WATERSHED SCIENCE BULLETIN

Center for Watershed Protection Association

Journal of the Center for Watershed Protection Association

Ask the Experts

Perspectives on the primary drivers of stream restoration, design approaches and techniques, and restoration potential

Watershed Science Bulletin is a publication of the Center for Watershed Protection Association

"*Ask the Experts: Perspectives on the primary drivers of stream restoration, design approaches and techniques, and restoration potential*" was first published in the *Watershed Science Bulletin September* 2017.

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Ask the Experts

The Watershed Science Bulletin often features interviews with experts in the watershed and stormwater professions. In this issue, four professionals weigh in with their perspectives on the primary drivers of stream restoration, design approaches and techniques, and restoration potential. Here is what our experts had to say…

George Athanasakes

Senior Principal, Stantec Consulting Services Inc., Louisville, KY

George Athanasakes serves as the Ecosystem Restoration Services Leader for Stantec and is responsible for leading ecosystem restoration for the firm throughout the United States. George has a diverse background that includes stream restoration, wetland restoration, dam removal, and watershed planning. George has served as the Principal-in-Charge, Project Manager and/or Design Engineer on more than 100 stream restoration projects incorporating a variety of restoration techniques. George consults on stream restoration projects throughout the United States. In addition, he has helped to bring innovation to the field of stream restoration by leading the development of the RIVERMorph software, which is the industry standard for stream restoration software throughout the United States and internationally. George holds Bachelor of Science and Master of Engineering degrees from the University of Louisville. He is also a registered Professional Engineer in several states.

Q: What have you observed as the primary driver for stream restoration, and do you feel it has produced the intended outcomes? What do you see as the future drivers and expected outcomes of stream restoration?

A: We live in a strange world, but oddly enough the need for mitigation has been one of the biggest drivers for the stream restoration market. It's a bit backward that impacts to some streams would drive the restoration of others. I have the unique opportunity with my role at Stantec to be involved in stream restoration projects throughout the United States. The market for stream restoration services is much more robust in the East than in the West, and the main driver for the market in the East is definitely the need for mitigation.

I do feel that stream mitigation has produced the desired outcomes and without it, I don't think we would have had the opportunity to restore as many streams as we have. I know there is a general feeling within academia that mitigation (and the overall field of stream restoration) is not producing

the desired results, but I just don't see it. I've seen a lot of great work accomplished over the years by a number of entities, and I think we will continue to see the profession evolve and get better over time. As a profession, we need to do a better job celebrating our successes by writing papers and documenting the results. Finding the time to do this is difficult in the consulting sector.

Future drivers that I see for funding stream restoration include the TMDL [total maximum daily load] market and simply philanthropy. I think the public is seeing the benefits of stream restoration and clean water and the demand is there to continue to restore our streams.

Q: Respond to critics who say we shouldn't be messing with the stream until we have provided suitable watershed controls to address the hydrologic regime.

A: If we waited for all the watershed controls to be in place before we restored streams, I don't think we would be doing much stream restoration. While good policy to force the need for the hydraulic controls is important, I would argue a well-thought-out stream restoration project does not need all controls to be implemented to be effective. When our company approaches a stream restoration project, we start by understanding channel evolution patterns and where the stream is in the context of channel evolution. This can be using Schumm's model or Rogen's succession stream type stages. We then design to bring the stream back into equilibrium, which often involves providing floodplain access and/or grade control. A stream with good floodplain access is resilient against a varying hydrologic regime, which often results in a shift in the flow duration curve. While we certainly need to understand the hydrologic regime of a reach of stream to restore it, I believe we can design around a varying regime.

Q: No two designers approach a project the same way. Designs can vary widely, with different underlying assumptions about effective discharge, channel evolution, and so forth, which is often confusing for managers/clients. Do you think there should be some form of standardization in the design approach taken? Is there only one way to approach a stream restoration design?

