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CITY OF FORT WAYNE
RIPARIAN MANAGEMENT PLAN
FINAL

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Key Definitions

Basal End – lower, thicker, base end of a live stake.

Bathymetry – the measurement of the depths and underwater features of a water body.

Bendway Weirs – similar to vanes, they are typically installed on the outside bank of a bend to redirect flow away from the streambank.

Bioengineering - bioengineering refers to the use of living and nonliving plant material in combination with both synthetic and natural support materials for slope stabilization, vegetation establishment and erosion reduction.

Coir Fiber Matting – woven mats made from the husks of coconuts used to stabilize streambanks.

Cross Vanes – rock or log linear structures that extend out from the streambank and into the stream channel in an upstream orientation; multiple vanes make up the cross vane as it extends across the entire stream channel in a "V" or "W" arrangement; they help redirect the flow away from the streambanks and towards the center of the channel.

Duck Bill Earth Anchors – metal anchor that is driven into the ground; typically used in combination with a steel wire to stabilize stream restoration log structures and prevent them from uprooting (http://www.earthanchor.com/duckbill/).

Eco-block – large concrete block with a steel loop; typically used in combination with a steel wire to stabilize stream restoration log structures and prevent them from uprooting.

Fascines – a bundles of sticks or branches bound together; typically made of live willow and dogwood branches for bioengineering applications.

Flashy Flows – streams that rapidly collect runoff, and quickly rise in elevation, then quickly subside after the rainfall stops.

Floodplain Benches – area of land adjacent to a stream that extends from the streambanks to the base of the valley; this low area experiences periodic flooding and associated deposition.

Fluvial Geomorphology – science of studying the shape of streams and how they interact with the land around them.

Girlding Roots – roots that grow around the trunk of a tree or shrub in a circular fashion, which can eventually "strangle" and kill the plant.

Herbivory Damage – damage to plants from wildlife, such as deer browse or felling from beavers.

Imbricated – when referring to rock, specifically rip-rap, meaning the rock edges overlap

J-Hooks/Vanes - rock structures that extend out from the streambank and into the stream channel in an upstream orientation with the "hook" facing downstream; they help redirect the flow away from the streambanks and towards the center of the channel.

Left Bank – the left bank of a stream when looking downstream; the orientation when noting left or right bank is always looking downstream.

Macroinvertebrates - organisms that are visible to the naked eye, which have no backbone; they live in on the bottoms of streams and lakes in, around, and under rocks, sediment, and woody debris.

Meander – a winding curve or bend of a river.

Monocultures – vegetation composed of only a single species on a particular piece of land.

Riffle Grade Control Structures – constructed riffles built in a stream to stabilize the stream bed and prevent downcutting or headcutting (upstream erosion).

Right Bank – the right bank of a stream when looking downstream; the orientation when noting left or right bank is always looking downstream.

Riparian Buffer – an area of trees, usually accompanied by shrubs and other vegetation, that is adjacent to a body of water and which is managed to maintain the integrity of stream channels and shorelines, to reduce the impact of upland sources of pollution by trapping, filtering and converting sediments, nutrients, and other chemicals, and to supply food, cover, and thermal protection to fish and other wildlife (Chesapeake Bay Program).

Rip-rap – typically some type of loose stone placed on streambanks to provide armoring and stability.

River Delta – type of landform that forms at the mouth of a river where it flows into another body of water; they are created as the sediment carried by the river is deposited once the river leaves its mouth.

Riverine – situated on a riverbank; riparian.

Rock and Log Vanes – rock or log linear structures that extend out from the streambank and into the stream channel in an upstream orientation; they help redirect the flow away from the streambanks and towards the center of the channel.

Rootwads – the root systems of upended trees; typically used in streambank stabilization approaches to create additional aquatic habitat; also used with a portion of the log attached at times; a series of rootwads can be used to form a revetment along a streambank.

Senescence – deterioration with age.

Standing Snag – a standing dead or dying tree; often used in restoration projects to provide additional habitat.

Step-Pools – within a stream, step-pools are similar to a series of steps; typically constructed out of flat boulders.

Thalweg – deepest part of a stream channel.

Toe of Slope – the lowest part of an embankment or streambank slope; the water and land interface at base flow conditions.

Vegetative Strata – a layer of vegetation, usually of the same or similar height; common strata are understory, subcanopy and canopy.

INTRODUCTION

This Management Plan sets forth the results of work completed by Biohabitats, Inc. to assess riparian conditions and develop related management strategies and recommendations for the City of Fort Wayne Riverfront Conceptual Plan along the St. Marys, St. Joseph and Maumee Rivers.

In support of this plan, Biohabitats conducted desktop analyses and field investigations to establish current ecological conditions of the riparian corridors within the study area. Drawing from this work, Biohabitats developed a summary of management recommendations and techniques for the study area that integrates ecological restoration, conservation, viewsheds, the Riverfront Conceptual Plan, and other opportunities into a cohesive structure that serves as a basis for future riparian management decisions. The plan should also serve as a foundation and guide for the City's future Riparian Maintenance Manager.

Section 1 provides background information on riparian buffers and their importance. Section 2 of the plan focuses on ecological conditions within specific zones of the study area, and describes the results of desktop analyses and field assessments. Section 3 details specific riparian buffer management strategies that can be utilized and implemented throughout the study area. Section 4 examines the short and long-term strategies of managing buffers in relationship to the Riverfront Conceptual Plan and any constraints associated with the conceptual plan. Finally, Section 5 provides detailed recommendations for the specific zones in the study area, how they fit into the context of the conceptual plan and next steps.

1. RIPARIAN BUFFERS

1.1. What are Riparian Buffers and Why are they Important?

Stream buffers, also known as riparian buffers, conserve and protect the areas adjacent to streams and rivers. Buffers differ greatly, as do the streams they border, ranging from flat floodplains to steep gorges. When functioning property, they serve as a vegetated, protective area between a body of water and human activity and development.

Although communities and residents value trees and other plants along rivers for their aesthetic qualities, the vegetation in the riparian buffer plays a critical role in providing for a healthy riverine system. Riparian plant communities maintain the riverine landscape and moderate conditions within the aquatic ecosystem.

Riparian vegetation serves as a buffer for the river against activities on upland and upstream areas. Most human activities whether development, agriculture, or even recreation, can result in impacts, which can negatively affect our rivers. Typically, more riparian vegetation and buffer provides more protection. Riparian vegetation also provides a multitude of ecosystem services as it captures, stores and filters pollutants in overland flow from upland sources, such as salt from roadways and excess fertilizer and sediment from lawns and cropland, which are major contributors to poor water quality in the Maumee watershed. The width, density, and structure of the riparian vegetation community are also important characteristics of the buffer that affect the level of its functionality. For example, narrow buffers of turf grass provide little in terms of protection and ecosystem services, while wider and continuous floodplain forests provide more substantial benefits.

High river flows can result in bank erosion, especially on bare soils, while overbank flows can cause additional soil erosion and scour on the floodplain. Vegetative roots along the bank help hold the streambanks in place and protect them against erosive flows. On the floodplain, vegetation slows flood flows by reducing the energy of water, which in turn lessens scour and erosion and enhances sediment deposition, improving water quality.

One of the other major benefits of vegetation in general is that it intercepts rainfall and slows runoff. This delay reduces the amount of runoff while increasing the amount of precipitation that infiltrates the ground and recharges the groundwater supply. This delay and reduction in runoff lowers the height of floodwaters, decreases the occurrence and severity of flooding, and results in fewer disturbances to the floodplains and streambanks.

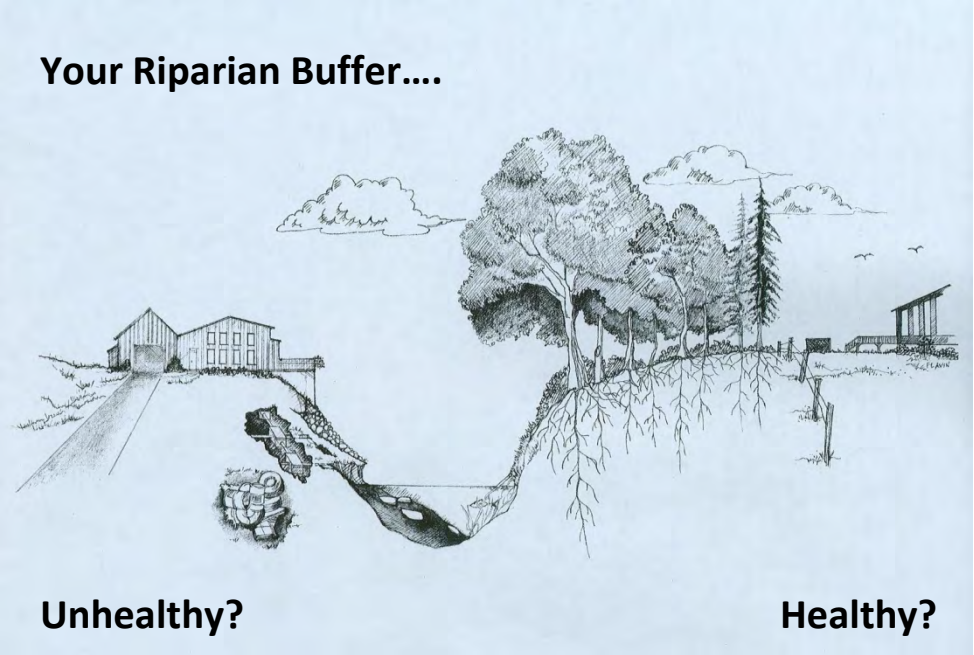

Figure 1.1. Healthy and unhealthy riparian buffers (Source: Amy Flavin; NYC DEP).

Riparian vegetation also provides important services and functions for aquatic and terrestrial wildlife that rely on riparian areas during all or a portion of their life cycle. Trees and shrubs shade rivers to help maintain cooler water temperatures, increasing dissolved oxygen, which benefits fish and other aquatic organisms. Large woody debris provide critical instream habitat for both fish and aquatic wildlife while undercut banks and overhanging vegetation provide additional cover for fish. Woody and leaf material also provide food sources needed by terrestrial insects and aquatic macroinvertebrates, which are a major food source of fish and other aquatic organisms. Riparian buffers also serve as nature's highways as the vegetated corridors provide access for wildlife as they move along rivers and into upland habitat areas. Riparian corridors are projected to become even more critical wildlife pathways as temperatures begin to increase with climate change and wildlife and vegetation potentially shifts from southern to northern ranges and lower to higher elevations.

A healthy riparian community typically has a range of vegetation types, species and strata. It should have a variety of vegetation types, including trees, shrubs, grasses, and herbs, which occupy the upper, mid and lower-stories of the forest. The plants should be adapted to frequent flooding. Sufficient regeneration of new plants is needed to ensure the future sustainability of the community. The plants should also be native to the local region, as the local wildlife and plant community have evolved together over thousands of years. Infestations of non-native species have created monocultures in many riparian areas, thus greatly reducing plant diversity, ecosystem services and wildlife habitat benefits.

Although healthy riparian buffers provide key ecosystem services like improving water quality and reducing flooding and erosion, they can also be aesthetically pleasing and functioning community assets worthy of our diligent management and protection.

2. STUDY ZONES ANALYSIS

2.1. Study Zone Breakdown

For the purpose of this management plan, the study area roughly encompassed the same study zone that was used for the Riverfront Study, which includes the St. Marys, St. Joseph and Maumee River corridors within the City of Fort Wayne, comprising approximately 2.6 total river miles and including 310 acres of land. The upstream end of the corridor begins at the train bridge between Van Buren St. and W. Main St., continues through downtown Fort Wayne and finally ends at E. Columbia St. at the eastern end of the corridor (Figure 2.1). The study area was divided into nine distinct zones, again roughly following those laid out in the Riverfront Conceptual Plan and includes the following: Bloomingdale Park, Guldlin Park, The Promenade, Headwaters Junction, Wells Corridor, Headwaters Park, Lawton Park, Old Fort, and The Confluence.

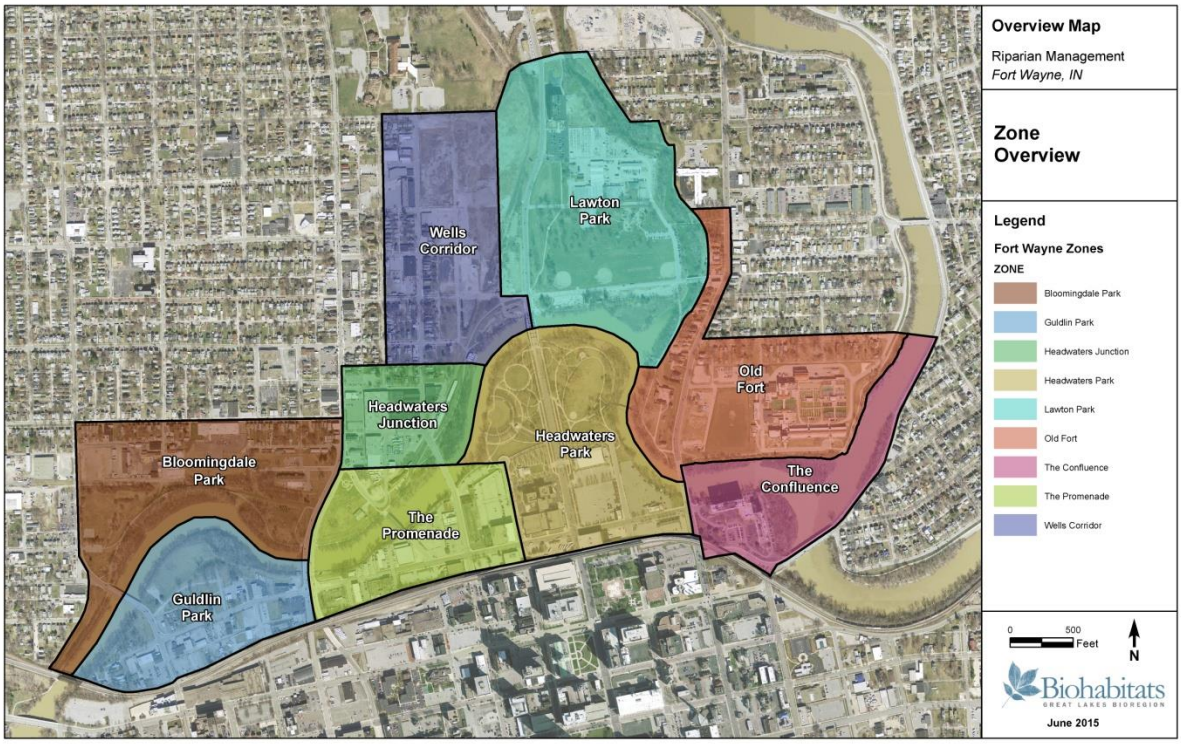

Figure 2.1. Zone Overview Map (Source: Biohabitats; July 13, 2015).

2.2. Study Zones Conditions

Riparian and shoreline conditions within the study area differ greatly not only between the St. Marys River, St. Joseph and Spy Run Creek, but along the St. Marys River itself. Overall, these extremes range from expansive natural areas such as floodplain forests, to highly engineered rip-rap banks and flood walls. In general the buffers were dominated by only four tree species including Eastern cottonwood (*Populus deltoides*), box elder (*Acer negundo*), silver maple (*Acer saccharinum*), and tree-of-heaven

(*Ailanthus altissima*). The understory was completely dominated by four invasive bush honeysuckle species (*Lonicera maackii, L. tatarica, L. morrowii, L. x bella*).

Table 2.1. Observed Study Area Riparian Species.

Common Name	Scientific Name
box elder	*Acer negundo*
silver maple	*Acer saccharinum*
*tree of heaven	*Ailanthus altissima*
*garlic mustard	*Alliaria petiolata*
marsh mallow	*Althaea officinalis*
catalpa	*Catalpa sp.*
Eastern redbud	*Cercis canadensis*
flowering dogwood	*Cornus florida*
red osier dogwood	*Cornus sericea*
*autumn olive	*Elaeagnus umbellata*
elm sp.	*Elmus sp.*
*Japanese knotweed	*Fallopia japonica*
ash sp.	*Fraxinus sp.*
honey locust	*Gleditsia triacanthos*
yellow daylily	*Hemerocallis lilioasphodelus*
*yellow flag iris	*Iris pseudacorus*
*Amur honeysuckle	*Lonicera maacki*
*Morrow's honeysuckle	*Lonicera morrowii*
*Bell's honeysuckle	*Lonicera x bella*
*Tatarian honeysuckle	*Lonicera tatarica*
*purple loosestrife	*Lythrum salicaria*
Virginia creeper	*Parthenocissus quinquefolia*
sycamore	*Platanus occidentalis*
Eastern cottonwood	*Populus deltoides*
pin cherry	*Prunus pensylvanica*
*Callery pear	*Pyrus calleryana*
oak sp.	*Quercus sp.*
*lesser celandine	*Ranunculus ficaria*
staghorn sumac	*Rhus typhina*
black locust	*Robinia speudoacacia*
raspberry sp.	*Rubus sp.*
willow sp.	*Salix sp.*
*crown vetch	*Securigera varia*
lamb's ear	*Stachys byzantina*
poison ivy	*Toxicodendron radicans*
clover sp.	*Trifolium sp.*
elm sp.	*Ulmus sp.*
grape vine	*Vitis sp.*
***indicates invasive species per Indiana Invasive Species Council**	

A visual fluvial geomorphic assessment of the project area was undertaken on May 6, 2015. The project area was analyzed for bank erosion sites using the Bank Erosion Hazard Index (BEHI) (Rosgen, 2001), a

field assessment method, which looks at seven factors to evaluate the potential of erosion based on different erosional processes. These seven factors are bank height, bankfull height, root depth, root density, bank angle, surface protection, and bank material stratification. Using these variables, erosion risk is established, which can be used to develop a priority ranking of the sites. With further evaluation, BEHI's can be used to develop stream bank erosion rates. The exercise undertaken for this assessment did not develop stream bank erosion rates. Within the project area, sites were identified for further analysis using this methodology if they showed signs of current erosion, such as a lack of vegetation and/or exposed roots. The length of the erosion and the height of the erosion up the bank were also identified. Parameters were only measured within the area of visual active erosion, for example, if only two thirds of the bank appeared to be actively eroding, the parameters were only calculated within this area. The table below provides a summary of the sites and the overall BEHI rating, for further detail, see Appendix A for locations, Appendix B for assessment data, and Appendix K for bathymetry maps.

Table 2.2. Study Area BEHI Ratings.

Site	River	Length	BEHI Score	BEHI Rating
1	St. Marys	300	19.4	Low
2	St. Marys	50	27.5	Mod
3	St. Marys	200	41.5	Very High
4	St. Marys	230	40.5	Very High
5	St. Marys	200	26.1	Mod
6	St. Marys	200	30.4	High
7	Spy Run Creek	60	32.0	High
8	St. Marys	300	31.7	High
9	St. Marys	200	36.5	High
Bathymetry data was collected by the Indiana Dept. of Natural Resources Division of Fish and Wildlife: Lake and River Enhancement Program on 8/25/15.				

Overall, the study area has a very limited amount of bank erosion sites given its length. For most of the project length the toe of the banks are protected by the backwater from the Hosey dam. Most erosion appears to occur during larger storm events, evidenced by scour high on the bank, and is usually due to lack of vegetative cover. The following sections provide more detailed analysis on the streambanks, erosion, riparian vegetation, and features within each of the distinct zones in the study area. Three separate maps for each specific zone are provided in Appendix A, which specifically assess vegetation, streambank conditions and erosion, and features such as existing viewsheds, several invasive species, vines damaging trees, herbivory damage, boat access, low-head dams, concentrated runoff and views that should be screened.

2.2.1. Bloomingdale Park

The Bloomingdale Park zone begins on the St. Marys at the upstream study area limits at the rail road bridge and extends approximately 2,800 linear feet downstream to the Ewing St. bridge. This zone encompasses only the left bank of the stream (when referring to the right or left bank of a stream, the view is always looking downstream). As the St. Marys enters the study area it includes a narrow band of floodplain forest ~50 feet in width along the left bank from the rail road bridge to the Van Buren St. bridge. After passing under the bridge, the buffer quickly expands to a broader floodplain forest ~150

feet wide between the St. Marys and the trail along the levee. It then narrows and rises sharply until it meets the Ewing St. bridge. The entire bank is also paralleled by a flood protection levee.

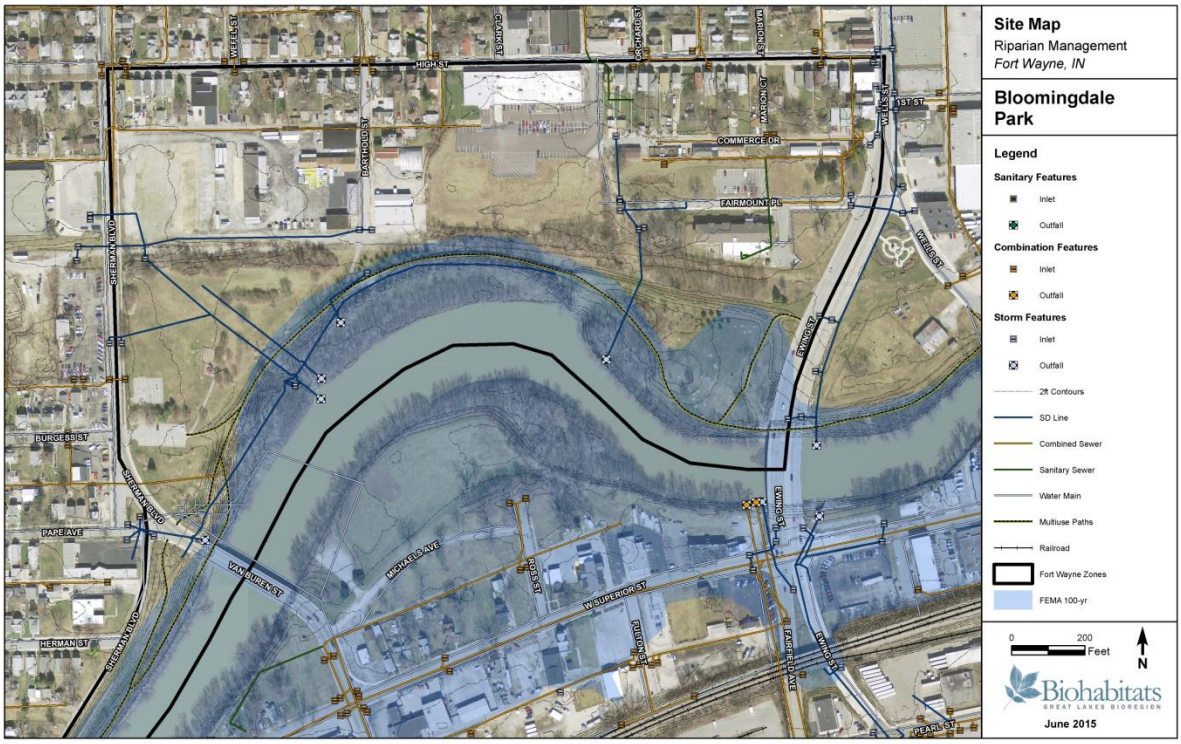

Figure 2.3. Bloomingdale Park Study Area (Source: Biohabitats; July 13, 2015)

Most of Bloomingdale Park's streambanks, which are located on an outside meander bend of the St. Marys River, are composed of low to moderate bank angles and are well vegetated. At the downstream end, where the bank changes to a steeper angle, there is one area (site 2, see Appendix A) of active streambank erosion which is located approximately 500 feet upstream of the Ewing Street Bridge. It is on the left bank, on the outside of a meander of the St. Marys River, and about 50 feet long. The bank has vegetation growing on the upper third of its height, but the bottom two thirds are eroding. The existing vegetation in this area is mostly shrubs and younger trees, with minimal herbaceous cover.

Figure 1.4. Shoreline and riparian conditions in the Bloomingdale Park floodplain (Source: Biohabitats; April 30, 2015).

The vegetation within the Bloomingdale Park study area lacks diversity. The lower floodplain areas are dominated by an even-aged stand of mature silver maple (*Acer saccharinum*) with little to no understory or regeneration, largely due to the high frequency of sediment deposition. Some marsh mallow (*Althaea officinalis*) is present towards the downstream end of the floodplain forest. The riparian slopes are somewhat more diverse with sycamore (*Platanus occidentalis*), cottonwood (*Populus deltoides*), elm (*Ulmus sp.*), and box elder (*Acer negundo*) present, but the understory is completely dominated by invasive bush honeysuckles (*Lonicera sp.*). The dense stands of honeysuckle have limited the regeneration of the existing trees, and recruitment of new woody vegetation is minimal. The honeysuckle also blocks views to the St. Marys from the adjacent trail. A number of tree-of-heaven (*Ailanthus altissima*) clumps and individuals exist along both sides of the trail. There is one location at the downstream end of the large floodplain forest that has been cleared and maintained to provide viewing access. There is also evidence of pedestrian access to the floodplain just downstream of the Van Buren St. bridge (Appendix A).

2.2.2. Guldlin Park

The Guldlin Park zone begins on the St. Marys at the upstream study area limit at the rail road bridge and extends approximately 2,800 linear feet downstream to the Ewing St. bridge. This zone encompasses only the right bank of the St. Marys. As the St. Marys enters the study area it includes a narrow band of vegetation ~25 feet wide on a steep slope along the right bank from the rail road bridge to the Lincoln Highway bridge. After passing under the bridge, the buffer quickly expands across the floodplain between the St. Marys and a small levee paralleling Michaels Ave. to the north. The narrow band of trees bordering the adjacent lawn area extends ~725 feet downstream until it widens to ~150 feet of mature floodplain forest. It then narrows and rises sharply until it meets the Ewing St. bridge.

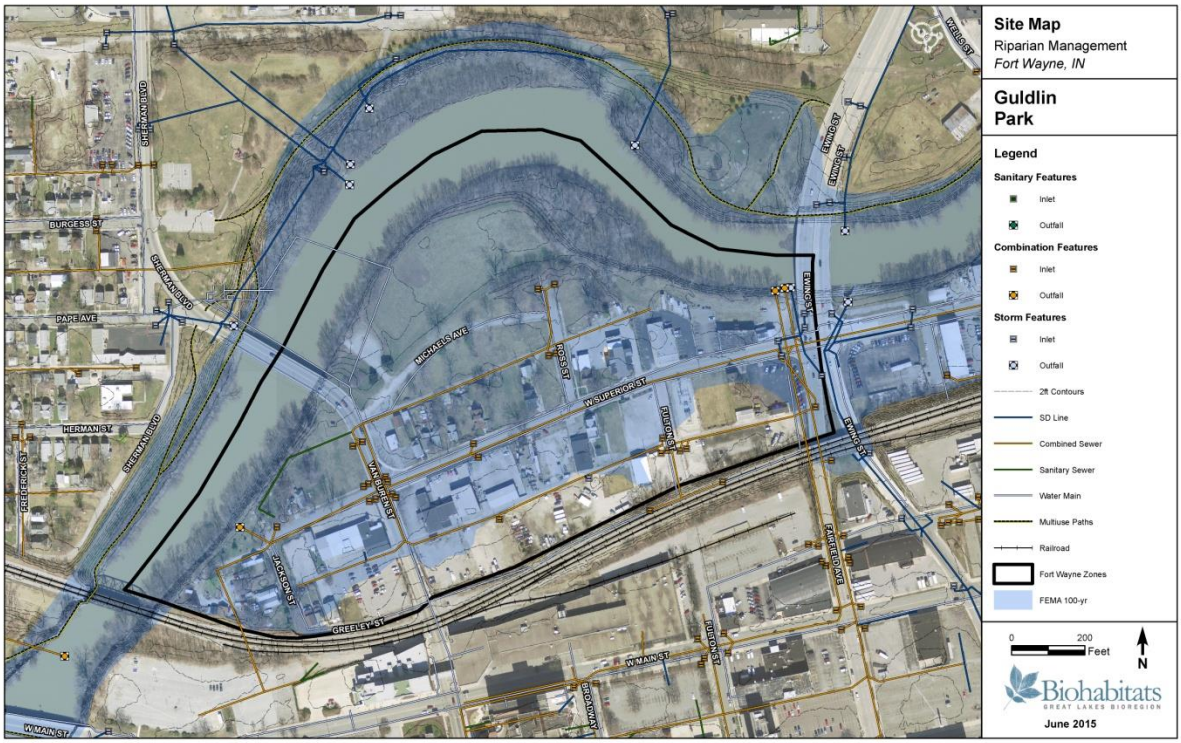

Figure 2.5. Guldlin Park Study Area (Source: Biohabitats; July 13, 2015)

Within Guldlin Park there is one site of active erosion, about 300 feet downstream of the Van Buren St. bridge. The area of active erosion (site 1, see Appendix A) is about 300 feet long and half of the existing bank height is eroding. Most of the banks within Guldlin Park are well vegetated and low gradient, being on the inside of a meander bend.

