Abstracts and Speakers
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Wetland Restoration and Creation: Case Studies and Lessons Learned
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Designing constructed wetlands to treat stormwater in Arkansas: Can we attain low ppb levels of lead in the final effluent?

Tim Barber, ERM

Stormwater from a 100-acre chemical manufacturing facility in Arkansas is managed by two retention ponds. Discharge from these ponds is managed under an NPDES permit, and monitoring data indicate exceedances of the lead and zinc water-quality standards. These issues were addressed in a sustainable manner by constructing a wetland downgradient from each pond to provide supplemental treatment and additional storm-surge capacity. The wetlands were sized based on historical discharge records, and will remove lead and zinc through biologically mediated, precipitation reactions that produce insoluble, metal-sulfide complexes. A proof-of-concept study was conducted to demonstrate that water spiked with high concentrations of lead and zinc compounds would be effectively treated. The tests were conducted using four-foot columns filled with wetland media consisting of organic-rich compost mixed with coarse sand. Different mixtures were tested to maximize the organic carbon content while maintaining sufficient hydraulic conductivity to allow for movement of water through the media. Following a 48-hour equilibration period, the porewater became anaerobic, and lead and zinc were effectively removed by running the solution through the column. Initially, discoloration of the elutriate was observed, most likely associated with dissolved organic carbon derived from the compost,but cleared after several rinses. In the final design, water from the ponds is gravity-fed into the wetlands through flow control mechanisms installed at the influent and effluent points to maintain hydraulic control and ensure sufficient water is maintained in the wetlands during the dry season and increased flows can be accommodated during the wet season. Emergent macrophytes were planted in the wetlands to control erosion, filter water that may bypass the media, and replenish organic matter to support sulfate-reducing bacteria in the sediment. The plants are not expected to significantly extract the metals. Construction was completed in the fall of 2017, and an 18-month establishment period is anticipated before performance specifications are fully satisfied. Currently, maintenance and monitoring activities are being conducted to assess the performance of the wetlands and determine if corrective actions or design modifications are required to meet the project objectives.

Incorporating soil functions into wetland restoration/creation projects - lessons across diverse geographic regions and wetland types

Jacob Berkowitz, US Army Corps of Engineers

While numerous wetland creation and restoration projects have been implemented in many regions globally few studies evaluate the benefits of soil biogeochemical functions, including those related to denitrification, carbon cycling, and excess nutrient retention. In response, a series of case studies are presented across varying geographic locations, spatial extents, and wetland types. First a small scale, innovative technique for wetland creation demonstrates excess nitrogen reduction potential in the Atchafalaya River, Louisiana; highlighting the importance of developing techniques that mimic natural process to maximize soil functions. Second, large scale (>11,000 ha) restoration efforts in the Mississippi River alluvial valley display significant improvements in carbon cycling and export functions; identifying the role of site selection and ground state conditions in predicting functional outcomes. Third, the capacity for restored/created wetlands to adsorb phosphorus is evaluated across portions of the Midwestern US including areas contributing to harmful algal blooms in the Great Lakes; underscoring the need for tools capable of predicting functional lifespans and end-states. Finally, the potential for rapid changes in soil morphology and chemistry following marsh restoration in coastal New Jersey related to soil biogeochemical reactions are discussed; including development of potential acidity. The case studies emphasize the importance of understanding complex soil processes and interactions related to wetland functions during design, implementation and monitoring of creation/restoration projects.

Constructed Wetland Treatment Systems: Metals Removal Design for Utility Wastewater

