Stream and Wetland Restoration Performance Assessment Project

Technical Report

Chagrin River Watershed Partners, Inc.

July 2018

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Introduction

Chagrin River Watershed Partners, Inc. (CRWP), in coordination with its member communities and partners, conducted assessments of long term performance for previously completed stream and wetland restoration projects in northern Ohio. While regulatory and funding agencies require monitoring for some restoration projects, monitoring often ends within a few years of construction. For this project, CRWP visited sixteen previously completed stream and wetland restoration projects and assessed the degree to which each is functioning as designed using standardized protocols and additional customized assessment criteria based on project goals. For this project, CRWP also developed and piloted a model restoration assessment checklist that may be used by project partners and natural resource professionals. In cases where projects were not functioning optimally, CRWP worked with communities and partners to identify remedies and funding sources. This technical report summarizes findings and recommendations to enhance the long-term performance of stream and wetland restoration projects. This project was funded through an Ohio Department of Natural Resources Coastal Management Assistance Grant (Project # DNRFH020 306-14).

CRWP is a nonprofit organization serving municipalities and park systems that drain to the Chagrin River. CRWP provides technical assistance to its members and develops cost effective, prevention-focused solutions to minimize new and address current natural resource management problems as communities grow. CRWP was formed in 1996 as communities were faced with rising infrastructure costs as a result of impacts due to development such as flooding, erosion and water quality problems. The organization now serves 34 member cities, villages, townships, counties and park districts, representing 91% of the Chagrin River watershed. CRWP's mission is to preserve and enhance the scenic and environmental quality of the ecosystem of the Chagrin River and its watershed in a manner that assures a sustainable future for people, plants and animals. CRWP also co-leads the Central Lake Erie Basin Collaborative, a network of northern Ohio watershed organizations that shares expertise and resources, pools strengths, and efficiently delivers services to protect our Great Lake. For more information about CRWP, please visit www.crwp.org.

Project Purpose and Research Questions

The Stream and Wetland Restoration Performance Assessment Project was developed in response to a request from CRWP's member communities and project partners for more information about the long-term performance of restoration projects. The research questions that guided this project include:

- Are projects meeting their long-term goals? Why or why not?
- If necessary, what are remedies, costs and funding sources to address any performance issues?
- What are some common themes and lessons learned from this project that may be helpful for current and future restoration implementers?

Literature Review

CRWP reviewed existing literature to inform this project. A full list of referenced literature is provided in the Appendix.

A Functional Assessment of Stream Restoration in Ohio (Mecklenburg and Fay, 2011) evaluated fifty-one stream restoration projects in Ohio, with an emphasis on physical characteristics such as morphology, hydraulic process, vegetation, soil and habitat. This study indicated that many sites demonstrated lack of floodplain connectivity, riffles were often filled with fines and colonized by wetland vegetation, and soils at some sites had poorer quality than those at reference sites. One conclusion of this study indicated that "the success of the observed stream restoration projects, as measured by several aspects of physical condition, varied widely despite meeting required permit performance criteria" and the study demonstrated "a need for physical standards for restoration projects that physically reconfigure streams." (p. 2)

For the white paper *How long is long enough to make a water quality improvement?* (Phillips, S., n.d.), the author reviewed the outcomes of four Ohio restoration projects to determine if receiving streams were affected positively, negatively, or not at all by upstream restoration projects. The study recommended that a variety of variables (e.g. utility crossings, budget, site constraints) must be considered in the design of restoration projects and these variables are also important to consider when assessing performance. It was noted that some assessment methods can skew overall project results by "scrutinizing very small project components in isolation." This study reinforced that "the ultimate test of success for stream ecosystem restoration is attaining the aquatic life goals set forth in Ohio's WQS [water quality standards] and the measurable sub-components of that process," such as habitat quality and biocriteria. The study also cautioned that "as with any activity-based planning approach, there is a natural tendency to measure success in terms of the activity and structural inputs of that process, which stops short of measuring the ultimate outcome (i.e., the biology) of the same process." (p. 10)

As a guide for restoration assessments, CRWP also referred to the Society for Ecological Restoration's *International Standards for the Practice of Ecological Restoration – Including Principles and Key Concepts* (McDonald, T., Gann, G.D., Jonson, J., Dixon, K.W., 2016). These standards were developed for restoration practitioners, operational personnel, planners, managers, funders, and regulators to help them develop high quality plans and achieve acceptable ecosystem recovery outcomes. The authors suggest that performance assessment should begin by identifying project success at the planning stage of restoration, and that progress should be assessed against the restoration target (reference ecosystem), restoration goals (conditions of reference ecosystem), and restoration objectives (outcomes needed to achieve targets and goals) of the project. The standards recommend that assessment results be used to inform ongoing management of the restoration project.

Subsequent to this literature review, CRWP identified remaining information gaps that informed this project. There is ongoing debate over the most appropriate way to assess the long-term success of restoration projects and a lack of simple assessment tools that may be used by communities, natural resource managers and other restoration partners that have implemented projects. Further, CRWP has assisted its members with the implementation of several stream and wetland restoration projects over its two-decade history, yet no previous study had assessed the long-term performance of multiple stream and wetland restoration projects completed in the Chagrin River watershed.

Methods

Site Selection and Assessments

For this project, CRWP assessed sixteen previously constructed stream and/or wetland restoration sites during the 2017 field season. Sites were chosen from a list of all projects for which CRWP has assisted its members with implementation. Sites were selected based on partner interest in the project's long-term performance and landowner/partner willingness to provide site access. CRWP developed a pre-assessment guide (See Appendix) to obtain useful contextual information for each project site, including:

- Restoration funding source, amount, year of award, applicant, and local match provided
- Project location, including latitude/longitude coordinates, and site access information
- Landowner contact information
- Information about restored and impacted water resources, including stream name and river mile, drainage area to stream or wetland, and 12-digit HUC watershed name and code
- Pre-construction aquatic life use attainment status and identification of any baseline pre-construction monitoring data
- Overall project goals (e.g. aquatic life use attainment or maintenance, habitat improvement, streambank stabilization, improved recreational or greenspace access, improved site safety, etc)
- Restoration objectives to meet project goals, including linear feet of stream restored, riparian acres revegetated, wetland acres restored, and acres preserved
- Year(s) of project implementation
- Design and/or construction firms involved in the project
- Identification of data indicating that project goals were met during the project's permit monitoring period
- Identification of most appropriate long-term assessment approach and location for each site
- Identification of assessment data already completed or planned for completion by outside agencies that may be included in the site's assessment

Permission was gained to access all sites on privately owned land and CRWP notified public partners when accessing sites on publicly owned land. For many sites, representatives of CRWP member communities and project partners joined CRWP staff for the assessments. At each site, appropriate standardized protocols were used to assess performance, including:

- Physical habitat assessments, such as:
    - Qualitative Habitat Evaluation Index (QHEI) for streams
    - Headwater Habitat Evaluation Index (HHEI) for headwater streams
    - Modified Bank Erosion Hazard Index (BEHI) as developed by Cleveland Metroparks and based on Dave Rosgen protocol
    - Ohio Rapid Assessment Method (ORAM) for wetlands
- Other customized assessment criteria based on specific project goals, such as:
    - Coverage of riparian vegetation within restoration reach
    - Presence and coverage of plant species installed during restoration
    - Presence and coverage of invasive plant species
    - Presence of stream characteristics conducive to nutrient assimilation
    - Visual assessments of floodplain connectivity

Figure 1. CRWP staff perform a stream habitat assessment at the Pleasant Valley Park floodplain restoration project site (Lake County). Photo source: Chagrin River Watershed Partners, July 2017.

Based on these standardized assessment protocols, CRWP developed model assessment checklists for restored streams and wetlands (See Appendix) that can be refined and used by communities and other natural resource partners for simple field assessments of long-term restoration performance. These checklists were piloted during each of the sixteen site assessments conducted for this project. Assessment results were compiled into a database for analysis.