A: There are multiple ways to design a stream, and we don't want to limit creativity by only allowing one approach. Having said that, we also don't want to promote approaches that don't work. This very question has been polarizing throughout the profession, and I think we simply need to acknowledge that there are multiple approaches and move on to focus on producing great projects. I told myself I was not going to go here when I first read this question, but here I go… The whole form versus process debate in our profession has also been very polarizing over the years. The two are not mutually exclusive and ultimately drive each other. You can't get to form without understanding process and vice versa. I think the entire profession needs to acknowledge that there are multiple approaches to restoring streams and strive to incorporate the most appropriate tools when needed. Our firm uses a variety of approaches, including the Natural Channel Design (NCD) approach developed by Dave Rosgen. We have found it to be very effective in restoring streams, and the method is rigorous and requires a keen understanding of stream processes to be implemented correctly. We view NCD as one of many tools in the tool box to achieve the end goal of a healthy functioning stream system.

Q: To successfully restore the physical, chemical, and biological functions of a stream, it is necessary to understand how these different functions work together and which restoration techniques influence a given function. Do you feel that we have enough tools to determine the restoration potential with respect to functional lift of a restoration project?

A: As a profession, I feel that there is a good understanding of the functions, and we generally have the means to influence physical and biological functions. Chemical functions are a mixed bag and are more difficult to influence. Regarding determination of restoration potential with respect to functional lift, where we are lacking is on the monitoring side. Again, we have the physical functions covered with typical monitoring; however, we currently lack typical monitoring budgets to really drive at the biological and chemical functions pieces. My hope is that this new emphasis on functional lift will help drive the funding to now prove that the functional lift is occurring. We have always assumed that if you build it, they will come. Now it is time to prove it, and as a designer there is nothing like specific, targeted monitoring to really learn how to fine tune the design process to ultimately achieve the main goals we are all striving to attain. In my mind, "these are exciting times," and I'm looking forward to the direction the field is headed to ultimately prove that the functional lift is there. I'm sure this will be a hot topic at many future stream restoration conferences for years to come.

Q: What have you observed as the main factors involved in stream restoration failure, and what techniques do you use to minimize risk?

A: I think there are several factors that lead to stream restoration failures. These include lack of experience of the designer, poor implementation, and bad timing. I'll try to address each of these in order in the following paragraphs.

With respect to the experience of the designer, this is a multidisciplinary field that, for the most part, is just beginning to be taught at the university level. I personally feel that training coupled with mentoring is the most important factor to develop the experience needed to successfully design and implement stream restoration projects. At our firm, we provide the training over time and really focus on the mentoring aspect. We believe strongly in sending our restoration team out in the field to collect the data themselves rather than have a dedicated survey team to do this. We believe this teaches staff how to "read the river." We also have staff work under lead designers for years before attempting a design and follow up with a lot of collaboration by experienced staff throughout the design process.

On the implementation front, there are a lot of great contractors with experience in stream restoration that do a great job, and we have had the pleasure to work with quite a few of them over the years. I think with this profession, it is critical to keep the design team involved in construction to aid in dealing with site conditions that may warrant changes and to keep the intent of the design at the forefront. It is also critical that the equipment operator has sufficient stream restoration experience and not just the construction company. It all comes down to the operator, so the experience needs to be there.

Lastly, it's a matter of timing. One of our key design goals is to have a naturally functioning stream that requires intact and mature vegetation. Immediately after a project is built, the stream is at its weakest state and is vulnerable until the vegetation and riffle armor become established. We could

spend a lot more money by using more rock and extending erosion control fabric throughout the floodplain, but that is costly and may not end up achieving a natural solution. I personally think our profession does not do a very good job setting the expectation of how a site strengthens over time and discussing the vulnerabilities of the site to significant flooding shortly after construction. The goal here is to create self-sustaining systems, but depending on timing of large floods, there may be some maintenance needed until the site matures.

Q: Do you have a stream restoration story that you'd like to share? Please indicate the type of stream restoration project, lessons learned, innovations, and so forth.