Figure 2.6. Maintained view looking across the St. Marys into Guldlin Park (Source: Biohabitats; April 30, 2015).

The vegetation within the Guldlin Park study area is also dominated by silver maple in general, which is present on both steep slopes and the floodplain. The lower floodplain areas consist of an even-aged stand of mature silver maple with little to no understory or regeneration, largely due to the high frequency of sediment deposition. The riparian slopes are somewhat more diverse as sycamore, cottonwood , elm, and box elder are present with intermittent honeysuckle . A grouping of tree-of-heaven and tall vines exist just upstream of the Van Buren St. bridge while the park provides motorized boat access on the downstream side of the bridge. A roughly 500 feet by 200 feet portion of the floodplain is currently maintained as lawn and serves as snow storage in the winter months. This area is also regularly inundated under high flows (Appendix A).

2.2.3. The Promenade

The Promenade Zone begins at the Ewing St. bridge and extends downstream along the left bank to the Harrison Street bridge and along the right bank just slightly further downstream than the parking lot at the upstream end of Headwaters Park. This is a highly commercial area with narrow riparian buffers and additional floodplain levees along the entire length of the left bank. Throughout this reach, the right bank buffer typically ranges from 0 to 25 feet wide and begins to approach 50 feet once it enters Headwaters Park. There is no floodplain interaction until the River meets Headwaters Park and here a large portion of the buffer is landscaped with a manicured understory. The buffer on the left bank through this reach varies from 50 feet to 125 feet. The largest buffers and floodplain forest reaches are found upstream of the Harrison St. bridge.

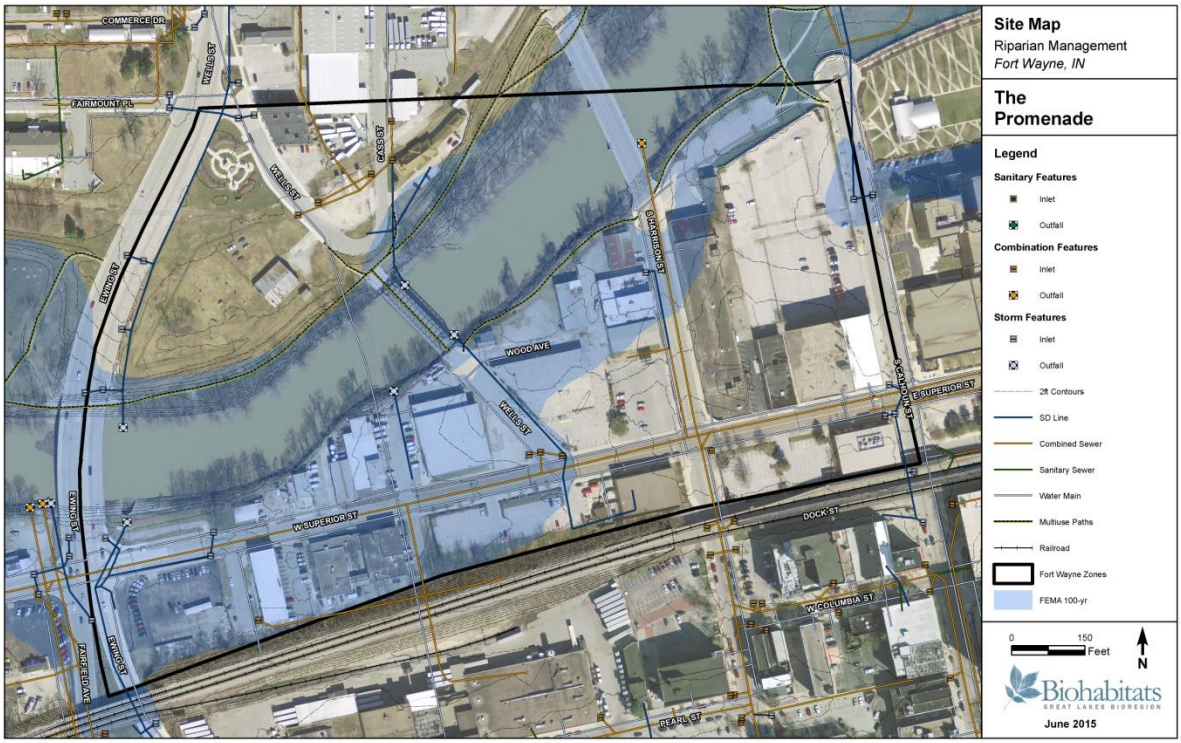

Figure 2.7. The Promenade Study Area (Source: Biohabitats; July 13, 2015).

Within The Promenade, there are two sites to note for bank erosion – Site 3 (Appendix A) is on the left bank near the Fort Wayne Outfitters, about 120 feet upstream of the Wells St. walking bridge. Site 4

(Appendix A), is located on the right bank about 200 feet downstream of the walking bridge. Site 3 is about 200 feet long and the bank is approximately 11 feet tall, with the lower one third eroding. Site 4 is 230 feet long and shows very similar characteristics to site 3. Most of the bank length in this area is very steep, but relatively well vegetated.

The vegetation in general is typical of the previous zones with silver maple dominating the low floodplain areas and mixed deciduous riparian tree species on the steep slopes, which include silver maple, sycamore, box elder, elm, cottonwood , and honey locust (*Gleditsia triacanthos*). The steeper slopes are also overrun with bush honeysuckle and there are multiple areas that include tree-of-heaven. The right bank also includes several areas where grape vines have smothered existing trees and begun to pull them down. Non-motorized boat access is available on the left bank adjacent to the Fort Wayne Outfitters and views are exceptional from the Wells St. walking bridge (Appendix A).

Figure 2.8. Grape vine damage to riparian vegetation (Source: Biohabitats; April 30, 2015).

2.2.4. Headwaters Junction

This is a fairly small zone, which begins on the left bank of the St. Marys and extends ~850 feet downstream to a combined sewer overflow (CSO) outfall. The left bank includes a low floodplain forest that varies from 75 to 150 feet as it parallels the Rivergreenway Trail.

Figure 2.9. The Headwater Junction Zone (Source: Biohabitats; July 13, 2015).

The proposed Headwaters Junction development is located on the downstream end of the inside of a meander on the left bank with streambanks composed of low to moderate angles and well vegetated. At the downstream end, where the bank approaches a CSO outfall, there has been some vegetation clearing, but the banks are stable. The floodplain and banks are wide throughout this reach varying from 75 to 150 feet.

Figure 2.10. Cleared view with Bradford pear trees flowering (white blossoms) (Source: Biohabitats; April 30, 2015).

Vegetation on the floodplain is dominated by silver maple and transitions to previously mentioned riparian tree species as the slope steepens. Bush honeysuckle is common on the slopes and there is one specific area where climbing vines (*Vitis sp.*) are a problem. There are also several Bradford pear (*Pyrus calleryana*) trees that were intentionally planted along the trail, which are considered an invasive species. Just upstream from the CSO outfall the silver maples have been cut to provide views of the water and Headwaters Park (Appendix A).

2.2.5. Wells Corridor

The riparian corridor within the Wells Corridor Zone only encompasses approximately 500 feet of the left bank of the St. Marys between the CSO located at the corners of 3rd St. and N. Calhoun St., extending downstream to the Clinton St. bridge. The buffer between the Rivergreenway Trial and the St. Marys averages approximately 50 feet.

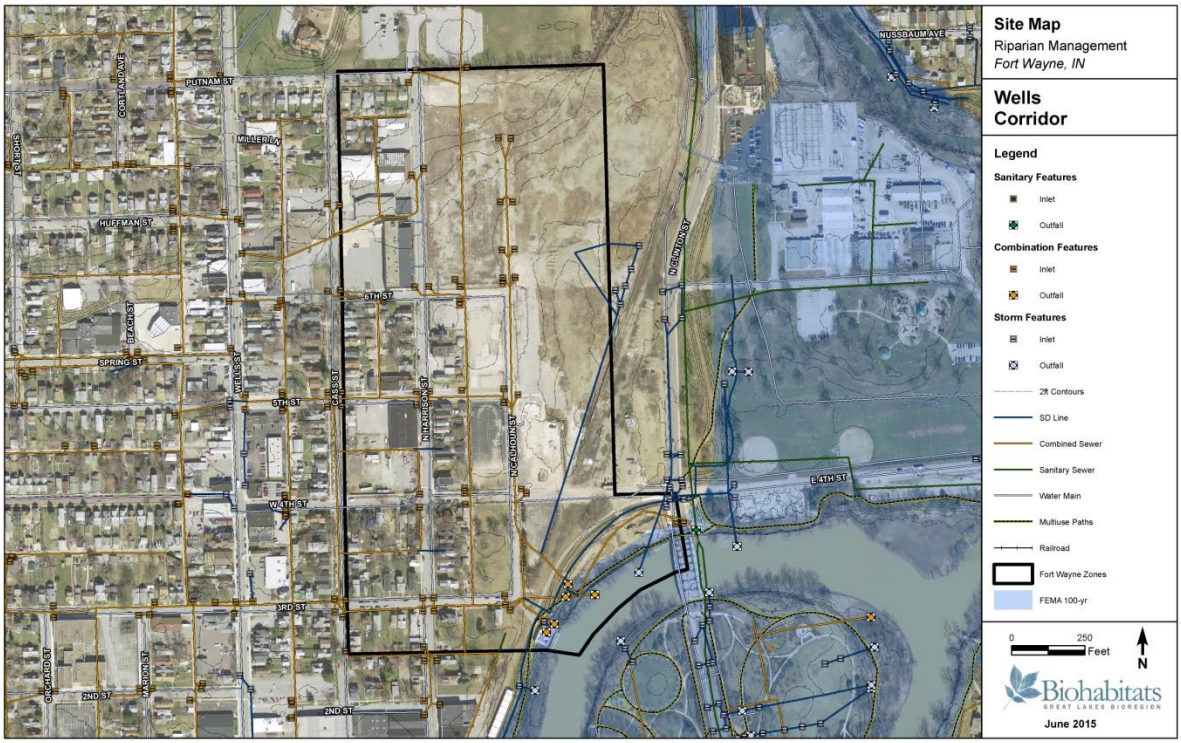

Figure 2.11. The Wells Corridor Zone (Source: Biohabitats; July 13, 2015).

Within this area there is one site of erosion to note, Site 6 (Appendix A), which is located directly upstream on the left bank of the Clinton Street bridge. This bank is on the outside of the meander, where there has been recent outfall work. The erosion is about 200 feet long and poorly vegetated.

Figure 2.12. Turf area between riparian vegetation and levee (Source: Biohabitats; April 30, 2015).

Riparian vegetation is consistent with the other zones with some silver maple regeneration near the Clinton St. bridge. There are two large areas of tree-of-heaven just outside the levees that will serve as a seed source in the future once the trees mature and a number of smaller clumps and individuals. A large turf area existing between the riparian buffer/trail and the levee that could possibly be transitioned to native meadow or riparian forest (Appendix A).

2.2.6. Headwaters Park

The Headwaters Park Zone begins just downstream of the Harrison St. bridge and continues downstream until the Spy Run Ave. bridge, consisting only of the right bank. A large portion of the riparian buffer is landscaped with a cleared understory. This condition persists throughout much of Headwaters Park, although there are stretches of floodplain forest within the park. The buffer ranges from 25-100 feet with the largest buffer and floodplain forest reaches found across from the Old Fort.

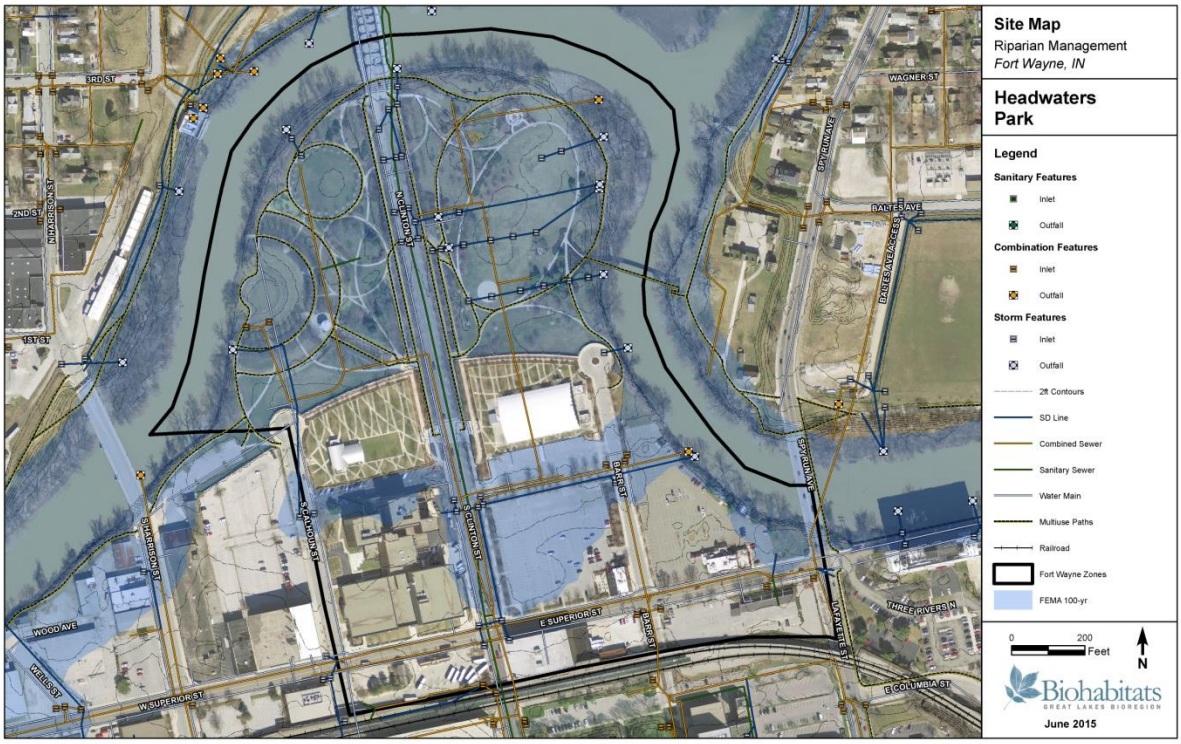

Figure 2.13. The Headwaters Park Zone (Source: Biohabitats; July 13, 2015).

Headwaters Park is located on the inside of a meander. As a result, most of the streambanks in this area are relatively short. The steeper gradient banks are located at the upstream and downstream ends of the park, where the banks are on the outside of the meander. The majority of the bank length in the park is well vegetated, except for two smaller portions, one of which has been identified as an erosion site (site 5, Appendix A) where the amphitheater looks out over the river. Site 5 is approximately 200 feet long and limited in height. Vegetation is predominantly managed turf, which is a major contributor to the erosion in this area due to the short root depth and the access and food it provides for geese. Site 9 (Appendix A) is also located within Headwaters Park, at the location where Barr Street ends in a cul-de-sac. It contains about 200 feet of eroding bank that is nine feet tall. The erosion section is about one-half the height of the bank, see Appendix I. This section is under discussion for an Indiana Department of Natural Resources (IDNR) – Lake and River Enhancement Program (LARE) stream restoration grant.

Vegetation within Headwaters Park typically consists of the more common riparian species found in the study area along the riparian slopes and floodplain, that shifts to more traditional landscaping plants as the riparian buffers meets the walking paths that parallel the river. There are a number of areas that include tree-of-heaven, mostly in the downstream end of the zone. Herbivory is evident throughout the park, particularly in a clearing just upstream of the Spy Run Creek confluence. Beaver have cleared an area of over 100 linear feet, which now consists predominantly of silver maple re-sprouts. There are several notable viewsheds in the park including the above mentioned area in addition to a location just upstream of the pedestrian bridge to the Old Fort, see Appendix A. A small patch of Japanese knotweed (*Fallopia japonica*) was discovered in the park in 2014 by Biohabitats' staff, but it appears it has been successfully treated (Appendix A).

Figure 2.14. Herbivory of silver maples in Headwaters Park (Source: Biohabitats; April 30, 2015).

2.2.7. Lawton Park

This zone begins at the Clinton St. bridge and continues downstream to just before the Historic Old Fort. All of Spy Run Creek is within the study area. The flood protection levees leave the River and follow the perimeter of Lawton Park, essentially paralleling the east of N. Clinton St. and the left bank of Spy Run. The levees follow the eastern edge of Historic Fort Wayne where they again join the St. Marys. The riparian buffer along the left bank from the N. Clinton St. bridge to the confluence of Spy Run Creek is ~50 feet in width until it reaches a large delta formation at the confluence. Most of the perimeter of this delta formation is forested, however the interior is mostly turf and devoid of woody vegetation. The riparian conditions within the Spy Run Creek are very constrained between Lawton Park and its associated facilities on the right bank and a flood protection levee on the left bank. The buffer is relatively narrow, varying from 25-75 feet. There is a large section of rip-rap (475 feet) on the left bank which is bordered by turf, which provides little habitat throughout that specific reach.

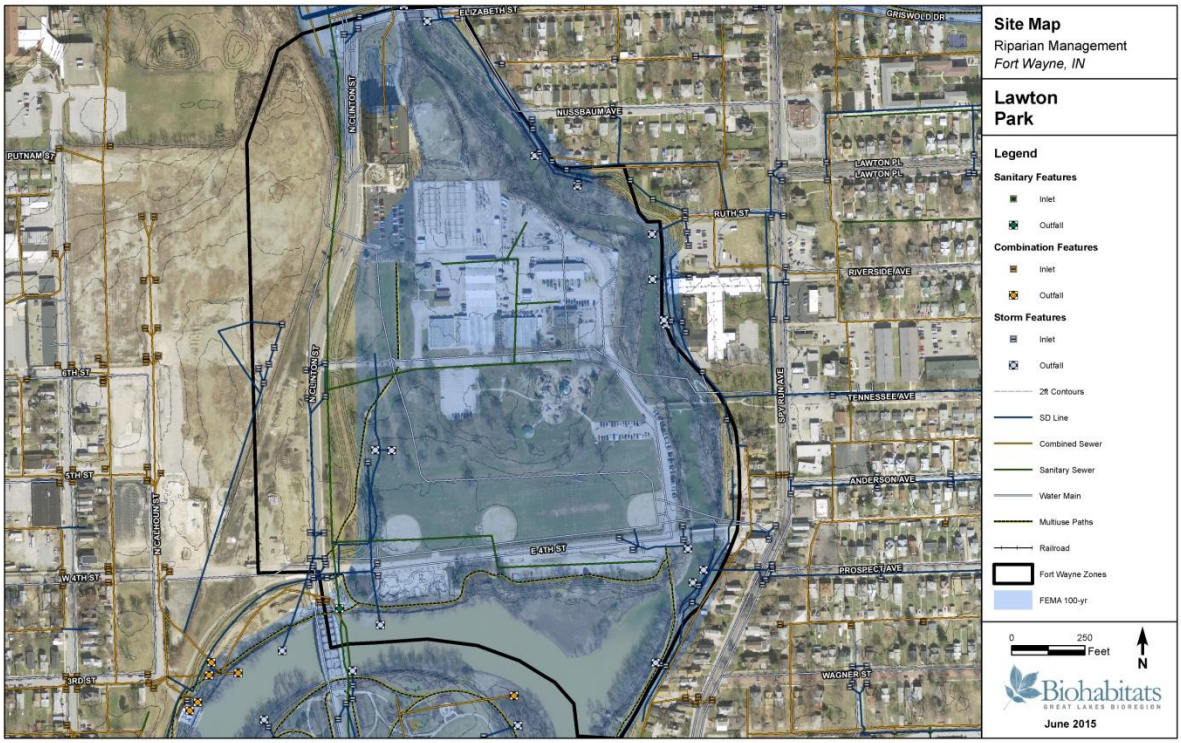

Figure 2.15. The Lawton Park Zone (Source: Biohabitats; July 13, 2015).

Lawton Park is bounded by streams on two sides, Spy Run Creek to the east and the St. Marys River to the south. Most of the banks are low gradient in slope, with one area of hardened left bank downstream of Ruth Street on Spy Run Creek. Spy Run Creek contains one erosion site, Site 7 (Appendix A), which is located on the left bank directly downstream of the pedestrian bridge at the mouth. It is about 60 feet long and very tall (15 feet). Most of the vegetation is shrub and small trees, the erosion is on the lower one third of the bank.

Figure 2.16. Large woody debris jam on Spy Run Creek (Source: Biohabitats; April 30, 2015).

Vegetation along the St. Marys River within this zone mainly consists of a narrow band of woody vegetation and low floodplain area at the confluence with Spy Run Creek, dominated by turf grass. Several clumpings and individual of tree-of-heaven and Norway maple (*Acer platanoides*) also occur here. An area of lesser celandine (*Ranunculus ficaria*) was discovered in the Spy Run Creek riparian corridor. This invasive was not found along the St. Marys or St. Joseph, and it is believed to be confined to this one location. Several low-head dams are located on Spy Run Creek in addition to a number of woody debris jams on the downstream pedestrian bridge and overlook (Appendix A).

2.2.8. Old Fort

The Old Fort Zone consists of approximately 1,000 linear feet of the left bank on the St. Marys River starting just downstream of the observation platform below the Spy Run Creek confluence, continuing downstream to the Spy Run Ave. bridge. Between the confluence and the Historic Old Fort the buffer is mainly limited to one to three rows of trees with most erosion occurring adjacent to the Historic Old Fort.

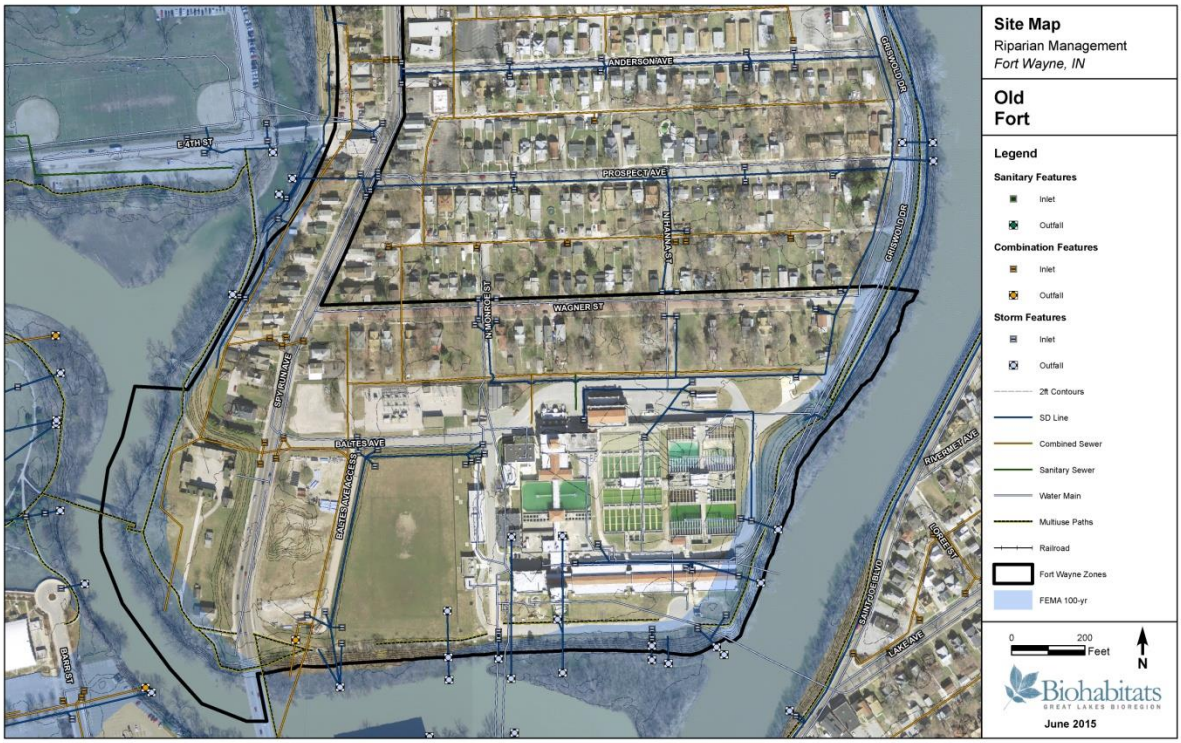

Figure 2.17. The Old Fort Zone (Source: Biohabitats; July 13, 2013)

On the west side of the Old Fort area the banks have a steep gradient. At site 8 (Appendix A), located on the east bank of the St. Marys River, about 300 feet of the eight foot tall bank is eroding. There is very little vegetative cover and the top of the bank is managed turf. The banks are nearly vertical and susceptible to continued erosion due to the lack of vegetation and continued mowing. See Appendix I for more information as this area is under discussion for an IDNR stream restoration grant.

Figure 2.18. Bank erosion at the Old Fort site (Source: Biohabitats; April 30, 2015).

The upstream portion of the Old Fort riparian buffer is more shrubby in character, including tree-of-heaven, staghorn sumac (*Rhus typhina*), and box elder. The buffer then transitions to mature cottonwoods as the river approaches the fort itself. The buffer width varies from 25-50 feet between the river and adjacent trail and is predominately managed turf grass with vegetation at the edge of slope and some scattered cottonwoods (Appendix A).

2.2.9. The Confluence

The final zone in the study area is The Confluence, beginning at the Spy Run Ave. bridge, extending downstream to the Columbia St. bridge. The zone also includes the lower ~1,700 linear feet of the St. Joseph River. Between the Lafayette St. bridge and the Columbia St. bridge the levees parallel the left bank adjacent to the water treatment plant and then continue along both banks of the St. Joseph. The riparian buffer along the right bank begins as a narrow 25-foot, steep buffer and then transitions to a floodplain forest approaching 200 feet wide where it meets the Columbia St. bridge. The left bank buffer is similar as it widens significantly where it meets the confluence of the St. Joseph. The delta formation is vegetated with young trees and is more developed from a habitat standpoint than the Spy Run delta.

This stretch of the St. Joseph River is the most engineered and hardened of the entire study area. The upstream portion of this reach has ~700 feet of rip-rap on the left bank that is approximately 20 feet wide. Three-foot diameter corrugated plastic planters are incorporated into the rip-rap at 20 foot spacing intervals along the length of the reach. These planters had been planted previously with vines, however none are surviving to date. The buffer then transitions to a ~650 foot stretch of natural vegetation, just below the rip-rap, at a ~50 foot width before transitioning back to rip rap until it meets the Columbia St. bridge. The right bank includes a narrow 50 foot strip of vegetation that transitions to rip rap. There are a number of mature cottonwood trees within this rip rap, which are experiencing herbivory damage from beavers.