Figure 2. CRWP discusses the performance of the Shadybrook Run stream restoration site (Lake County) with Holden Arboretum staff. Photo source: Chagrin River Watershed Partners, September 2017.

Project Equipment

Funding from the Ohio Department of Natural Resources Coastal Management Assistance Grant allowed CRWP to purchase field monitoring equipment to assist with collection of habitat and chemical water quality monitoring at each site. The following equipment was purchased:

- Hanna Instruments pH/EC/DO waterproof portable logging multiparameter meter (HI98194)
- Hanna Instruments combo pH/Conductivity/TDS tester (HI 98129)
- Meter calibration solutions (pH, conductivity) and cleaning/storage solutions
- 300-ft open reel measuring tape
- AA batteries for multiparameter meters

Assessed Stream and Wetland Restoration Sites

CRWP assessed sixteen previously constructed stream and/or wetland restoration sites completed between 2003 - 2015. All sites included either a stream restoration or streambank stabilization component. Four sites included wetland restoration. Seven sites included restoration of primary

headwater streams (draining <1 square mile). Nine sites were publicly owned (owned by a municipality or park district) and seven sites were privately owned. All sites were restored with support from state or federal grant funds, such as the Ohio Environmental Protection Agency (EPA) Section 319 Grant Program, Ohio EPA Water Resource Restoration Sponsor Program, Ohio EPA Surface Water Improvement Fund, Great Lakes Restoration Initiative, and the Great Lakes Basin Fish Habitat Partnership.

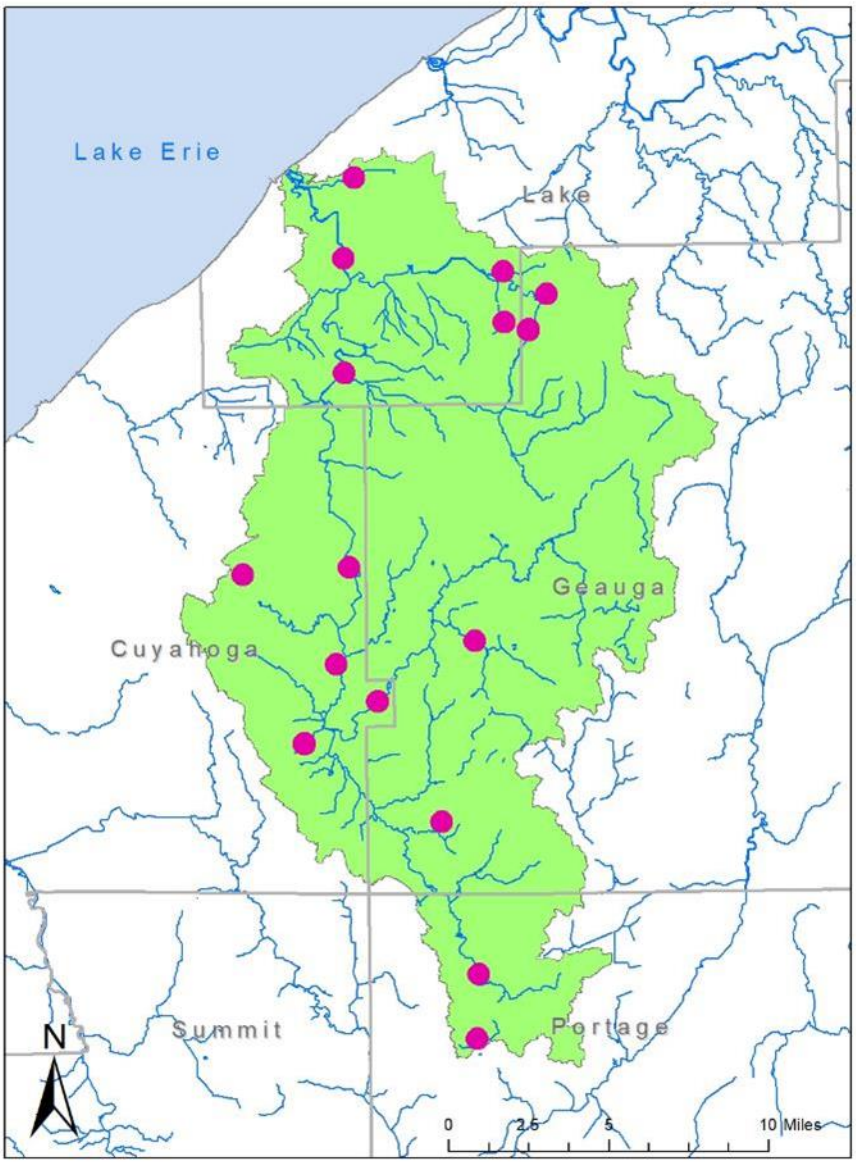

Figure 3. Map of stream and wetland restoration sites assessed in 2017 for this project (project sites in pink). The Chagrin River Watershed is shaded green.

Table 1. List of stream and wetland restoration sites assessed in 2017 for this project, including year of project completion.

PROJECT	YEAR OF COMPLETION
Silver Creek Stream Restoration (Geauga Park District, Russell Township)	2003
Shadybrook Run Stream Restoration (Holden Arboretum, Kirtland Hills)	2009
Kenston Lake Dam Modification and Stream Restoration (Bainbridge Township)	2011
Pleasant Valley Park Floodplain Restoration (Lake Metroparks, Willoughby Hills)	2011
Chagrin River Green Bank Stabilization (Hunting Valley)	2011
Ivex of Ohio, Lower Dam Modification and Stream Restoration (Chagrin Falls Village)	2012
Sulphur Springs Stream Restoration (Cleveland Metroparks, Solon)	2012
Harmon Homestead Stream and Wetland Restoration (Aurora)	2013
East Branch Chagrin River Stream Restoration Project at Riverwood (Holden Arboretum, Chardon Township)	2013
Chagrin River Bendway Weir Restoration Demonstration Project (Willoughby)	2013
Ward Creek Stream Restoration (Willoughby)	2013
Forest Ridge Preserve Headwater Stream Restoration (Moreland Hills)	2013
Pierson Creek Headwater Stream Restoration (Holden Arboretum, Kirtland)	2014
Wisner Road Headwater Stream Restoration (Chardon Township)	2014
Ursuline College Stream Restoration (Pepper Pike)	2014
Aurora Branch Chagrin River Restoration (Aurora)	2015

Project Outreach

In Fall/Winter 2017 and Spring 2018, CRWP reached out to its member communities and project partners to share a summary of each site's project performance, strategies to address any performance issues, and potential funding sources to implement these strategies. In May 2018, CRWP held two half-day trainings to share project results and lessons learned with natural resource professionals and other restoration implementers. Results from these trainings are detailed in the *Discussion* section of this report. CRWP also presented a summary of project results at the Ohio Stormwater Conference in Sandusky, Ohio and at CRWP's Board of Trustees meeting, both in May 2018.

Project Results

Summary of Results

In general, assessments indicated that most restoration projects were performing successfully when compared with original project goals. A full summary of results is provided as an Appendix. Highlights include:

- Fifteen of 16 restored stream reaches assessed with QHEI indicated “good” or “excellent” habitat narrative scores.
- Four of 5 restored wetlands assessed with ORAM indicated Category 2 or higher quality habitat wetlands.
- No significant erosion was observed within or directly adjacent to restoration reaches at 10 out of 16 sites.
- Evidence of stream access to floodplains was observed at 11 out of 16 sites.
- Vegetative cover within the restoration reach was >95 percent at all sites.
- Average invasive plant species cover within restoration reaches was approximately 18 percent (based on visual assessment).
- No significant trash or dumping was observed at any site.

Case Studies: Success Stories

Three sites serve as case studies that demonstrate the successful characteristics of many assessed sites: Pleasant Valley Park floodplain restoration project, Ivex of Ohio lower dam modification and stream restoration project, and the East Branch Chagrin River stream restoration project at Riverwood.