Katie Bland, Burns & McDonnell Engineering

Industrial and utility water consumers face increasingly stringent regulations for discharge of wastewater to surface waters. As regulations become more stringent, industrial clients are seeking treatment technologies that are effective, have low capital costs, and low maintenance requirements. While constructed wetland treatment systems (CWTS) are more commonly used for storm water runoff, municipal wastewater treatment polishing, and in mining water treatment applications, this technology is emerging as a viable solution for wastewater streams for the industrial and power sectors as well.   Constructed wetlands use natural biological processes to reduce the concentrations of constituents in wastewater and are especially effective for metals removal. The reduction of metals is currently a topic of concern for the industrial and power industries as they seek technologies to reduce constituents such as selenium and mercury to extremely low levels.   Westar Energy required further polishing of their flue gas desulfurization (FGD) wastewater stream in order to meet Kansas Antidegradation standards for discharge to the Kansas River. As part of the treatment technology evaluation, Westar opted to engage in a pilot performance study of a CWTS for treatment of a small portion of their FGD wastewater. The design and construction of the pilot was completed in approximately one year, and the pilot operated for the following two years.   The project challenges were twofold in that they included both the innovative design of the pilot project and the extensive water quality modeling to predict the final water quality of a potential full scale CWTS. Successfully moving past these challenges, Westar proceeded with the design and construction of a full scale CWTS for polishing of FGD wastewater. The full scale system was commissioned in the spring of 2014 and is still operating today. This technology has been favorable for Westar in that it was constructed and has been operated with low capital and operating costs, and is effective for removal of metals. Recent performance data will be included as part of this presentation.

Integrating Surface Water Quality Improvements Into Coastal Restoration â€“ An Urban Retrofit Best Management Practice (BMP) Case Study

Steven Gruber, Burns&McDonnell Engineering

Big Canyon is a 1,300 acre coastal watershed in Newport Beach, California that drains to Upper Newport Bay, an important coastal ecological preserve. Big Canyon Creek, which drains the watershed, is a perennial urban stream that is impaired due to elevated levels of selenium, which has been shown to be toxic at high levels to wildlife. As a result, a total maximum daily load (TMDL) has been established for the creek to protect the stream's biota and beneficial uses. Big Canyon Creek also suffers from anthropogenic alterations that have negatively impacted stream hydrology and water quality, as well as riparian vegetation and wildlife habitat. The Big Canyon Restoration and Water Quality Improvement Project (project), located less than a half-mile from the Creek's discharge into Upper Newport Bay, is a multiple benefit project, integrating (a) water quality improvements of dry weather flows, (b) passive treatment of wet weather runoff with wetland creation, (c) flood plain reestablishment with streambed and streambank stabilization, (d) riparian restoration, and (e) enhanced public access. Comprehensive groundwater and surface water investigations, which were conducted to understand the patterns of selenium loading in the creek, identified one reach where groundwater seeps greatly increased selenium levels in creek surface waters. In order to decrease selenium concentrations to meet TMDL requirements, these seeps were isolated and diverted to the sanitary sewer in order to reduce selenium concentrations in dry weather flows. During wet weather, stormwater runoff from a major arterial roadway is captured and treated through subterranean bioretention cells planted with native vegetation and specifically designed to remove a suite of pollutants common to urbanized watersheds (metals, nutrients, organics, and indicator bacteria). Treated water from these storm events then flows into newly created ephemeral wetlands that are hydrologically connected back to the creek. In addition, several elements were integrated into the project to further improve water quality by re-establishing the functionality of Big Canyon Creek. These elements include a re-connection of the creek to a newly restored floodplain, streambed restoration to enhance in-stream habitat, and stream re-alignment and bank stabilization with eco-friendly vegetated soil revetments to reduce erosion, prevent stream incision, and enhance recruitment of native vegetation.

Is There a Soil Sampling and Analysis Approach That Practitioners and Policy Makers Can Use to Improve Soil Development in Restored Wetlands? Part 1

