors of America Environmental Conference, *Using Green Infrastructure to Manage Stormwater During and After Construction*, Crystal City, VA, June, 2012

New Jersey Water Environment Association Annual Conference, *2-Day Stormwater Seminar*, Atlantic City, April, 2012

WEFMAX Annual Meeting, *Stormwater at WEF*, Baltimore, MD, April, 2012

Cincinnati Municipal Sewer District Stormwater and Watershed Workshop, *Sustainable Watersheds*, Cincinnati, OH, February, 2012

2011 (1)

StormCON, *The Integrated Water Paradigm*, Anaheim, CA, August, 2011