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Session 1B: Ecological Restoration

Kentucky Water Resources Research Institute, University of Kentucky

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The Restoration of Cane Run Creek through Lexington's Coldstream Park and UK's Coldstream Research Campus

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The Coldstream Park Stream Corridor Restoration and Preservation Supplemental Environmental Project (SEP) was developed by the Lexington-Fayette Urban County Government (LFUCG) for inclusion in its Federal Consent Decree to resolve alleged violations of the Clean Water Act. The recently-completed project restored 4,400 linear feet of intermittent stream and its riparian area and created three wetlands to improve water quality and to provide improved habitat for both aquatic and terrestrial organisms. The project location was chosen because Lexington owns a linear park through UK's Coldstream Research Campus. Coldstream Park includes Cane Run Creek, as well as the Legacy Trail along the east side of the creek, which made it an ideal location for a stream restoration project that would improve the experience of trail users and provide educational opportunities for those interested in urban streams.

The project area is located within the Inner Bluegrass karst region, which is one of the four major karst regions in Kentucky. Downstream of the project area (during normal and low-flow conditions), Cane Run sinks into an underground conduit system which feeds the Royal Spring aquifer. Royal Spring is the source of drinking water for the city of Georgetown to the northwest. Following significant rainfall events when surface flow exceeds the intake capacity for the aquifer, the creek flows to North Elkhorn Creek in Scott County.

Over time, the creek had been straightened for farming purposes. Then as development occurred in Cane Run's headwaters in north Lexington, runoff flows increased which led to both severe erosion and degraded water quality. The erosion ultimately resulted in a stream which was disconnected from its floodplain. The design strove to reconnect the stream with its floodplain, slow the flowrate of runoff from the adjacent land, reduce the flowrate through the restoration area, and achieve a better riparian area using native vegetation. Pollutants entering Cane Run from adjacent land were treated with a series of BMPs including stormwater wetlands, a bioswale, and native riparian zone plantings.

The project had its share of design and construction challenges, including stakeholder opposition to removing existing vegetation; resolving whether the stream should be separated from its existing karst features or not; conflicts with existing utilities; construction sequencing with two nearby sanitary sewer Consent Decree projects; and changing permitting requirements. With a focus on the desired outcome for this project, the project team was able to successfully address all of the challenges encountered. The project was completed in September 2018 which met the Consent Decree completion deadline. Lexington also fulfilled the monetary obligation that was stipulated for this project in the Consent Decree.

This project was undertaken in connection with the settlement of an enforcement action under the Clean Water Act, United States et al. v. Lexington-Fayette Urban County Government, brought on behalf of the U.S. Environmental Protection Agency.

Using Multiple Methods for Better Stream Restoration: Including 2-Dimensional Modeling

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Stream restoration is complex with many variables and constraints to consider. Natural Channel Design techniques are very important and helpful; however, we find that it is important to consider or incorporate other methods as well. In many areas where the native stream material is small, there is a need to consider Threshold Design techniques with Natural Channel Design, so the channel can remain stable under larger flows and have some long-term stabilizing features. We have also found that 2-Dimensional (2D) flow analysis on reaches that have a floodplain is very insightful and can be used to make better design decisions with a more informed view of the flood flows on the project.

2D flow analysis can allow the designer to better understand many different components about a stream restoration project, including multi-directional flows, how shear stress values change and shift with rising water elevations and changing slopes, where areas of high and low shear stress occur, how flood flows interact with the bankfull channel, and how flood flows ultimately affect the long-term stability of the bankfull channel. The use of 2D flow analysis has allowed us to better visualize the dynamics of flood flows across our project sites and has benefited our designs in many ways, at different stages of a project.

