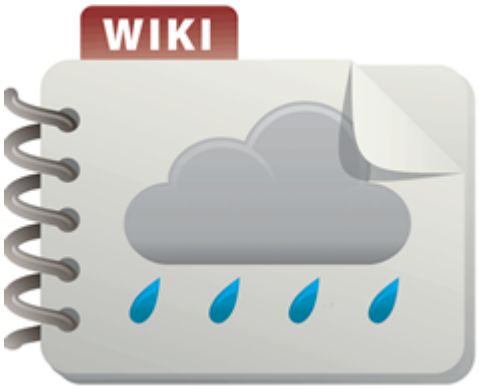

Page Content

Case studies for wet swale

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Village of Carpentersvillle, Kane County, Illinois

- Location: Village of Carpentersvillle, Kane County, Illinois

- Owners: Village of Carpentersvillle
- Designer: HR Green
- Year of Completion: July 2016
- Design Features: Wet swale, two-stage design, grade control/rock checks, vane weirs, vegetation restoration
- Total Construction Cost: 7,973 linear feet of streambank restoration with eight meanders and riffle sections at $486,726; 1.37 acres of wetland restoration at $345,621

Eroded and failing structure banks contributing to sediment and nutrient loads along Carpenter Creek.

HR Green worked with the Village of Carpentersvillle, Kane County, Illinois to design and implement water quality and flood reduction improvements. The Carpenter Creek Design Build Project achieved multiple benefits including flood reduction, floodplain and habitat enhancements, and non-point source pollution reduction relating primarily to streambank erosion. Carpenter Creek discharges to the Fox River, which contains identified impaired stretches for the designated uses of aquatic life and fish consumption. As a tributary to the Fox River, Carpenter Creek was assessed, and 1,800 feet of its length was identified as having highly eroded stream banks contributing substantial amounts of sediment loads and sediment-bound nutrients to the Fox River. This was significant as a Rapid Assessment, Point Method (RAP-M) study noted approximately twenty-three percent of the observed sediment loads in the Jelkes Creek-Fox River Watershed (JCFRW) are a result of stream bank erosion.

To address the stream bank erosion and to improve ecology, the proposed improvements to Carpenter Creek consisted of **bank stabilization**, construction of **two-stage channel**, stream relocation and meandering, wetland enhancement basins, and **rock riffle** and **grade control structures**. This project reduced the annual load of phosphorus by 612 lbs of phosphorus, nitrogen by 1,607 lbs, sediment by 499 tons, and total suspended solids by 192,383 lbs.

Though this channel is mapped as a Water of the United States (WOTUS), the flow regime is very similar to **wet swale** (https://stormwater.pca.state.mn.us/index.php?title=Wet_swale_(wetland_channel)) conditions. Low flows in the channel trickle through and maintain a wet sub-soil condition, while storms cause the channel to **flash**. This case study is not intended to reflect stream restoration or stabilization nor present any guidance for **fluvial systems** management.

Initial studies began as early as 2012 and design and construction activities were completed from April 2015 to July 2016.

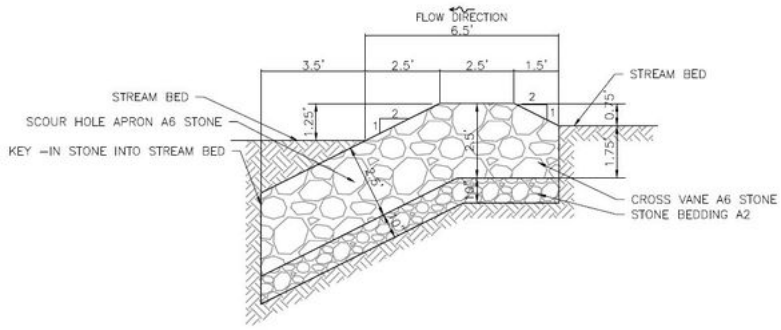
Design Consideration Summary

For the plan set for this example, link to this file - File:Carpenter Creek detail.pdf.