Andy Herb, AlpineEco

Although there has been a transition over the last 30 years to recognizing that created or restored wetlands should provide similar ecosystem functions to those wetlands they are replacing, success monitoring programs are still mainly focused on the initial establishment of hydrology and vegetation. Assessing soil development, which is key to ecosystem functions such as water quality improvement, is not required or practicable for most monitoring programs. Studies of restored wetlands of different ages make it increasingly clear that development of soil organic matter and other attributes generally lag decades behind establishment of hydrology and vegetation. Although regulatory agencies may not require it, it may benefit wetland restoration practitioners (or policy makers seeking to improve restoration requirements) to perform focused soil sampling and analysis on projects of varying age or construction method as a means of improving soil development outcomes. To explore the viability of this approach, a practitioner (Herb) and a researcher (Baldwin) will implement a simple, inexpensive soil sampling and analysis program for multiple created and restored wetlands in Colorado and compare them to similar 'natural' wetlands. The samples will be analyzed for pH, soil organic matter, cation exchange capacity, percent carbon, percent nitrogen, and other parameters. The presentation will provide a summary of the sites sampled, the sampling results for each of the restored sites as they compare to the natural sites, an evaluation of the cost and utility of the approach and, if warranted, recommendations for practitioners to improve their wetland restoration projects through focused soil sampling and analysis.

Is There a Soil Sampling and Analysis Approach That Practitioners and Policy Makers Can Use to Improve Soil Development in Restored Wetlands? Part 2

Andy Baldwin University of Maryland

The main findings and conclusions from Part 1 will be briefly summarized, and questions will be posed to stimulate discussion. Questions will be solicited in advance from a small panel of wetland restoration practitioners, policy makers, and researchers, who will also participate in the discussion. The discussion will be followed by a brief wrap up and plans for next steps.

Restoring Diverse Wetland Habitats on a Previously Contaminated Site: Shpack Superfund Site Wetland Restoration

Christina Hoffman ERM

After approximately 20 years of investigation, a former landfill, known as the Shpack Landfill Superfund Site, was slated for remediation. The radioactive material was first removed by the U.S. Army Corps of Engineers, and the remaining chemical contamination was remediated by the potentially responsible parties in charge of the clean-up. Several acres of wetlands were delineated at the Site during the investigation phase of the project; therefore, the final remedial design included restoration of these wetland areas, including an increase in the total acreage of wetlands to compensate for the temporal loss of the functions and services of the wetlands since first being impacted. Palustrine emergent and palustrine forested wetlands were the design targets, punctuated with vernal pools and a small stormwater treatment wetland adjacent to the larger wetland complex. Remediation required the excavation and removal of approximately 20,000 cubic yards of soil and underlying sediments in 2014. Due to ample groundwater data collected during the contamination investigations, the wetland design incorporated groundwater as the source of hydrology for the restored wetlands, as opposed to utilizing overland flow. Working with construction contractors to create 5.8 acres of functioning wetland on a former landfill presented challenges due to the nuances of re-creating a natural habitat using widely fluctuating groundwater elevations, engineered topsoil, and wildlife habitat enhancement elements. Guiding equipment operators in the art of installing the various elements and microtopography included in the wetland design was part of the fun. Time of year constraints (early snow in New England) and steep slopes added to the challenges during the construction phase. Many lessons were learned and three years of annual monitoring since construction was completed tells the whole story.

Potential for Riparian Restoration on River-Reservoir Deltas in the Great Plains

W. Carter Johnson, Johnson Environment

More riparian forest vegetation was destroyed in the Missouri River Basin due to dam construction than in any other watershed in the Great Plains. Losses of biodiversity in the riparian forests that remain between reservoirs and downstream of the last dam continue due to river regulation that has stopped most flooding, channel movement, and sediment transport. A half-century of published research has identified approaches that could have started the restoration process; however, very little has been implemented except localized sandbar and shallow-water habitat construction designed to assist listed species that inhabit riverine, not riparian, habitats. Prospects continue to be dim for river re-regulation to initiate alluviation and channel movement. The remaining forests dominated by cottonwood and willow, termed 'the living dead,' are senescing at increasing rates. Recent appearance of young riparian forests associated with deltas emerging in reservoirs caught the attention of our team of riparian ecologists who published a seminal paper on the subject in BioScience in 2015. Evidence provided from one field study and that of aerial images of multiple deltas suggests that river-reservoir deltas could be a 'silver lining' in a darkening cloud hanging over the disabled Missouri River. More study of these novel delta environments is needed to determine the magnitude of riparian expansion that can be expected in future decades under existing or more favorable reservoir operational rules.