Stantec has designed and helped implement various stream restoration projects throughout Kentucky and the United States. We have been able to use 2D flow analysis on many different types of projects and at different stages of the projects as well. We have used 2D flow analysis to better understand some existing conditions and inform the proposed design. We have also used it multiple times to analyze proposed designs for refining and optimizing the final design. This includes using it to identify areas that would be under high stress during flood flows that need design adjustments, additional erosion control blanket, or other methods to help reduce erosion during the vulnerable growth stage of the project. 2D flow analysis is very helpful with understanding challenging sites. A restoration project previously designed and constructed by others was having multiple repeat issues during flood events. Stantec used 2D flow analysis to better understand the dynamics of the flood flows across the site as well as inform and guide the new design. We have gained confidence in our 2D models by comparing existing site observations to existing models. Similarly, we have compared field observations on restoration sites after flood events to the 2D models previously prepared for the design. This has given us good validation for the models. Stantec would like to take the time to demonstrate the various benefits of 2D modeling and the ways we have used it to improve designs and the overall success of our stream restoration projects.

About the Speaker: Wanda Lawson P.E. is a Stream Restoration Designer and Project Manager with Stantec. She has been working on stream restoration projects for 15 years in Kentucky and across the United States. Mrs. Lawson obtained a Bachelor of Science in Biosystems and Agricultural Engineering from the University of Kentucky.

An Ongoing Success Story: What Data, Persistence, and Patience has Enabled in the Hanging Fork Watershed

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The Dix River Watershed has been receiving special attention by the USEPA and the Kentucky Division of Water since its selection as a Clean Water Action Plan Priority in 1998. Unfortunately, efforts to address this recognized need for attention did not begin in earnest until 2006, when the Dix River Watershed Council began formally meeting and intensive water quality sampling was conducted.

The Dix River and its impoundment, Herrington Lake, serve as a major drinking water supply source for the Boyle, Garrard and Mercer County region. The lake was created in 1925 by Kentucky Utilities for hydropower, but it is also a recreational attraction for boaters and anglers, and many homes are located along its shores. It includes several tributaries which are impaired for pathogens and nutrients, and the lake itself is documented as impaired for nutrient enrichment.

The unwieldy size of the Dix River Watershed, covering 424 square miles in parts of five different counties, led the Council to focus on two subwatersheds where water quality improvements were most likely to be feasible. KDOW contracted with Third Rock Consultants to conduct and analyze the data from the Hanging Fork and Clarks Run subwatersheds, and ultimately utilize their findings to help develop the watershed planning documents.

The parallel efforts of the local Watershed Council and Third Rock's sampling and analysis ultimately produced two high-value products--USEPA-approved Watershed-Based Plans for both the Hanging Fork and Clarks Run watersheds. Both documents included specific recommendations to address water quality problems, especially those relating to instream high bacteria levels. *E. coli* concentrations in area streams often ranged from ten to 1,000 times greater than the statewide limit for safe wading/swimming. Follow-up microbial source tracking indicated that the bacteria sources were predominantly human rather than livestock, as had been assumed due to the rural, agricultural areas of the watersheds.

One of the highest-priority recommendations for improving water quality in the Hanging Fork watershed was to extend a sanitary sewer line along US127 into Hustonville to capture over 1,250 homes utilizing often-failing septic systems. This line would also enable the decommissioning of an inadequate package sewer treatment plant at the Hustonville Elementary School.

The Lincoln County Sanitation District was formed to pursue this recommendation and became an invaluable partner in the watershed improvement effort. The Sanitation District worked closely with the Bluegrass Area Development District and local officials to acquire a variety of grants and loans for the sewer extension. Phase I of the project has been completed and will capture sewage from approximately 600 homes in the watershed. Planning and funding arrangements for a second phase to capture additional homes and business are currently underway.

As with many sewer extension projects, area residents had mixed reactions to the need to connect to sanitary sewer and face monthly bills for the service. Fortunately, the Sanitation District was able to partner with the Kentucky Division of Water and the Rural Community Assistance

Partnership (RCAP) to develop a USEPA 319-h funded homeowner assistance program, which would defray costs of connecting their homes to the new sewer line. This program is providing cost-share funding at an income-based percentage rate, as well as helping residents understand the rationale for sewer collection through a partnership with the environmental education organization, Bluegrass Greensource. As of February 2019, 344 applicants had been approved for funding assistance, $242,851in reimbursements had been provided to 263 recipients, and 378 total sewer connections had been completed.