A design goal for this project was to reduce the nutrient and sediment loads to Carpenter Creek. The **vane weir structures**, riffles, and wet swales/wetlands created during this project were utilized to control nutrient and sediment loads while also dissipating energy in the system and allowing more storage in the channel. This allowed for an increase in infiltration while providing a green infrastructure connection to Carpenter Park and the surrounding area.

Five vane weir grade control structures were installed north of the Maple Avenue culvert. Each vane weir provides grade control and provides approximately 12 inches of elevation change from the upstream channel **invert** to the downstream invert. The structures are shaped to direct the flow into the center of the channel where a **scour hole** will form. The scour holes have been designed to dissipate energy and reduce the erosive forces along the banks

throughout the channel. An added benefit of the vane weirs is that they will aerate and thus oxygenate the stream as it spills over the weir. The scour holes that have formed provide a permanent pool and habitat for fish, insects, amphibians and birds. Each vane weir was constructed with 10 inches of **riprap** (https://stormwater.pca.state.mn.us/index.php?title=Erosion_prevention_practices_-_Riprap) #1 stone bedding. The stone used to construct the actual weir was riprap #6 (https://www.pca.state.mn.us/sites/default/files/psriprap.pdf) which has a mean diameter of 15 inch stones and a maximum diameter of 22 inch stones. The stones were keyed in 30 inches into the stream bed to ensure that the grade control structures are not washed way or damaged during high flows. Additionally, a **hydraulic model** of the vane weirs was developed to calculate the erosive forces on the structures and determined that according to the model, the stones used will not be moved by a 100-year flow.



View of vane weir profile. Click on image for better resolution.

View of vane weir installed.

In addition to bank stabilization, wet swale structures were designed and installed along this project utilizing rock riffle grade structures. These grade-control structures provide additional retention capacity of surface run-off within the system, promoting infiltration into the native sandy soils present in the project extent. These structures also serve to reduce the erosive forces through energy dissipation to improve overall water quality. Eight riffles were constructed as part of the stream restoration project. Five of the riffles incorporated large woody debris on the upstream end; this will help to direct flows into the center of the riffle and they will provide structural habitat. The large woody debris was sourced by recycling trees from the tree clearing performed on the project site. The rock "riffles" provide grade control and **energy dissipation** (https://stormwater.pca.state.mn.us/index.php?title=Sediment_control_practices_-_Outlet_energy_dissipation) which in turn reduces bank erosion and reduces the sediment and nutrient loading to the creek and the Fox River. In total, 13 stone grade control structures were installed (including riffles and vane weirs).

Each riffle is approximately 14 feet long and provides between 12 and 24 inches of grade change between the upstream and downstream channel inverts. The crest of each riffle is approximately eight feet wide and is depressed to direct flow into the center of the riffle. The crest is constructed of riprap #6 and the downstream end of the riffles were constructed using riprap #3 which has a mean diameter of five inches and a maximum diameter of 10 inches. The riffles also create a boundary between the wetland basins. The wet swales were placed near creek meanders and were sized based on the **longitudinal slope** of the run and the restricted easement boundaries of the project. In doing so, this project doubled the wetland coverage within the project area.

A portion of the project extent has been negatively impacted by several invasive woody species including European buckthorn, honeysuckle, box elder, and white mulberry that needed to be addressed and managed after the installation of these practices. Wetland vegetation consisted of emergent **plugs** in the wet swales and **mesic** prairie plants upslope of the emergent plugs (Plants for swales (https://stormwater.pca.state.mn.us/index.php?title=Plants_for_swales)). Native soil was comprised of primarily silty loam or sandy soils, so infiltration throughout the project corridor varied. As this was a design-build project, it offered an opportunity to install the wet swale basins and monitor how the system responded in order to make sure plantings were placed in areas where they could

establish and thrive. An example of this was an area where ponding in the swale was higher than anticipated. Adjustments were made to eliminate the emergent plugs at the bottom of the basin and instead place them in the saturated extent of the swale that was higher on the sloped surface. The mesic prairie plants were moved higher up the slope to account for the adjustment.

View of construction with erosion control.