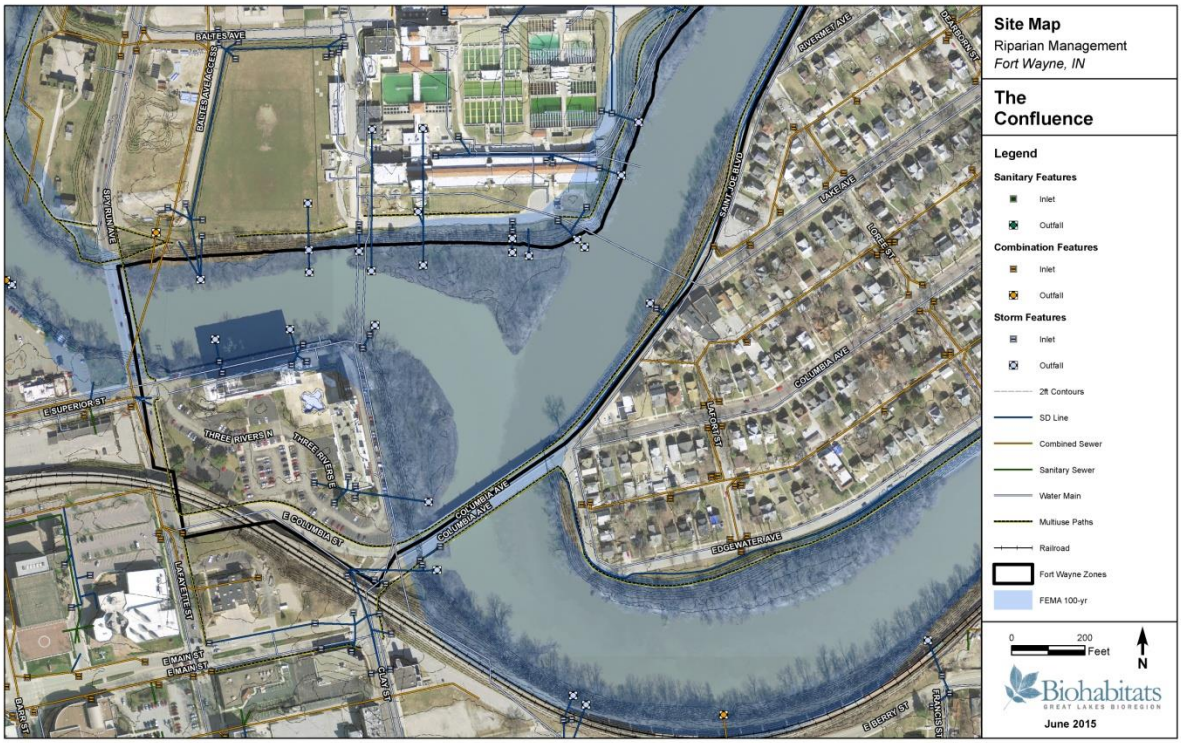

Figure 2.19. The Confluence Zone (Source: Biohabitats; July 13, 2015).

The banks along the St. Joseph River on the west side are low gradient in slope along the confluence with the St. Marys River and steeper further upstream. This section of steeper banks has been stabilized as a part of the Army Corp of Engineers project with rip-rap, as have the left banks. The left bank of the St. Marys contains a narrow stretch of floodplain forest that widens to a broad peninsula type feature at the confluence. The right bank of the St. Marys is relatively steep to the north of the Three Rivers Apartments and then flattens and widens to a broad floodplain forest dominated with silver maple as the river turns south.

Figure 2.20. Rip-rap planters on the left bank of the St. Joseph (Source: Biohabitats; April 30, 2015).

Vegetation along the St. Marys right bank is predominately tree-of-heaven , honeysuckle and silver maple, which then transitions to a mature even-aged silver maple floodplain forest. The left bank vegetation of the St. Marys River is similar to the right bank with scattered invasives in the more narrow reach, which then opens up to a young silver maple floodplain forest at the confluence. Rip-rap on the St. Joseph has significantly reduced the amount of vegetation within the riparian buffers, however a young stand of silver maple and black willow (*Salix nigra*) has developed at the base of the rip-rap for approximately 650 feet. A number of random tree-of-heaven seedlings and purple loosestrife (*Lythrum salicaria*) were observed growing through the rip-rap at the top of slope. The right bank includes several large mature cottonwoods growing in the rip-rap of the lower reach, although they have herbivory damage from beavers. A small clump of autumn olive (*Eleagnus umbellata*) was identified, along with some tree-of-heaven, purple loosestrife, and crown vetch (*Coronilla varia*) paralleling the road to the south of the water treatment plant. The rip-rap then transitions to a narrow floodplain forest and more gently sloping banks with more prevalence of honeysuckle (Appendix A).

3. RIPARIAN BUFFER MANAGEMENT

3.1. Riparian Vegetation

The types of vegetation within a riparian buffer can have a significant effect on the ecological function, health, maintenance and effectiveness of a riparian buffer. Selecting the right plant is an important decision and is influenced by factors such as soil conditions, sun/shade, existing plant material, desired and allowable land use, viewsheds, aesthetics, and nursery availability. Native plants should be used to the greatest extent possible as they are adapted to the climate and relatively resistant to most diseases and insects in the area, leading to a greater likelihood of creating a regenerative ecosystem. Natives also provide specific food sources and habitat that are preferred by native wildlife, which in turn contributes to a more robust and resilient ecosystem in challenging urban and suburban settings.

The vegetative composition of a riparian buffer can vary greatly based on the position in the landscape and streambank. Management goals and objectives can also be reflected in buffer vegetation choices. Techniques to establish and restore riparian buffers also can vary. The most cost effective approach is natural regeneration, where an existing natural buffer is allowed to develop through succession of native plants. New vegetation is established through wind, insect and animal dispersal of the naturally occurring seed crops each year. Early successional species stabilize the riparian area and eventually give way to climax successional species over time. This approach can also be supplemented through management strategies that include invasive species management, selective thinning, supplementary native plantings, and reduced mowing.

An alternative to natural regeneration is active restoration or revegetation, which expedites results in areas that have little or no existing or desired vegetation. In general, this type of restoration focuses on quickly establishing native woody material using plantings and bioengineering, and establishing herbaceous plant material through direct seeding. Bioengineering refers to the use of living and nonliving plant material in combination with both synthetic and natural support materials for slope stabilization, vegetation establishment and erosion reduction. In large restoration efforts, herbaceous plant material is often not planted due to high mortality rates from herbivory, high costs associated with herbivory protection and the fact that the seed mixes used are dominated by herbaceous species. In smaller applications like rain gardens planting herbaceous plant material is more appropriate, but given the challenges to herbaceous establishment within the Riverfront riparian study area, the focus should be on establishing native woody species.

From a safety perspective, selection of appropriate native plant material needs to take into account the location of trails, utilities, levees and other amenities in and around the riparian areas. For example, there are several excellent native trees such as silver maple and black willow that thrive in harsh riparian conditions, but can develop brittle branches that could pose a safety issue if located immediately adjacent to a trail. The plant schedules and restoration techniques described in the following sections can be utilized to actively restore a riparian buffer.

3.1.1. Floodplain Benches

Floodplain benches are very common on broad, meandering streams and rivers, and are found throughout Fort Wayne. The benches are at a lower elevation than the stream's main floodplain and regularly experience high flows, sediment deposition, ice, and woody debris. Because of these extreme

events, vegetation on these benches needs to be extremely resilient. Plants must be able to rapidly establish, grow quickly, tolerate periodic inundation and recover from damage and breakage.

Figure 3.1. Typical floodplain bench with silver maple floodplain forest (Source: Biohabitats; April 30, 2015).

The floodplain benches within the study area are typically dominated by an even-aged stand of silver maple ~75 feet tall with almost no understory, regeneration or diversity. The lack of regeneration can be attributed to heavy sedimentation, which hinders seed establishment, yearly drawdowns which alter the hyrdoperiod, and herbivory from beaver and geese.

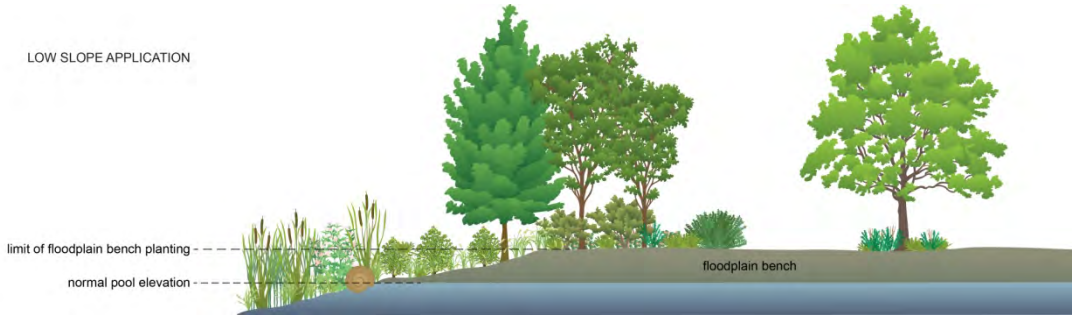

Figure 3.2. Floodplain bench restoration approach (Source: Biohabitats; August 4, 2015).

The plant and seed schedules that follow were developed and selected based on existing conditions within the study area, species native to the region, nursery availability, resistance to diseases and pests, growth habitat, wildlife value, and aesthetics. Figure 3.2 and table 3.1 reflect an active restoration approach on a floodplain bench that is predominately devoid of woody vegetation (trees and shrubs). For a supplemental restoration effort where some woody vegetation is present, the spacing would depend on the density of existing woody vegetation, but a good rule of thumb is to double the spacing, thus reducing the quantity per acre by 50% respectively for trees and shrubs. Planting activities should occur in spring or late fall. Spring plantings may require periodic watering if drought conditions occur during the summer of year 1. Fall plantings on the other hand typically do not need post-installation follow-up watering and are preferred for increased survivability. Bioengineering material such as live stakes are probably the preferred option for floodplain benches within the study area given the amount

of sedimentation, since live stake growth rates are better adapted than containerized stock to high sedimentation rates. Because of this the stakes should be in the 3-4 foot height range (2/3 of the stake is below the ground).

Table 3.1. Floodplain Forest – Active Restoration Plant Schedule

PLANT COMPOSITION SCHEDULE

FLOODPLAIN BENCH - Active Restoration — **Size: 1 Acre**

Overall Minimum Spacing (ft.)	Quantity per acre	Vegetation Strata/ Species Name	Common Name	Spacing Type	Size
15	194	**TREES**			
		Acer negundo	Box elder	RANDOM	2-3 gal.
		Acer saccharinum	Silver maple	RANDOM	2-3 gal.
		Betula nigra	River birch	RANDOM	2-3 gal.
		Platanus occidentalis	Sycamore	RANDOM	2-3 gal.
		Populus deltoides	Eastern cottonwood	RANDOM	2-3 gal.
		Quercus bicolor	Swamp white oak	RANDOM	2-3 gal.
		Salix nigra	Black willow	RANDOM	2-3 gal.
		Ulmus americana	American elm	RANDOM	2-3 gal.
		= total			
10	436	**SHRUBS & VINES**			
		Alnus incana	Speckled alder	CLUSTER	1-2 gal.
		Alnus serrulata	Smooth alder	CLUSTER	1-2 gal.
		Cornus amomum	Silky dogwood	CLUSTER	1-2 gal.
		Cornus sericea	Red-osier dogwood	CLUSTER	1-2 gal.
		Rosa palustris	Swamp rose	CLUSTER	1-2 gal.
		Salix exigua	Sandbar Willow	CLUSTER	1-2 gal.
		Salix discolor	Pussy willow	CLUSTER	1-2 gal.
		Salix sericea	Silky willow	CLUSTER	1-2 gal.
		= total			
N/A	20	**NATIVE SEED - ERNMX-154 Flood Plain Seed Mix: Ernst Conservation Seeds** *http://www.ernstseed.com/seed-mix/?category-id=39*			
N/A	varies	**COVER CROP***			
		varies per time of year	varies per time of year	SEED	N/A
		= total			

*Cover crop recommendations: Grain Oats (Jan.-Aug.) 30 lbs./acre or Grain Rye (Aug.-Dec.) 20 lbs./acre or Millet (May-Sept.) 10 lbs./acre.
Use a weed free straw mulch after seeding to reduce herbivory.
Bark protectors and stakes for all trees.

Given the planting density and size of material, a contractor could expect to charge approximately $20,000 for acquisition and installation of all plant material and seed for a 1-acre project using larger 3-gallon trees and 2-gallon shrubs. The following is a cost estimate if the planting effort were done in-house or through volunteers.

Table 3.2. Material Costs for 1-acre Active Restoration project.

Item (quantity)	Cost
Seed (20 lbs plus cover crop)	$900
Shrubs (436)	$3,500
Trees (194)	$3,000
Bark protectors (194)	$1,100
Wood stakes (194)	$850
Straw bales (100)	$300
Total	$9,650

If coir fiber matting is used as part of a restoration, then straw mulch could be reduced or eliminated. Substituting bareroot stock for some containerized stock is an option, but in areas of heavy flows, inundation and sedimentation it is not recommended given the smaller size of bareroots, both height and root mass . Below is an alternative floodplain bench seed mix that was recommended by staff from the Indiana Department of Natural Resources. This seed can be custom made by Ernst Conservation Seed.

Table 3.3. IDNR recommended floodplain bench seed mix.

SEED COMPOSITION SCHEDULE

FLOODPLAIN BENCH - Active Restoration — **Size: 1 Acre**

Overall Minimum Spacing (ft.)	Quantity per acre	Vegetation Strata/ Species Name	Common Name	Spacing Type	Size
N/A	30	**SEED MIX – IDNR RECOMMENDED**			
	8.1	*Lolium multiflorum*	Annual rye	CLUSTER	1-2 gal.
	14.1	*Elymus canadensis*	Canada wild rye	CLUSTER	1-2 gal.
	4.5	*Elymus virginicus*	Virginia wild rye	CLUSTER	1-2 gal.
	3.3	*Trifolium hybridum**	Alsike clover	CLUSTER	1-2 gal.
	30	**= total**			

*Trifolium pretense (Red clover) may be substituted.

3.1.2. Riparian Slopes

The majority of the streambanks and riparian areas within the study area fall into two categories, low floodplain benches and slopes. The slopes can vary greatly in their steepness from gradual to near vertical. These areas are typically not subject to the extreme conditions that the floodplain benches receive. Although the lower elevations of slopes will still experience high flows, woody debris, ice and some sedimentation, these effects are mainly concentrated on the toe of the slope. With higher elevations and fewer stressors, the slope can support a more diverse plant palate in general. Nevertheless, with the narrow riparian buffers within the study area and the urban context, the existing vegetative community diversity is limited and is dominated by an invasive understory of honeysuckle (*Lonicera sp.*), see table 3.4.

Figure 3.3. Typical riparian slope with cleared honeysuckle in foreground (Source: Biohabitats; April 30, 2015).

Table 3.4. Dominant Species within the Study Area Riparian Corridor

Common Name	Scientific Name
silver maple	*Acer saccharinum*
Eastern cottonwood	*Populus deltoides*
box elder	*Acer negundo*
*tree-of-heaven	*Ailanthus altissima*
*honeysuckle sp.	*Lonicera sp.*
***indicates invasive species per Indiana Invasive Species Council**	

The approach to both active restoration and natural regeneration on riparian slopes needs to take into account the potential adverse conditions that can occur at the toe of slope and lower elevations. Both moderate (Figure 3.4) and steep (Figure 3.5) slopes will most likely require some type of toe protection and stabilization in the form of boulders, which will vary in extents depending on a number of factors including the steepness of the slope. Plants on the lower slope need to be resilient like the floodplain bench plants and the plant schedule below includes many of those species.

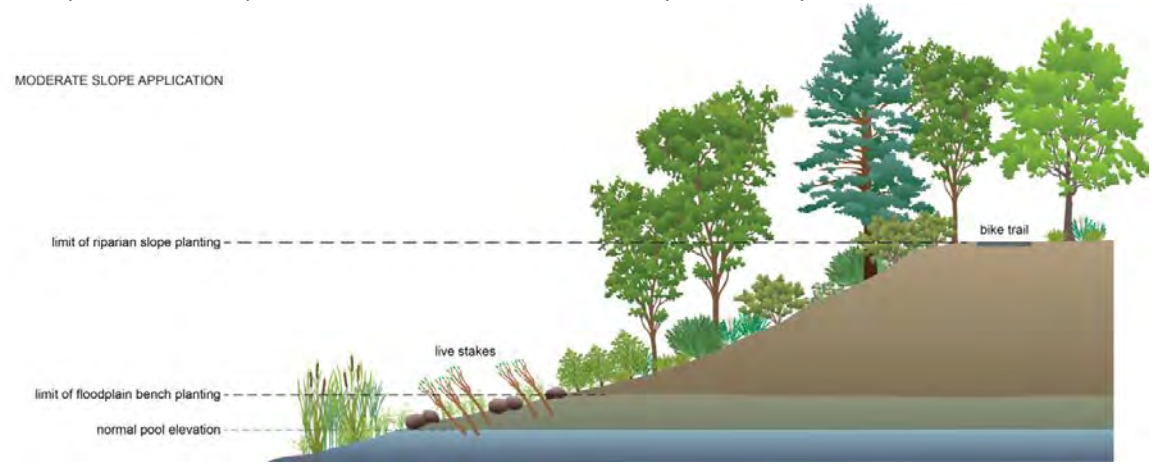

Figure 3.4. Riparian slope restoration approach for moderate slopes (Source: Biohabitats; August 4, 2015).

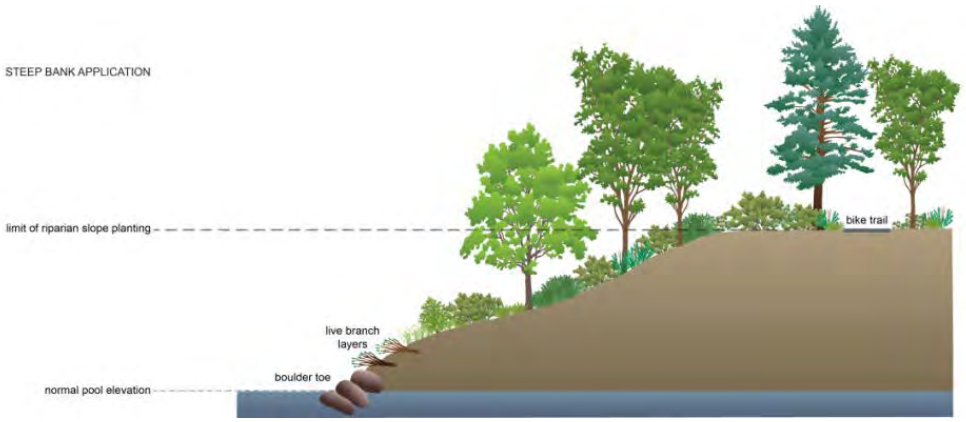

Figure 3.5. Riparian slope restoration approach for steep slopes (Source: Biohabitats; August 4, 2015).

Table 3.5. Riparian – Active Restoration Plant Schedule

PLANT COMPOSITION SCHEDULE **RIPARIAN SLOPES - Active Restoration**					**Size: 1 Acre**
Overall Minimum Spacing (ft.)	**Quantity per acre**	**Vegetation Strata/ Species Name**	**Common Name**	**Spacing Type**	**Size**
15	194	**TREES**			
		Acer rubrum	Red maple	RANDOM	2-3 gal.
		*Acer saccharinum***	Silver maple	RANDOM	2-3 gal.
		Carpinus caroliniana	Ironwood	RANDOM	2-3 gal.
		Celtis occidentalis	Hackberry	RANDOM	2-3 gal.
		Cercis canadensis	Eastern redbud	RANDOM	2-3 gal.
		Cornus florida	Flowering dogwood	RANDOM	2-3 gal.
		Liquidambar styraciflua	Sweetgum	RANDOM	2-3 gal.
		Liriodendron tulipifera	Tulip tree	RANDOM	2-3 gal.
		Nyssa slyvatica	Black gum	RANDOM	2-3 gal.
		Pinus strobus	Eastern white pine	RANDOM	2-3 gal.
		*Platanus occidentalis***	Sycamore	RANDOM	2-3 gal.
		Prunus serotina	Black cherry	RANDOM	2-3 gal.
		Quercus alba	White oak	RANDOM	2-3 gal.
		Quercus macrocarpa	Bur oak	RANDOM	2-3 gal.
		Quercus palustris	Pin oak	RANDOM	2-3 gal.
		Quercus rubra	Red oak	RANDOM	2-3 gal.
		= total			
10	436	**SHRUBS & VINES**			
		Amelanchier canadensis	Serviceberry	CLUSTER	1-2 gal.
		Aronia meloncarpa	Black chokeberry	CLUSTER	1-2 gal.
		*Cornus amomum***	Silky dogwood	CLUSTER	1-2 gal.
		Cornus racemosa	Gray dogwood	CLUSTER	1-2 gal.
		*Cornus sericea***	Red-osier dogwood	CLUSTER	1-2 gal.
		Corylus americana	American hazelnut	CLUSTER	1-2 gal.

		Hammamelis virginiana	Witchhazel	CLUSTER	1-2 gal.
		Lindera benzoin	Spicebush	CLUSTER	1-2 gal.
		Parthenocissus quinquefolia	Virginia creeper	CLUSTER	1 qt. - 1 gal.
		Physocarpus opulifolius	Eastern ninebark	CLUSTER	1-2 gal.
		Prunus virginiana	Chokecherry	CLUSTER	1-2 gal.
		Rhus glabra	Smooth sumac	CLUSTER	1-2 gal.
		Rhus copallina	Flameleaf sumac	CLUSTER	1-2 gal.
		*Salix discolor***	Pussy willow	CLUSTER	1-2 gal.
		Sambucus canadensis	Elderberry	CLUSTER	1-2 gal.
		Vacinium corymbosum	Highbush blueberry	CLUSTER	1-2 gal.
		= total			
N/A	20	**NATIVE SEED - ERNMX-178 Riparian Buffer Mix: Ernst Conservation Seeds** *http://www.ernstseed.com/seed-mix/?category-id=57*			
		= total			
N/A	varies	**COVER CROP***			
		varies per time of year	varies per time of year	SEED	N/A
		= total			

*Cover crop recommendations: Grain Oats (Jan.-Aug.) 30 lbs./acre or Grain Rye (Aug.-Dec.) 20 lbs./acre or Millet (May-Sept.) 10 lbs./acre.

Use a weed free straw mulch after seeding to reduce herbivory.

Bark protectors and stakes for all trees.

**Species that are appropriate to plant at the toe of slope.

Planting costs would be almost identical to active restoration of the floodplain bench, see table 3.2.

3.1.3. Upland Areas

For the purpose of this plan, upland areas are considered any areas above the top of bank (top of the riparian slope) that rarely experience any inundation from floodwaters. These areas may be inside or outside the levees. A number of the plant species listed in the riparian slope plant schedule are also included in the upland plant schedule, as well as, more drought tolerant species. Within the study area the majority of the upland areas are unforested, managed turf or developed. Small areas that do include some semblance of a forest are patchy and dominated by invasives. The plant schedule below provides a suite of species that can be planted as part of an upland forest restoration or simply as a landscaping component.

Table 3.6. Upland – Active Restoration Plant Schedule

PLANT COMPOSITION SCHEDULE

UPLAND AREAS - Active Restoration — **Size: 1 Acre**

Overall Minimum Spacing (ft.)	Quantity per acre	Vegetation Strata/ Species Name	Common Name	Spacing Type	Size
15	194	**TREES**			
		Acer rubrum	Red maple	RANDOM	2-3 gal.
		Acer saccharum	Sugar maple	RANDOM	2-3 gal.
		Betula papyrifera	Paper birch	RANDOM	2-3 gal.

		Carpinus caroliniana	Ironwood	RANDOM	2-3 gal.
		Carya ovata	Shagbark hickory	RANDOM	2-3 gal.
		Celtis occidentalis	Hackberry	RANDOM	2-3 gal.
		Cercis canadensis	Eastern redbud	RANDOM	2-3 gal.
		Cornus florida	Flowering dogwood	RANDOM	2-3 gal.
		Fagus grandifolia	American beech	RANDOM	2-3 gal.
		Juglans nigra	Black walnut	RANDOM	2-3 gal.
		Liquidambar styraciflua	Sweetgum	RANDOM	2-3 gal.
		Liriodendron tulipifera	Tulip tree	RANDOM	2-3 gal.
		Nyssa slyvatica	Black gum	RANDOM	2-3 gal.
		Pinus strobus	Eastern white pine	RANDOM	2-3 gal.
		Prunus serotina	Black cherry	RANDOM	2-3 gal.
		Quercus alba	White oak	RANDOM	2-3 gal.
		Quercus macrocarpa	Bur oak	RANDOM	2-3 gal.
		Quercus palustris	Pin oak	RANDOM	2-3 gal.
		Quercus rubra	Red oak	RANDOM	2-3 gal.
		Tilia americana	American basswood	RANDOM	2-3 gal.
		= total			
10	436	**SHRUBS & VINES**			
		Amelanchier canadensis	Serviceberry	CLUSTER	1-2 gal.
		Ceanothus americanus	New Jersey tea	CLUSTER	1-2 gal.
		Cornus racemosa	Gray dogwood	CLUSTER	1-2 gal.
		Corylus americana	American hazelnut	CLUSTER	1-2 gal.
		Lindera benzoin	Spicebush	CLUSTER	1-2 gal.
		Parthenocissus quinquefolia	Virginia creeper	CLUSTER	1-2 gal.
		Physocarpus opulifolius	Eastern ninebark	CLUSTER	1-2 gal.
		Prunus virginiana	Chokecherry	CLUSTER	1-2 gal.
		Rhus aromatica	Fragrant sumac	CLUSTER	1 qt. - 1 gal.
		Rhus glabra	Smooth sumac	CLUSTER	1-2 gal.
		Rhus copallina	Flameleaf sumac	CLUSTER	1-2 gal.
		Rosa virginiana	Virginia rose	CLUSTER	1-2 gal.
		Rubus odoratus	Flowering raspberry	CLUSTER	1-2 gal.
		Salix discolor	Pussy willow	CLUSTER	1-2 gal.
		Sambucus canadensis	Elderberry	CLUSTER	1-2 gal.
		Vacinium corymbosum	Highbush blueberry	CLUSTER	1-2 gal.
		Viburnum acerifolium	Mapleleaf viburnum	CLUSTER	1-2 gal.
		Viburnum trilobum	American Crannberrybush	CLUSTER	1-2 gal.
		= total			
N/A	20	**NATIVE SEED - ERNMX-123 Native Upland Wildlife Forage & Cover Meadow Mix**			
		= total			
N/A	varies	**COVER CROP***			
		varies per time of year	varies per time of year	SEED	N/A
		= total			

CON=container

P.L.S=Pure Live Seed

*Cover crop recommendations: Grain Oats (Jan.-Aug.) 30 lbs./acre or Grain Rye (Aug.-Dec.) 20 lbs./acre or Millet (May-Sept.) 10 lbs./acre

Bark protectors and stakes for all trees

Since the uplands in the study area are high usage areas and very visible, the Parks and Recreation Department's Landscape Architect should be heavily involved in the design and plant selection of an upland area restoration project. Planting costs would be similar to active restoration of the floodplain bench and riparian slope, see table 3.2.

3.1.4. Rip-Rap Planters

The left bank of the downstream portion of the St. Joseph River is armored with rip-rap. The downstream 4,000 linear feet of bank includes three-foot diameter corrugated plastic planters located at the top of the slope on a 20-foot spacing interval. Previous attempts to grow vines in the planters were unsuccessful, most likely due to lack of watering and species selection. In an effort to soften thermal and visual impacts of the rip-rap, while providing habitat for birds and insects, the planters could be re-planted with a selection of native vines. It is important to use multiple species to provide diversity and hopefully eliminate the threat of disease or a pest that can eradicate a species, like the Emerald Ash Borer has done to ash species. Two to three plants should be planted in each planter, with alternating species in every other planter. It is probable that the planters will need to be weeded and have the soil amended to help ensure better survival. The preferred planting window is fall, with watering limited to initial installation and several following weeks. A spring planting would require watering at installation and most likely periodically throughout the spring and summer depending on the amount of rainfall.

Figure 3.6. Virginia creeper growing down and over concrete rip-rap along the Detroit River (Source: Biohabitats; June 12, 2014).

Table 3.7. Rip-Rap Planter Plant Schedule

PLANT COMPOSITION SCHEDULE RIP-RAP PLANTERS					
Overall Minimum Spacing (ft.)	**Quantity per planter**	**Vegetation Strata/ Species Name**	**Common Name**	**Spacing Type**	**Size**

1	2 or 3	**VINES**			
		Campsis radicans	Trumpet creeper	CLUSTER	1 qt. - 1 gal.
		Clematis virginiana	Virgin's Bower	CLUSTER	1 qt. - 1 gal.
		Parthenocissus quinquefolia	Virginia creeper	CLUSTER	1 qt. - 1 gal.
		Vitis riparia	Riverbank grape	CLUSTER	1 qt. - 1 gal.
		= total			

3.2. Stream Restoration and Streambank Stabilization

While stream restoration design strives to look as natural as possible and blend with the landscape, there is frequently a need to include in-stream structures that protect the bed and banks locally where shear stresses are predicted to be high. These structures provide stability so riparian vegetation can establish and persist, and to protect local infrastructure. Such structures can also provide important in-stream habitat components, such as persistent pools for fish refugia. In some cases, grade control and flow direction structures can be composed of logs (anchored with duck bill earth anchors or eco-blocks to keep the wood structures from floating). This technique can create a more natural looking restoration project.