The Elf of the wetlands in Taiwanâ€"Restoration of Taipei Grass Frog

Cheng-Hsaing Liu, Taiwan Wetland Restoration Society

More than 100 years ago, people in Taoyuan County, Taiwan, built ponds for water storage. Over 10,000 ponds as shiny and beautiful as jade made Taoyuan the area of highest pond density in the world and formed a dense ecological network. After the Kuomintang government retreated to Taiwan in 1949, the Shimen Reservoir was built and ponds have gradually lost their function of water storage. Many people began to drain the ponds and reclaimed the land for housing construction. As a result, the number of ponds decreased sharply and indirectly led to the disappearance of many wetland species. At that time, the cross-strait relations between Taiwan and mainland China were tense. Worrying that Mao Zedong would destroy the Shimen Reservoir, so Jiang Kai Shek connected several ponds in the Yangmei area to form a reserve storage pond for battle readiness, of which No. 731 pond has remained the same for 50 years because of its isolated location, and has become the last habitat of many native species in Taiwan. Taipei Grass Frog is very small in size and has beautiful golden folding lines on the back. It, elusive like a fairy, appeared and disappeared in the grass by the water, a wetland species in farmland and irrigation canals in western counties of Taiwan. It was first discovered by an American scholar in 1909, who named it Hylarana taipehensis. However, with the destruction of wetlands and the reduction of habitats, there are only totally less than 100 this endangered frogs found in four locations in Taiwan. Due to the demand on high quality water and environment, the existence of Taipei grass frog reflects the good environmental conditions of wetlands and it becomes an indicator species of Taiwan's wetlands. There were nearly 200 Taipei grass frogs in No. 731 pond according to a survey conducted in 2005, but there were only seven according to a survey conducted a few years later. It is believed that this may resulted from improper management of wetlands and the pollution in the nearby irrigation canals. Since 2015, the team has found that during the day, the Taipei grass frog likes to stay on the secret berm plants on the bank 10 ~ 35cm away from the water and breeds next to the floating plants at night, and disperses the eggs on the aquatic plants in the area 3 to 5 meters in diameter. As a result, the team succeeded in stabilizing the growth of the population of Taipei grass frogs by growing more aquatic plants, creating habitats for the frogs to forage.

Functional restoration of floodplain wetlands impacted by tie-hacking in the early 1900's in the Bighorn Mountains of Wyoming.

Richard McEldowney, Confluence Consulting

The term 'tie-hacking' refers to the process used in the late 1800's and early to mid-1900's of cutting timber for use as railroad ties. As part of this process timber was cut from the surrounding forest, skidded to a river, and the logs floated down to the railroad under construction. Frequently the rivers were temporarily dammed in order to create enough water to float the logs down the river, the dams were then blown up and the logs and water were swept down river in the resulting torrent. This process had significant impacts to the riverine systems used for this purpose. Restoration actions were undertaken by the Wyoming Department of Transportation and the U.S. Forest Service (USFS) at Shutts Flats on the South Fork (SF) Tongue River in the Bighorn Mountains, near Burgess Junction, WY. Restoration was intended to serve as compensatory mitigation for impacts associated with roadway improvements on a nearby U.S. Highway 14. Previous impacts to the SF Tongue system resulted in a change of floodplain elevation causing it to be disconnected from the river and diminishing the level of service provided by the floodplain wetlands found along the river. In one of the first of its kind in the western U.S., compensatory mitigation was based on functional units instead of acres. The project restored over 15 functional units based on MDT's Montana Wetland Assessment Method. Targeted ecosystem functions included flood attenuation, general wildlife habitat, short and long term water storage, sediment/nutrient/toxicant removal, and production export/food chain support. The primary restoration elements included low-flow sedge benches, floodplain reconstruction, development of a wetland swale, and increasing habitat diversity. The project increased palustrine aquatic bed habitat for use by the Columbia spotted frog, a USFS Sensitive Species found in the project area. Approximately 2.5 acres of wetland habitat was directly restored/created, and hydrology was restored to approximately an additional 3 acres of decadent scrub-shrub wetland habitat at the north end of the Flats. The presentation will use the Shutts Flats case study to demonstrate how a functional assessment method can be integrated into the wetland restoration planning process to maximize wetland functions.