The Pleasant Valley Park floodplain restoration project was completed in 2011 and 2012 by Lake Metroparks and is located along the Chagrin River in Willoughby Hills, Ohio. Pre-construction monitoring by Ohio EPA indicated partial attainment of warmwater habitat (WWH) at two downstream monitoring locations. Prior to construction, the site was a former nursery and site conditions included the Chagrin River’s poor access to its floodplain due to the presence of levees. Project goals were to increase floodplain storage, enhance water quality treatment through floodplain access, restore wetlands, and improve wildlife habitat. To meet these goals, Lake Metroparks removed 650 feet of levees along the Chagrin River, restored 3.5 acres of wetlands through drain tile and gravel road removal, created vernal pools, treated invasive species including large amounts of Japanese knotweed, and restored the newly accessible floodplain to 17 acres of forest and meadow habitat. Post-construction monitoring by Ohio EPA in 2014 indicated a stream habitat assessment QHEI score of 73.0 (“good” narrative rating) adjacent to the restoration reach.

Figure 4. Aerial imagery of the Pleasant Valley Park floodplain restoration project, both pre-construction (2009) and post-construction (2017). Image source: Google Earth.

To assess the Pleasant Valley Park floodplain restoration project, CRWP replicated Ohio EPA's post-construction QHEI, conducted ORAM habitat assessments for the restored wetlands, and conducted visual assessments of vegetative cover in the riparian zone, invasive plants, and floodplain access.

Figure 5. Pre- and post-construction conditions for the Pleasant Valley Park floodplain restoration project.

CRWP's 2017 assessment results indicated a habitat assessment QHEI score of 80.5 ("excellent" narrative rating) adjacent to the restoration reach, which was slightly improved from Ohio EPA's 2014 assessment. CRWP's ORAM assessments indicated Category 2 (moderate quality) habitat within two restored wetlands, which was expected as these restored wetlands continue their establishment.

Riparian vegetative cover was estimated >95 percent within the restoration reach (based on visual assessment). Coverage of invasive plant species within the restoration site was relatively low (estimated <10% coverage) and should remain low with continued treatment and management by the land managers. Visual evidence indicated that the Chagrin River now has access to its floodplain (on the left bank) and riparian wetlands at the site, which will assist with dissipation of high flow energies and help reduce flooding and erosion in downstream areas.

Figure 6. Restored 3.5-acre wetland (left) and vernal pool habitats (right) at the Pleasant Valley Park floodplain restoration project site. Photo source: Chagrin River Watershed Partners, July 2017.

The Ivex of Ohio lower dam modification and stream restoration project was completed by the Village of Chagrin Falls in 2011 and 2012. Pre-construction monitoring by Ohio EPA in 2008 indicated non-attainment of WWH at the project site and a QHEI stream habitat assessment score of 59.5 ("fair" narrative rating). Project goals were attainment of WWH at the project site, restored natural stream flow, restored floodplain connectivity, improved aquatic habitat upstream of the dam, moderation of the dam's impact on water temperatures, and decreased risk of spillway failure. The Village's objectives to meet these goals included lowering the earthen dam and concrete spillway by approximately 10 feet, reestablishment of a natural stream corridor, and revegetation of the former lake bed. Post-construction monitoring by Ohio EPA in 2014 indicated QHEI stream habitat assessment scores of 74.75 within the restoration reach and 72 downstream of the restoration reach (both "good" narrative ratings), and full attainment of WWH downstream of the restoration site (the restoration site itself has not been monitored by Ohio EPA for aquatic life use attainment since 2008).

Figure 7. Pre-construction (2007) and post-construction (2017) aerial imagery of the Ivex of Ohio lower dam modification and stream restoration project. A yellow arrow indicates the location of the modified dam. Image source: Google Earth.

To assess the Ivex of Ohio lower dam modification and stream restoration project, CRWP replicated the Ohio EPA's post-construction QHEI stream habitat assessments and conducted visual assessments of vegetative cover in the riparian zone, invasive plants, and floodplain access.

Figure 8. Pre-construction and construction conditions for the Ivex of Ohio lower dam modification and stream restoration project. Photo source: Chagrin River Watershed Partners.

Figure 9. Post-construction conditions for the Ivex of Ohio lower dam modification and stream restoration project (Cuyahoga County). Photo source: Chagrin River Watershed Partners, 2013.

CRWP's 2017 assessment results indicated habitat assessment QHEI scores of 70.0 ("good" narrative rating) within the restoration reach and 81.0 ("excellent" narrative rating) downstream of the restoration reach. These results mirror 2014 post-construction habitat monitoring results, affirming that habitat had improved both within and downstream of the restoration reach since construction. Further, 2017 habitat assessment scores were slightly higher than post-construction stream habitat monitoring results from 2014, possibly indicating even further habitat improvement in the years since the post-construction monitoring period; however, it should be noted that the QHEI is a qualitative assessment and this improvement may not be significant enough to determine further habitat improvement since 2014. Riparian vegetative cover was estimated >95 percent (based on visual assessment). Coverage of invasive plant species within the restoration site was approximately 25 percent. This site was observed during high flow conditions after a heavy rain event in July 2017. It was noted that floodplain access was not optimal upstream of the modified dam; future quantitative assessments could be conducted to confirm this.

Figure 10. Upstream end of the restoration reach at the Ivex of Ohio lower dam modification and stream restoration project. Photo source: Chagrin River Watershed Partners, 2017.

The East Branch Chagrin River stream restoration project at Riverwood was completed in 2013 by the Holden Arboretum in Chardon Township, Geauga County, Ohio. Pre-construction monitoring by Ohio EPA indicated full attainment of coldwater habitat (CWH) for the East Branch at the project site. Pre-construction stream habitat QHEI assessments by Ohio EPA indicated 81.5 ("excellent" narrative rating) within the restoration reach. Project goals were to restore eroding streambanks, restore floodplain access, and establish forested floodplain habitats within the restoration area. Holden Arboretum's objectives to meet these goals were to remove a levee along the East Branch, restore a headwater stream, stabilize a second headwater stream, and install native vegetation in the newly accessible floodplain that will transition from herbaceous to woody plants over time ("relay floristics"). Post-construction stream habitat monitoring by Ohio EPA in 2015 indicated a score of 85.0 ("excellent" narrative rating) within the restoration reach.

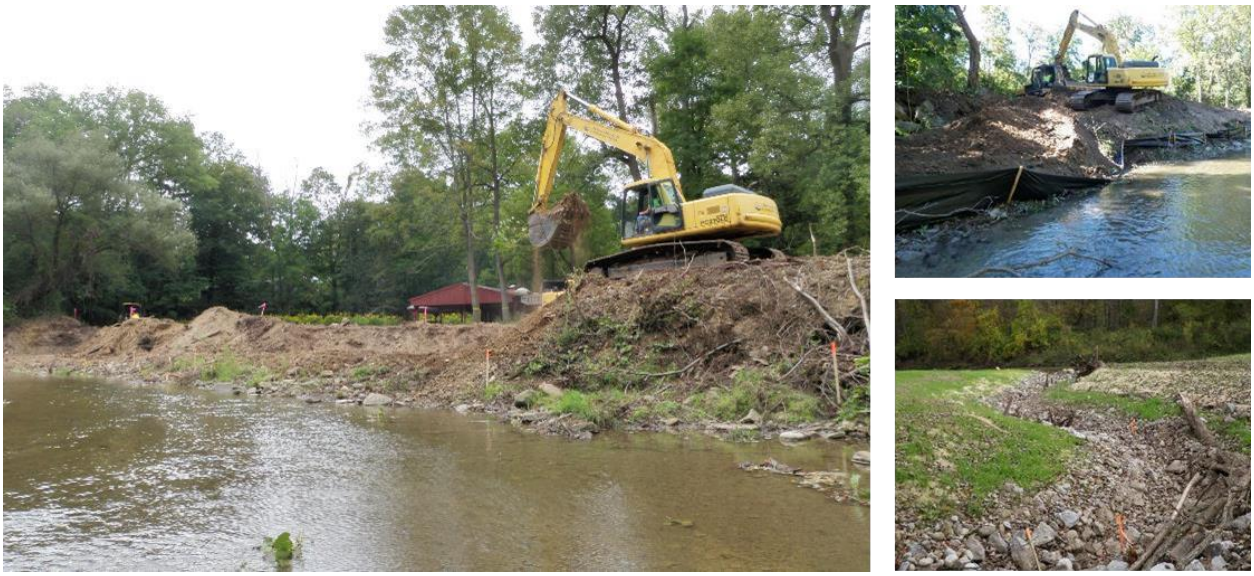

Figure 11. Construction conditions for the East Branch Chagrin River stream restoration project at Riverwood. Photo source: Chagrin River Watershed Partners, 2013.