Depending on stream size, planform pattern, and channel slope, designs can incorporate a wide range of structures, including:

- Rock vanes
- Log vanes
- Cross vanes
- Bendway weirs
- J-Hooks
- Boulder toe protection
- Grade control structures

Often in stream restoration design, in-stream structure design and placement is based upon planform alignments or general “rules of thumb” that do not take into account hydraulic conditions and materials at a site. Many problems can arise without careful consideration of the hydraulic effects of in-stream structures (vanes, cross vanes, j-vanes, riffle grade controls, step-pools, etc.). These problems include steep drops below structures preventing aquatic species migration, structure undermining resulting in failure, and excessive scour downstream or excessive deposition upstream of a structure. Site conditions often limit the applicability and potential success of certain structures and channel entrenchment, slope, substrate, bank materials and tailwater conditions affect the stability and success of in-stream structures.

Hydraulic models, fluvial principles and lessons learned from past projects allow stream restoration firms to design and evaluate in-stream structures to ensure the proper selection, placement, orientation, and slope of each structure. These techniques range from critical and normal flow depth calculations to more involved submerged weir flow equations or estimates of a range of flow conditions.

These hydraulic tools help determine and compare pre- and post- design shear stresses within the channel to ensure that channel dimensions and associated channel stabilization and habitat structures will remain stable for flows up to a targeted discharge. These hydraulic calculations and considerations

can prevent significant remediation efforts in the future, thus all potential stream restoration work should be evaluated and designed by qualified professionals familiar with stream restoration.

The use of bank and bed protection structures for stabilization, grade control, and flow control tend to "lock" a stream in place. That is, they mute the natural dynamics of the stream system to migrate in the floodplain such that only extreme flow events cause changes to the channel geometry, rather than the annual, small adjustments that would naturally reshape the channel. Where design evaluations and calculations suggest that "softer" measures are sufficient, these can be preferable in terms of allowing natural alluvial adjustment and aesthetics.

Restoration designs regularly incorporate live stakes, rootwads, large woody debris bundles, and woody debris complexes to stabilize eroding banks. Often on-site materials can be re-purposed for these structures to minimize cost and utilize local materials—and sometimes create new design details to combine live materials in innovative ways to meet specific project objectives. The use of natural structural materials (tree logs, rootwads, rocks, etc.) along with vegetation installation (live stakes, bundles, container grown-nursery stock, etc.) typically provides the most habitat diversity for bank and riparian slope stability.

Soil bioengineering techniques include rootwad revetments, live fascines, live brush mattresses, live branch layering, and live joint planting, which can be used in certain situations on stream restoration projects. Soil bioengineering techniques have specific applications and limitations based on many factors including physical and biological characteristics of soils, horticultural principles and applications, availability and suitability of native plants species, proper installation procedures and techniques, and timing and coordination between harvesting, fabrication, and installation. As previously mentioned, a qualified stream restoration firm should be able to select the appropriate restoration and stabilization techniques. However, there may be minor streambank stability issues that can be simply addressed with some of the techniques mentioned below.

3.2.1. Armored and Bioengineered Streambank Stabilization Techniques

Stabilizing the toe of slope is perhaps the most critical aspect of streambank stabilization since a failure at the toe can cause failure of the entire slope restoration. Toe treatments vary depending on the size of the stream and flows, steepness of the bank, and soil conditions. Larger streams may require an armored approach, while smaller streams may only require vegetation. Based on the size of the three rivers within the study area, and widespread steep bank conditions, armored toe structures may be appropriate. The graphics below provide examples of different stabilization technique combinations with armored toes.

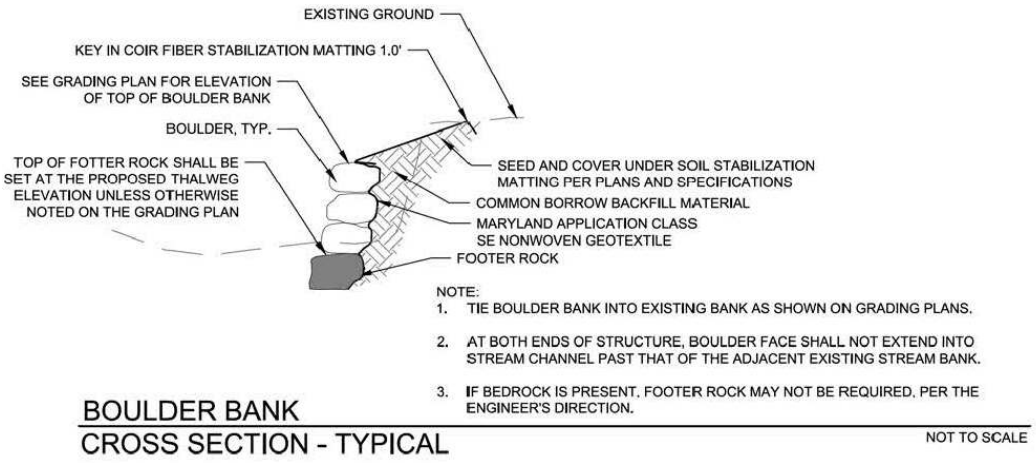

Figure 3.7 Boulder Bank Detail (Source: Biohabitats).

The boulder bank treatment shown above is a common approach in situations where it is unfeasible to re-grade or taper the steep slopes to a stable angle due to lack of available space laterally within the riparian buffer. The approach would be applicable for the streambank erosion on the St. Marys at the eastern edge of Headwaters Park just upstream from the newly installed stormwater outfall where boulders stacked against the existing vertical bank could prevent further erosion. The detail below is a variation on the boulder bank treatment and typically used in a situation where the streambank has eroded a considerable distance and the restoration intent is to restore the streambank to its original shape. In this application the boulder toe is placed at or near the original streambank location and a bench is created between the boulder toe and existing streambank. In this specific scenario the "gap" or "void" is filled in with soil, covered with coir fiber matting, and planted with native vegetation. Coir fiber matting is a common material in streambank restoration, protecting newly graded, seeded and planted streambanks from erosion while vegetation becomes established. Coir fiber matting is made from the husk of coconuts and is biodegradable, unlike plastic matting, which can become a wildlife hazard and interfere with vegetation. Cost estimates for this type of application vary greatly depending on the height of the structure and depth of the footers. For example, a 6-foot high wall (exposed) with a 3-foot footer and 3-feet wide is approximately $275 per linear foot. These are dimensions similar to those that may be appropriate for the Headwaters Park site noted above.

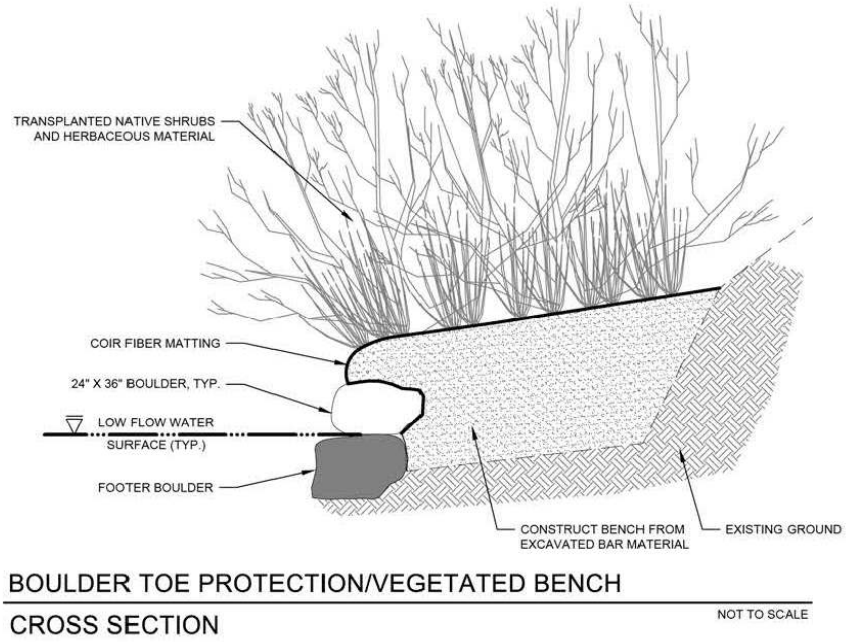

Figure 3.8. Boulder Toe Protection with Vegetated Bench Detail (Source: Biohabitats).

Similar to boulder bank structures, bolder toe is commonly used in conjunction with different bioengineering techniques. Typical techniques used on stream restoration projects are live branch layering and live stakes. These methods use cuttings from specific species, predominately willow (*Salix sp.*) and dogwood (*Cornus sp.*), that can be "planted" or staked in the ground and will grow into trees and shrubs. Cuttings are taken from plants when they are in the dormant season and installed immediately (preferably soaked in water for 24 hours prior) or stored in cold storage until installation, which is typically early spring or in late fall at the beginning of the dormant season. It is possible to install live stakes during the growing season if soil moisture conditions allow, but survival rates decline if soil moisture is lost during low precipitation periods. Cuttings also come in many shapes, sizes and configurations, including stakes, whips and posts, as well as, bundles that can be used in live branch layering applications and fascines. The detail below shows a boulder toe treatment with live branch layering above it. Shrub species are often used, since their stems are pliable under high flows while trees are more rigid and likely to break once established. Also, at higher planting densities needed for soil stabilization, trees become crowed and grow into each other. Trees also can present problems if they uproot, potentially causing failure of the slope and boulder toe. A cost estimate for boulder toe based on a 3-foot high wall, 3-foot footer and 3-feet of width is ~$175 per linear foot. Using rip-rap instead of boulders reduces costs to approximately $125 per linear foot. Containerized plant material costs are included in Table 3.2. Using a soil lift and live branch layering increases costs to ~$203 per linear foot while live stakes would be slightly less. Using a layer of live branches behind/above the toe without a soil lift reduces the cost to $186 per linear foot.

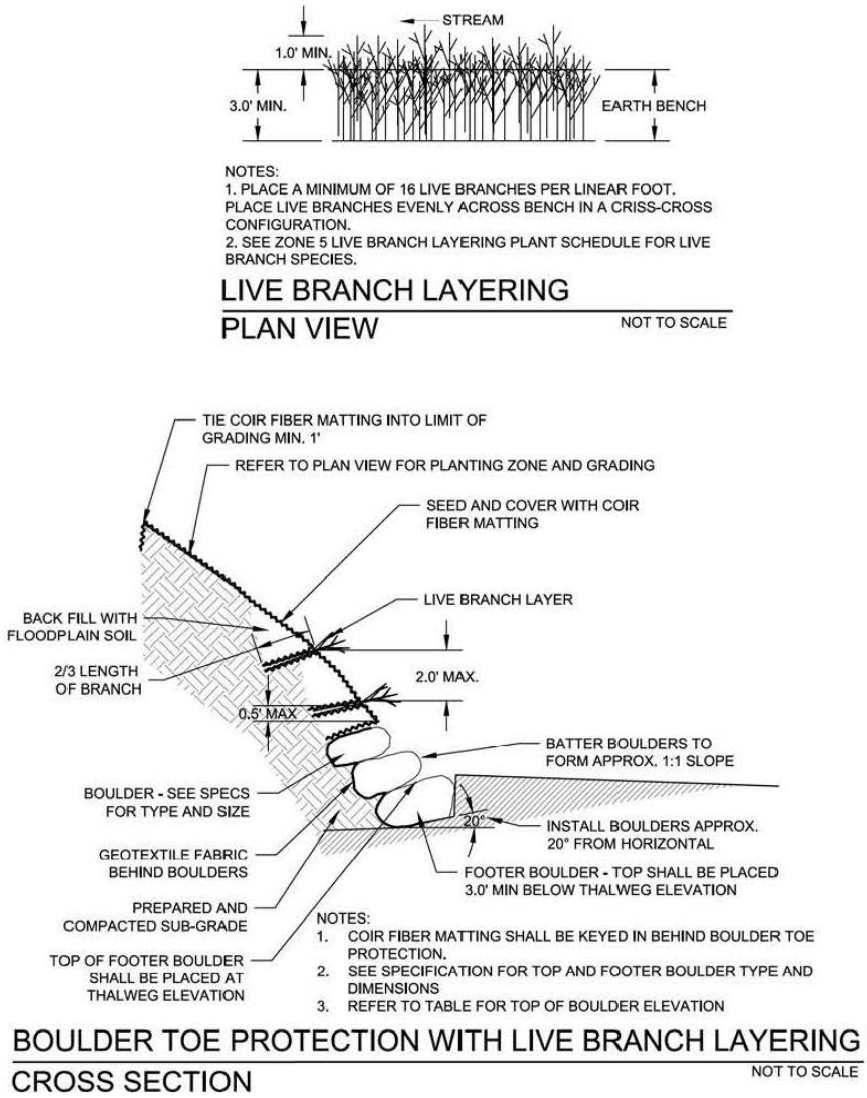

Figure 3.9. Boulder Toe with Live Branch Layering Detail (Source: Biohabitats).

Figure 3.10. Boulder toe with live branch layering during construction and 3-years post construction (Source: Biohabitats; Oct. 23, 2011 & Aug. 14, 2014).

Live branch layering is typically installed with a series of soil lifts made with coir fiber matting, sometimes referred to as "soil burritos". The lifts provide a solid stable platform for the live branches to grow in as shown above. Costs average ~$28 per linear foot per lift, assuming 3-foot long live branch layering material.

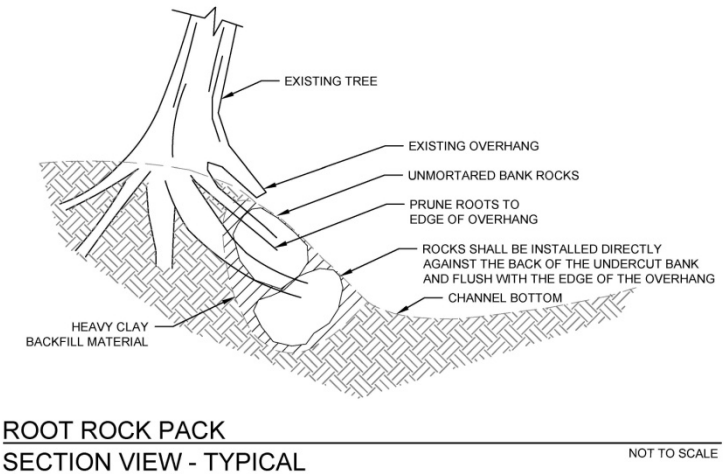

Figure 3.11. Root Pack Detail (Source: Biohabitats).

In situations where there is good existing vegetation on the upper portions of the streambank, but the lower portion of the bank is being scoured and eroded, boulders can be packed into the bank to stabilize the toe and support the upslope vegetation. This Root Pack technique provides toe stabilization while preserving existing vegetation on the bank and limiting grading. Costs would depend on the type of rock being used and size of cavity to fill, but if it is imbricated then costs would be ~$100/ton or ~$200/CY. If smaller rock or regular rip-rap is used, then costs are ~$70/ton or ~$120/CY. Based on the detail above, assuming a height of 6-feet and depth of 3-feet, costs per linear feet range from ~$36-$60 per linear foot.

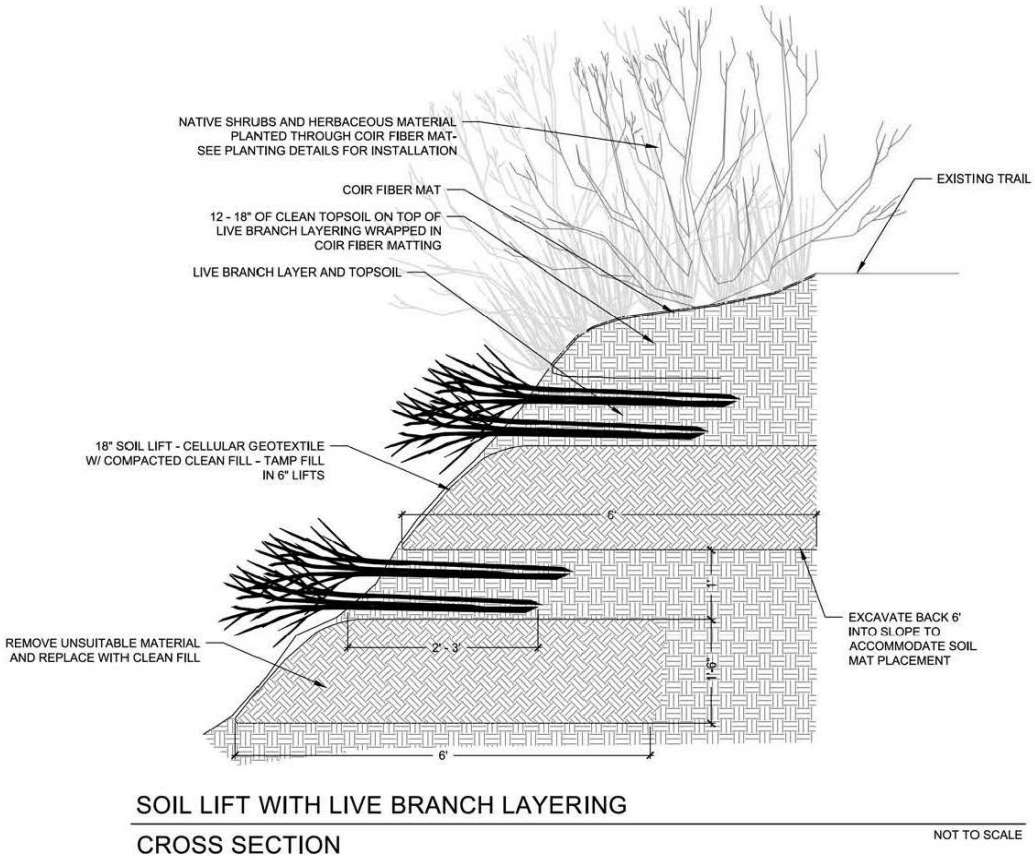

Figure 3.12. Soil Lift with Live Branch Layering Detail (Source: Biohabitats).

The detail below shows a slight variation of Figure 3.9 using live stakes instead of live branch layering. Establishment of live stakes is typically somewhat slower than live branch layering, but is a valuable technique in areas where space is limited or is inaccessible to equipment. Live branch layering is generally installed more densely than live stakes as the live branches already have stems and leaves, while live stakes have no lateral stems or leaves.

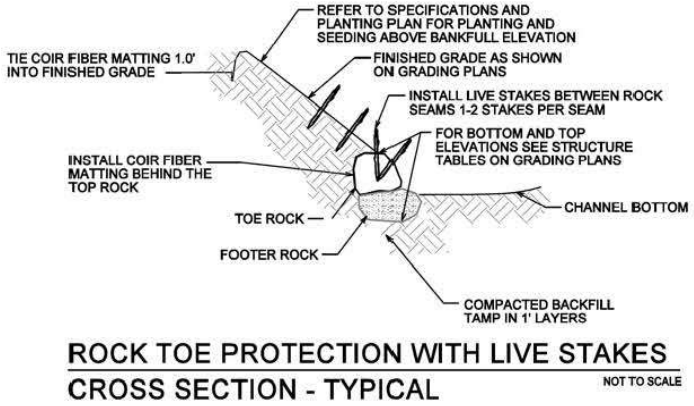

Figure 3.13. Boulder Toe Protection with Live Stakes Detail (Source: Biohabitats).

An alternative to boulder toe that is used in more natural settings is toe wood. Instead of armoring the toe with boulders or rock, rootwads are anchored into the bank with the tree roots serving as the toe

protection. This technique is sometimes used in projects that involved cutting and clearing trees as a creative way to adaptively re-use the trees instead of bringing in rock material, which ultimately reduces costs. This technique also provides enriched aquatic habitat and is typical of projects aimed at increasing fish habitat. Given the amount of woody debris that accumulates in the rivers within the study area and the frequency of ice jams, this technique would be more applicable on a smaller stream such as Spy Run Creek. The roughness of the root wads would lend themselves to collecting additional woody debris and the uneven surfaces could be problematic during ice flows. If adequate on-site material exists and nothing needs to be imported, then costs are ~$140 per linear foot however, if material needs to be imported then it could add up to 50% to the cost. If the logs do not need the rootwads attached, then the cost could drop to ~$70 per linear foot.

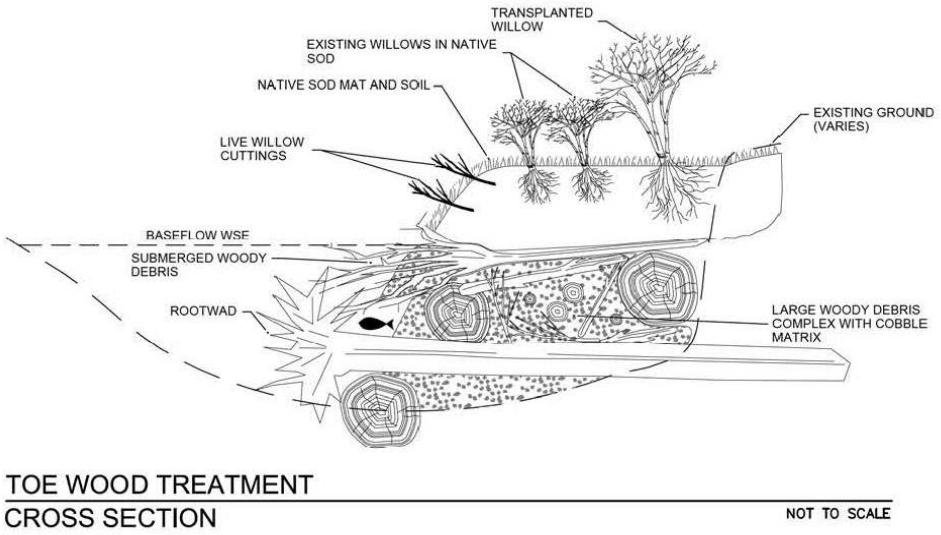

Figure 3.14. Toe Wood Bank Treatment Detail (Source: Biohabitats).

Another alternative to wood and boulder toe is coir logs, which are made from the same coconut fiber material used in the coir fiber matting. The logs come in varying lengths and sizes and can be used for a number of different applications. As shown below they can be used as toe protection on smaller streams or gentle streambanks. They can be installed mid-slope to dissipate runoff or used in swales as check dams. In many instances live branches or stakes are installed in front of or behind the coir logs to provide increased stability and habitat. They are also relatively easy to work with, require no machinery and can readily be installed by volunteers. Costs when using a 12-inch coir log are ~$20 per linear foot. If a layer of live branches is added above the coir log without a soil lift the cost increases to ~$33 per linear foot and ~$48 per linear foot if using a soil lift.

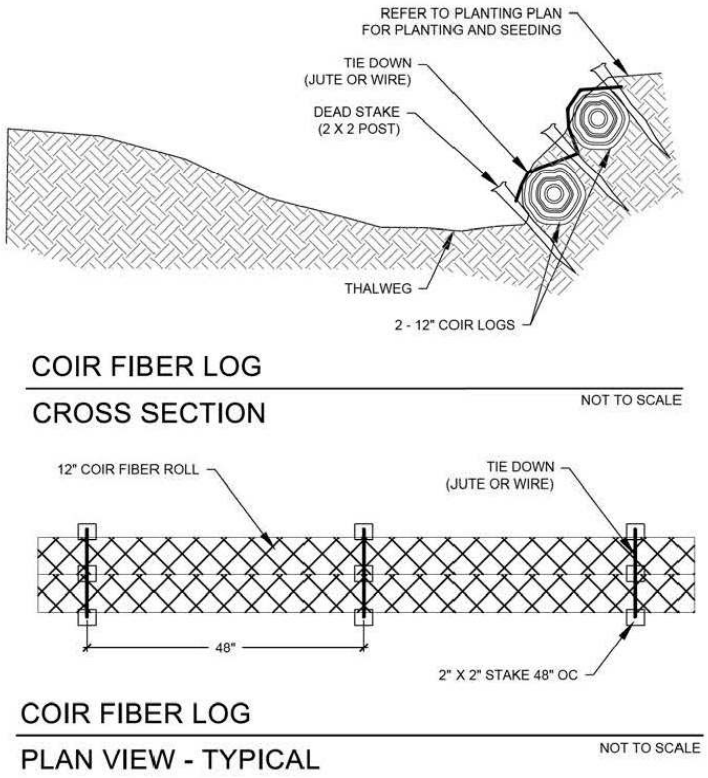

Figure 3.15. Coir Fiber Log Detail (Biohabitats).

Along with installation and proper harvesting and storage, plant selection of bioengineering material is a critical component of a successful bioengineering project. There are only a select number of trees and shrubs that are able to regenerate from a cutting. As noted earlier the most successful are the willows (*Salix sp.*) and dogwoods (*Cornus sp.*). With this in mind a typical bioengineering specification for a shrub live branch layering application may include at least two *Salix* and one *Cornus* species respectively. A bundle of branches (3-4 branches thick) will cover three linear feet of bench, while spacing of live stakes will vary depending on project goals, but 1.5-3 feet on center is common. The non-willow and dogwood species are more adapted to wetland, lake and vernal pool applications and they typically can not withstand severe flows, ice damage, and herbivory.

Table 3.8. Bioengineering Plant Material Plant Schedule.

PLANT COMPOSITION SCHEDULE **BIOENGINEERING PLANT MATERIAL**					**Size: 1 Acre**
Overall Minimum Spacing (ft.)	**Quantity per acre**	**Vegetation Strata/ Species Name**	**Common Name**	**Spacing Type**	**Size**
varies	varies	**TREES**			
		Platanus occidentalis	Sycamore	RANDOM	varies
		Populus deltoides	Eastern cottonwood	RANDOM	varies
		Salix nigra	Black willow	RANDOM	varies
		= total			

varies	varies	**SHRUBS**			
		Cephalanthus occidentalis	Buttonbush	RANDOM	varies
		Cornus amomum	Silky dogwood	RANDOM	varies
		Cornus sericea	Red-osier dogwood	RANDOM	varies
		Physocarpus opulifolius	Ninebark	RANDOM	varies
		Salix exigua	Sandbar Willow	RANDOM	varies
		Salix discolor	Pussy willow	RANDOM	varies
		Salix sericea	Silky willow	RANDOM	varies
		Sambucus canadensis	Elderberry	RANDOM	varies
		Viburnum dentatum	Arrowwod viburnum	RANDOM	varies
		= total			

3.2.2. Planting Techniques

The details below show the proper techniques associated with planting balled and burlapped, containerized, plug, bareroot, and live stake stream restoration plantings.

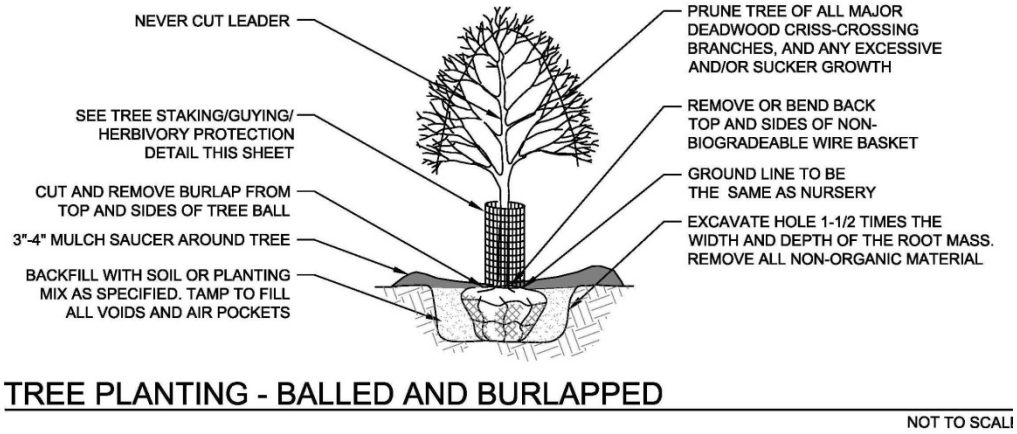

Figure 3.16. Balled and Burlapped Tree Planting Detail (Source: Biohabitats).