A: The most interesting and enjoyable project I've been involved in by far is our Hatchery Creek Stream Restoration project near Jamestown, Kentucky. We worked for an awesome client, building a trout stream where one did not previously exist and were able to design the stream to support all life stages of trout. We ultimately designed and built low and high gradient C stream types, sections of DA (braided) channel, and a step pool system. There were very unique conditions we had to consider for the design, including a relatively constant base flow source that was disproportionately high relative to the drainage area, lack of sediment supply, the ability to bleed off large flood flows, and a great opportunity to focus on trout habitat. All throughout the design process, our team approached this as a once-in-a-career type project, so we really focused on maximizing the opportunity before us. I feel very blessed to have been involved with this project and to work with such a talented team implementing a very unique project that I will revisit as a fishing destination for years to come. For more info on this project visit https://fw.ky.gov/Fish/Pages/Hatchery-Creek-Stream.aspx.

Richard Starr

Vice President/Senior Water Resources Scientist, Ecosystem Planning and Restoration, LLC, Columbia, MD

Mr. Starr has more than 25 years of experience in watershed and stream assessment, planning, and restoration. He has led comprehensive and critical studies for major watershed-based ecosystem restoration projects and water resources development projects, such as flood protection, water supply, and recreation. He has developed, designed, and monitored plans for wildlife and fisheries habitat-enhancement projects, stream restoration projects, TMDL reduction projects, stormwater management, and floodplain management projects. He has conducted numerous geomorphic watershed and stream assessments, implemented stream restoration and fish passage projects, provided construction oversight, developed stream assessment protocols and tools, produced numerous technical and planning documents, and developed and delivered training courses on functional-based stream assessment and restoration. Mr. Starr previously worked for the U.S. Fish and Wildlife Service for 16 years as the Chief of the Habitat Restoration Division, Chesapeake Bay Field Office, where he led and managed the Stream Habitat Assessment and Restoration Team, Partners for Fish and Wildlife

Program, and the Schoolyard Habitats Program. Mr. Starr also worked for the U.S. Army Corps of Engineers, Baltimore District, for 9 years as a Senior Water Resources Scientist and Project Manager, where he led large-scale and complex water resource development projects.

Q: What have you observed as the primary driver for stream restoration, and do you feel it has produced the intended outcomes? What do you see as the future drivers and expected outcomes of stream restoration?

A: The two biggest stream restoration drivers are related to mitigation and TMDL reduction credits. Stream mitigation will likely continue to be a significant stream restoration driver; however, TMDL stream restoration may not be a future driver given current government administration priorities.

Stream restoration outcomes related to mitigation are primarily influenced by the regulatory process. Federal and state regulatory laws specifically state restoration mitigation requirements. Mitigation restoration guidelines and methodologies have been developed by federal and state agencies but can vary by jurisdictional areas. Currently, many of these documents require mitigation on a linear footage basis with supporting watershed and reach level environmental assessment data. Typically, however, the linear footage requirements are not directly related to stream corridor functions. Relating mitigation requirements to stream functions will help ensure critical stream functions are assessed, impaired stream functions are identified, achievable goals and objectives are established, and overall functional uplift is documented. Will Harman, with Stream Mechanics, has recently developed a quantitative, function-based tool for the North Carolina Division of Mitigation Services that directly ties stream functions to linear stream footage. It can be download from http://stream-mechanics.com/stream-functions-pyramid-framework/. Mitigation restoration effectiveness could be enhanced if mitigation requirements where related to stream functions.

Stream restoration outcomes related to TMDL reduction credits are primarily influenced by Municipal Separate Storm Sewer System (MS4) permit reduction requirements and the "Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects." While many stream managers and practitioners strive to maximize ecological uplift, the TMDL requirements are water quality based. Therefore, final stream restoration designs may not address all impaired stream functions, especially those related to aquatic instream habitat and biology. A potential solution would be for the states to provide TMDL reduction incentives for projects proposing restoration activities that would result in biological functional uplift.