Applicable Costs

This design-build project received Section 319 funds (https://www.epa.gov/nps/319-grant-program-states-and-territories) with matching funds from the developer fee and the Village-completed work as an in-kind match. An Illinois EPA (IEPA) Proposed Best Management Practice (BMP) Application Form (https://www2.illinois.gov/epa/Documents/epa-forms/water/watershed/bmp-nps-instructions.pdf) completed for this project identified expenses associated with the construction of 7,973 linear feet of streambank restoration with eight meanders and riffle sections at $486,726; 1.37 acres of wetland restoration at $345,621; and eight rain gardens (https://stormwater.pca.state.mn.us/index.php?title=Bioretention) at $22,125.00 broken down as follows:

- Bank restoration including riffles and meanders
  - Earthwork (5,500 cubic yards): $302,500.00
  - Erosion Control – Silt Fence (3,987 linear feet): $15,948.00
  - Restoration / Plantings – Mesic Plugs/Seeding (3.37 acres): $17,524.00
  - Erosion Control – Blanket (16,310 square yards): $81,550.00
  - Stone Rip Rap (178 square yards): $8,544.00
  - Tree Removal (3.37 acres): $60,660.00
- Wetland Restoration
  - Earthwork (4,200 cubic yards): $231,000.00
  - Erosion Control – Silt Fence (2,530 linear feet): $10,120.00
  - Restoration / Plantings – Emergent Plugs/Seeding (3.13 acres): $16,276.00
  - Erosion Control – Blanket (15,149 square yards): $75,745.00
  - Stone Rip Rap (260 square yards): $12,480.00
- Rain Gardens
  - Earthwork (90 cubic yard): $4,950.00
  - Erosion Control – Blanket (267 square yards): $1,335.00
  - Restoration/Plantings – Plugs (2,400 square feet): $15,840.00

Views of the vane weir and riffle control structures installed.

Views of the vane weir and riffle control structures installed.

Maintenance

A 10-Year Operation and Maintenance (O&M) Plan was completed to address the ongoing activities to maintain the BMPs implemented in this project. Maintenance activities are described as two phases (short-term and long-term O&M) that are then followed by ongoing maintenance in perpetuity. The Village is responsible for maintenance of the project and will work with an ecological consultant to maintain and inspect the project site. The short-term O&M spans the first 3 years after the installation of the practices, and the long-term O&M then covers years 4-10. These activities are outlined to ensure the long-term viability of the BMPs implemented and focus on sediment and debris removal, native vegetation establishment, and the stability of riffle and cross vane weir structures. Recommendations are from Chapter 16 of NRCS National Engineering Handbook Part 654 Stream Restoration Design (https://directives.sc.egov.usda.gov/viewerFS.aspx?hid=21433).

Link here for information on operation and maintenance of wet swales. (https://stormwater.pca.state.mn.us/index.php?title=Operation_and_maintenance_of_wet_swale_(wetland_channel))

Short Term Maintenance

For the first three years, annual maintenance of planted communities will likely consist of a combination of mowing, selective herbicide application, supplemental seeding/planting, and supplemental removal of invasive woody species. Other activities, such as debris removal within the stream and repair of in-stream structures, will be completed as required. **Prescribed burning** shall become the primary method for promoting the growth of native species and controlling non-native species but is not recommended until the beginning of the fourth year following planting. Short term maintenance task descriptions and proposed implementation schedule includes inspections as frequently as quarterly or as needed. Increased maintenance activities are recommended for vegetation during quarters 2 and 3 and wood species removal during quarters 1 and 4. Nominal stream adjustment is likely as sediment settles into in-stream structures and bed transport stabilizes.

Mowing – Vegetation within the riparian enhancement areas shall be mowed to a height of 6-10 inches after vegetation has reached a height of 24 inches and before non-native or invasive species go to seed. Mowing should be conducted twice during the first and second full growing seasons, likely in late June and late August. Mowing should be conducted only as needed following the second full growing season.

Herbicide Application – Herbicide application shall be limited to areas where mowing is not possible or is not effective. Herbicide shall be applied to target species (i.e. non-native and/or weedy species) using a hand-held wick application, whenever possible to avoid spraying native species, or by careful spot spraying. Best application period is just before flowering of targeted species. Herbicide can be applied any time during the growing season as needed.