To assess the East Branch Chagrin River stream restoration project at Riverwood, CRWP replicated Ohio EPA's post-construction QHEI assessment and conducted visual assessments of vegetative cover in the riparian zone, invasive plants, and floodplain access. CRWP's 2017 assessment results indicated a habitat assessment QHEI score of 75.75 ("excellent" narrative rating) within the restoration reach, indicating maintenance of excellent habitat conditions. Riparian vegetative cover was estimated >95 percent (based on visual assessment). Coverage of invasive plant species within the restoration site was very low (approximately <5 percent based on visual estimate). Due to adequate invasive plant species management by Holden Arboretum, the facilitation of installed native plant species was good. Visual evidence indicated that the East Branch of the Chagrin River now has access to its floodplain (on the left bank) at the site, which will assist with dissipation of high flow energies and will help reduce flooding and erosion in downstream areas.

Figure 12. Post-construction conditions at the East Branch Chagrin River stream restoration project at Riverwood indicated the East Branch's access to its floodplain within the restoration reach (left) and good establishment of installed native plant species (right). Photo source: Chagrin River Watershed Partners, 2017.

Common Challenges and Lessons Learned

CRWP's Stream and Wetland Restoration Performance Assessment assessments indicated that most restoration projects were performing successfully when compared with original project goals. However, common challenges were observed that can serve as helpful lessons for current and future restoration implementers.

Invasive and nonnative plant species were observed at every assessed restoration site and visual estimates identified the three most commonly encountered invasive plant species as common reed (*Phragmites australis*), reed canary grass (*Phalaris arundinacea*), and narrowleaf cattail (*Typha angustifolia*). However, the estimated percent cover of invasive plant species within the restoration area varied by site. Based on discussions with project implementers and site managers, CRWP staff expect that the degree of invasive plant species cover (and the successful establishment of installed native plant species) is influenced by the degree of active invasive species management by the implementer or site manager within the first few years following restoration. At one site, the installed woody species were being outcompeted by *Phragmites australis*, leading to lack of riparian cover and shade within the stream restoration reach. CRWP staff believe these conditions may have contributed to the observed growth of algae within this stream. At another site, one reach of a restored headwater stream was totally inaccessible for assessment due to the cover of *Phragmites australis* and vegetative litter associated with this invasive plant. To ensure the growth of woody species that provide bank stabilization and stream shading, restoration implementers and site managers should expect to do some initial invasive plant species management within the first few years after the completion of the project or until installed native plant species are well established.

Figure 13. At one site, installed woody plant species were being outcompeted by Phragmites australis, which may have contributed to lack of riparian vegetative cover and shade and the growth of algae in a restored stream reach. Photo source: Chagrin River Watershed Partners, 2017.

In addition to initial invasive plant species management, it is important for land managers to develop the use of best landscape management practices as they maintain a restoration site. This includes the maintenance of an adequately sized vegetated buffer area along restored streams and wetlands. At one site, CRWP staff observed minor erosion occurring at the upstream end of the restoration reach where a land manager on the adjacent parcel was mowing directly to the stream's edge. The lack of deep-rooted and woody vegetation along this portion of the restored stream may have contributed to this erosion. In this case, CRWP recommended that the restoration implementer reach out to the land manager on the adjacent parcel to suggest a "no mow" approach along the stream. Similar situations may serve as opportunities for natural resource managers to educate landowners and project partners about riparian zone management.

Figure 14. At one site, a practice of mowing to the edge of the stream was contributing to a lack of deep-rooted and woody vegetation and may have been contributing to minor erosion within the stream restoration reach. Photo source: Chagrin River Watershed Partners, 2017.

CRWP staff also observed that there may be unintended downstream consequences of hardening streambanks in an effort to improve streambank erosion. At one site, a bioengineered streambank stabilization approach was used to stabilize eroding streambanks with rock and vegetation. The goal of this project (bank stabilization) was being met within the project reach; however, erosion was occurring immediately downstream of the stabilized reach. In this case, the stream's flow energies may have been directed to the hardened streambanks and then transferred downstream where there was no bank protection. It may be beneficial for future restoration implementers to consider the use of strategies that dissipate and slow down high energy flows, such as the establishment of a floodplain bench or reconnection of the stream to its floodplain.

Figure 15. At one site, hardened streambanks within a streambank stabilization project reach may be contributing to erosion immediately downstream. Photo source: Chagrin River Watershed Partners, 2017.

Finally, it may be important for restoration partners to set realistic expectations with landowners about the natural aesthetics commonly found at restoration sites. At one site assessed through this project, the land manager indicated a desire for a more manicured look and expressed concerns about the increased time and cost requirements to remove weeds around installed native vegetation rather than brush hogging and spraying the entire site. Restoration partners can work with landowners to set realistic expectations at the beginning of the project planning process and achieve aesthetic, maintenance, and restoration goals through native plant choices and management practices (e.g. mowing a clean line around the outer edge of a riparian buffer area).

In addition to identification of helpful lessons for current and future restoration implementers, this project also offers several recommendations for assessment of restoration sites. To obtain an accurate understanding of the function of restored areas, it is best to avoid assessing restoration sites during high flow or very low flow conditions. CRWP visited some sites during low flow conditions and staff found it difficult to observe the true function of the restored areas at these sites. Additionally, when possible, it is best to have at least two monitoring locations for a restoration site, especially large sites. There is a risk of undervaluing or overvaluing the success of a restored site by having only one monitoring location. At one very large site, CRWP chose to replicate Ohio EPA's pre- and post-construction QHEI assessments by completing a QHEI assessment in the same location. CRWP's QHEI score at this location indicated low quality habitats that did not reflect the quality of the entire restoration reach at this site. In this case, two or more QHEI assessments would have provided a better representation of the project's success.

Outcomes of Project Outreach

In May 2018, CRWP held two half-day trainings to share results and lessons learned from this Stream and Wetland Restoration Performance Assessment Project with natural resource professionals and other restoration implementers. A total of 40 participants attended these trainings. In an effort to reach a variety of natural resource managers across northern Ohio, one training was held inside the Chagrin River watershed at Cleveland Metroparks' North Chagrin Reservation in Willoughby Hills, Ohio and one training was held outside the Chagrin River watershed at the ODNR Old Woman Creek National Estuarine Research Reserve in Huron, Ohio. For both trainings, CRWP partnered with Cleveland Metroparks to provide information about the Metroparks' Acacia Country Club restoration performance assessment, including use of the streams function pyramid developed by StreamMechanics. Both trainings also included group discussions to facilitate a conversation around restoration performance assessment in Ohio. Group discussion questions included:

- What makes a stream or wetland restoration project successful?
- Share an example of a stream or wetland restoration project with which you have been involved. What were some successes or challenges that you experienced?
- What advice ("lessons learned") would you give someone else doing a stream or wetland restoration project?
- Are you planning any future stream or wetland restoration projects? If so, are you considering how you will assess the long-term success of these projects during the planning process? What assessment metrics are you considering?
- Is this model assessment checklist a helpful tool for evaluating the performance of restoration projects? Would it be helpful to have a standardized restoration performance assessment method that can be tailored and used across the region?
- What other monitoring interests do you have regarding stream and wetland restoration?