A Case Study of the Knickerbocker Floodplain Reconnection Project: Wetland, Stream and Floodplain Restoration of Thornton Creek in an Urban Watershed

Emily Swaim, Soundview Consultants
The case study of the Knickerbocker floodplain reconnection project examines fifteen individuals associated with ten regulatory agencies and parties by analyzing the complexities associated with a collaborative wetland, stream, and floodplain restoration project within the urbanized South Branch of Thornton Creek in Seattle, Washington. I documented pre-project implementation, design principles, construction activities, wetland and stream restoration and monitoring practices at the South Branch of Thornton Creek by conducting interviews of all parties involved. The purpose of this case study is to provide insight and knowledge of the elements required to design, implement, construct, and complete a hyporheic floodplain expansion of a degraded, urbanized stream and wetland complex as well as evaluate the effectiveness of the restoration project based upon social science data and the collaborative team-playing essential features needed to make it successful. Methodologies used to collect the interview transcript data included following the Qualitative Case Study Methodology: Study Design and Implementation for Novice Researchers (Baxter and Jack, 2008) as well as A Guide for Designing and Conducting a Case Study for Evaluation Input (Palena et.al, 2006) with use of an Olympus Digital Voice tape recorder VN-7200 for personal interviews. While many challenges are associated with collaborative design principles, the Knickerbocker project was completed on schedule and within budget, while working with over ten different agencies and parties. Lessons learned are to collaborate early and effectively, establish public outreach, encourage public involvement from the beginning, identify all stakeholders, and hire private contractors for specific assignments to control speed and completion of tasks. Challenges included: multiple voices and oppositions, a New Zealand mud snail infestation, and designing a risky, controversial and exploratory 'living laboratory'. Some individuals associated with Knickerbocker project declined to comment or participate in this qualitative intrinsic case study. Therefore, there are potential data gaps or lost content not collected nor archived. This study provides collaborative and synergistic context for proposed urban restoration and floodplain reconnection projects in both the public and private sectors and provides insight into the nature of multi-party coordination in a grant-funded urban stream and wetland restoration project.

How Far Can We Go with Science as a Bridge?

Hsiao-Wen Wang, National Cheng Kung University
Creating wise use management plans for a wetland requires an understanding of the functions and ecosystem services that the wetland provides. But such basic processes are being ignored as Taiwan pushes its new green energy policy, pressuring agencies in charge of implementing the wetland act of Taiwan to twist the meaning of wetland wise use to include utility solar. Budai Salt Pan wetland, located on the southwestern coast of Taiwan, is one of the wetlands facing solar development. Through participatory research, 11 ecosystem services were identified in Budai Salt Pan wetland, and through ecological assessments, the wetland was found to hold critical habitat for a diverse array of water birds, including the endangered Black-faced Spoonbill, Great Knot, Baer's pochard, Nordmann's greenshank, and the Far Eastern curlew. Hydraulic surveys, modeling, and experiments showed that flood mitigation and habitat quality in the wetland could both be enhanced through water management, providing the possibility of reducing flood risk in the surrounding communities. Though this research is on hand, these factors were not considered when developing solar development plans in the wetland. In order to protect Taiwan's wetlands, and support a sustainable transition to green energy, we worked with experts to create a holistic framework for finding least conflict siting of solar panels, focusing on mixed use designs in energy centers as oppose to rural coastal wetlands. As wetlands will continue to be considered for solar development in Taiwan, we also created a Checklist assessment for the Taiwanese government to follow in order to understand if a wetland is appropriate for solar development, and if so, what regulations should exist to mitigate harm. This assessment requires decision makers to identify and protect critical ecological areas and critical ecosystem

services in order to ensure there is at least a minimum level of protection for both the species who require the wetland habitats, and the communities who rely on the wetland ecosystem services.