Supplemental Seeding and Planting- Seed or plants do not always grow as intended and remedial work is needed. Additional seed and live plant material can always be installed to supplement initial seeding to cover bare areas or to out-compete invasive species. If seeded areas fail to meet performance standards for a given year, a remedial seeding/planting action plan may need to be implemented that takes into consideration the site goals and specific deficiencies causing the remedial action. Reseeding/planting should generally be completed in May-June for seed and anytime during the growing season for wetland plant plugs.

Supplemental Woody Species Removal - Routine follow up removal of non-native or invasive woody species is critical for the success of the project. This benefits the soil-stabilizing understory vegetation by reducing shade suppression, reducing competition between native and non-native species, and preventing debris jams in the stream channel. Target species may include the following: *Rhamnus cathartica* (common buckthorn), *Ulmus americana* (American elm), *Acer negundo* (box elder), *Populus deltoids* (eastern cottonwood), *Lonicera tartarica* (Honeysuckle) *Salix sp.* (Willow), *Prunus serotina* (black cherry), and *Morus alba* (white mulberry). **Brushing** is most effective when combined with selective stump herbicide application of particularly problematic species. Winter is the ideal season for brushing and subsequent burning of brush material.

Debris Removal and Repair of In-stream Structures - Debris jams shall be removed and damaged in-stream structures repaired annually during the short term maintenance period.

Channel – Rock riffles and cross vane weirs shall be repaired particularly following intense rain events that tend to relocate structures before they become sedimented into place. Rock that comprises riffles and cross vane weirs can be re-used and should be placed in accordance with the plan details and specifications. Fallen trees or debris should be removed as soon as possible to prevent flow diversions and **pinch points** that may increase stream velocities and cause erosion.

Floodplain, wetlands & Riparian Buffers– Overbank grading shall be maintained per the design plans. Dumping, obstructions, or encroachments should be removed promptly. Vegetated buffer boundaries should be maintained per the design plans. Pedestrian access to the stream should be inspected for erosion and stabilized as necessary to prevent further erosion.

Meander bends – Eroding or unstable banks usually occur along the outside of bends and should be stabilized with rock toe and native vegetation as necessary in accordance with the plan details and specifications to prevent further erosion and destabilization of existing treatments.

Prescribed Burning - Prescribed burn management shall become the primary method for long-term management of the native plant communities. Burning should begin in spring prior to the fourth growing season if fuel is sufficient. Burning should then be conducted at least every 3 years. Burning should be conducted by an entity experienced in burn planning and permit application as well as prescribed burn management.

Wet swale - Recommended Short Term (3-Year) Maintenance Schedule for Carpenter Creek project. Numbers indicate quarter in which maintenance should occur.
Link to this table

Long Term Maintenance

Long term maintenance and monitoring (4-10 years) is expected to extend from the 2019 growing season through 2025 for this project. Maintenance activities during this period include short term maintenance activities, although the frequency of these activities is anticipated to decrease as prescribed burning becomes the primary management tool for controlling non-native species and as the channel reaches equilibrium associated with meander geometry and sediment transport. Prescribed burn schedule for the project starts in quarters 2 and 4 of the fourth year and reoccurs at this frequency every other year.

Monitoring and Reporting

The Village has employed an ecological firm to complete monitoring of the project and associated reporting. Monitoring and reports specifically address how well the planted communities and stream restoration BMPs meet and maintain the 3-year performance standards. Final Construction Documents include a Planting Plan and Details Map that are used during site visits to locate planting zones and stream stabilization structures.

Monitoring

- Twice annual monitoring of all planting zones and stream stabilization structures shall be conducted during the short term (3 years) maintenance and monitoring period. Annual monitoring shall be conducted in the long term (4-10 years)
- The site visit(s) each year shall be conducted between June 1 and September 30 for vegetation establishment and monitoring of in-stream structures and stream morphology.
- Each visit shall be conducted by qualified professionals with adequate plant identification skills and/or who are also able to make recommendations regarding management of native plant communities and assess

performance of stream restoration BMPs. The site inspector(s) shall collaborate over the needed maintenance requirements for a given year with the Village of Carpentersville.
- The vegetation monitoring shall be conducted using the meander search method to identify 1) approximate percent vegetative coverage by native and non-native species within each plant community, 2) to create a species list for each plant community that can be compared to installed plant lists, and 4) to make recommendations related to site management to meet 3-year performance standards.
- Representative photographs of the restored native plant communities and stream stabilization areas shall be taken to document the site conditions through time.