CRWP gained helpful feedback during group discussions at these two trainings and through additional communication with natural resource managers following presentations about this project at the Ohio Stormwater Conference and CRWP's Board of Trustees meeting. Some highlights of this feedback are provided below:

- Public perception of a project's success may be the ultimate measure of success. Public and stakeholder outreach should be conducted as early and often as possible during the restoration planning process.

- Ongoing management of invasive plant species, a common need at most restoration sites, is difficult to achieve with limited staff and funding for this work. Similarly, it is difficult to identify funding for ongoing project operation and maintenance.
- It is important to consider the overall effect of multiple restoration projects on aquatic life use attainment within a watershed.
- It is important to consider the degree of impervious cover in the area draining to a restoration site and whether or not this has changed since project installation.
- A simple and rapid restoration assessment tool tailored for the northeast Ohio region is valuable for natural resource managers to facilitate consistent measurement of project success.
- The creation of a stream restoration roundtable group has been suggested as a way for restoration implementers to share information about successful restoration strategies and assessment methods and to stay updated on new research in this field.

Figure 16. Jenn Grieser of Cleveland Metroparks speaks about the Metroparks' Acacia Country Club restoration performance assessment at a training for natural resource professionals on May 21, 2018.

Figure 17. Group discussion during the Stream and Wetland Restoration Performance Assessment training for natural resource professionals on May 21, 2018.

Figure 18. Kim Brewster of Chagrin River Watershed Partners speaks about the Stream and Wetland Restoration Performance Assessment project at a training for natural resource professionals on May 22, 2018.

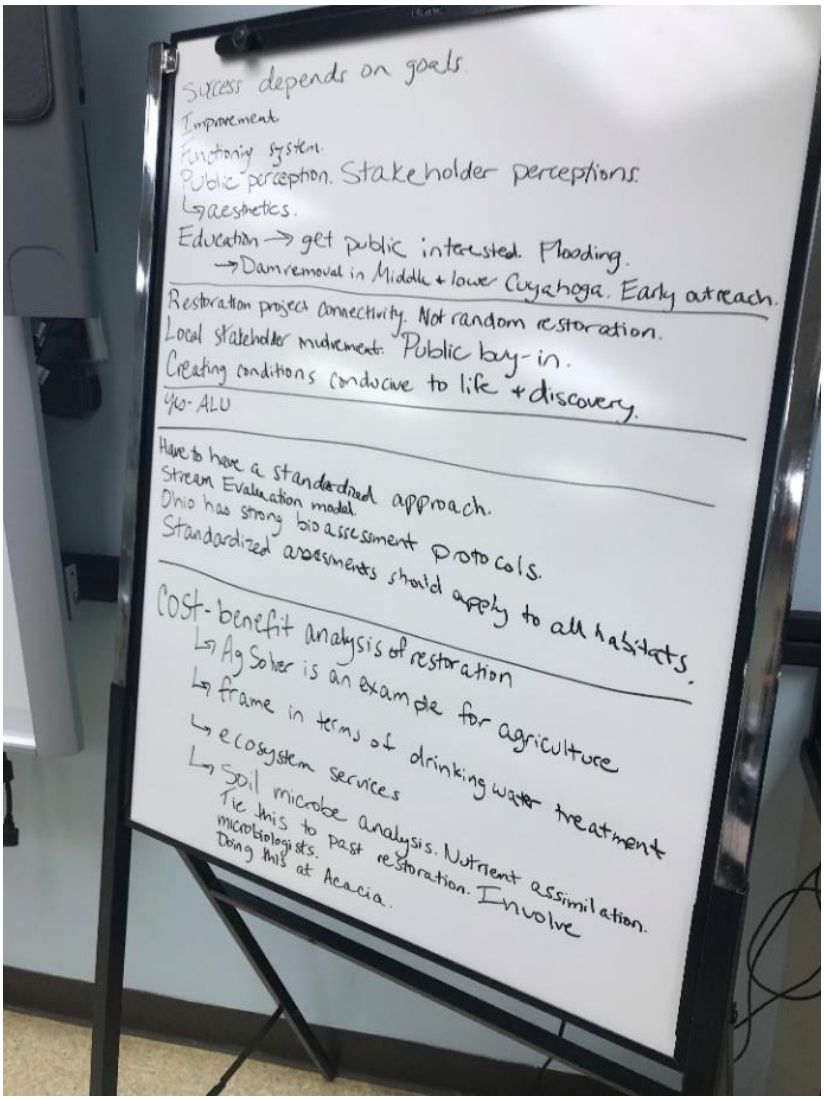

Figure 19. Notes from a group discussion during the Stream and Wetland Restoration Performance Assessment training for natural resource professionals on May 22, 2018.

CRWP also partnered with the Ohio Coastal Training Program to evaluate both trainings; evaluation feedback will help improve future trainings for natural resource managers. Across both workshops there were 40 participants; participants represented a range of professional affiliations including non-profit organizations, private consulting firms, universities, and government agencies (municipal, county, state and regional). Evaluation results indicate that:

- 95 percent of participants agreed or strongly agreed that participating in the workshop was a good use of their time;
- 100 percent of participants indicated the training increased their knowledge of stream and wetland restoration performance *some*, *a lot*, or *a great deal*;
- 68 percent of participants learned something new that they intend to apply in their future work or personal decisions and 32 percent indicated that they may apply what they had learned.
- The following comment was received from one of the workshop participants:

"This workshop was very well done. The information was clear and all topics in the agenda were discussed. The speaker did a fantastic job with presenting. Technical terms were clarified. Concepts were adequately discussed without going off on tangents not relevant. I really hope more work like this, assessing past projects and reflecting on results as well as sharing with stakeholders will be funded more often."

These workshops also led to additional opportunities for sharing the results of this project with natural resource managers. For example, Great Lakes Commission staff participated in one of the project's workshops and invited CRWP to submit an abstract to present about this project at the 2018 Great Lakes Restoration Conference.

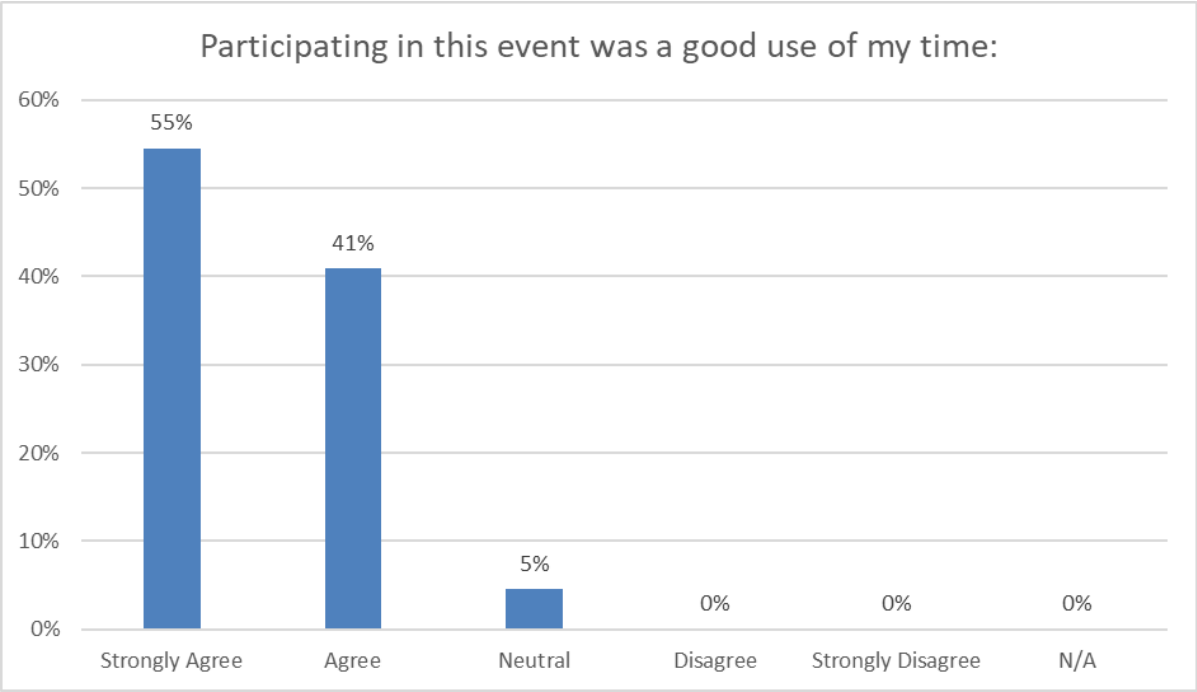

Figure 20. Summary of evaluation responses for May 21st and May 22nd trainings.