Q: Respond to critics who say we shouldn't be messing with the stream until we have provided suitable watershed controls to address the hydrologic regime.

A: Implementing stream restoration projects along with watershed best management practices (BMPs) is an excellent approach in achieving comprehensive improved watershed health; however, effective stream restoration can occur without watershed BMPs. Managing stream energy associated with the watershed flow regime is critical, and the key is through floodplain connectivity. As flood flows increase, stream water levels increase, and as stream water levels increase, stream energy increases. Large, well-connected floodplains allow flood flows to spread and dissipate energy. The floodplain size and flood flow access frequency will influence the effectiveness of the floodplain in reducing stream energy. Therefore, the larger the floodplain, the better. Many times,

though, a large floodplain area is not always available due to encroachment from development, especially in urban landscapes. However, an adequate floodplain can still be constructed that will appropriately dissipate energy. This type of floodplain is often referred to as a nested channel, where there are channels for base flows, channel forming flows, and flood flows. It does not reduce stream energy to the same extent as a large floodplain and requires more vertical and lateral instream control structures, but it can remain stable without applying watershed controls. Again, applying watershed controls along with stream restoration is the preferred approach to watershed restoration, but it is not a requirement to improve stream stability and function.

Q: No two designers approach a project the same way. Designs can vary widely, with different underlying assumptions about effective discharge, channel evolution, and so forth, which is often confusing for managers/clients. Do you think there should be some form of standardization in the design approach taken? Is there only one way to approach a stream restoration design?

A: Stream restoration is relatively new and an evolving science. Many different stream approaches have been developed over the past two decades that can be used to effectively restore streams. The selection of a particular design approach or combination of approaches should be based on which one best meets project goals and design objectives and would naturally form and be self-maintaining under current-day watershed and reach level conditions. Focus should be placed on how a specific design approach could influence and modify existing stream functions. A design alternatives analysis should be conducted to adequately evaluate technically and economically feasible design solutions. It should consider, at the minimum, restoration potential, constraints, potential adverse impacts to existing natural resources, potential functional uplift, implementation costs, uncertainty, and risk. It is critical to allow the design goals and objectives and existing watershed and site conditions to lead the development of designs. This will assist in maximizing potential functional uplift and minimizing adverse impacts to existing natural resources.

While it is unlikely that one particular design approach could be applied to any proposed project, there is a project process that could be applied to most stream restoration projects. Several documents have been written describing this process, and one such recent document is the *Function-Based Stream Restoration Project Process Guidelines*, which can be found at https://www.fws.gov/chesapeakebay/stream/protocols.html. It is a standardized science-based and function-based process that can quantify the degree of functional uplift and/or loss of biological, chemical, and physical processes. The process is composed of sequential steps that directly link project goals with design elements to support stream functions. The steps include: programmatic goals, watershed assessment, reach level assessment, restoration potential, design objectives, design alternatives analysis, design development, and monitoring. Following a project process will help ensure that designers conduct critical tasks through the project process, ultimately reducing risk and uncertainty and increasing project success.

Q: To successfully restore the physical, chemical, and biological functions of a stream, it is necessary to understand how these different functions work together and which restoration techniques influence a given function. Do you feel that we have enough tools to determine the restoration potential with respect to functional lift of a restoration project?

A: There are many available stream assessment and design tools. They range in content, complexity, level of effort, regionality, and so forth. Though recently there has been an emphasis on function-based assessments, specifically on how stream functions (physical, chemical, and biological) interrelate. In 2012, the U.S. Environmental Protection Agency and U.S. Fish and Wildlife Service funded the development of a function-based document titled *A Function-Based Framework for Stream Assessment and Restoration Projects*, often referred to as the Stream Functions Pyramid. The document is based on the premise that there is a hierarchal relationship between stream functions where lower level functions support higher level functions and that they are all influenced by local geology and climate. The Pyramid is a broad-level view of stream functions and consists of five categories (hydrology, hydraulics, geomorphology, physicochemical, and biology) that evaluate stream functions. The framework that supports the Pyramid, commonly referred to as the Stream Functions Pyramid Framework (SFPF) is a "drilling down" approach that provides more detailed forms of analysis and quantification of stream functions. Since the development of the SFPF, several other useful function-based application protocols and guidelines have been developed, which can be downloaded using the link provided above.