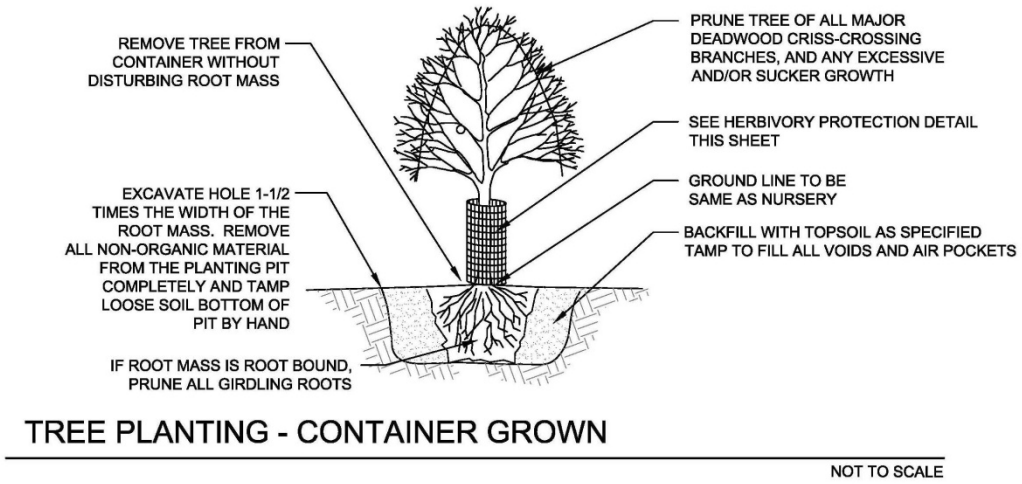

Figure 3.17. Container Tree Planting Detail (Source: Biohabitats).

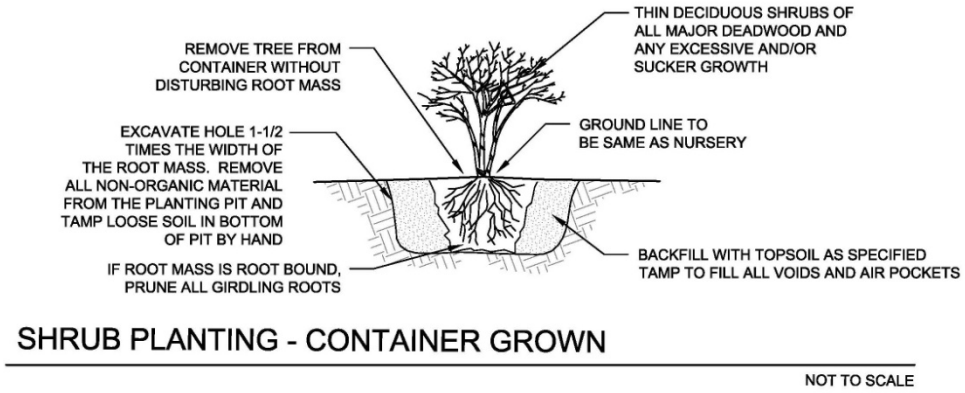

Figure 3.18. Container Shrub Planting Detail (Source: Biohabitats).

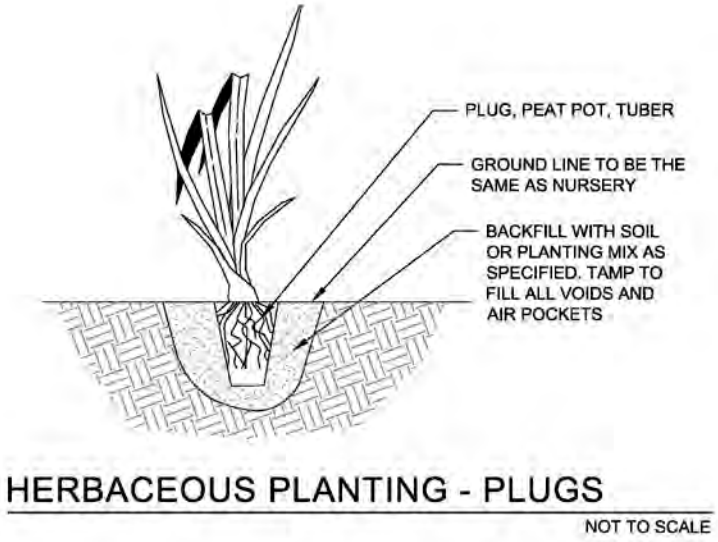

Figure 3.19. Herbaceous Plug Planting Detail (Source: Biohabitats).

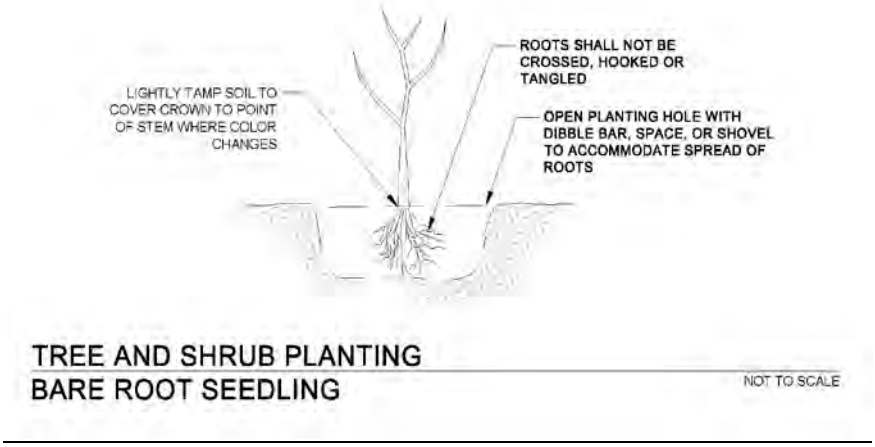

Figure 3.20. Bareroot Planting Detail (Source: Biohabitats).

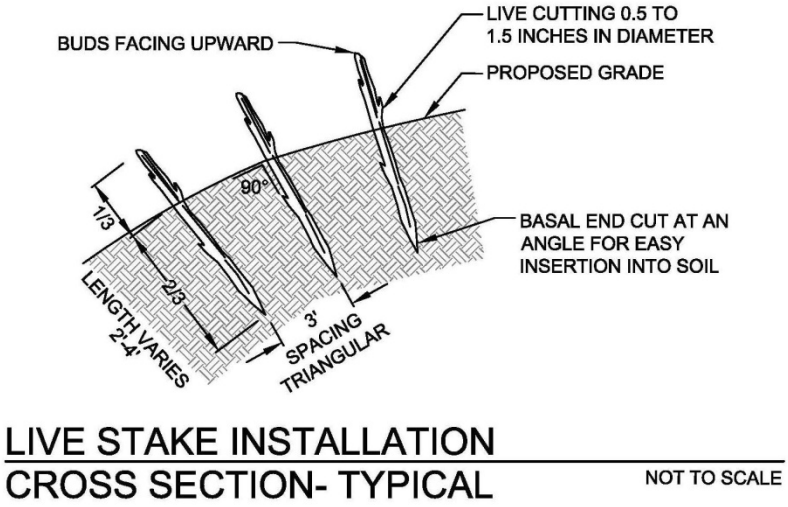

Figure 3.21. Live Stake Planting Detail (Source: Biohabitats)

3.3. Invasive Species Management

Biological threats posed by invasive species are inherently linked to the complex mosaic of natural and built features on the landscape. An approach to invasive species management should include three key components: characterization, management planning, and intervention strategies. Understanding the spatial dynamics of a biological invasion is the critical first step in assessing risks and identifying effective control strategies. The second step requires an effective plan that is grounded in good field knowledge, understands the property owner's needs, has realistic budget projections, and includes a sound strategy for measuring results. Biological systems are dynamic and change over time, so it is critical that a plan be flexible and adaptive in nature. An integrated, ecologically-based approach in management serves as a roadmap for success in protecting and restoring natural resources. Finally, effectively treating the invasion depends upon a comprehensive understanding of the organism, the ecosystem at risk, any regulatory constraints, and the control tools available. Intervention is part of the larger goal of ecological restoration where integrated and ecologically-based approaches are utilized to protect natural resources.

The Riverfront study area brings a unique set of challenges given its urban setting, flashy flows and seasonal drawdowns. Preliminary field assessments identified a multitude of invasive species with the dominant species listed below. Additional species found include Norway maple (*Acer platanoides*), Bradford pear (*Pryus calleryana*), Japanese knotweed (*Fallopia japonica*), autumn olive (*Elaeagnus umbellate*), purple loosestrife (*Lythrum salicaria*), crown vetch (*Securigera varia*), and lesser celandine (*Ranunculus ficaria*). All are listed on the Indiana Invasive Species Council's official plant list with the majority receiving an invasive rank of "High":

Table 3.9. Predominant Invasive Species within the Study Area Riparian Corridor

Common Name	Scientific Name
Tree-of-heaven	*Ailanthus altissima*
Bell's honeysuckle	*Lonicera x bella*

Amur honeysuckle	*Lonicera maackii*
Morrow's honeysuckle	*Lonicera morrowii*
Tatarian honeysuckle	*Lonicera tatarica*
***indicates invasive species per the Indiana Invasive Species Council**	

As a whole, it was observed by Biohabitats staff that several invasive and pioneer species are more adapted to project conditions and dominate the riparian vegetation in the study area (Table 3.9). Diversity within the riparian buffer is lacking within all vegetative strata. Although there are some larger buffer areas, buffer canopies are typically limited to one to three tree widths, which provides reduced ecological benefits. The main invasive species of concern are tree of heaven, honeysuckle, Japanese knotweed, autumn olive (*Elaeagnus umbellate*) and lesser celandine (*Ranunculus ficaria*). Tree of heaven and honeysuckle have colonized the riparian corridor, with honeysuckle completely dominating the understory layer. Treatment of these invasives has been ongoing. Biohabitats did discover a small patch of Japanese knotweed at Headwaters Park in 2014, which was subsequently treated. This is of particular concern because knotweed spreads via rhizomes, stem sections and even seed in preferred riparian areas. Once established along a stream it can quickly move downstream and can colonize an entire corridor. The exposed floodplain areas along the St. Marys are susceptible to knotweed, although the periodic flooding of those areas and seasonal drawdowns may suppress colonization somewhat. Regardless, treatment of knotweed is a critical priority in the study area. Autumn olive and lesser celandine were only found in two locations, but have the potential to rapidly spread, thus it would only take a minimal effort to eradicate them.

Figure 3.22. Honeysuckle understory common on riparian slopes (Source: Biohabitats; April 30, 2015).

3.3.1. Characterization

The first important step in any invasive management plan or effort is inventorying existing vegetation and characterizing the baseline condition. Proper identification and characterization of vegetation and invasive species is fundamental to this step. Since the diversity of vegetation in the Riverfront study area is relatively low, developing an inventory and maintaining it should not be overly challenging, nor should detecting new invasives if they appear. The inventory should be mapped to show the

distribution of vegetation and invasive species across the study area. The plant inventory can then be cross-referenced with invasive species lists for the state of Indiana to help determine their level of invasiveness and priority level for removal and/or treatment. The size and location of occurrences helps guide treatment efforts. Priority should be given to small, localized infestations as opposed to large expansive infestations. The concept is to protect areas that are relatively uninfested first, and then treat the larger infestations and control their spread. For example, in the Riverfront study area a small patch of Japanese knotweed (*Fallopia japonica*) was discovered last year. Since the invasive ranking of knotweed is "high", and the patch is located within Headwaters Park at the water's edge, its treatment priority is high to prevent establishment, rather than giving priority to treating the extensive bush honeysuckle (*Lonicera sp.*) stands that dominate the study area. The second treatment priority is lesser celandine (*Ranunculus ficaria*) and autumn olive (*Elaeagnus umbellate*) since they are confined to two locations and considered a "high" priority. The third treatment priority is tree-of-heaven (*Ailanthus altissima*) because it has a spotty distribution and its spread can be interrupted and prevented. Then the bush honeysuckle infestation can be controlled with a targeted effort.

As part of this plan, the Riverfront study area was characterized to establish baseline conditions. In the future, the Riparian Maintenance Manager will update the Riverfront study area mapping and establish baseline conditions on streams and riparian corridors outside the Riverfront study area within the City limits.

Several organizations in Indiana have compiled extensive invasive species lists and they can be found in the table below.

Table 3.10. Indiana Invasive Species Lists.

Organization	Website Link
Indiana Invasive Species Council	http://www.entm.purdue.edu/iisc/invasiveplants.php
Indiana Cooperative Agricultural Pest Survey Program	http://extension.entm.purdue.edu/CAPS/plants.html
Indiana Department of Natural Resources	http://www.in.gov/dnr/naturepreserve/6346.htm

Fact sheets on a number of invasives are provide in Appendix C, which provide more detailed information on identification, habit and treatment.

3.3.2. Management Goals

Once there is a thorough understanding of the extent and distribution of invasives within an area, the next decision is how to manage them or what to manage them for. Strategies can range from different allowable percentages of invasive or target specific species or vegetation strata. In many areas it is unfeasible for 100% eradication given the species present and their distribution. In some scenarios 100% eradication may completely remove the majority of vegetation leading to other issues. In many instances the invasive vegetation in the riparian corridor may be the dominant species present, e.g. the bush honeysuckles (*Lonicera sp.*) in the Riverfront study area, and complete removal would result in an unvegetated site that is susceptible to further invasive establishment and/or erosion. Although those plants are providing some stability to the riparian slopes, they are also screening views and negatively impacting wildlife habitat, reducing diversity in the ecological community. One of the intriguing things about being on the rivers in Fort Wayne is how the existing vegetation blocks out much of the City

infrastructure, thus providing the user with a recreation experience resembling that of a natural area as opposed to an urban area. The problem is most of that vegetation is invasive.

One of the other key considerations when treating and removing invasives is the void that is left once they are removed, especially when small "windows" are cleared in large infestations. Adjacent invasives will readily move into those newly disturbed "windows" thus understanding that invasive removal and native restoration need to go hand and hand is key. It does not matter whether the invasives were removed to enhance viewsheds or simply because they are invasive, there needs to be a follow-up restoration component once the invasives are removed. The type of restoration will ultimately depend on the vision of the particular area, whether the vegetation is low-growing and/or high canopy trees to keep viewsheds open, or rapidly spreading native shrubs to stabilize slopes or screen views. Specific goals and strategies for each zone will be discussed later in this plan.

3.3.3. Removal and Treatment

Removal and treatment of invasives can vary greatly depending on the species, size of the species, extent of infestation and timing of treatment. Proper safety training is critical as many treatment methods include the usage of herbicides and equipment such as chainsaws. Appendix D provides a detailed invasive species removal/treatment specification specifically tailored to stream restoration and riparian areas. The specification provides detailed treatment methodologies and timings for the species presented in Table 3.9 and other invasives. It is assumed that the Riparian Maintenance Manager would be responsible for the removal and treatment of invasives with the help of volunteers however, a rough cost estimate on invasive treatment per acre is ~$4,500 if hiring a contractor.

3.4. Herbivory Management

The most robust and well thought out streambank restoration project can be quickly be ruined with nuisance herbivory (vegetative damage by wildlife). Wildlife is commonly attracted to the new young, native plants as a food source, thus protection measures need to be incorporated into any restoration or planting effort. Herbivory has been noted up and down the study area streambanks. The most common culprits include beaver, deer and Canadian geese. Within the study area, herbivory from beaver was quite evident on large cottonwoods (*Populus deltoides*) and young silver maples (*Acer saccharinum*) throughout. Given the narrow corridors, limited tree diversity and lack of tree recruitment, protecting the large, mature cottonwoods is critical, as well as, restoring areas that may have already been suppressed by herbivory.

3.4.1. Beaver Protection

There are several methods that can be used to discourage beavers from damaging trees, the most common being a heavy wire mesh wrapped around the tree. The mesh size should be less than 1" and the material should be at least 3' in height. The mesh can be secured by wiring the ends together. If the tree is on a steep slope, modifications will need to be made to the mesh so it does not leave any gaps on the downslope side. Trees that beavers favor, such as cottonwoods (*Populus deltoides*) and willows (*salix sp.*), should be targeted first, as well as, large trees and those in critical locations. For example, the mature cottonwoods located in the rip-rap on the lower right bank of the St. Joseph would be considered critical trees because there are only a few remaining on the rip-rap bank, and per USACE regulations that direct that once the trees are felled or removed no woody vegetation is allowed to replace the trees. Other critical locations could be adjacent to trails, boat launches and infrastructure

where downed trees could present a significant safety hazard if they were weakened or felled by beavers.

Figure 3.23. Example of beaver protection that needs to be modified (Source: Biohabitats; April 30, 2015).

Another popular method to control beaver herbivory is tree painting. The paint is mixed with sand, which prevents the beavers from chewing on the desirable native trees. The paint stays on the trees for about 3-4 years and does not appear to hurt older trees. Appendix E contains a specification on the tree painting materials and procedures.

Chemical repellents have also been used but they have shown to have limited success since they wash away after a certain amount of time and need to be reapplied periodically. Some repellents also emit a very unpleasant odor, and they may not be practical in areas near trails.

3.4.2. Deer Protection

Although deer provide little threat to large, mature trees, they can have a decimating effect on young vegetation as they feed on saplings and rub trees with their antlers during the rut. Due to the explosion of deer populations in rural and urban settings, many of the more common native plant species that they favor have been significantly reduced. In urban forests, deer quickly browse and kill regenerating native woody plants leaving a barren understory. As the understory is cleared, opportunistic invaders that deer do not favor, like bush honeysuckles, quickly take hold. The results are forests dominated by an invasive shrub understory and an aging tree canopy. As mature trees senescence and die, there are no younger trees waiting in the mid and understory to replace them and the forest slowly transitions to invasive dominated systems. This is apparent in the Riverfront study area where bush honeysuckle

dominates the understory, tree-of-heaven is present and regeneration of native trees and shrubs is sparse. As invasives are removed and replaced with natives, trees need to be protected from herbivory.

There are several methods and options for deer protection that can be utilized in restoration efforts. For smaller plantings, the entire area can be fenced off with 8-foot heavy-duty plastic fencing/netting. This type of application will also discourage other wildlife such as beaver, geese, and rabbits that are also attracted to the new vegetation. However, this type of application may not be appropriate for larger restoration efforts or in areas that experience frequent inundation. A more common approach to deer protection in larger restoration efforts is to leave the shrubs unprotected, but install either a plastic mesh tube or a larger metal cage around the tree trunks. The advantage to the mesh tubes is that they can be cut to varying heights although 4 foot is typically the largest size that is available. For larger trees the mesh tube can be placed directly around the tree trunk and zip tied together, but for smaller trees a wood stake may be needed to support the mesh tube. There has been anecdotal evidence that beavers can chew through the plastic tubes on young trees, thus an alternative approach is to use wire tubes on beaver's preferred species and plastic tubes on the others. The cages also tend to be more appropriate with trees that have more frequent lower lateral branches.

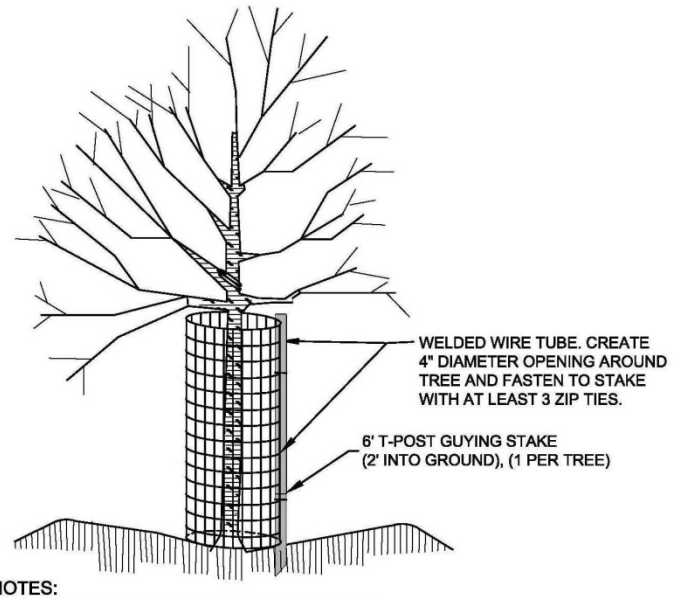

Figure 3.24. Herbivory Tree Protection (Source: Biohabitats).

As with beaver protection, there are a multitude of chemical repellents targeted for deer and other wildlife, but again these sprays need to be consistently reapplied and some have an unpleasant odor. An additional method that has been used on restoration projects has been placing dog hair in the tree tubes and around the plants. As with the repellents the dog hair will need to be reapplied, but many

dog groomers are willing to provide dog hair for restoration efforts and the effect of the hair seems to persist much longer than the sprays.

Another approach for large restoration efforts is to plant several sacrificial trees amongst the plantings that deer tend to favor with the intent of keeping herbivory concentrated on those sacrificial trees. It has been our experience that during the rut white pine (*Pinus strobus*) is the preferred tree that male deer will target. Damage from their antlers can be extreme as bucks will typically "top" the tree by breaking the main leader leaving it stunted and susceptible to other stressors. An alternative approach has been to install six-foot high (2-inch diameter) white pine posts into the ground to serve as rubbing posts. Both of these examples are very inexpensive and could easily be incorporated into a project.

3.4.3. Canadian Geese Protection

Although typically not a problem with woody vegetation, Canadian geese can do significant damage to newly planted herbaceous material, especially emergent vegetation (EV) and submerged aquatic vegetation (SAV). In addition to being an herbivory problem, geese can have significant negative impacts on water quality with the amount of waste they produce in and around riparian areas. Goose netting can be used similarly to deer netting or a single rope fence strung approximately 1-foot off the ground will keep geese out of an area. Another approach is to create 20 ft. x 20 ft. pens with stringing and flagging over the top, which is quite effective but expensive. Perhaps the biggest deterrent to geese is a healthy riparian buffer with grasses, shrubs and trees. Geese tend to avoid these areas as they assume predators are hiding in the vegetation. Their preference is for clear, low areas with low-growing vegetation where they have access to both the water and vegetation.

Figure 3.25. Canadian goose nest at the downstream end of Headwaters Park (Source: Biohabitats; April 30, 2015).

There are a number of approaches that are used to harass geese including dogs, drones, and trapping, but perhaps the most unobtrusive from a public perspective is egg addling. Addling prevents the embryo from developing, thereby slowing the growth of local populations. Because no young are produced, aggressive protection behavior from adults is also eliminated. A food grade corn oil is the preferred method because the oil keeps air from passing through the eggshell. The process should be

done in early spring during the period when geese are nesting within 14 days of incubation. Individuals or entities that wish to addle eggs must register with the USFWS: https://epermits.fws.gov/ercgr/gesi.aspx.

3.5. Riparian Viewshed Management

From urban cities to national parks, viewsheds are managed for multiple objectives, from simply providing a view of a particular feature for aesthetic reasons to creating safe sight lines for vehicular or pedestrian traffic. In addition, as with any type of management approach on the landscape, careful planning needs to be employed when managing viewsheds. Mature vegetation that is cleared to create or accentuate views cannot easily be replaced. Viewshed management is further complicated in riparian buffers where important buffer functions such as streambank stabilization and connectivity can be negatively impacted. Viewshed management in the riparian buffer setting is a balancing act between creating views to the water, while maintaining the ecological and structural integrity of the riparian buffer. Similar to the approach with invasive species management, the approach to riparian viewshed management is threefold: assessing or characterizing the existing viewsheds, determining management goals regarding which viewsheds to maintain and which ones to reforest, and creating and maintaining viewsheds while not compromising the integrity of the riparian buffers.

3.5.1. Identifying Viewsheds

The initial step in this process is identifying what viewsheds, good or bad, exist in a given area. This information provides a baseline moving forward in the planning, restoration and maintenance processes. Mapping can provide an overall sense of the number of viewsheds and their characteristics, including areas that are devoid of woody vegetation or areas with no understory and an elevated tree canopy, etc.

3.5.2. Viewshed Management Goals

Differing from a viewshed that focuses on a specific amenity such as a statue or building, riparian viewsheds tend to focus on the water itself or features located on the opposite bank. There are also two perspectives to those viewsheds, one from the top of bank and one from the water. A paddler or boater that is participating in an outdoor activity may prefer a minimal number of cleared viewsheds where they can get glimpses of amenities and architecture above the streambanks, while a walker or biker along the trail may prefer many views of the water given their general position on the outside of the riparian buffer.

Managing views, especially in the case of Fort Wayne, also needs to take into account future development and masterplans and allow for flexibility. This forward thinking will also shape restoration and invasive species management efforts. For example, it may make sense to post pone restoring a failing streambank and buffer to a riparian forest when the short-term plan for that area is an elevated walkway along the bank. The remaining sections will address some of these specific viewshed issues and locations in greater detail.

3.5.3. Creating and Maintaining Viewsheds

The actual physical work involved in clearing and maintaining viewsheds is quite similar to that identified in the invasive species management specification (Appendix D), and typically includes chainsaws,

loppers and pruners. With these tools a number of different approaches can be taken to create different types of viewsheds. One of the most common approaches is to create a "clearing" by removing all the woody vegetation and leaving an herbaceous ground cover. This approach is only recommended for short distances in riparian buffers since woody vegetation is a valuable structural component of the buffer. After removing the woody vegetation, the stumps may need to be treated to reduce re-sprouting or if the stem was an invasive species.

Figure 3.26. Viewshed of the City from the St. Marys (Source: Biohabitats; April 30, 2015).

Two other common approaches include removing a specific vegetative layer or strata. A "canopy" viewshed is created by removing all of the understory and all or a majority of the midstory. This has occurred in the Riverfront study area where many riparian areas have been cleared of the invasive bush honeysuckle (*Lonicera sp.*). Low lateral branches on the canopy trees can be pruned to provide increased views without removing the trees. Several riparian trees such as cottonwood and sycamore have naturally high canopies, thus locations with those trees make more sense for the "canopy" approach. Conversely, the "understory" approach removes all or a majority of the canopy and mid-story trees, leaving the understory trees and shrubs. In this scenario, the perspective view may be focused more on the opposite bank as opposed to the water in the "canopy" approach. The "understory" approach is most applicable in areas with native shrubs and/or areas that are dominated by the invasive tree-of-heaven, whose removal is encouraged.

The final two approaches are the more preferred in terms of ecological stewardship. The first is a "thinning" approach, where select trees and shrubs are thinned from a riparian area to provide small or filtered views through the vegetation. This approach still provides connectivity and ecosystem services, but does not create any vegetative gaps like the first three approaches. Lastly, the "toe" approach ideally maintains the entire canopy and critical vegetation at the toe of slope/water's edge where stability is critical, but allows for the removal of the understory on the slope above the toe. This approach provides views to the water from the top of bank while also providing some visual buffer for recreationists on the water.

Regardless of the approach, when clearing vegetation for viewsheds invasive species should be the first species removed. After their removal the viewshed can be reassessed and determined if any natives

then need to be removed. In many scenarios, by simply removing a few invasive species adequate views can open up instead of removing all the vegetation within a certain strata or all together.

Vines can also impact views in a number of ways. They can block views by creating walls of green vegetation in the summer and brown vegetation in the winter. The weight of the vines can also pull down and damage or uproot trees. In other scenarios they can form a ground cover over the riparian slope, opening up views which may not be desirable. A common approach to removing climbing vines if they are not desired is to first cut the vine at ground level and then cut the vine again at eye level or higher. This way when the vine resprouts it will be difficult for the vine to gain a foothold in the tree again.

Figure 3.27. Vines pulling down trees along the St. Marys (Source: Biohabitats; April 30, 2015).

3.6. Large Woody Debris Management

Although woody debris is an integral component to streams and floodplains, in urban systems it can become problematic. In natural systems woody debris can naturally accumulate and then deposit in floodplains, but in many urban situations those floodplains have been removed and the river is confined within its banks with little floodplain access. The main problem in urban situations is damage from large woody debris to infrastructure like bridge abutments, CSOs, boat launches, trails, boardwalks, and dams. There is also the potential for large woody debris jams that collect along the banks to become entangled with existing trees and shrubs currently growing on the banks. If and when these jams become unstable and dislodge, there is great potential for trees on the bank to become damaged or even uproot, causing more bank instability and large woody debris.

The larger the debris jam, the more potential for damage, thus the approach to manage them should not be reactive, but proactive. Debris jams should be dealt with when they are small and manageable. When removing a debris jam, large wood should be removed from the river entirely and not just placed on a floodplain or sent further downstream to cause additional problems to other infrastructure or other communities. An excellent example of a community taking a proactive approach to woody debris and trash removal in its river is the City of Cleveland. The City received a $435,160 EPA grant to fund two tandem boats to maintain the Cuyahoga River and Lake Erie marinas year round, as long as water

access is available. The two boats, Jetsam (w/attached crane) and Flotsam (w/attached excavator) are operated by the Port of Cleveland and can even be linked together to form one large platform (Figure 3.28).