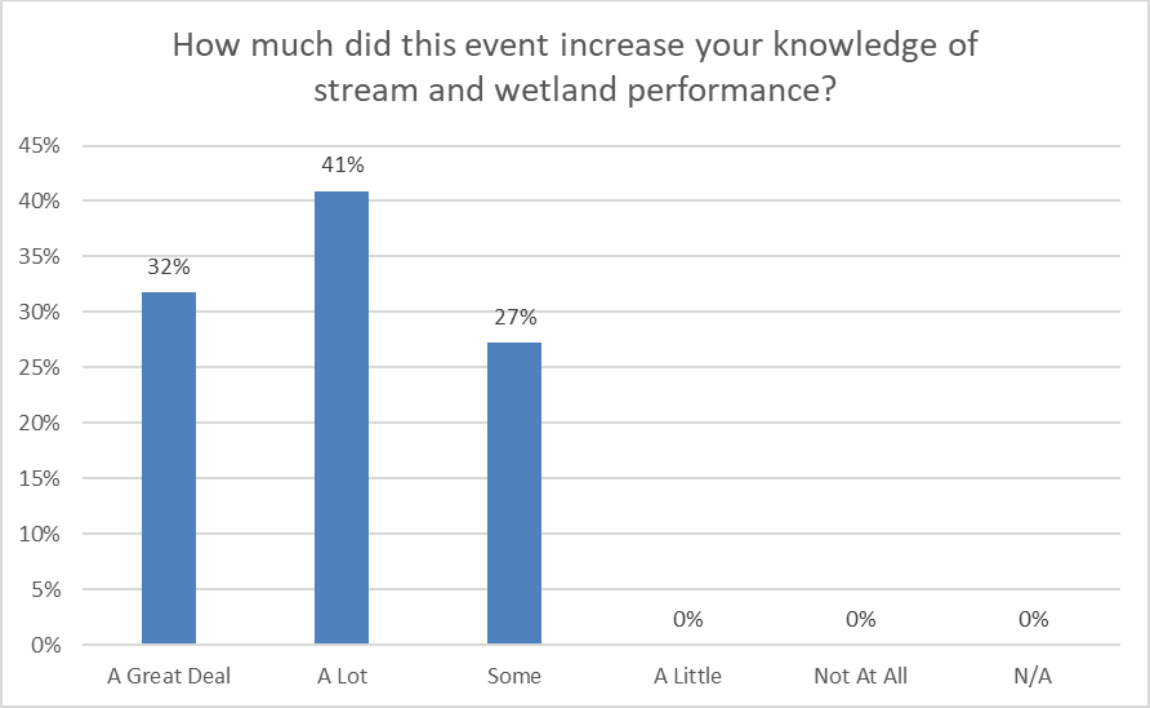

Figure 21. Summary of evaluation responses for May 21st and May 22nd trainings.

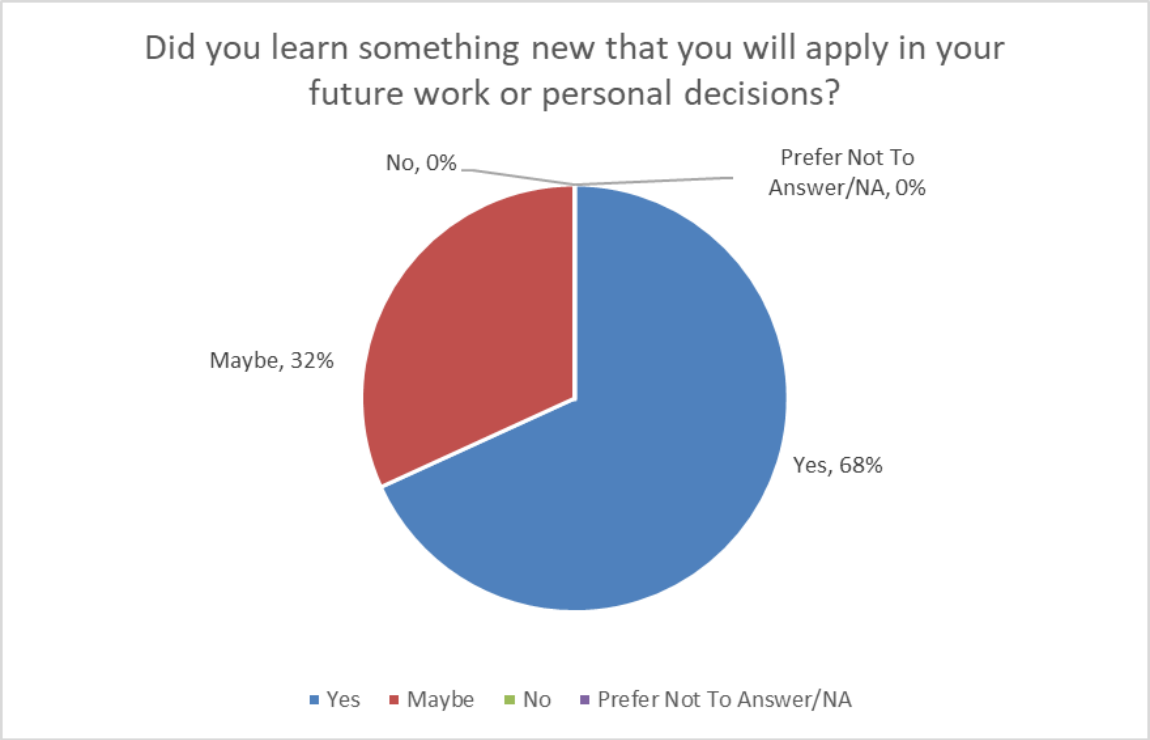

Figure 22. Summary of evaluation responses for May 21st and May 22nd trainings.

Discussion

Results of this Stream and Wetland Restoration Performance Assessment Project indicate that most assessed restoration projects were performing successfully when compared with original project goals. Case studies of successful projects and identification of common challenges and lessons learned will help inform the management of current and future stream and wetland restoration projects.

Existing literature and discussions during the trainings conducted for this project indicate that debate remains over how to define a successful restoration project. Opinions vary regarding the use of water quality improvement goals (e.g. aquatic life use attainment and subcomponents) versus structural project goals (e.g. establishment of floodplain access) for evaluating project success. Project goals may also vary depending on the perspective of different project partners (e.g. funding agency versus landowner). Project goals may also vary depending on the perspective of the assessor. For example, during one training it was suggested that the success of a project should not be determined by how it performs against the original project goals but how the project has adapted to changing factors over time. It can be difficult to assess multiple projects in a consistent manner when project goals vary widely. For this project, CRWP considered the attainment or maintenance of aquatic life use designations as the ultimate goal of restoration and chose to assess subcomponents of these standards, particularly habitat quality. However, it was also important to assess other project components that indicate project success based on member and partner goals, such as enhanced recreational access or improved site safety.

The model restoration assessment checklists developed through this Stream and Wetland Restoration Performance Assessment Project may serve as simple and rapid tools for use by natural resource managers in the field. These checklists are designed to be refined based on a project's specific goals and assessment needs. Based on outreach conducted for this project, it is evident that a simple and rapid restoration assessment tool tailored for the northeast Ohio region is valuable for natural resource managers to facilitate consistent measurement of project success; however, debate remains over how this tool may be refined for widespread use.