The most challenging functions to predict potential uplift are related to water quality and biology. There are available assessment tools that are effective in evaluating existing functional conditions; however, there is often not enough time or money to invest pre-and post-restoration assessments to fully understand these parameters to a point where potential uplift can be accurately predicted. Therefore, managers and designers often must make assumptions about these parameters; sometimes those assumptions are right, sometimes they are wrong.

These tools are a good start in determining restoration potential with respect to functional uplift of restoration projects; however, rigorous, science-based research is needed to verify stream restoration project outcomes, especially biological uplift. Therefore, the Chesapeake Bay Trust has created a Restoration Research Award Program to answer key stream restoration questions. Results of this research program will help managers and designers better predict proposed functional uplift.

Q: What have you observed as the main factors involved in stream restoration failure, and what techniques do you use to minimize risk?

A: There are two primary factors that I have observed that influence stream failures. The first is a lack of knowledge regarding project area watershed and stream functions. A lack of understanding leads to uncertainty, which increases risk of failure. Watershed and reach level assessments, based on the project type, size, location, and complexity of a restoration effort, should always be conducted. By conducting an appropriate level of assessment, uncertainty is reduced. To further reduce uncertainty, proposed restoration design outcomes should be verified. This can be done with engineering models, empirical relationships, cited literature, or even personal past experiences from implementing similar projects. Ultimately, the more uncertainty can be reduced, the more risk and potential project failure can be reduced. Therefore, designers and managers should always strive to collect data and conduct analyses to a level that will allow them to be knowledgeable of stream functions and make informed decisions.

The second factor influencing project failure is inappropriate design goals and objectives. Well-articulated goals and objectives establish a foundation for project success. They lead the stream restoration process from assessment through design and monitoring. Vague, too broad, poorly articulated, or unachievable goals and objectives often lead to project failure at worst and misunderstandings at best because uncertainty is introduced in how project success or failure will be evaluated. This uncertainty increases project risk, as described above. Therefore, managers and designers should establish clearly defined, quantifiable, and measurable design goals and objectives at the start of a project and revisit and refine them, if necessary, at every stage of the project process to increase project success.

Q: Do you have a stream restoration story that you'd like to share? Please indicate the type of stream restoration project, lessons learned, innovations, and so forth.

A: The stream restoration story I would like to share is related to a project where we were able to apply several different design approaches. This project area was large enough (approximately 5 miles in length) that it contained a wide range of stream corridor conditions: ephemeral, intermittent, and perennial flows; zero- through third-order streams; headwater, colluvial valleys to mainstem, alluvial valley streams; forested and nonforested floodplains; wetlands; and stable and unstable stream conditions. The design goals and objectives were to improve water quality by reducing sediment, nitrogen, and phosphorus loads; improve instream aquatic habitat for warm-water species; improve floodplain connectivity by increasing floodplain inundation and attenuation; and improve riparian corridor vegetation by increasing forested and wetland areas. Our design team allowed the design goals and objectives and existing site conditions to lead the development of designs. As a result, the team recommended three different design approaches that maximized functional uplift and minimized adverse impacts to existing natural resources. The team recommended regenerative storm conveyance (RSC) for headwater, ephemeral streams to maximize flood flow storage and attenuation; natural channel design (NCD) for stream reaches currently connected to the floodplain and only requiring localized restoration activities; and a combined NCD and valley restoration (VR) for perennial streams currently disconnected from the floodplain with little to no existing forested or wetland areas. The combined NCD and VR approach was used to design a channel shape that could manage the existing sediment supply load while frequently accessing the floodplain. Had the design team only used one design approach, potential uplift would have been reduced, and potential adverse impacts to existing resources would have increased. This project demonstrates that more than one design approach can be effective in maximizing ecological uplift and the importance existing watershed and stream functions play in developing stream restoration designs.