Figure 3.28. Jetsam and Flotsam on the Cuyahoga River (Source: Port of Cleveland).

Figure 3.29. Woody debris jam near Spy Run Creek confluence overlook (Source: Biohabitats; April 30, 2015).

One of the initial tasks of the City's new Riparian Maintenance Coordinator should be to explore potential grants and funding sources for the potential design and acquisition of a debris removal boat(s), as well as, different boat and equipment combinations that make the most sense to the Three Rivers area and the City of Fort Wayne, see Appendix G. Our understanding is that the County is responsible for the removal of woody debris on vehicular bridge abutments while the City is responsible for removal on the Hosey dam and pedestrian bridge abutments. Estimates are the County spends over $100k annually to hire contractors to remove woody debris, perhaps if the City were to acquire a maintenance boat/equipment then they could contract with the County for woody debris removal to help offset some of the equipment, maintenance and salary costs associated with managing the woody debris.

4. RIVERFRONT CONCEPTUAL PLAN

4.1. Managing Buffers in Conjunction with the Conceptual Plan

As the finishing touches are put on Fort Wayne's Riverfront Conceptual Plan, one of the first questions that arises is how to manage the City's riparian areas along the riverfront with an overarching plan for redevelopment in place. But the plan is conceptual thus it is a vision with many moving pieces and parts. It is understand that the plan will help guide development, redevelopment will not conform to the conceptual plan 100% completely due to the myriad of influences that affect urban redevelopment and river manipulation. Given these circumstances, the City should begin to look at both short and long-term coordination between the conceptual plan and riparian buffer management within the study area.

Figure 4.1. Fort Wayne's Riverfront Conceptual Plan (source: SWA).

4.1.1. Short Term

Presentations and discussions regarding the conceptual plan by members of the Riverfront Implementation Committee and the Riparian Management Plan Advisory Team indicate the short-term focus or targets of the plan are the Promenade and the Environmental Stewardship Center, currently shown in Guldlin Park. Riparian buffer conditions within the Promenade zone are in fair to poor

condition, with generally steep banks and narrow vegetated corridors dominated by invasives. There do not appear to be any significant areas of erosion. Given these existing conditions and the large amount of built structures in the conceptual plan shown in the riparian corridor and also extending into the river, it appears that management efforts within this reach should be minimal knowing the potential for significant clearing and manipulation of the existing vegetation and shoreline. Considering the degree of invasive presence and the level of planned development that will require substantial clearing, minimal management in this area makes sense. Tree-of-heaven, autumn olive, lesser celandine , and Japanese knotweed should be managed based on their relatively low numbers in the study area and their tendencies toward rapid dispersal, infestation and establishment. Otherwise, planting and restoration efforts can be kept to a minimum, with localized, specifications taken if critical streambank erosion develops or property owners want to enhance their buffers with native vegetation.

Figure 4.2. The Promenade (source: SWA).

The other component of the conceptual plan that has gained considerable traction is the Environmental Stewardship Center shown in Guldlin Park. A group of individuals led by Dr. Bruce Kingsbury, Director of the Environmental Resources Center at Indiana University-Purdue University Fort Wayne, has been actively exploring the idea and recently visited similar facilities, most notably the Cleveland Metroparks' Watershed Stewardship Center in Parma, Ohio to gain a better understanding of their facilities and amenities. Although the center is currently shown in the Guldlin Park area, there has been discussion of other sites, for several reasons. Although structures are restricted in the park's floodplain, restoration

features such as constructed wetlands and ponds could be built in the floodplain with the facility itself centered on Superior Street. Regardless of the exact location, the themes and mission of the center itself need to be further developed, to help drive the nature and character of the facility and determine the type of amenities to create and showcase. Although the expansive turf area in Guldlin Park presents an excellent site for some type of ecological restoration, including floodplain forests and wetlands, all discussions on restoration in Guldlin Park should be spearheaded by the committee tasked with developing the Environmental Stewardship Center, if it is in fact going to be located in or adjacent to the park. From an ecological perspective, the existing floodplain forest is not regenerating and should be enhanced and restored. How it is enhanced and regenerated should be tightly integrated with the plans and vision for the center.

Figure 4.3. Bloomingdale and Guldlin Parks (source: SWA).

If the center should be located in an alternative location within the study area, the same principles apply regarding the development of restoration features in conjunction with the new center. At that point, restoration efforts at Guldlin could be complementary or stand alone, but regardless given the building restrictions in Guldlin and the existing conditions of the riparian corridor, this location makes the most sense for a large-scale restoration project within the study area.

4.1.2. Long Term

Trying to incorporate riparian buffer management strategies into a long-term conceptual plan vision can be difficult, understanding that the implementation of the master plan could be a 10, 20, or 50-year process and, as previously mentioned, specific components of the conceptual plan will no doubt change over time. So it is illogical and impractical to begin clearing riparian areas based on what is shown on the conceptual plan. Instead, the focus should be on removing invasives, restoring appropriate native vegetation, and stabilizing failing streambanks. However, all of these actions can and should be done in coordination, to some extent, with the conceptual plan. For example, a particular streambank may need to be restored where the conceptual plan shows a trail located close to the water's edge. Given this scenario, the restoration approach might be a tall boulder bank treatment so a future trail could be located close to the water's edge, but above the top of bank. As another example, if a riparian slope is cleared of invasives, but needs to be restored with native vegetation, and that location on the conceptual plan is intended to be a river overlook, then the vegetation selected to restore the bank might focus more on shrub species as opposed to trees to accommodate the potential for future viewsheds. Shrub and tree selection for restoration efforts also need to be a long-term consideration, especially given the future potential for clearing and removal for redevelopment. Suitable bioengineering species (see table 3.8) could be used in restoration efforts so they could then be harvested down the road if that particular area were then slated for redevelopment. Section 5 will explore more specific recommendations for each of the zones in greater detail.

4.1.3. Constraints

The Riverfront Conceptual Plan does include some constraints to the overall health of riparian buffers within the study area. Due to the urban context of The Promenade/Headwaters Junction zones, the existing narrow buffers in those areas could be highly manipulated based on the conceptual plan. With this in mind, as those areas are redeveloped, careful consideration should be taken to integrate as many planting and green infrastructure features as possible into those designs in order to maintain buffer connectivity between Bloomingdale/Guldlin Parks and Lawton/Headwaters Parks while improving stormwater management and urban ecology. Another constraint or concern from not only a riparian buffer health perspective, but also a stream health perspective are the two large "pools" shown on the conceptual plan at Bloomingdale/Guldlin Parks and Lawton Park. The floodplain forests at Bloomingdale and Guldlin Parks are the most intact, expansive and diverse within the study area. If portions of the forest are removed to create more open water it will not only eliminate critical habitat, but also reduce their ability to slow floodwaters and process sediment and nutrients. From a feasibility and sustainability standpoint, it will most likely be difficult to obtain the necessary Army Corps of Engineers (USACE) permits to dredge the river and excavate the floodplains given if intent of the "pools" is about experience and aesthetics, and not a component of any stream or riparian restoration strategy. Technically the "pools" are eliminating and further degrading existing habitat, two things that the USACE will not look favorably upon when examining a permit. The other major concern with the "pools" is their long-term sustainability given the hydrologic influences of the Hosey dam, which slows the river's flow velocity and enhances sediment deposition within the study area. Upstream agriculture practices contribute a large amount of sediment to the system, which further compounds the issue. By widening the river in those two areas to create the "pools", flow is slowed even further, encouraging more sediment deposition. Periodic dredging will likely be required to keep the "pools" from silting in, if they are even allowed to be constructed. The "pool" features are components of the conceptual plan, it is therefore recommended that initial discussions with the USACE take place to discuss their feasibility, although our perspective from an ecological standpoint is that they should not be constructed.

5. RECOMMENDATIONS

The following Section provides general and zone specific recommendations of tasks and strategies for management of riparian buffers within the study and surrounding areas.

5.1. Study Zones Recommendations

5.1.1. Bloomingdale Park

If the Riverfront Conceptual Plan's vision of Bloomingdale Park were implemented, the riparian buffer would be drastically reduced, with hundreds of trees being cleared to dredge and widen the river to create one of the two "pools". From an ecological perspective, this is the longest floodplain forest within the study area and largest overall natural area when Guldlin Park's floodplain forest across the river is included. As a result of this dichotomy, the most logical approach is minimal or "maintenance" management of the riparian buffers within this zone. Suggested activities would include addressing the section of streambank erosion noted in Section 2.2.1, maintaining the existing cleared viewshed, treatment of honeysuckle and other invasives, subsequent follow-up restoration with native species plantings, and bioengineering restoration in the floodplain areas (live stakes).

One possible approach to restoring the section of eroding streambank would be a technique similar to figure 3.8 where boulders are packed under the existing vegetation so that vegetation can be saved as opposed to re-working the entire slope. Honeysuckle treatment should be a late summer and fall activity with follow-up plantings in late fall, several weeks after treatment to allow the herbicide to penetrate the honeysuckles root system. Cuttings and wood chips from the honeysuckle should not be left in place. Bareroot and/or small containerized tree and shrub stock would be practical plant material sizes for the restoration planting. Another potential type of restoration would involve the installation of live stakes in late fall in the floodplain forests. Shrub species might be the focus in the narrow floodplain forest upstream of the Van Buren St. bridge while both trees and shrubs would be appropriate in the larger downstream floodplain forest. The live stakes would be used to try and jump start natural regeneration as the high levels of sedimentation continue to significantly limit any natural regeneration by native woody vegetation. Initial restoration efforts should focus on the water's edge and then move landward in subsequent years. Since Guldlin Park appears to be the current location for the Environmental Stewardship Center, complimentary recreation and restoration activities could happen across the river at Bloomingdale Park, thus any potential floodplain restoration should be discussed with the Environmental Center Stakeholder Group.

Figure 5.1. Sediment deposition upstream of Bloomingdale Park with garlic mustard in foreground (Source: Biohabitats; April 30, 2015).

In 2014 Biohabitats staff discovered a Canada goose nest on a woody debris pile in the larger floodplain forest, thus searching for nests in the early spring and follow-up egg addling could be an additional activity. This floodplain area was also littered with trash and debris making it a suitable candidate for clean-up efforts and garlic mustard pulls are also easy activities to organize. Below is a bulleted prioritization list for the Bloomingdale Park zone:

- Debris Jam removal at the Ewing St. bridge
- Monitor two large uprooted cottonwoods at the downstream end of the floodplain forest; if they shift or become a debris trap they may accelerate or increase streambank erosion
- Streambank stabilization (site #2)
- Invasive species removal/treatment of tree-of-heaven (volunteer activity except herbicide application)
- Canada geese egg addling (volunteer activity)
- Install live stakes (shrub species) along the streambank under the power lines just upstream of the Van Buren St. bridge (volunteer activity)
- Installing live stakes in the floodplain forest (volunteer activity)
- Installing live stakes in the narrow floodplain forest upstream of the Van Buren St. bridge (volunteer activity)
- Invasive species removal/treatment of bush honeysuckles and replanting of cleared areas (volunteer activity except herbicide application)
- Reduce extent of mowing at large cleared viewshed as shown on Feature Assessment Map
- Maintain the 3 existing viewsheds as noted on the Feature Assessment Map in Appendix A (potential volunteer activity)
- Garlic mustard pulls (volunteer activity)

5.1.2. Guldlin Park

It may be prudent to delay activities in the Guldlin Park Zone until the Environmental Center Stakeholder Group decides on a location for the center since Guldlin Park has been the most actively discussed location and is depicted on the conceptual plan. Noted earlier, the vision and mission of the center should drive any restoration efforts in the floodplain areas of Guldlin Park, especially the turf area. In the meantime, invasives and vines can be treated just upstream of the Van Buren St. bridge, goose nests can be searched for in the larger floodplain forest, garlic mustard can be pulled, and trash can be removed from the floodplain forest. There is a small stretch of bank erosion, noted in Section 2.2.2, which could be addressed although of the areas noted in the BEHI this location would be a lesser priority as there are no real safety or infrastructure hazards. So address or not, which is the recommendation? The boat launch also provides a great location for interpretative signage on the importance of riparian buffers

During the presentation of the draft management plan, there was an extensive discussion on mowing regimes, meadow establishment, and goose management in regards to the large, existing turf area at Guldlin Park. The conclusion was that an approximate 10 ft. strip of lawn adjacent to the boat launch and paralleling the river should be allowed to grow and no longer be mown on a regular basis to help deter geese from accessing the site. During the last mowing of the season the 10 ft. goose strip could then be mown to eliminate any woody species in the goose strip.

If the future decision is to locate the center elsewhere, then an entire suite of restoration options may apply to the large turf area in the park. Given the size of the area and frequent inundation, careful consideration needs to go into the restoration approach and design, since the floodplain is inundated multiple times a year. With this inundation will come sediment deposition and introduction of aquatic species into any type of wetland and/or water feature. Below is a bulleted prioritization list for the Guldlin Park zone:

- Reduce mowing to allow a “goose buffer” parallel to the river and adjacent to the boat launch
- Streambank stabilization (site #1)
- Invasive species removal/treatment of tree-of-heaven (volunteer activity except herbicide application)
- Canada geese egg addling (volunteer activity)
- Installing live stakes in the floodplain forest (volunteer activity)
- Cutting vines just upstream of the Van Buren St. bridge (volunteer activity)
- Invasive species removal/treatment of bush honeysuckles and replanting of cleared areas (volunteer activity except herbicide application)
- Install interpretative signage at the boat launch
- Garlic mustard pulls (volunteer activity)

5.1.3. The Promenade

The conceptual plan’s vision of The Promenade is extremely urbanized with numerous walkways and platforms extending along and even over the river. One can then assume that little, if any, of the existing riparian vegetation will remain since The Promenade appears to be Phase I of the implementation of the conceptual plan. With that in mind and given the narrow nature of most of the buffers, the immediate approach should be to address the two streambank issues described in Section 2.2.3, and the treatment of tree-of-heaven, and climbing vines. Due to the lack of robust vegetation on

the banks and close proximity to the trails, a restoration approach such as figure 3.5 would be most applicable. There is also an area that has already been cleared of honeysuckle however, the woodchips were left onsite making revegetation more complicated. If the woodchips are not removed, then revegetation should be delayed several years to allow the wood chips to break down as fresh woodchips will make the soil pH extremely acidic and reduce plant survival. If the wood chips are not going to be removed, then they should be spread as thin as possible and not piled up around any desirable trees or shrubs since the mulch will smother the roots and hold moisture around the trunk causing it to potentially decay and weaken.

Figure 5.2. Wood chips smothering tree roots (Source: Biohabitats; April 30, 2015).

Goose nesting is unlikely in this zone due to the steep and narrow buffers and recreation activity near the Fort Wayne Outfitters, except in large woody debris piles that have accumulated in the river near bridge abutments. The Outfitters and Wells St. bridge are also potential locations for interpretative signage. Given the recent release of an RFP for the schematic design and cost estimate for The Promenade, activities in this zone should probably be focused on signage and egg addling as the majority of existing vegetation in the narrow riparian buffers will likely be eliminated or significantly reduced in the new schematic design given the theme of The Promenade. Below is a bulleted prioritization list for The Promenade zone:

- Interpretative signage installation at the Outfitters and Wells St. bridge
- Canada geese egg addling (volunteer activity)
- Address concentrated runoff location on left bank
- Invasive species removal/treatment of tree-of-heaven and Norway maple (volunteer activity except herbicide application)
- Invasive species removal/treatment of bush honeysuckles and replanting of cleared areas (volunteer activity except herbicide application)
- Vine cutting/clearing upstream of the Harrison St. bridge (volunteer activity)
- Remove/disperse existing wood chip piles (volunteer activity)
- Garlic mustard pulls (volunteer activity)

5.1.4. Headwaters Junction

Similar to The Promenade, the Headwaters Junction Zone becomes a more urbanized area in the conceptual plan with much of the riparian vegetation removed or reduced. The existing riparian buffer within this reach is predominantly a low floodplain forest with stable banks. There are several areas with invasives and climbing vines that can easily be accessed in addition to honeysuckle removal and replacement with natives. A viewshed also exists that can be maintained and enhanced (Appendix A). The existing viewshed was created by removing a number of silver maples, however they were not treated with an herbicide and continue to resprout. Instead of continuing to cut the regrowth year after year, the stems/stumps could be treated with a herbicide to kill them altogether. The viewshed could then be enhanced by planting more ornamental native shrubs (red osier dogwood, silky dogwood *and pussy willow*) along the lower portions of the slope, which will also provide stability and habitat and food for wildlife.

Figure 5.3. Viewshed with silver maple suckers (Source: Biohabitats; April 30, 2015).

The floodplain forest could also be enhanced with live stakes, however there are larger floodplain forests in the study area with greater restoration and enhancement priorities. Finally, the floodplain forest is prime goose nesting area and should be explored thoroughly in the early spring for nests. Below is a bulleted prioritization list for the Headwaters Junction zone:

- Viewshed maintenance, treat silver maple seedlings and plant native shrubs at viewshed just upstream from CSO outfall (volunteer activity except herbicide application)
- Invasive species removal/treatment of tree-of-heaven (volunteer activity except herbicide application)
- Canada geese egg addling (volunteer activity)
- Installing live stakes in the floodplain forest, priority being low area along trail (volunteer activity)
- Cutting vines (volunteer activity)
- Invasive species removal/treatment of bush honeysuckles and replanting of cleared areas (volunteer activity except herbicide application)
- Garlic mustard pulls (volunteer activity)

- Invasive species removal/treatment of Bradford pear (volunteer activity except herbicide application)

5.1.5. Wells Corridor

The narrow existing riparian buffer in the Wells Corridor Zone is shown as a broad river walk in the conceptual plan. The buffer itself is relatively poor in quality, with erosion on the downstream end near the Clinton St. bridge (see Section 2.2.5), due in part to recent construction activities in the area. A boulder toe with live branch layering approach (figure 3.9) would be appropriate given the lack of vegetation and available space. Containerized plants could then be planted above the live branch layering as part of a volunteer restoration planting effort. The zone does include two large stands of tree-of-heaven behind the levee, which should be treated while they are young and manageable.

In certain locations the trail alignment is located close to the streambank. By moving the trail further away from the streambank the riparian buffer could expand. Another approach to expand the existing buffer is to plant the turf area between the streambank and trail with native trees and shrubs. A key location for this approach is the NE corner of the CSO building, which will help screen the building from the trail.

Figure 5.4. Existing lawn area for potential meadow restoration (Source: Biohabitats; April 30, 2015).

The most intriguing aspect of this zone is the potential for an upland restoration project in the large turf area between the trail and the levee. Considering the future conceptual plan, instead of a more costly and involved forest restoration that could be removed in the future, a less costly alternative is meadow restoration. Once established, the meadow would require less maintenance and mowing (1-2 times yearly), provide habitat for birds and insects, and eliminate a food source for geese. Below is a bulleted prioritization list for the Wells Corridor zone:

- Streambank stabilization (site #6)
- Monitor recently uprooted silver maple just downstream of CSO outfall; if it shifts or become a debris trap it may exasperate streambank erosion and threaten the integrity of the adjacent trail

- Reduce mowing to allow turf area between riparian buffer vegetation and trail to grow in, plant with trees and shrubs (volunteer activity)
- Invasive species removal/treatment of tree-of-heaven (volunteer activity except herbicide application)
- Canada geese egg addling (volunteer activity)
- Installing live stakes in the floodplain forest, priority is where silver maple uprooted just downstream of CSO outfall (volunteer activity)
- Screen view of northeast side of CSO building from trail with native trees and shrubs (volunteer activity)
- Invasive species removal/treatment of bush honeysuckles and replanting of cleared areas (volunteer activity except herbicide application)
- Garlic mustard pulls (volunteer activity)
- Pull trail away from streambank where it encroaches
- Convert turf area to native meadow

5.1.6. Headwaters Park

The conceptual plan leaves Headwaters Park alone for the most part, thus any activities related to restoration need to be closely coordinated with the Parks and Recreation Department. The two main concerns for Headwaters Park involve areas of streambank erosion, see Section 2.2.6. The area adjacent to the amphitheater is less severe, but is critical to address due to its high profile location and use as river access for boaters. Understanding that views to and from the river are important in this location, as well as aesthetics, the approach here needs to be minimal in size and scale. Based on the gentle slopes, the bank could be stabilized with coir logs and/or regraded. A dwarf variety of red osier dogwood (*Cornus sericea 'Insanti'*) that grows to 4-5 feet could then be planted along the water's edge to help stabilize the banks. If height is not a concern the native species could be used (8-10 feet in height). Plantings could be a combination of bioengineering materials and containerized stock, or herbaceous material if height is of concern. An alternative approach is to add a section of boulder toe at the access point to provide a more stable and formal access location. Conversely, the downstream erosion is much more severe and in immediate need of restoration. This location has already been discussed with IDNR as a potential grant project in the near future using a boulder bank/root pack approach (see Appendix I).

Figure 5.5. Bank erosion at Headwaters Park near amphitheater (Source: Biohabitats; April 30, 2015).

Besides the streambank erosion there are multiple individuals and groupings of tree-of-heaven and Norway maple that should be treated plus vines that are damaging trees. Honeysuckle is prevalent on the riparian slopes, but treatment should be coordinated with the Parks and Recreation Department to develop a replanting strategy and plant schedule. Beaver herbivory was observed in multiple locations so protection should be installed in those areas, focused on large specimen trees, large trees that show existing damage, trees near trails, and trees on steep slopes with narrow buffers. Beavers typically prefer cottonwoods and willows, but have also targeted silver maple in the study area.

Just downstream from the amphitheater on the opposite bank of the St. Marys is a CSO. The buffer directly across from the CSO could be enhanced with a number of dense supplemental plantings of shrubs to help screen the CSO from the park. Two potential shrubs to augment those listed on plant schedules in Section 3 include inkberry (*Ilex glabra*) and northern bayberry (*Myrica pensylvanica*). Although they are not native to Indiana, they are native to the northeastern US and could easily be incorporated into a planting island in a more ornamental setting such as Headwaters Park. As an evergreen and semi-evergreen shrub respectively, their ornamental nature would be conducive to a park planting and their evergreen character would provide screening year round.

Besides the amphitheater and overlooks, there are two other important viewsheds in the park to maintain. The first is located at the end of the large oval, directly across from the Spy Run Creek delta, and the second just upstream of the pedestrian bridge to the Old Fort. The view into Lawton Park and Spy Run Creek delta is also an import viewshed from the water with views into the park and City beyond. This low bench is dominated by silver maple resprouts from recent beaver herbivory and marsh mallow (*Althaea officinalis*). As previously described earlier, one approach to managing this viewshed would be to treat the silver maple stems/stumps. The area could then be planted with native shrubs to reduce

the potential for recruitment of silver maples and other trees, keeping the area tree free. Potential shrub candidates include buttonbush (*Cephalanthus occidentalis*), red osier dogwood , silky dogwood, swamp rose (*Rosa palustris*), pussy willow, and silky willow (*Salix sericea*).

The view to the Old Fort does not need to be enhanced by removing large numbers of trees, but simply by removing the honeysuckle , pruning lateral tree branches or selective thinning. Goose nests were also observed in the vicinity of the recently replaced outfall at the downstream end of the park and more nests are likely further upstream in the wider buffers. Riparian buffer signage could easily be incorporated given the amount of trails and visitors. Below is a bulleted prioritization list for the Headwaters Park zone:

- Streambank stabilization (site #9)
- Streambank stabilization (site #5) (potential volunteer activity)
- Invasive species removal/treatment of tree-of-heaven (volunteer activity except herbicide application)
- Viewshed maintenance, plantings to screen views of CSO (potential volunteer activity)
- Viewshed maintenance, treatment of silver maple seedlings and shrub plantings across from Spy Run Creek delta(potential volunteer activity except herbicide application)
- Canada geese egg addling (volunteer activity)
- Cutting vines just upstream of the Clinton St. bridge (volunteer activity)
- Invasive species removal/treatment of bush honeysuckles and replanting of cleared areas (volunteer activity except herbicide application, coordination w/Parks Dept.)
- Install interpretative signage (amphitheater, viewshed to Spy Run Creek delta, The Gas House Deck)
- Install herbivory protection on key trees (potential volunteer activity)
- Garlic mustard pulls (volunteer activity)

5.1.7. Lawton Park

Perhaps the most significant proposed changes to any riparian buffer in the new conceptual plan happen along the St. Marys as it passes through Lawton Park. Here the river is widened and dredged to create another "pool" and the river is bordered by a wide river walkway. Knowing this makes it difficult to propose restoration activities along the St. Marys, however the USACE approval of such a design is highly unlikely. From an ecological perspective, the turf covered Spy Run Creek delta is a strong candidate for restoration. Understanding this balancing act most likely means restoration should be limited to bioengineering materials (live stakes) along the water's edge of the delta and conversion of the turf delta to a wet meadow (ERNMX-122), although meadow conversion can take 2-3 years.

There is one noted area of erosion, see Section 2.2.7, on the right bank just downstream of the downstream pedestrian bridge on Spy Run Creek. The erosion is limited to the lower portion of the bank with existing vegetation above, thus a root pack (figure 3.11) approach is probably most appropriate. Invasives are common with a somewhat large patch of lesser celandine located along Spy Run Creek. Since this is the only known location in the study area, its treatment should be prioritized before it becomes established elsewhere in the study area.

Figure 5.6. Lesser celandine infestation along Spy Run (Source: Biohabitats; April 30, 2015).

The other main issues associated with this Zone are two low-head dams on Spy Run Creek and several large woody debris jams in the vicinity of the confluence. Removal of the low-head dams and the restoration of Spy Run Creek should be a priority for stream health and fish passage improvement, providing a connection to planned stream restoration projects upstream of the study area. The woody debris jams should be removed to reduce their potential impacts to downstream bridge abutments. Goose nests are also assumed to be quite common in the riparian corridor based on the lack of public access. Below is a bulleted prioritization list for the Lawton Park zone:

- Streambank stabilization (site #7)
- Debris jam removal
- Removal of low-head dams
- Invasive species removal/treatment of lesser celandine
- Invasive species removal/treatment of tree-of-heaven and Norway maple (volunteer activity except herbicide application)
- Viewshed maintenance, plantings to screen views of delta from parking lot and trail
- Canada geese egg addling (volunteer activity)
- Invasive species removal/treatment of bush honeysuckles and replanting of cleared areas (volunteer activity except herbicide application)
- Install interpretative signage (trail entrance to delta)
- Garlic mustard pulls (volunteer activity)
- Monitor Spy Run Creek riparian buffers for Japanese knotweed (*Fallopia japonica*)

5.1.8. Old Fort

The Old Fort Zone remains relatively unchanged in the conceptual plan. There are several tree-of-heaven trees, but the main focus in this zone is the bank erosion adjacent to the Old Fort. Within this reach the banks are nearly vertical. There is limited woody vegetation with mowing to the water's edge. This section was included in a discussion with IDNR regarding potential streambank stabilization funding and approved for $42,000 in funding, see Appendix I. It is unlikely that the entire reach can be stabilized for this amount, so future stabilization work maybe required. The selected design-build firm should work closely with the Parks Department's Landscape Architect regarding the planting plan and plant schedule given the high profile location and important views of the Old Fort from Headwaters Park.

Figure 5.7. Vertical banks adjacent to Old Fort (Source: Biohabitats; April 30, 2015).

As part of the restoration approach, the banks could be stabilized with boulder toe protection and then graded back, incorporating bioengineering and containerized plant material. The large lawn area shown above could then be restored to a riparian forest, eliminating mowing which is compromising bank stability. Below is a bulleted prioritization list for the Old Fort zone:

- Streambank stabilization (site #8), IDNR grant
- Streambank stabilization (site #8), areas not addressed with IDNR grant
- Herbivory protection of large trees along streambank (volunteer activity)
- Invasive species removal/treatment of tree-of-heaven (volunteer activity except herbicide application, coordination with bank stabilization design-build firm)
- Viewshed maintenance, plantings to screen views of eroding streambanks at Headwaters Park and new stormwater outfall
- Canada geese egg addling (volunteer activity)
- Invasive species removal/treatment of bush honeysuckles and replanting of cleared areas (volunteer activity except herbicide application)
- Install interpretative signage (streambank restoration location, unless specific sign included with project)
- Garlic mustard pulls (volunteer activity)

5.1.9. The Confluence

The riparian buffers in The Confluence Zone also change very little in the new conceptual plan. There are no major areas of bank erosion, although there are some concentrated areas of runoff at the Three Rivers Apartments that could simply be armored with cobble to reduce erosion. The parking lot drains along the northern edge of the building could also be retrofit with some type of trash trap and/or rain chain as there are no grates over the drains, allowing runoff and garbage to quickly access the riparian buffer and St. Marys. There are also a number of tree-of-heaven trees around the building, across the river, and on the right bank of the St. Joseph River. Several trees were recently uprooted in the riparian buffer to the north of the apartments, so this area should be monitored for potential erosion.