During this project, there was a need for CRWP to balance the number of desired site assessments with the project timeframe and the amount of information necessary for restoration assessment at each site. For this reason, CRWP chose to rely on qualitative assessments which provide a relatively rapid understanding of project performance. However, qualitative assessments can be limiting due to their subjectivity. Future studies could obtain quantitative data at each restoration site, such as biological monitoring (e.g. Index of Biotic Integrity assessments for fish, Invertebrate Community Index assessments for macroinvertebrates, or the Vegetative Index of Biotic Integrity for plant communities).

Conclusion

In coordination with its member communities and partners, CRWP conducted assessments of long-term performance for previously completed stream and wetland restoration projects in northern Ohio. This technical report summarizes findings and recommendations to enhance the long-term performance of stream and wetland restoration projects. Assessments indicated that most restoration projects were performing successfully when compared with original project goals and providing good or excellent stream or wetland habitat. This Stream and Wetland Restoration Performance Assessment Project was made possible through funding from the Ohio Department of Natural Resources Coastal Management

Assistance Grant Program, Northeast Ohio Regional Sewer District, Lake County Stormwater Management Department, George Gund Foundation and with cooperation from CRWP member communities and park districts for participation in these assessments. CRWP also appreciates assistance from Cleveland Metroparks and the Ohio Coastal Training Program with the development of trainings for this project.

List of Appendices

STREAM AND WETLAND RESTORATION PERFORMANCE ASSESSMENT PROJECT: SUMMARY OF RESULTS

PROJECT	YEAR OF COMPLETION	Good/Excellent QHEI scores within restoration reach?	HHEI scores indicating Class 2 or 3 within restoration reach?	Restored wetlands meeting Category 2 or higher?	Riparian vegetative cover >95%?	No significant erosion within or directly adjacent to project reach?	Invasive plant species present? (Approx. % cover and species)	Presence of stream characteristics conducive to nutrient assimilation ?	Is there evidence that stream has access to floodplain?	No significant trash/dumping within restoration reach?
Silver Creek Stream Restoration (Geauga Park District, Russell Township)	2003	✓	n/a	n/a	✓	Minor	50% (1,2,3,4,8)	✓	Some	✓
Shadybrook Run Stream Restoration (Holden Arboretum, Kirtland Hills)	2009	✓	n/a	✓	✓		5% (8)	✓		✓
Kenston Lake Dam Modification and Stream Restoration (Bainbridge Township)	2011	n/a	Not assessed	n/a	✓	✓	50% (1,2,3,8)		✓	✓
Pleasant Valley Park Floodplain Restoration (Lake Metroparks, Willoughby Hills)	2011	✓	n/a	✓	✓	✓	10% (1,3,5,6,7,8)	✓	✓	✓
Chagrin River Green Bank Stabilization (Hunting Valley)	2011	✓	n/a	n/a	✓		30% (6,7,8)		✓	✓
Ivex of Ohio, Lower Dam Modification and Stream Restoration (Chagrin Falls Village)	2012	✓	n/a	n/a	✓	✓	25% (1,3,8)			✓
Sulphur Springs Stream Restoration (Cleveland Metroparks, Solon)	2012	✓	n/a	n/a	✓		10% (2,3,4)	✓	✓	✓
Harmon Homestead Stream and Wetland Restoration (Aurora)	2013	n/a	✓	✓ (2/3)	✓	✓	30% (1,2,3,4)	✓	✓	✓
East Branch Chagrin River Stream Restoration Project at Riverwood (Holden Arboretum, Chardon Township)	2013	✓	Not assessed	n/a	✓	✓	<5% (8)	✓	✓	✓
Chagrin River Bendway Weir Restoration Demonstration Project (Willoughby)	2013	✓*	n/a	n/a	✓	✓	10% (5,8)	✓	✓	✓
Ward Creek Stream Restoration (Willoughby)	2013	✓	n/a	n/a	✓		10% (1,2)	✓	Some	✓
Forest Ridge Preserve Headwater Stream Restoration (Moreland Hills)	2013	n/a	✓	n/a	✓	Minor	10% (8)	✓	✓	✓
Pierson Creek Headwater Stream Restoration (Holden Arboretum, Kirtland)	2014	n/a	✓	n/a	✓		<5% (8)	✓	✓	✓
Wisner Road Headwater Stream Restoration (Chardon Township)	2014	n/a	✓	n/a	✓		10% (1,6,8)			✓
Ursuline College Stream Restoration (Pepper Pike)	2014	✓	✓	n/a	✓	✓	<5% (3)	✓	✓	✓
Aurora Branch Chagrin River Restoration (Aurora)	2015		Not assessed		✓	✓	20% (1,2,3,4,6,8)	✓	✓	✓
SUMMARY		**10 out of 11 assessed (91%)**	**5 out of 5 assessed (100%)**	**4 out of 5 assessed (80%)**	**100% of sites**	**10 out of 16 (63% of sites)**	**18% average**	**12 out of 16 (75% of sites)**	**11 out of 16 (69% of sites)**	**100% of sites**

* already achieved pre-construction

1 - *Phragmites australis*
2 - reed canary grass
3 - narrowleaf cattail
4 - multiflora rose
5 - Japanese knotweed
6 - butterbur
7 - purple loosestrife
8 - other, well established invasives

STREAM RESTORATION PERFORMANCE ASSESSMENT FIELD CHECKLIST	
PROJECT NAME:	
NAME OF STREAM/WATER BODY AND RIVER MILE:	
ASSESSMENT LOCATION DESCRIPTION:	
ASSESSMENT LOCATION LATITUDE/LONGITUDE:	
NAME(S) AND AFFILIATIONS OF FIELD PERSONNEL:	
DATE/TIME:	
WEATHER CONDITIONS: ***(check one)*** **_X__ Clear ___ Overcast ___ Rain showers ___ Air temperature _~85__ degrees (°) Fahrenheit (F)**	
PRECIPITATION DURING LAST 24 HOURS? YES or NO ***(circle one)***	
WATER LEVEL/FLOW CONDITIONS: HIGH AVERAGE LOW ***(circle one)***	
ADDITIONAL VISIT REQUIRED? ***(Provide explanation)***	

Project Goals	Assessment	Score/Measurement	Notes
Meet/maintain attainment of Aquatic Life Use designation	Index of Biotic Integrity (IBI)		
	Invertebrate Community Index (ICI)		
Improve habitat	Qualitative Habitat Evaluation Index (QHEI)		
	Headwater Habitat Evaluation Index (HHEI)		
Stabilize streambanks	Bank Erosion Hazard Index		
	Downstream sedimentation? (Downstream QHEI)		
Improve water quality	Temperature (° Celsius)		
	pH		
	Specific Conductivity (µS/cm)		
	Total Dissolved Solids (ppm)		
	Dissolved oxygen (mg/L and %)		
	Water column transparency		
	Visible water pollution?		
Decrease nutrient enrichment	Evidence of nutrient enrichment (e.g. algal blooms?)		
	Nitrate/Nitrite/Phosphorus concentration or loading		
	Presence of stream characteristics conducive to nutrient assimilation (e.g. vegetated riparian buffer >100ft, floodplain access, and natural channels/coarse substrates/flow velocity diversity)?		
Enhancement of riparian vegetation	Riparian vegetative cover (% cover)		
	Tree/shrub/livestake survival (% survival)		
	Presence/absence of planted species		
	Invasive plant species present? (Provide approx. % cover and list species present)		
Improve floodplain connectivity	Visual inspection during or immediately after storm event (provide notes and photos)		
	Comparison of pre- and post-construction cross sectional surveys		
	Is there evidence that stream has access to floodplain? (e.g. note any entrenchment, steep banks, etc)		
Land preservation	Compliance with deed restrictions		
Social/cultural	Public safety maintained/improved?		
	Recreational access maintained/improved?		
Visual	Current photos attached for comparison with pre- and post-construction conditions?		
Other	Trash/Debris/Illegal dumping within project site		