Scott McGill

Founder and CEO, Ecotone, Inc., Forest Hill, MD

Scott McGill is the founder and CEO of Ecotone, Inc., an ecological restoration design-build firm. He is a noted restoration ecologist with more than 24 years of experience in the design of stream, wetland, and watershed restoration solutions using fluvial geomorphic principles, natural stability concepts, and live vegetative materials. Mr. McGill has designed and/or supervised the construction of more than 85 stream and wetland restoration projects, has extensive project management experience, and is well respected in the field of ecological restoration. He has applied his design-build experience in the assessment and restoration of urban and rural aquatic habitats throughout the United States. Mr. McGill has organized, coordinated, and taught numerous short courses and seminars on innovative and sustainable approaches to ecological restoration.

Q: What have you observed as the primary driver for stream restoration, and do you feel it has produced the intended outcomes? What do you see as the future drivers and expected outcomes of stream restoration?

A: The stream restoration "industry" in the Mid-Atlantic [region] seems particularly focused on TMDL and MS4 goals. That makes practical sense, too, because stream restoration provides generous credit ratios and usually is more cost-effective than other BMPs—both factors have made it a favored approach. As a result, we've seen the scale and scope of restoration activities increase dramatically, which essentially suggests someone is achieving more TMDL goals. One "negative" effect, however, is the struggle design firms have to meet the demand. Coincidentally, competition for design talent is aggressive as well. In the short-term, water quality improvement will continue to drive stream restoration activities, but in the longer view we see stream restoration as an effective adaptation tool to mitigate some effects of climate change.

Q: Respond to critics who say we shouldn't be messing with the stream until we have provided suitable watershed controls to address the hydrologic regime.

A: I'm a stream restoration practitioner but also a critic who thinks that a lot of short-sighted work has been put into the ground over the last 20 years or so in the Mid-Atlantic. A lot of stream restoration in urban watersheds is simply stream bank stabilization, but we call it stream restoration. Usually there isn't available adjacent space to restore floodplain capacity. Watershed restoration on a landscape scale continues to be elusive within the Chesapeake Bay Watershed. It may be unrealistic to expect removal of impervious surfaces on a landscape scale, so we are left trying to alleviate that condition with instream techniques and methods.

Q: No two designers approach a project the same way. Designs can vary widely, with different underlying assumptions about effective discharge, channel evolution, and so forth, which is often confusing for managers/clients. Do you think there should be some form of standardization in the design approach taken? Is there only one way to approach a stream restoration design?

A: Actually, I'd argue that methods and approaches already are way over-standardized, with overlapping factors of safety. The three competing approaches in our region are RSC, NCD, and legacy sediment removal. Our company functions as a design-build contractor, and we've constructed many types of restoration projects—our own and by other firms. In our experience, our local government partners frequently have adopted standards that favor one type of restoration approach over another. Regulatory agencies have adopted preferences as well. Design firms, in general, tend toward one approach over another. There are a lot of talented designers and some great companies out there, but the stream restoration community will yield better quality and sustainability—overall, all companies and all projects together—if we develop techniques that incorporate the best features of each design approach depending on the goals and objectives of the project. In addition, more practitioners in the East need to cross-pollinate ideas and approaches to restoration with our colleagues in the Pacific Northwest as well as Europe. Specifically, I'm a proponent of restoration work in the Pacific Northwest associated with salmon habitat restoration, which utilizes process-based restoration, adaptive management, and ecosystem services of the American beaver (*Castor canadensis*). The results they're producing are compelling and are delivered at a fraction of the cost of more invasive restoration approaches favored in the eastern United States.

Q: To successfully restore the physical, chemical, and biological functions of a stream, it is necessary to understand how these different functions work together and which restoration techniques influence a given function. Do you feel that we have enough tools to determine the restoration potential with respect to functional lift of a restoration project?