A small stand of autumn olive (*Elaeagnus umbellata*) was discovered along the right bank of the St. Joseph River, which should be addressed immediately given it was the only stand observed in the Riverfront study area. Tree-of-heaven and purple loosestrife (*Lythrum salicaria*) seedlings were observed in the rip-rap along the right bank of the St. Joseph River and can easily be treated or removed. Additional loosestrife was observed just south of the water treatment plant on the side slopes of the levee, along with crown vetch (*Securigera varia*) however, this area is maintained to be woody species free and is therefore a lower priority.

Figure 5.8. Uncovered drains at the Three Rivers Apartments (Source: Biohabitats; April 30, 2015).

Beaver are fairly active in this area. They have routinely targeted several large cottonwoods on the right bank of the St. Joseph, although wire cages have since been installed. Some of the cages need to be adjusted as the downslope side of the tree is still exposed and experiencing herbivory. The floodplain forests could be enhanced with bioengineering starting at the water's edge and moving landward in subsequent years. The major potential restoration project for this zone is the planters located at the top of the rip-rap along the St. Joseph. A plant schedule is presented in Section 3 detailing appropriate

species and density. Based on the sheer number of planters and potential issues with watering, this project should be slated for the fall since watering will most likely be limited to installation. Based on discussions during the Draft Plan presentation, efforts will be made with USACE for a pilot project to plant the 10 furthest downstream planters this fall and gauge their success for future upstream plantings. Below is a bulleted prioritization list for The Confluence zone:

- Install herbivory protection (focus on remaining large trees in rip-rap)
- Invasive species removal/treatment of autumn olive (volunteer activity except herbicide application)
- Address concentrated runoff areas at apartments
- Modify parking lot drains at apartments
- Invasive species removal/treatment of tree-of-heaven (volunteer activity except herbicide application)
- Canada geese egg addling (volunteer activity)
- Invasive species removal/treatment of bush honeysuckles and replanting of cleared areas (volunteer activity except herbicide application)
- Invasive species management of purple loosestrife (volunteer activity except herbicide application)
- Invasive species management of crown vetch (volunteer activity except herbicide application)
- Install interpretative signage (noted viewshed)
- Garlic mustard pulls (volunteer activity)

5.2. General Recommendations

The recommendations below address more general ecological restoration and protection principles associated with riparian buffer management. These are principles and techniques that are not only applicable within the study area, but can be applied community wide and beyond.

5.2.1. Buffer Protection

One way that communities can protect riparian buffers is by considering regulatory approaches such as applying a buffer protection overlay district with associated guidelines that specify widths and allowable uses. Communities should note that it is important to look at the full suite of zoning and land development regulations when considering this option to maintain flexibility in how development and redevelopment occurs so that other objectives such, as densities, are not impacted by the overlay. Communities might also find that other existing local laws are inflexible and lead to conflicts with establishing buffers. Examples include setbacks, road standards and utility rights-of-way requirements. Those laws merit review and modifications and should be considered to accommodate more environmentally sensitive development. Links to stormwater management requirements may exist as well, where it may be feasible to establish riparian buffers as a means of receiving stormwater management credit. Buffer recommendations within the study area should be based in part on existing urban development characteristics and land use, and the conceptual plan and would most likely have different minimum widths for different zones. For example, The Promenade may have buffer width requirements of 25 feet while more natural areas like Guldlin Park could be 100 wide or more. The point is that without some form of protection the vegetation within those buffers is always subject to potential removal, which can have a negative impact on the stability of the river, its ability to trap and

process nutrients, and overall habitat and aesthetic quality. Good examples of regulatory approaches and language can be found on EPA's website (http://water.epa.gov/polwaste/nps/mol1.cfm), Pace's Land Use Law Center (http://www.law.pace.edu/landuse), Chagrin River Watershed Partners (http://www.crwp.org/index.php/member-services/model-regulations/riparian-setbacks) and the Center for Watershed Protection (http://www.cwp.org/) (Appendix J).

There are also non-regulatory tools that are available where buffer regulation is not feasible or desired. Communities can also establish buffers on public lands only. Interaction between various community agencies is necessary when implementing such a policy to ensure the appropriate training and education are provided on the benefits of riparian buffers. Including signage and outreach serves to then reinforce the importance and benefits of riparian buffers. After a community demonstrates that it is actively participating in a voluntary manner, it will be easier to develop partnerships with other organizations, groups and individuals to encourage them to protect riparian buffers on their own property. Communities can also establish incentive systems that identify and recognize riparian buffer friendly businesses and landowners, as well as, providing property tax breaks for landowners who set aside and preserve buffers.

5.2.2. Buffer and Streambank Restoration

The importance of healthy riparian buffers and streambanks has been discussed at length in this plan. Moving forward, baseline conditions of riparian vegetation and streambank erosion should continually be monitored and re-evaluated on a yearly basis to note any changes in conditions and more importantly any potential hazards. Based on field work in 2014 and 2015 it is apparent that certain reaches within the study area will require streambank stabilization work in the near future. The City should make a concerted effort to budget and plan for these activities, as well as, pursue restoration funding from organizations like the Indiana Department of Natural Resources and EPA's Great Lakes Restoration Initiative. Many of these types of restoration grants will require conceptual level designs, analysis and cost estimates. Consulting firms are often hired to complete this conceptual level work for pursuing restoration funding however, many times they will perform this work at a reduced rate or free of charge. It is also a very common practice for municipalities and watershed organizations to invite consultants on walk-overs to provide their professional opinion on potential restoration projects, something the City's future Riparian Buffer Manager should strongly consider if they do not have a technical background in stream restoration and invasive species management.

Buffer and streambank restoration also needs to adhere to the City's Overall Operation, Maintenance, Repair, Replacement, and Rehabilitation Manual (October 2002). Previously completed slopes and levees that were not cleared as part of the USACE project may remain with vegetation unless erosion and other natural causes remove the trees and shrubs. Once that vegetation is removed it cannot be replaced by woody vegetation however, vines are allowed in the planters that were installed in the rip-rap along the St. Joseph. A 15-foot buffer width of turf is also preferred adjacent to the levees, thus planting large trees near levees should be avoided. Regarding allowable tree removals, from a habitat perspective it is preferred that the rootwad and a portion of the trunk (10-foot minimum) be allowed to remain to provide standing snag habitat for birds and bats. Removing the upper stem will also significantly reduce the weight load on the snag, reducing the chance of uprooting it.

Figure 5.9. Broken cottonwood tree still providing habitat on streambank (Source: Biohabitats; April 30, 2015).

Several of the factors that will have a significant impact on restoration and vegetation establishment in general are the hydrologic impacts of the Hosey Dam, upstream agriculture, and the annual drawdowns of the rivers. These impacts will be more apparent in the floodplain and lower slopes as those areas receive higher rates of sedimentation. Dam removal and modification was previously explored in Biohabitats' Ecological Conditions Technical Memo (July 11, 2014) as part of the Riverfront Conceptual Plan and the recommendation was to keep the dam and backwater it creates for recreation and stormwater purposes, thus its removal will not be further discussed.

High levels of sedimentation in the three rivers are predominately a watershed-scale non-point source pollution issue, but annual drawdowns affect sedimentation, and they are controlled by the City (Resolution #94-9-12-07-2). Between April 15th and October 15th, the Hosey Dam Tainter Gate is lowered to increase the amount of impounded water to facilitate boating and recreation activities and improve river aesthetics during the summer recreation season. During the winter period (October-April?10/15-4/15) City Utilities will raise and lower the gate as needed to accommodate construction, maintenance and other related activities. In discussion with members of the Riparian Management Plan Advisory Team it was noted that during this period approximately 10-15 foot wide mud flats persist along the rivers, which becomes an aesthetic problem. The City usually allows 1-2 weeks during the fall/winter to remove hazard trees during the drawdown period so they can more easily access the streambanks.

The prolonged 6-month drawdowns have a significant effect on the hydroperiod along the streambanks, which makes growing conditions more difficult for plants in the riparian corridor and river shallows. If the overall length of the winter drawdown period can be reduced, divided into several "work windows", or only used when maintenance is required then vegetation along the streambanks and in the river

should begin to recover and/or can be restored. Discussion during the draft plan presentation indicated that the different City agencies may be able to better coordinate the necessary work during the drawdowns to reduce the length of the drawdowns. Submerged aquatic vegetation and emergent vegetation that would normally persist at the river's edge and in its shallows can not thrive due to the prolonged six-month drawdown and the drastic change in water levels and hydroperiod. The drawdowns also have an impact on the aquatic organisms in the rivers and alter and reduce instream habitat. Ideally, the winter drawdown period can be modified from an ecological and river health perspective. However, if the winter drawdown period is maintained, the City might experiment in using cover crops, such as grain rye, on an annual basis along the mud flats, to not only improve aesthetics, but also provide some minimal cover and forage for wildlife. Cover crops are typically annuals and would need to be replanted ever year since their life span is only one growing season.

5.2.3. Buffer and Stream Outreach

Riparian buffer outreach is available in a myriad of media and forms, from websites and print material like brochures and pamphlets, to signage, education programs and facilities like the proposed Environmental Stewardship Center. Given the momentum of this Center and the realistic possibility that it may be a viable project in Fort Wayne, Center can become the buffer and stream outreach driver for the City and surrounding areas. As evidenced by the success of Cleveland Metroparks' Watershed Stewardship Center, a very effective form of outreach is to attract people to a state of the art facility and physically engage them, especially children, in fun activities like a bio-blitz or through demonstration features like constructed wetlands and rain gardens. Although those other forms of outreach are important on their own, when they work in conjunction with the center the message becomes more real and integrated, especially when the branding theme of the center is common throughout.

Figure 5.10. Cleveland Metroparks Watershed Stewardship Center (Source: Cleveland Metroparks).

Other key component to successful outreach are active volunteers and river champions, who are often at the forefront of stream and riparian assessments, invasive species management, and restoration plantings. Their enthusiasm and volunteer labor facilitate projects which might not happen without their support. They are often the unofficial spokespersons for the streams and buffers of an area, thus ideally they receive training on these subjects. One of the ways that volunteers could be further integrated into outreach efforts, as well as the future center, is through a program that the Watershed Stewardship Center has developed called the Watershed Volunteer Program. The program engages

residents in an array of active management projects to improve watershed conditions. Volunteers attend various training sessions on a variety of watershed related topics with follow-up restoration and monitoring activities. Participants select three learning modules, two restoration activities and two monitoring activities to receive a Watershed Steward Certificate, The Watershed Book and Guide to Ohio Streams. Those stewards can take what they have learned and implement projects and monitoring in their own communities. Perhaps an organization like the Tri-State Watershed Alliance, who does extensive work with volunteers, could work in conjunction with the center and develop a similar type of volunteer program for the Fort Wayne area.

Signage is another potential tool that is underutilized in the restoration world. Restoration sites obviously present excellent opportunities for interpretative signage to educate, explaining the purpose of restoration, what an invasive species is and why it is important to remove it and replace it with native plants, etc. Another effective tool is the concept of branding- highlighting a watershed, important wildlife species, watershed organization or environmental center to raise awareness about the importance of protecting buffers, streams and watersheds in general across a larger area and to a larger audience. One of the best examples of this is the Hudson River Estuary Program and their Atlantic sturgeon logo.

Figure 5.11. Hudson River estuary log along the Wallkill River (Source: NYSDEC).

The Estuary Program's logo is a common sight along Hudson Valley highways. Through a partnership with the New York State Department of Environmental Conservation, New York State Department of Transportation, New York State Thruway Authority and New York State Bridge Authority, the sturgeon signs appear where major roads cross the Hudson River and tributaries of the estuary. The sign reminds travelers that these smaller streams are intimately connected to the Hudson and that the overall health of the river depends on the health of its watershed. The sturgeon logo reinforces the estuary's critical role as vital fish and wildlife habitat and the need to protect the entire watershed. Parallels can easily be drawn between the Hudson River and the Maumee River, the Hudson River Estuary and the western Lake Erie Basin, and the Atlantic sturgeon and the walleye. Imagine passing over the many bridges of Fort Wayne seeing a walleye logo surrounded by the words "Lake Erie Watershed" or "Western Lake Erie Basin Watershed", helping to reinforce the notion of watershed protection. Although the walleye

logo may make sense for a broader watershed-scale effort, the Environmental Stewardship Center and the logo they develop could play that role on a more localized scale in and around Fort Wayne from a branding perspective.

5.2.4. Invasive Species Management

Section 5.1 provides specific recommendations for invasive species management in each of the study area zones and from an overall viewpoint, the approach should be to prioritize treatment of species found in low densities and small infestations, which currently include tree-of-heaven , lesser celandine, autumn olive, and Japanese knotweed. Purple loosestrife and crown vetch were also found in low densities, but would be a second tier priority given their locations and herbaceous nature. Regarding tree-of-heaven, female trees should be targeted first since they are capable of producing hundreds of thousands of seed per year while males do not produce seeds. Annual vegetation assessments or walk-overs should be conducted by the Riparian Maintenance Manager and used to identify any new invasive species and infestations that should be treated. The manager should also keep abreast of new invasives that have been found in the surrounding region or are anticipated to move into the Fort Wayne area. These should not be limited to plant species, but diseases and pests such as the Emerald Ash Borer (EAB) that can also have a significant impact on native vegetation. Fortunately ash is not a dominant species in the study area riparian corridors, thus the impact from EAB is minimal, but pests like the Asian Longhorned Beetle could be devastating to Fort Wayne's floodplains as they target maples trees like box elder (*Acer negundo*) and silver maple .

Within the study area, bush honeysuckles make up the bulk of invasive species and individuals as they completely dominate the forest understory. Removal and treatment of the honeysuckle needs to done with a restoration plan in place. Without replacing the understory with some type of native plant material, the honeysuckle will quickly re-sprout from untreated stumps and seeds dispersed by birds and other wildlife. Cuttings and fresh mulch from the honeysuckle should also be removed as leaving them in place will smother the roots of existing vegetation and make restoration efforts more difficult.

5.2.5. Planting Projects

New riparian planting projects will most likely fall into two categories, streambank restoration and restoration of areas treated for invasives. Ultimate success of these will depend on herbivory protection, timing of planting, soil conditions, quality and size of plant material and watering regime. Many of the restoration techniques and appropriate plants are detailed in Section 3 and some potential projects are noted in Section 5.1, but there is no overarching general approach to planting except in the use of natives. The types and species of vegetation will be determined on a site-specific basis and should be done in coordination with the Parks and Recreation Department's Landscape Architect. Volunteers are also commonly used for restoration activities and should continue to be recruited and adequately trained in planting activities and identification of invasive species.

Timing for such activities should be limited to spring and fall, with fall being preferred since watering requirements are reduced. Bioengineering harvesting is limited to the plant dormancy season with early spring and late fall installations. Toe protection planting is more conducive to bioengineering practices such as live stakes and posts, while slopes are better suited to small containerized material and bareroots. The root structure of existing canopy trees on slopes and the various existing armoring materials will make digging difficult, thus smaller plants will be easier to install. Plants used for restoration efforts should be from local or regional nurseries and ideally from those located slightly

south of the Fort Wayne area given climate change implications and the northerly migration of plant species. Bareroot seedlings are available on the IDNR website (http://www.in.gov/dnr/forestry/3620.htm), trees are available from Woody Warehouse (http://www.woodywarehouse.com/#!tree-species/c1vpv), Cardno Native Plant Nursery carries seed, herbaceous and woody plant material (http://www.cardnonativeplantnursery.com/) while Ernst Conservation Seeds carries the seed mixes noted in Section 3 (http://www.ernstseed.com/).

5.3. Next Steps

5.2.1. Plan Implementation

As the Riverfront Conceptual Plan is finalized and implemented, the Riverfront Implementation Committee will be tasked with sequencing and prioritizing activities and features associated with the plan. These should be done in conjunction with the guidance and recommendations set forth in this management plan and the future Riparian Maintenance Manager when concerning the rivers and riparian buffers.

5.2.2. Riparian Maintenance Manager

The City of Fort Wayne has been exploring opportunities to develop and create a position for a Riparian Maintenance Manager to implement the Riparian Management Plan and manage the City's riparian areas. The responsibilities for this position are envisioned to include a combination of river maintenance (large woody debris, floatable and trash removal), streambank assessment and restoration, vegetation assessment, invasive species management, vegetation restoration, volunteer coordination and management, public education and outreach, and grant writing. The manager is expected to coordinate and work with multiple City agencies, committees and organizations. Appendix G and H includes previously developed equipment and yearly job task lists while the position description was included in a separate submittal.

5.2.3. Signage and Outreach

The figure below is an example of a graphic focused on the importance of riparian buffers that could be used in multiple formats, including signage, print materials and presentations. The document itself is intended to be non-technical and more understandable to the lay individual. If this graphic is intended to be used as an interpretative sign along Fort Wayne's rivers, then prominent and active locations such as boat launches, pedestrian bridges, overlooks and streamside trails are ideal locations, however potential locations within each zone were previously detailed. Appendix F contains a larger version of the graphic.

Figure 5.12. Riparian buffer interpretative graphic (Source: Biohabitats; Aug. 5, 2015)

5.2.4. Volunteer Activities

Volunteers are often critical components to conserving, protecting, restoring, and managing our natural resources and the City of Fort Wayne is no different. Tri-State Watershed Alliance volunteers are already participating in a number of activities including egg addling and invasive species removals. The list below details general activities that volunteers could potentially assist with in coordination with the future Riparian Maintenance Manager.

- Install herbivory protection
- Invasive species removal/treatment (hand pulling, cutting with loppers and pruners)
- Bioengineering plant material harvesting
- Canada geese egg addling
- Plantings (bioengineering, containerized, bareroots, plugs)
- Streambank stabilization (coir logs, bioengineering, plantings)
- Viewshed maintenance (pruning, clearing)
- Vine removal/cutting
- River clean-ups
- Vegetation, streambank and feature assessments (after receiving training and/or in coordination with Riparian Maintenance Manager)
- Water quality monitoring (after receiving training and/or in coordination with Riparian Maintenance Manager)
- Watering of recently planted/established plant material

- Assistance during water-related events (Stewardship Ambassadors, tours, environmental education)
- Native seed collection
- Tree surveys for pests and pathogens (Emerald Ash Borer, Asian Long-horned Beetle, Hemlock Wooly Adelgid, Beech Leaf Fungus, etc.)
- Monitoring of planting and bioengineering projects/plant material (survival, vigor, herbivory, etc.)
- Scout work days, Eagle Scout projects

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Appendix A
GIS Mapping (Streambank Analysis, Vegetation Analysis, & Features)

Feature Assessment

Riparian Management

Fort Wayne, IN

Bloomingdale Park

Legend

Viewshed

Site Features

- Tree of Heaven (Ailanthus altissima)
- Norway Maple (Acer platanoides)
- Access
- Boat Access
- Concentrated Runoff
- Debris Jam
- Tree of Heaven
- Tree of Heaven/Vines
- Understory Cleared & Chipped

0 200 Feet

N

Biohabitats

GREAT LAKES BIOREGION

August 2015

Streambank Assessment

Riparian Management

Fort Wayne, IN

Bloomingdale Park

Legend

1 Unstable

CATEGORY

- Steep gradient/Stable
- Low-moderate gradient/Stable
- Hardened/Stable
- 2ft Contours

0 200 Feet

N

Biohabitats
GREAT LAKES BIOREGION

August 2015

Vegetation Assessment

Riparian Management

Fort Wayne, IN

Bloomingdale Park

Legend

Vegetation

Category

- Mature Forest
- Young Forest/Narrow Buffer
- Turf Grass/Clearings
- Armored/Hardened

0 200 Feet

N

Biohabitats
GREAT LAKES BIOREGION

August 2015

Feature Assessment

Riparian Management

Fort Wayne, IN

Guldlin Park

Legend

Viewshed

Site Features

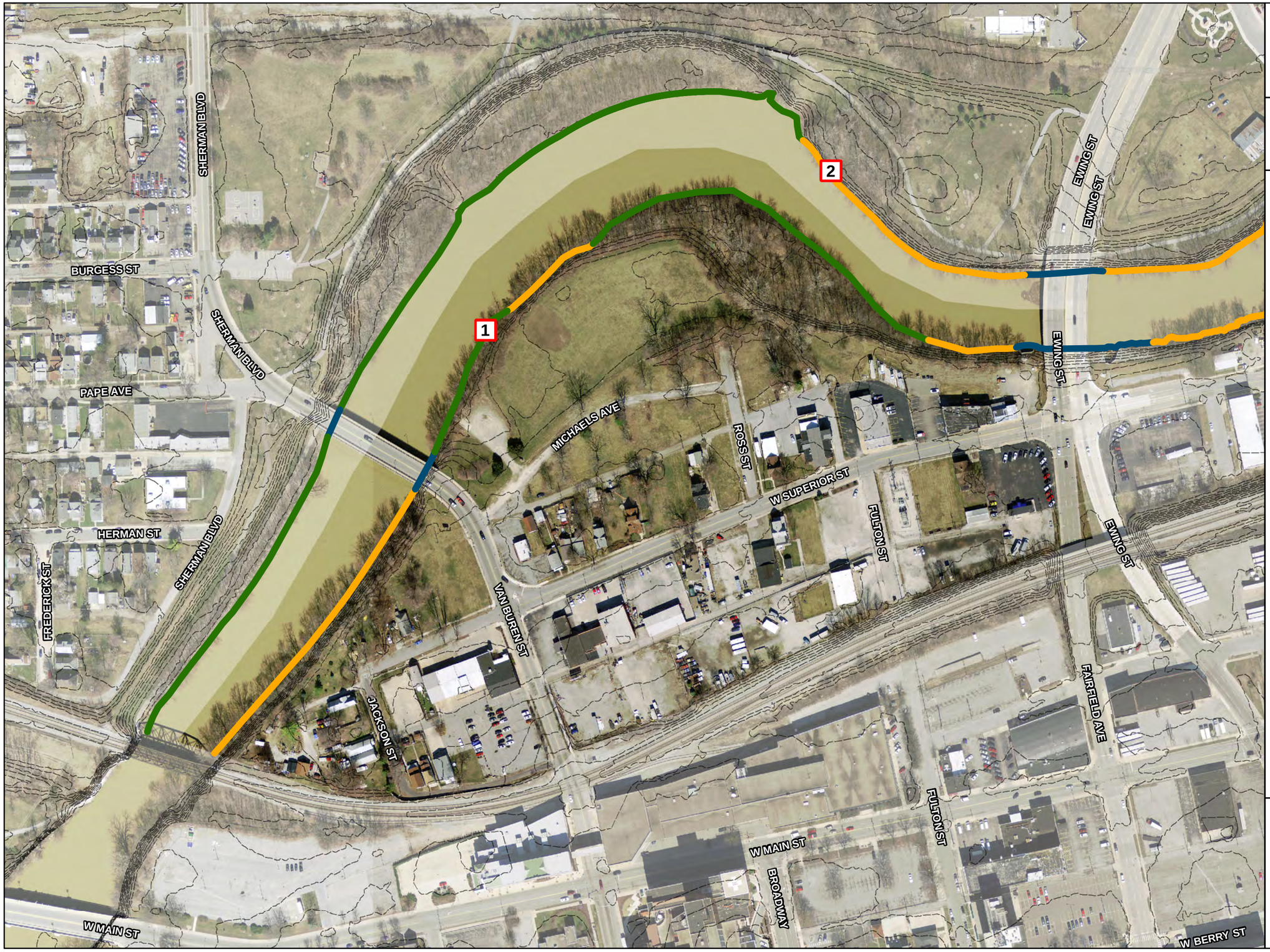
- AA — Tree of Heaven (Ailanthus altissima)
- V — Vines
- Access
- Boat Access
- Concentrated Runoff
- Debris Jam
- Tree of Heaven
- Tree of Heaven/Vines

0 200 Feet

N

Biohabitats
GREAT LAKES BIOREGION

August 2015



Streambank Assessment

Riparian Management

Fort Wayne, IN

Guldlin Park

Legend

1 Unstable

CATEGORY

- Steep gradient/Stable
- Low-moderate gradient/Stable
- Hardened/Stable
- 2ft Contours

0 200 Feet

N

Biohabitats
GREAT LAKES BIOREGION

August 2015

Vegetation Assessment

Riparian Management

Fort Wayne, IN

Guldlin Park

Legend

Vegetation

Category

- Mature Forest
- Young Forest/Narrow Buffer
- Turf Grass/Clearings
- Armored/Hardened

0 200 Feet

N

Biohabitats
GREAT LAKES BIOREGION

August 2015

Feature Assessment

Riparian Management

Fort Wayne, IN

The Promenade

Legend

Viewshed

Site Features

- AA — Tree of Heaven (Ailanthus altissima)
- AP — Norway Maple (Acer platanoides)
- V — Vines
- Boat Access
- Concentrated Runoff
- Debris Jam
- Tree of Heaven
- Tree of Heaven/Vines
- Understory Cleared & Chipped

0 200 Feet

N

Biohabitats
GREAT LAKES BIOREGION

August 2015

Streambank Assessment

Riparian Management

Fort Wayne, IN

The Promenade

Legend

1 Unstable

CATEGORY

- Steep gradient/Stable
- Low-moderate gradient/Stable
- Hardened/Stable
- 2ft Contours

0 200 Feet

N

Biohabitats
GREAT LAKES BIOREGION

August 2015

Vegetation Assessment

Riparian Management

Fort Wayne, IN

The Promenade

Legend

Vegetation

Category

- Mature Forest
- Young Forest/Narrow Buffer
- Turf Grass/Clearings
- Armored/Hardened

0 200 Feet

N

Biohabitats
GREAT LAKES BIOREGION

August 2015

Feature Assessment

Riparian Management

Fort Wayne, IN

Headwaters Junction

Legend

Viewshed

Site Features

- AA — Tree of Heaven (Ailanthus altissima)
- PC — Bradford Pear (Pyrus calleryana)
- AP — Norway Maple (Acer platanoides)
- V — Vines
- Access
- Screen View
- Tree of Heaven/Vines

0 100 Feet

N

Biohabitats
GREAT LAKES BIOREGION

August 2015

Streambank Assessment

Riparian Management

Fort Wayne, IN

Headwaters Junction

Legend

1 Unstable

CATEGORY

- Steep gradient/Stable
- Low-moderate gradient/Stable
- Hardened/Stable
- 2ft Contours

5

0 100 Feet

N

Biohabitats
GREAT LAKES BIOREGION

August 2015

Vegetation Assessment

Riparian Management

Fort Wayne, IN

Headwaters Junction

Legend

Vegetation

Category

- Mature Forest
- Young Forest/Narrow Buffer
- Turf Grass/Clearings
- Armored/Hardened

0 100 Feet

N

Biohabitats
GREAT LAKES BIOREGION

August 2015

Feature Assessment

Riparian Management

Fort Wayne, IN

Wells Corridor

Legend

Viewshed

Site Features

- AA — Tree of Heaven (Ailanthus altissima)
- PC — Bradford Pear (Pyrus calleryana)
- AP — Norway Maple (Acer platanoides)
- V — Vines
- Herbivory
- Screen View
- Tree of Heaven

0 200 Feet

N

Biohabitats
GREAT LAKES BIOREGION

August 2015

Streambank Assessment

Riparian Management

Fort Wayne, IN

Wells Corridor

Legend

1 Unstable

CATEGORY

Steep gradient/Stable

Low-moderate gradient/Stable

Hardened/Stable

2ft Contours

0 200 Feet

N

Biohabitats
GREAT LAKES BIOREGION

August 2015

Vegetation Assessment

Riparian Management

Fort Wayne, IN

Wells Corridor

Legend

Vegetation

Category

- Mature Forest
- Young Forest/Narrow Buffer
- Turf Grass/Clearings
- Armored/Hardened