Other notes:

WETLAND RESTORATION PERFORMANCE ASSESSMENT FIELD CHECKLIST			
PROJECT NAME:			
ASSESSMENT LOCATION DESCRIPTION:			
ASSESSMENT LOCATION LATITUDE/LONGITUDE:		**WETLAND SIZE (ACRES):**	
NAME(S) AND AFFILIATIONS OF FIELD PERSONNEL:			
DATE/TIME:			
WEATHER CONDITIONS: ***(check one)*** **___ Clear ___ Overcast ___ Rain showers ___ Air temperature ___ degrees (°) Fahrenheit (F) or Celsius (C)** ***(circle one)***			
PRECIPITATION DURING LAST 24 HOURS? YES or NO ***(circle one)***			
WATER LEVEL/FLOW CONDITIONS: HIGH AVERAGE LOW ***(circle one)***			
ADDITIONAL VISIT REQUIRED? ***(Provide explanation)***			

Project Goals	Assessment	Score/Measurement	Notes
Improve function and quality of wetland	Ohio Rapid Assessment Method for Wetlands (ORAM)		
Enhancement of wetland vegetation	Vegetative cover in planting area (% cover)		
	Tree/shrub/livestake survival (% survival)		
	Presence/absence of planted species		
	Invasive plant species present? (Provide approx. % cover and list species present)		
Improved floodplain connectivity to wetlands	Visual inspection during or immediately after storm event (provide notes and photos)		
	Comparison of pre- and post-construction cross sectional surveys		
	Is there evidence that stream has access to floodplain? (e.g. note any entrenchment, steep banks, etc)	Y or N	
Creation of vernal pools	Does vernal pool dry up once throughout the year?	Y or N	
Land preservation	Compliance with deed restrictions	Y or N	
Social/cultural	Public safety maintained/improved?		
	Recreational access maintained/improved?		
Visual	Current photos attached for comparison with pre- and post-construction conditions?	Y or N	
Other	Trash/Debris/Illegal dumping within project site	Y or N	

Other notes:

Stream/Wetland Restoration Performance Assessment
Pre-Assessment Guide

PROJECT ADMINISTRATION

PROJECT NAME:
RESTORATION FUNDING SOURCE:
AMOUNT OF FUNDING AWARDED:
LOCAL MATCH AMOUNT/SOURCE PROVIDED FOR PROJECT:
TOTAL COST OF PROJECT INSTALLATION:
YEAR OF FUNDING APPLICATION:
YEAR FUNDING AWARDED:
YEAR(S) OF PROJECT CONSTRUCTED:
FUNDING APPLICANT:
GRANT ADMINISTERED BY:
DESIGN, DESIGN/BUILD, OR CONSTRUCTION FIRMS INVOLVED IN PROJECT:

PROJECT LOCATION AND SITE CHARACTERISTICS

PROJECT LOCATION DESCRIPTION OR ADDRESS:
MUNICIPALITY NAME:
COUNTY NAME:
LANDOWNER NAME:
LANDOWNER CONTACT INFORMATION:
LANDOWNER CHANGES SINCE PROJECT COMPLETION? NEW PARTNERS TO INVOLVE?
PERMISSION GRANTED TO ACCESS FOR ASSESSMENT?
SITE ACCESS INFORMATION (e.g. park at pulloff along Township Road 251 and walk down path to site)
PROJECT LATITUDE/LONGITUDE COORDINATES:
USGS QUAD NAME:
12-DIGIT HUC WATERSHED CODE:
12-DIGIT HUC WATERSHED NAME:
WATERWAY NAME:
RIVER MILES (RM):
DRAINAGE AREA OF RESTORED STREAM/WETLAND:
PRE-CONSTRUCTION AQUATIC LIFE USE (ALU) STATUS (ATTACH ASSESSMENT FORMS)
- *OHIO EPA SAMPLING LOCATION:*
- *LOCATION IN RELATION TO RESTORATION SITE:*
- *YEAR ASSESSED:*
- *ALU DESIGNATION (e.g. WWH):*
- *ALU ATTAINMENT STATUS (FULL, PARTIAL, NON):*
- *IBI SCORE:*
- *ICI SCORE:*
- *QHEI TOTAL SCORE AND NARRATIVE RANGE:*
    - *Metric 1 score:*
    - *Metric 2 score:*

Metric 3 score:
Metric 4 score:
Metric 5 score:
Metric 6 score:

RESTORATION GOALS

IMPROVEMENT IN ALU ATTAINMENT STATUS
MAINTENANCE OF ALU ATTAINMENT STATUS
WATER QUALITY IMPROVEMENTS
BIOLOGICAL IMPROVEMENTS
HABITAT IMPROVEMENTS
RESTORE NATURAL FLOW
IMPROVED FLOODPLAIN CONNECTIVITY
SOCIAL/CULTURAL
PUBLIC SAFETY
IMPROVE RECREATIONAL ACCESS
LAND PRESERVATION
OTHER

RESTORATION OBJECTIVES

LINEAR FEET RESTORED:
WETLAND ACRES RESTORED:
RIPARIAN ACRES VEGETATED:
ACRES PRESERVED (INDICATE LAND USE TYPES PRESERVED)
DESCRIPTION OF RESTORATION ACTIVITIES:

RESTORATION ASSESSMENT

AGE OF PROJECT:
DESIGNED LIFESPAN OF PROJECT:
POST-CONSTRUCTION AQUATIC LIFE USE (ALU) STATUS (ATTACH ASSESSMENT FORMS)
OHIO EPA SAMPLING LOCATION:
LOCATION IN RELATION TO RESTORATION SITE:
YEAR ASSESSED:
ALU DESIGNATION (e.g. WWH):
ALU ATTAINMENT STATUS (FULL, PARTIAL, NON):
IBI SCORE:
ICI SCORE:
QHEI TOTAL SCORE AND NARRATIVE RANGE:
Metric 1 score:
Metric 2 score:
Metric 3 score:
Metric 4 score:
Metric 5 score:
Metric 6 score:

DID PROJECT MEET GOALS DURING PROJECT MONITORING PERIOD? (LIST DATA AND SOURCE)
ASSESSMENT PLANNED BY OUTSIDE AGENCY (LIST ASSESSING ENTITY, TYPE OF ASSESSMENT, AND PLANNED DATE OF ASSESSMENT):
APPROPRIATE METHODS FOR CURRENT ASSESSMENT (CHECK ALL THAT APPLY, PROVIDE AS ATTACHMENTS)

- QHEI
- HHEI
- BIOLOGICAL ASSESSMENTS (IBI/ICI)
- BEHI
- SURVIVAL OF PLANTED SPECIES
- PRESENCE OF INVASIVE PLANT SPECIES AND PERCENT COVER
- PHOTOGRAPHS (COMPARE TO PRE- AND POST-CONSTRUCTION PHOTOGRAPHS)
- CURRENT AERIAL MAPS

ASSESSMENT LOCATIONS:
WILL DOWNSTREAM OHIO EPA SAMPLING LOCATIONS ALSO BE ASSESSED?
SHOULD PROJECT BE OBSERVED DURING HIGH FLOW TO ASSESS FLOODPLAIN CONNECTIVITY?
ADDITIONAL ASSESSMENT NOTES:

DOES PROJECT CURRENTLY MEET ORIGINAL GOALS?
SURROUNDING LAND USE CHANGES?
WHAT IS IMPERVIOUS COVER IN AREA DRAINING TO RESTORATION PROJECT? HAS THIS CHANGED?
OTHER PROJECTS BEING IMPLEMENTED UPSTREAM THAT MAY CONTRIBUTE TO GOALS NOT MET?
OTHER LANDOWNER CONSIDERATIONS

OTHER ATTACHMENTS:

ASSESSMENT LOCATION MAP
LANDOWNER ACCESS PERMISSION FORMS

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