A: In urban watersheds, functional lift is limited by land-use conditions within the catchment area. Opportunities for ecological functional lift are much higher in more rural watersheds and often can be accomplished at a lower relative cost. Floodplain function drives stream function. Converting sediment export reaches into storage reaches while spreading stream energy across the entire floodplain is a fascinating approach. Truly exciting restoration jump starts positive ecological feedback loops so that benefits and uplifts are multiplied with time. As far as tools, we do not subscribe to any one-size-fits-all approach to determine restoration potential but think it is dangerous to tie ecological restoration success to metrics that have a high degree of natural and seasonal variability, such as benthic community condition.

Q: What have you observed as the main factors involved in stream restoration failure, and what techniques do you use to minimize risk?

A: Failure is a complicated concept in ecological restoration. Most projects' success or failure is tied to criteria that must be met within a short time period, an economic timescale, such as 5 years. We know that ecological timescales are longer than that. A project may "succeed" in the parochial time frame of regulatory-mandated monitoring but fail in the context of an ecological

timescale. Our team strives to initiate positive feedback loops in projects where the restored site becomes stronger and more resilient, and ecosystem services drive continued functional lift over an ecological timeframe. To minimize risk and promote long-term sustainability, we utilize native vegetation as the major component for stability, utilize sunlight to provide energy during the early stages of a project, spread energy across the floodplain, and provide sediment storage.

In no particular order, the following are factors that alone or in combination become the seeds of long-term failure:

- lack of training and experience in ecological restoration design
- over-engineering—overlapping factors of safety
- devotion to one design philosophy
- focusing on event-based vs. process-based approaches to restoration and contracting
- design-bid-build contracting methods

Q: Do you have a stream restoration story that you'd like to share? Please indicate the type of stream restoration project, lessons learned, innovations, and so forth.

A: At Ecotone we've had the opportunity to design, build, and monitor numerous ecological restoration projects over the past 20 years. We go back and visit these sites periodically, and they continue to teach us lessons. One characteristic we see repeatedly over long spans of time is projects that featured floodplain reconnection all are colonized by beaver. This observation led us to learn more about the water quality benefits beavers and their dams can provide long-term, which certainly challenged some of our preconceived notions about both stream and ecological restoration. We now design to encourage beaver activity on our projects. We believe *C. canadensis* has a place in the field of ecological restoration.

Drew Altland

Manager, Water Resources, Rummel Klepper & Kahl, LLP, York, PA

Drew Altland is a Manager of Water Resources with Rummel Klepper & Kahl, LLP (RK&K) and a professional engineer with 24 years of experience throughout the eastern United States. He specializes in stream and wetland assessment and restoration design; watershed and floodplain studies; geomorphic assessments; hydrologic, hydraulic, and sediment transport analysis; 2-D hydrodynamic modeling; stormwater BMP design; environmental permitting; and construction management services. He has a Bachelor of Science in Civil Engineering with a water resources focus from the Pennsylvania State University and is a registered professional engineer in Maryland, Pennsylvania, North Carolina, and Kentucky.

Q: What have you observed as the primary driver for stream restoration, and do you feel it has produced the intended outcomes? What do you see as the future drivers and expected outcomes of stream restoration?

A: The primary drivers in the regions I work are currently TMDL/MS4 and mitigation needs/mandates. I believe these initiatives are making strides in meeting their intended objectives to improve local stream resources and address credit/regulatory needs in the near-term and will have regional benefits in time. However, the pace to meet the mandated milestones and achieve implementation can detract from the best outcomes of functional uplift and longevity of success. Competing objectives, such as protection of trees or demands to limit the restoration footprint, can also influence the intended outcomes. I expect that climate change will become a more significant driver for stream projects related to flood control, stream and infrastructure stabilization, and tidal fringe migration/conversions.