The Lincoln County Sanitation District has been recognized for its tremendous efforts to improve the water quality of Hanging Fork creek, as well as strengthen economic opportunities and the quality of life in the watershed. In 2018, they were awarded the Kentucky DEP's Environmental Pacesetter Award, and they received national recognition from the USEPA for performance and innovation in creating environmental success through the agency's PISCES program.

The Division of Water appreciates the local engagement of the Sanitation District and the many other partners in the Dix River Watershed. It is expected that these management efforts and continuing collaboration will produce direct water quality improvements when the streams are re-sampled by the Division.

Reclaiming Mill Creek: A Case Study in Urban Stream Restoration

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Urbanization is second only to agriculture in causing stream impairment in the Unites States and Europe, despite the relatively small area cities occupy relative to farms (Paul and Meyer, 2001). Impacts to streams include significant alteration in flow regime and sediment supply, lateral and vertical confinement, and habitat alteration, with a time scale of decades to centuries depending on date of settlement (Niezgoda and Johnson, 2005). With growing understanding of functions and values of streams, urban stream restoration has become an emerging field in the last 20 years (Gurnell et al., 2007). As the field is still young, there is substantial uncertainty in system assessment and design methodology (Brown, 2000; Niezgoda and Johnson, 2005); even determining a critical design variable like the channel-forming discharge is problematic (Annable et al., 2011). Therefore, a combination of engineering methodologies may be required for effective implementation of a restoration strategy. A recent restoration project in Cincinnati, Ohio utilized a combination of hydraulic modeling, field geomorphic assessment, "green" natural channel design, and traditional "gray" structures for rehabilitation of a highly impacted urban stream.

Mill Creek, located in southwest Ohio, flows approximately 30 miles from its headwaters in Butler County, through the city of Cincinnati, and on to its confluence with the Ohio River. The stream played an important role in the development of Cincinnati, providing drinking water, hydropower, transportation, and sanitation. Mill Creek was subject to intensive urbanization and manipulation, to the point where in 1997, American Rivers designated it as "the most endangered urban river in North America" (MCA, 2019). Stantec partnered with the Mill Creek Alliance to restore approximately 3,500 feet of this stream in 2017. The project reach flows through an industrial area with an active steel recycling facility and electric utility substation, a public golf course, and then a naturalized area with a city nature preserve. Substantial bank erosion was present on the landfill deposits of the steel yard, mass wasting baled plastic, asbestos shingles, and scrap metal into the stream. Invasive species dominated the riparian zone throughout the reach, and improper channel dimension with lack of floodplain connectivity led to bed instability and localized scour.

Design objectives for the project included hazardous material removal, bank reconstruction and stabilization, infrastructure protection, floodplain re-connection, instream habitat improvement, and riparian zone enhancement. Significant site constraints were present, including existing bank armor, two major active sanitary sewer lines, and a private rail line. To meet project objectives within these constraints, the design combined elements of traditional hydraulic civil design and natural channel design while relying heavily on both hydraulic modeling and field studies. Construction incorporated an imbricated stone toe, streambank reconstruction, rock riffle installation, and floodplain grading. The project has resulted in an ecologically and hydraulically diverse stream system with substantially less waste loading into Mill Creek. Since the start of construction, the project reach has experienced storm events near the 5 and 10-year return intervals, as well as several greater-than bankfull events with only minor repairs necessary. Improvement in stream bioassessment scores, bed and bank stability, and riparian zone quality from pre-construction conditions was observed within the first year following the construction. Improvements are expected to continue as the system matures.

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About the Speaker: Jonathan Scheibly, PWS, PE, is a Water Resources Engineer with Stantec. He has been working on stream and wetland restoration projects for over 12 years in Kentucky and across the United States. Mr. Scheibly holds a Bachelor of Science in Biology from the University of Kentucky, a Master of Science in Biology from Morehead State University, and a Bachelor of Science in Civil Engineering from the University of Kentucky.