Reporting

- An annual letter report shall be prepared and submitted to the Village of Carpentersville at the end of each growing season and not later than December 31 of the monitoring year.
- The report shall identify management recommendations and services that have been conducted throughout the growing season and outline future management recommendations.
- The report shall include a section that addresses the required 3-year performance standards found in this maintenance and monitoring plan.
- Site photographs shall be included in the report to document the site conditions.

Performance Standards

Reports address how well the planted communities and restoration BMPs meet 3-year performance standards. Standard categories include vegetation performance and stream stabilization performance. The stabilization standard did not include additional areas but guaranteed in-stream structures are stay in place. The vegetation performance standards include criteria related to selective tree and brush removal; native seeding establishment; **herbaceous perennial** planting establishment.

Vegetation Performance Standards

Selective Tree and Brush Removal

- The Contractor guarantees not more than 10 percent of the cut stumps shall be re-sprouting one full growing season after completion of Selective Tree and Brush Removal. If more that 10 percent of cut stumps are resprouting, the Contractor shall return to the site and treat all resprouts.

Native Seeding

- The Contractor shall guarantee each vegetation community will meet or exceed the following performance criteria three full growing seasons after provisional acceptance: 80 percent total plant cover and at least 60 percent relative cover by planted native species in each prairie community and at least 40 percent in each emergent wetland community. In addition, non-native and/or invasive native species shall collectively not comprise greater than 30 percent relative cover in each community. Invasive/non-native shrubs and trees shall not exceed 10 percent of any vegetation community

Herbaceous Perennial Planting

- The Contractor shall guarantee planted herbaceous plants will meet or exceed the following performance criteria one full growing season after provisional acceptance: 70 percent survivorship of all herbaceous plants. If more that 30 percent of plants do not survive after one year, the Contractor shall return to the site and replant lost plugs with different species or as specified by the Village to meet the performance standard.

Related pages

- Terminology for swales (grass channels)
- Overview for dry swale (grass swale)
- Types of infiltration
- Types of filtration
- Design criteria for dry swale (grass swale)
- Construction specifications for dry swale (grass swale)
- Operation and maintenance of dry swale (grass swale)
- Assessing the performance of dry swale (grass swale)
- Calculating credits for dry swale (grass swale)
- Cost considerations for dry swale (grass swale)
- Case studies for dry swale (grass swale)
- Plants for swales
- Check dams for stormwater swales
- External resources for dry swale (grass swale)
- References for dry swale (grass swale)
- Requirements, recommendations and information for using dry swale (grass swale) without an underdrain in the MIDS calculator (https://stormwater.pca.state.mn.us/index.php?title=Requirements,_recommendations_and_information_for_using_swale_without_an_underdrain_as_a_BMP_in_the_MIDS_calculator)
- Requirements, recommendations and information for using dry swale (grass swale) with an underdrain in the MIDS calculator (https://stormwater.pca.state.mn.us/index.php?title=Requirements,_recommendations_and_information_for_using_swale_with_an_underdrain_as_a_BMP_in_the_MIDS_calculator)
- Requirements, recommendations and information for using swale side slope as a BMP in the MIDS calculator

Task	Year 1	Year 2	Year 3
Mowing: Conducted twice in the first and second years; once annually thereafter if needed to control invasive species. Late June and late August are ideal mowing dates.	2, 3	2, 3	
Herbicide Application: Conducted at least twice annually for weed control, or as supplement to mowing and brushing.	2, 3	2, 3	2, 3
Supplemental Seeding/Planting: Only if required to meet guarantees for native vegetation cover.	2, 3	2, 3	2, 3
Supplemental Woody Species Removal: Conducted as needed to meet performance standards, preferably during winter months.	1, 4	1, 4	1, 4
Debris Removal/In-stream Structure Repair: Inspect & Repair as needed.	1, 2, 3, 4	1, 2, 3, 4	1, 2, 3, 4