Q: Respond to critics who say we shouldn't be messing with the stream until we have provided suitable watershed controls to address the hydrologic regime.

A: I believe that argument is becoming harder to make throughout the Mid-Atlantic region and eastern U.S. as more studies are completed and decision makers and funders are becoming increasingly aware that many streams are highly unstable and consequently shedding large volumes of sediment from the stream channels themselves. In the Chesapeake Bay Watershed, the debate has now largely turned to how much of this eroding stream channel sediment is or is not making it to the Bay due to potential sediment storage zones along the streams. My belief is that in most cases it would be impossible to manage enough runoff (infiltrate and/or store and release) in the watershed to self-heal our impacted streams in the eastern U.S. There are simply too many incised streams that experience erosion during routine discharges, less than the 1-year storm event, for watershed controls alone to make any notable improvements. Plus, in the Mid-Atlantic area a significant contributor to stream bank erosion is freeze and thaw of bank sediments that crystallize then fall from the stream bank when the sun melts the ice crystals. Freeze/thaw erosion occurs repeatedly in incised stream channels over the winter months.

Q: No two designers approach a project the same way. Designs can vary widely, with different underlying assumptions about effective discharge, channel evolution, and so forth, which is often confusing for managers/clients. Do you think there should be some form of standardization in the design approach taken? Is there only one way to approach a stream restoration design?

A: In my opinion, it is too early in the evolution of this field and physical influences on streams too dynamic to devise a standard or single approach for stream restoration that crosses all the diverse conditions and regional influences presented on individual project sites. I do think the field has progressed significantly the last 20 years and from lessons learned, designers have a much better idea of what is critical to promote improved restoration outcomes and long-term sustainability.

Q: To successfully restore the physical, chemical, and biological functions of a stream, it is necessary to understand how these different functions work together and which restoration techniques influence a given function. Do you feel that we have enough tools to determine the restoration potential with respect to functional lift of a restoration project?

A: I believe there is still a lot of research and work to be done before we can understand how all these different processes function, interact, and influence each other. As I mentioned, a lot of progress has been made to understand which physical attributes should be considered in a stream restoration to produce a design that gives the best possible outcomes to achieve long-term stability and promote nutrient processing and ecological uplift potential. Much of this goes back to understanding how the stream has been impacted both historically and in our modern era to identify the impairments and which functions have been lost. Once this understanding is gained and the current site constraints are identified, the restoration approach should be devised to restore as many lost functions of the presettlement (pre-1600s) stream/floodplain system as is feasible.

Q: What have you observed as the main factors involved in stream restoration failure, and what techniques do you use to minimize risk?

A: One of the setbacks that affects design in an evolving field like stream restoration is that there are many influences along the path of project initiation, design, and permitting that direct the approach or dictate the means and methods of the design, which can lead to diminished restoration outcomes or even failures. Some designers are not well-equipped to identify the influences that generate risk or are willing to accept risks and move forward with compromised designs to avoid regulatory or client conflicts. I have observed several common factors that led to failures, including lack of understanding of critical site-specific constraints that impact design; relying on reference reach and/or bankfull regional curve data in inappropriate situations; focusing too heavily on limiting the restoration footprint to preserve adjacent lands, trees, or other resources; and putting too much faith in restoration design manuals and standards. In my experience, most restoration failures ultimately come down to design approaches failing to reduce and/or control shear stresses within a project site to ensure long-term stability.

Q: Do you have a stream restoration story that you'd like to share? Please indicate the type of stream restoration project, lessons learned, innovations, and so forth.

A: On the topics of innovation and lessons learned, a design tool that I have relied heavily on for close to a decade now is the use of 2-D hydrodynamic modeling to assess existing physical impairments and design restoration approaches that ensure long-term stability. These modeling tools allow me to test drive the restoration design under extreme flooding conditions, then make adjustments to promote success long before construction and even prior to permitting reviews. The lessons learned using these design methods have been immense, both allowing me to refine my design approach and to better inform the regulatory community, allowing faster authorizations.