0 200 Feet

N

Biohabitats
GREAT LAKES BIOREGION

August 2015

Feature Assessment

Riparian Management

Fort Wayne, IN

Headwaters Park

Legend

Viewshed

Site Features

- AA — Tree of Heaven (Ailanthus altissima)
- PC — Bradford Pear (Pyrus calleryana)
- AP — Norway Maple (Acer platanoides)
- V — Vines
- Access
- Boat Access
- Concentrated Runoff
- Debris Jam
- Herbivory
- Screen View
- Tree of Heaven
- Tree of Heaven/Vines

0 200 Feet

N

Biohabitats
GREAT LAKES BIOREGION

August 2015

Streambank Assessment

Riparian Management

Fort Wayne, IN

Headwaters Park

Legend

1 Unstable

CATEGORY

- Steep gradient/Stable
- Low-moderate gradient/Stable
- Hardened/Stable
- 2ft Contours

0 200 Feet

N

Biohabitats
GREAT LAKES BIOREGION

August 2015

Vegetation Assessment

Riparian Management

Fort Wayne, IN

Headwaters Park

Legend

Vegetation

Category

- Mature Forest
- Young Forest/Narrow Buffer
- Turf Grass/Clearings
- Armored/Hardened

0 200 Feet

N

Biohabitats
GREAT LAKES BIOREGION

August 2015

Feature Assessment

Riparian Management

Fort Wayne, IN

Lawton Park

Legend

Viewshed

Site Features

- AA — Tree of Heaven (Ailanthus altissima)
- AP — Norway Maple (Acer platanoides)
- V — Vines
- Debris Jam
- Herbivory
- Lesser Celandine
- Low Head Dam
- Screen View
- Tree of Heaven

0 250 Feet

N

Biohabitats
GREAT LAKES BIOREGION

August 2015

Streambank Assessment

Riparian Management

Fort Wayne, IN

Lawton Park

Legend

1 Unstable

CATEGORY

- Steep gradient/Stable
- Low-moderate gradient/Stable
- Hardened/Stable
- 2ft Contours

0 300 Feet

N

Biohabitats
GREAT LAKES BIOREGION

August 2015

Vegetation Assessment

Riparian Management

Fort Wayne, IN

Lawton Park

Legend

Vegetation

Category

- Mature Forest
- Young Forest/Narrow Buffer
- Turf Grass/Clearings
- Armored/Hardened

0 300 Feet

N

Biohabitats
GREAT LAKES BIOREGION

August 2015

Feature Assessment

Riparian Management

Fort Wayne, IN

Old Fort

Legend

Viewshed

Site Features

- LS — Purple Loosestrife (Lythrum salicaria)
- EU — Autumn Olive (Elaeagnus umbellata)
- AA — Tree of Heaven (Ailanthus altissima)
- AP — Norway Maple (Acer platanoides)
- V — Vines
- Access
- Concentrated Runoff
- Debris Jam
- Herbivory
- Low Head Dam
- Screen View
- Tree of Heaven
- Autumn Olive
- Norway Maple/Tree of Heaven/Vines

0 200 Feet

N

Biohabitats
GREAT LAKES BIOREGION

August 2015

Streambank Assessment

Riparian Management

Fort Wayne, IN

Old Fort

Legend

1 Unstable

CATEGORY

- Steep gradient/Stable
- Low-moderate gradient/Stable
- Hardened/Stable
- 2ft Contours

0 200 Feet

N

Biohabitats
GREAT LAKES BIOREGION

August 2015

Vegetation Assessment

Riparian Management

Fort Wayne, IN

Old Fort

Legend

Vegetation

Category

- Mature Forest
- Young Forest/Narrow Buffer
- Turf Grass/Clearings
- Armored/Hardened

0 200 Feet

N

Biohabitats
GREAT LAKES BIOREGION

August 2015

Feature Assessment

Riparian Management

Fort Wayne, IN

The Confluence

Legend

Viewshed

Site Features

- LS — Purple Loosestrife (Lythrum salicaria)
- EU — Autumn Olive (Elaeagnus umbellata)
- AA — Tree of Heaven (Ailanthus altissima)
- V — Vines
- Access
- Concentrated Runoff
- Debris Jam
- Herbivory
- Screen View
- Tree of Heaven
- Autumn Olive
- Norway Maple/Tree of Heaven/Vines

0 200 Feet

N

Biohabitats
GREAT LAKES BIOREGION

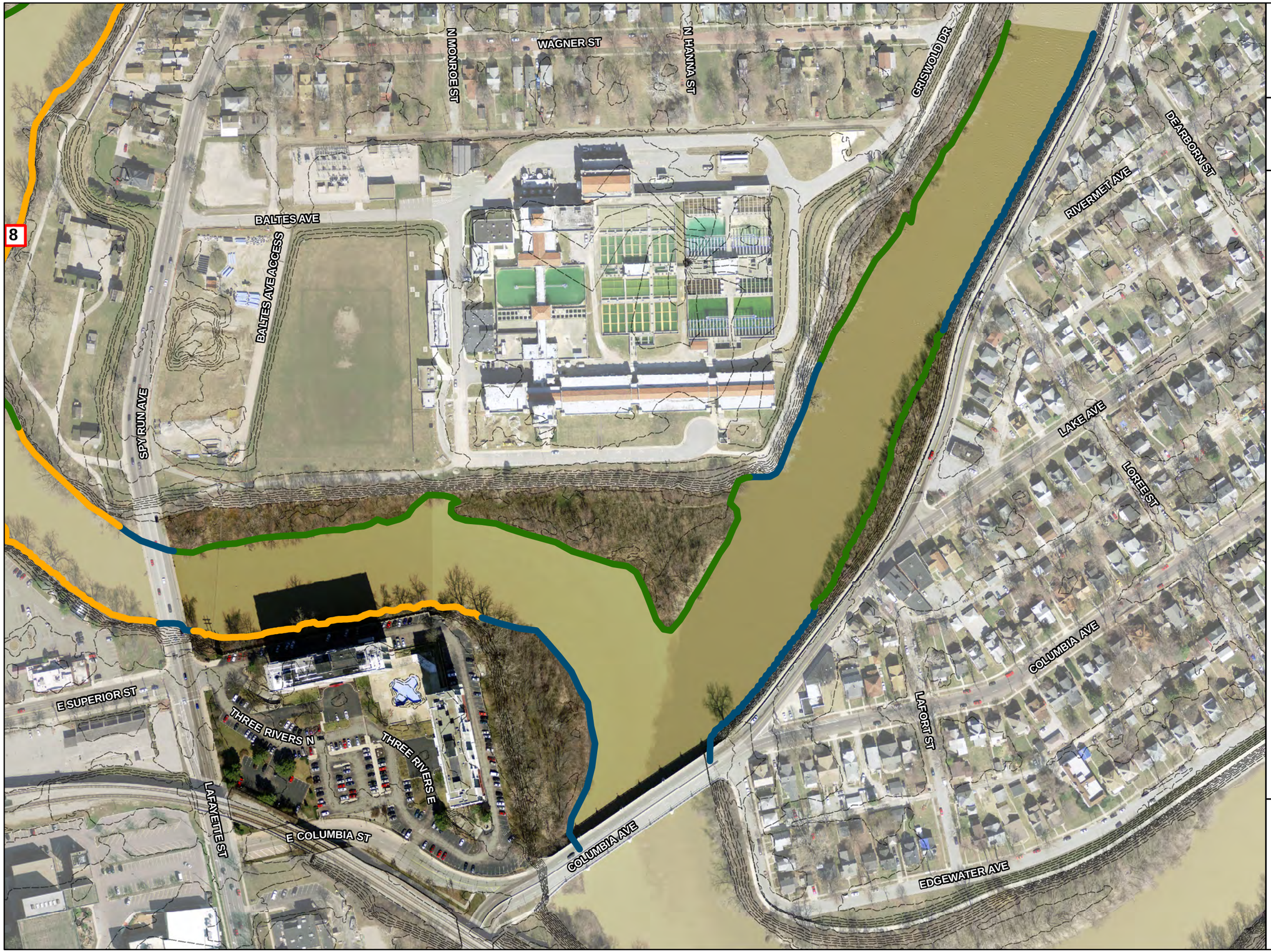
August 2015

Streambank Assessment

Riparian Management

Fort Wayne, IN

The Confluence



Legend

1 Unstable

CATEGORY

- Steep gradient/Stable
- Low-moderate gradient/Stable
- Hardened/Stable
- 2ft Contours

0 200 Feet

N

Biohabitats
GREAT LAKES BIOREGION

August 2015

Vegetation Assessment

Riparian Management

Fort Wayne, IN

The Confluence

Legend

Vegetation

Category

- Mature Forest
- Young Forest/Narrow Buffer
- Turf Grass/Clearings
- Armored/Hardened

0 200 Feet

N

Biohabitats
GREAT LAKES BIOREGION

August 2015

Appendix B
Bank Erosion Hazard Index (BEHI) Spreadsheets

BEHI DATA
FORT WAYNE, INDIANA
Staff Suzanne Hoehne
Date 5/6/2015
Notes: all based on visual estimates from water

SITE	1				2				3			
RIVER	St. Mary				St. Mary				St. Mary			
	Assessed Value	Score	BEHI Value	BEHI Rating	Assessed Value	Score	BEHI Value	BEHI Rating	Assessed Value	Score	BEHI Value	BEHI Rating
Length of Erosion	300				50				200			
Bathmetry depth	6				10				4			
Bankfull Height (assume 2')	8				12				6			
Bank height from water	6				8				11			
Bank Height	12	1.5	5.9	Mod	18	1.5	5.9	Mod	15	2.5	8.5	Very High
Root Depth	6	0.5	1	Very Low	3	0.166667	5	Mod	1	0.1	8.5	Very High
Root Density	80	40	2	Low	90	15	5.6	Mod	45	3.0	9.5	Extreme
Bank Angle	65	65	4.5	Mod	85	85	6.5	High	80	80	6	High
Surface Protection	29	29	6	High	50	50	4.5	Mod	15	15	9	Extreme
Erosion Height	3				5				4			
Materials			0				0				0	
Stratification			0				0				0	
Total Score			19.4	Low			27.5	Mod			41.5	Very High

4				5				6			
St. Mary				St. Mary				St. Mary			
Assessed Value	Score	BEHI Value	BEHI Rating	Assessed Value	Score	BEHI Value	BEHI Rating	Assessed Value	Score	BEHI Value	BEHI Rating
230				200				200			
8				12				4			
10				14				6			
11				2.5				8			
19	1.9	7.5	High	14.5	1.035714	1.1	Very Low	12	2	7.9	High
1	0.1	8.5	Very High	1.5	0.103448	3	Low	3	0.25	4.7	Mod
45	2.4	9.5	Extreme	20	2.068966	8	Very High	90	22.5	5.5	Mod
80	80	6	High	90	90	8	Very High	85	85	7.8	High
15	15	9	Extreme	30	30	6	High	50	50	4.5	Mod
4				2				5			
		0				0				0	
		0				0				0	
		40.5	Very High			26.1	Mod			30.4	High

7				8				9			
Spy Run				St. Mary				St. Mary			
Assessed Value	Score	BEHI Value	BEHI Rating	Assessed Value	Score	BEHI Value	BEHI Rating	Assessed Value	Score	BEHI Value	BEHI Rating
60				300				200			
4				16				8			
5.5				18				10			
15				8				9			
19	3.454545	10	Extreme	24	1.333333	5.2	Mod	17	1.7	6.8	High
9	0.473684	3.5	Low	6	0.25	2.5	Low	1	0.1	8.2	Very High
20	9.473684	8	Very High	10	2.5	9	Extreme	50	2.9	9	Extreme
60	60	4	Mod	90	90	8	Very High	90	90.0	8	Very High
25	25	6.5	High	20	20	7	High	50	50.0	4.5	Mod
6				8				5			
		0				0				0	
		0				0				0	
		32	High			31.7	High			36.5	High

Appendix C
Invasive Species Fact Sheets

New Invasive Plants of the Midwest Fact Sheet

TREE OF HEAVEN
Ailanthus altissima

Description: Tree of heaven is a deciduous tree that grows to 80 feet. The stems are smooth with pale gray bark. Leaves are alternate, 1-4 feet long, and compound with 11-25 leaflets with 1 or more glandular teeth near the leaf base. Flowers are yellow-green and located near the branch tips with male and female flowers on separate trees. Its seeds are in twisted flat 'wings' borne in clusters. All parts of this tree have a very strong odor.

Native range: Central China (http://www.nps.gov/plants/alien/fact/aial1.htm)

Ecological threat: This plant threatens woodland edges and forest openings. Tree-of-heaven is a prolific seed producer, grows rapidly, and can overrun native vegetation. Once established, it can quickly take over a site and form an impenetrable thicket. Ailanthus trees also produces toxins that prevent the establishment of other plant species. The root system is aggressive enough to cause damage to sewers and foundations.

Current North American Range: Tree of heaven is currently very common throughout Iowa, Missouri, Illinois, Indiana, Ohio, and Michigan. It is also known to be in eastern Wisconsin and southern Ontario.

Current Midwest general distribution, including southern Ontario ☐ Not Known ▒ Isolated ▒ Locally Abundant ▒ Widespread

Early Detection and Rapid Response Can Help Stop the Spread!

MIPN.org
Midwest Invasive Plant Network

TREE OF HEAVEN, *Ailanthus altissima*

MANAGEMENT OPTIONS: (http://www.nps.gov/plants/alien/fact/aial1.htm)

Elimination of Ailanthus requires diligence, due to its abundant seed production, high seed germination rate, and vegetative reproduction. Followup monitoring and treatment when needed should be an integral part of any serious ailanthus management program. Regardless of method selected, treated areas should be rechecked one or more times a year and any new suckers or seedlings treated (cut, sprayed or pulled) as soon as possible, especially before they are able to rebuild root reserves. Establishing a thick cover of trees (preferably native, and non-invasive) or grass sod will help shade out and discourage establishment of ailanthus seedlings. Targeting large female trees for control will help reduce spread of ailanthus by seed.

Mechanical methods

Young seedlings may be pulled or dug up, preferably when soil is moist. Care must be taken to remove the entire plant including all roots and fragments, as these will almost certainly regrow. Root suckers appear similar to seedlings, but would be connected to a pre-existing lateral root, and would be nearly impossible to remove effectively. Cutting alone is usually counter-productive because ailanthus responds by producing large numbers of stump sprouts and root suckers. However, for small infestations, repeated cutting of sprouts over time can exhaust the plants reserves and may be successful if continued for many years or where heavy shade exists. If possible, the initial cutting should be in early summer in order to impact the tree when its root reserves are lowest. Cutting large seed producing female trees would at least temporarily reduce spread by this method.

Chemical methods

Foliar sprays applied when trees are in full leaf are very effective, and should be the method of choice where ailanthus size and distribution allow effective spray coverage of all foliage without unacceptable contact with nearby desirable vegetation or applicator. Where ailanthus is in association with other exotic weed species, as is often the case, foliar spray allows treatment of the entire area at one time. Limitations of the method are the seasonal time frame, the need to transport a larger, more diluted volume of spray material, and the fact that rapid growing ailanthus are often out of effective reach.

Basal bark application is one of the easiest methods and does not require any cutting. It works best during late winter/early spring and in summer. The base of the tree stem must be free of snow, ice, or water on the bark from recent rainfall, though precipitation following application is inconsequential. Late winter/early spring (February 15-April 15, Mid-Atlantic) is generally the most productive time, since vegetation near the base of the trees is usually absent or leafless. Late spring and early summer applications (April 15-June 1, Mid-Atlantic), when plant fluids are moving upwards to support new growth, are questionable. Application during the summer (June 1-September 15, Mid-Atlantic) works very well as long as vegetation is not a hindrance, and allows lower concentrations of herbicide to be used. Fall to mid-winter applications (October-January) have given poor results.

The hack-and-squirt or injection method is very effective and minimizes sprouting and suckering when applied during the summer. Root suckering will be an increasing problem in the fall, winter and spring.

The cut stump method is useful in areas where the trees need to be removed from the site and will be cut as part of the process. While situations exist that dictate this method over the others given above, felling trees is usually less effective in killing the root system, slower, more labor intensive, and more hazardous to personnel than other methods. This method is likely to be most successful during the growing season, with diminishing success through the early fall.

For more information on control and management of this species, please visit the following Web sites:
www.usda.plants.gov, www.nps.gov/plants/alien/factmain.htm, tncweeds.ucdavis.edu/comtrol.html, dnr.wi.gov/invasives/plants.htm, www.invasivespeciesinfo.gov/plants/main.shtml, http://www.nps.gov/plants/alien/fact/pope1.htm

Early Detection and Rapid Response Can Help Stop the Spread!

MIPN.org
Midwest Invasive Plant Network

INVASIVE PLANT SPECIES FACT SHEET

IPSAWG
Invasive Plant Species Assessment Working Group

Japanese Knotweed

Polygonum cuspidatum (Fallopia japonica)

Pictures By (From Top to Bottom): J. M. Randall, J. Swearingen @ www.invasives.org and B. Rice.

Invasive Plants are a Threat to:

- **Forests and wetlands**
- **Native plants**
- **Perennial gardens**
- **Wildlife**
- **Lakes and rivers**
- **Human Health**
- **Farmland**

Date Updated: 10/06

Description:

Japanese knotweed is an herbaceous perennial. This stout, shrub-like plant forms large dense clumps that measure between 3-9 feet high. It reproduces by seed and by large rhizomes which may reach a length of 15-18 feet. The stems are reddish in color, ridged, jointed and hollow. The leaves are alternate on the stem, broadly truncate at the base and 2-3 inches wide. The leaf veins are often reddish and the petioles are 1 inch long and ridged. The flowers bloom in late summer and are small and greenish white.

Distribution:

Japanese knotweed is found in moist, open to partially shaded habitats. It has been reported from riverbanks and islands, wetlands, along roadways, hillsides, and disturbed areas in a variety of soil types and pH's. Japanese knotweed can also tolerate adverse conditions such as high temperatures, high salinity, drought and floods. It has spread across the United States, from the Northeastern states to California. It is found in most counties in Indiana, though most populations are small (<1/4 acre).

Problem:

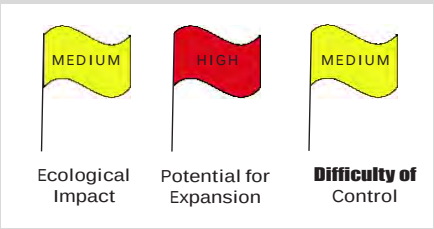
Japanese knotweed emerges in early spring and grows quickly and aggressively. It forms dense, nearly pure stands which crowd out native plants. By eliminating grasses and other native plants along creeks, the banks are less stable and more likely to shear off during flooding. This greatly increases sediment in the creek. It spreads rapidly through rhizomes and seeds. Fragments are transported to new sites by water and by human interactions. Once established, Japanese knotweed is very difficult to eradicate.

Origin:

Japanese knotweed is native to Japan, China, and parts of Korea and Taiwan. It was introduced from Japan to the United Kingdom as an ornamental plant in 1825, and from there to North America in the late nineteenth century.

Picture By: J. Randall

IPSAWG Ranking:



IPSAWG Recommendation:

- Do not buy, sell or plant Japanese knotweed in Indiana.
- Help by eradicating Japanese knotweed on your property.

This ranking illustrates the results of an assessment conducted by the **Invasive Plant Species Assessment Working Group** (IPSAWG), which is made up of many organizations and agencies concerned about invasive plant species. IPSAWG's goal is to assess which plant species may threaten natural areas in Indiana and develop recommendations to reduce their use in the state.

For more information about IPSAWG and the assessment tool used to rank invasive species, visit their website:

www.invasivespecies.IN.gov

ALTERNATIVES to Japanese knotweed:

New England Aster
(*Aster novae-angliae)*

Blue False Indigo
(*Baptisia australis)*

Sweet Joe-Pye-Weed
(*Eupatorium purpureum)*

Queen-of-the-Prairie
(*Filipendula rubra)*

Pictures By (Top to Bottom): J. Anderson, T. Barnes, R. Mohlenbrock and T. Barnes @ USDA-NRCS Plants Database.

Control Methods:

Manual control consists of digging out the rhizomes or cutting the stalks. However, digging is very labor intensive and tends to spread the rhizome fragments and promote disturbance and is not recommended. If cutting is used, at least three cuts are needed in a growing season just to offset rhizome production. Successful eradication is not likely with cutting alone. Glyphosate and triclopyr has been found to be effective against Japanese knotweed. Application is more effective in the fall when leaves are translocating to rhizomes. It is recommended to apply 2.0% glyphosate or triclopyr to the leaves in August with a prior cut in late spring or early summer. A 0.5% nonionic surfactant is recommended in order to penetrate the leaf cuticle. Regardless of which control is used, if some rhizomes remain in the soil Japanese knotweed will return once management is relaxed. **Always read and follow** pesticide label directions.

Japanese knotweed invading a riverbank. (Picture By: J. M. Randall)

Eight Easy Ways to Combat Invasive Plants

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2. Seek information on invasive plants. Sources include botanical gardens, horticulturists, conservationists, and government agencies.
3. Scout your property for invasive species, and remove invasives before they become a problem. If plants can't be removed, at least prevent them from going to seed.
4. Clean your boots before and after visiting a natural area to prevent the spread of invasive plant seeds.
5. Don't release aquarium plants into the wild.
6. Volunteer at local parks and natural areas to assist ongoing efforts to diminish the threat of invasive plants.
7. Help educate your community through personal contacts and in such settings as garden clubs and civic groups.
8. Support public policies and programs to control invasive plants.

For More Information:

On this assessment and IPSAWG:

IPSAWG
www.invasivespecies.IN.gov

On identification and control techniques:

The Nature Conservancy's Wildland Weeds
www.tncweeds.ucdavis.edu

On native plant alternatives and sources:

Indiana Native Plant and Wildflower Society
www.inpaws.org

This grant project made possible with United States Forest Service funds administered by the IDNR, Division of Forestry.

INVASIVE PLANT SPECIES FACT SHEET

IPSAWG
Invasive Plant Species Assessment Working Group

Crown Vetch

Coronilla varia

Pictures By (From top to bottom): D. Tenaglia, D. Tenaglia and D. Powell @ www.invasive.org.

Invasive Plants are a Threat to:

- **Forests and wetlands**
- **Native plants**
- **Perennial gardens**
- **Wildlife**
- **Lakes and rivers**
- **Human Health**
- **Farmland**

Date Updated: 10/06

Description:

Crown vetch is a perennial herb in the pea/legume family. It has spreading to diffuse, creeping stems that can reach two to six feet in length. The leaves are dark green, compound and bear fifteen to twenty-five leaflets. The seed pods are narrow, segmented, pointed, borne in crown-like clusters and may be two to three inches long. The pea-like, pinkish-white to deep pink flowers occur in clusters at the end of extended stalks and appear from late spring through summer. Crown vetch has a multi-branched root system and can spread by its strong rhizomes.

Distribution:

Crown vetch prefers sunny, open areas. However, it is tolerant of temperatures down to -33º C, periods of drought and periods of heavy precipitation. Since crown vetch was originally planted for erosion control, it is now located mostly along roadsides, rights-of-way, open fields, waste grounds and on gravel bars along streams. It is documented as naturalized in all but four U.S. states and is found in every county in Indiana.

Problem:

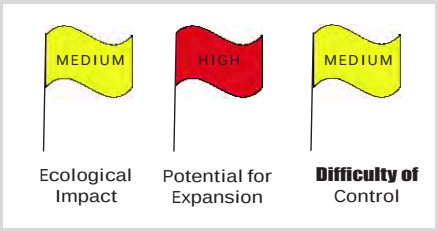
Crown vetch becomes a problem when it invades natural areas, such as native grassland prairies and dunes, where it works to exclude native vegetation by fully covering and shading those native plants. It can climb over small trees and shrubs, and eventually form large monocultures. It seeds prolifically, but can also rapidly spread by rhizome growth. Due to its nitrogen fixing capabilities, it has the capacity to adversely affect the nitrogen cycle of the native communities that may depend on infertile soils. It can also alter available fuel loads in fire-adapted ecosystems, changing fire intensity.

Origin:

Crown vetch is from the Mediterranean region of Europe, northern Africa and southwest Asia. It was introduced to the United States in the 1950's and was primarily used for erosion control. Its use for erosion control has greatly decreased in Indiana, given both its invasiveness and the availability of species that are much better at controlling erosion.

Picture By: D. Powell @ www.invasive.org.

IPSAWG Ranking:



IPSAWG Recommendation:

- Do not buy, sell or plant crown vetch in Indiana.
- Help by eradicating crown vetch on your property.

This ranking illustrates the results of an assessment conducted by the **Invasive Plant Species Assessment Working Group** (IPSAWG), which is made up of many organizations and agencies concerned about invasive plant species. IPSAWG's goal is to assess which plant species may threaten natural areas in Indiana and develop recommendations to reduce their use in the state.

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ALTERNATIVES
to crown vetch:

Roundheaded bushclover
(*Lespedeza capitata)*

Purple vetch
(*Vicia americana*)

Goat's-rue
(*Tephrosia virginiana*)

Creeping Phlox
(*Phlox subulata*)

Pictures By (Top to Bottom): K. Yatskievych, G. Monroe @ USDA-NRCS Plants Database, D. Reed @ www.2bnthewild.com and T. Barnes @ USDA-NRCS Plants Database.

Control Methods:

Herbicides are currently the most effective means to control large infestations of crown vetch. Higher rates of effectiveness can be obtained if the herbicide treatment follows the removal of the accumulated plant litter by burning, mowing or grazing. In early spring, 2, 4-D amine can be foliar-applied for good control. Glyphosate can also be foliarly applied in early spring at 1 or 2% solution. Triclopyr applied at a 2% solution reportedly kills 99% of crown vetch in large infestations. Clopyralid is an even more target-specific herbicide. A 0.25% solution of clopyralid with 0.5% surfactant can reportedly kill 100% of crown vetch cover. Manual or mechanical methods can be used to control crown vetch. However, these methods are often time consuming and labor-intensive, as all pieces of the stems, roots, and rhizomes must be carefully removed.

Mowing can eventually control crown vetch if it is repeated several times a year for several years. Prescribed burning may also be effective in late spring but should also be repeated for several years. **Always read and follow pesticide label directions.**

Dense growth of crown vetch.
Picture By: C. Evans @ www.invasive.

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4. Clean your boots before and after visiting a natural area to prevent the spread of invasive plant seeds.
5. Don't release aquarium plants into the wild.
6. Volunteer at local parks and natural areas to assist ongoing efforts to diminish the threat of invasive plants.
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8. Support public policies and programs to control invasive plants.

For More Information:

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IPSAWG
www.invasivespecies.IN.gov

On identification and control techniques:

The Nature Conservancy's Wildland Weeds
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On native plant alternatives and sources:

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INVASIVE PLANT SPECIES FACT SHEET

Asian Bush Honeysuckle

Lonicera maackii, L. tatarica, L. morrowii, L. X bella

Amur, Tartarian, Morrow's, Belle's honeysuckle

IPSAWG
Invasive Plant Species Assessment Working Group

Pictures By (From Top to Bottom): J. M. Randall, T. Ransburg and Indy Parks.

Invasive Plants are a Threat to:

- **Forests and wetlands**
- **Native plants**
- **Perennial gardens**
- **Wildlife**
- **Lakes and rivers**
- **Human Health**
- **Farmland**

Date Updated: 10/06

Description:

These upright shrubs with arching branches are 6-15 feet tall. Each of these species has opposite leaves with paired berries and hollow branchlets. They stand out in the understory of forests as the first shrubs to leaf out in the spring and the last to lose their leaves in the fall. The paired, tubular flowers are white on Amur and Morrow honeysuckle, pink on Tartarian honeysuckle, and vary from white to deep rose on Belle's honeysuckle. The red to orange berries are dispersed by birds. Commonly sold cultivars include Arnold's Red, Zabelli and Rem Red.

Distribution:

These invasive bush honeysuckles generally range from the central Great Plains to southern New England and south to Tennessee and North Carolina. In Indiana they are particularly invasive in central and northern parts of the state, but are starting to move into the southern portion. Asian bush honeysuckles are relatively shade-intolerant and most often occur in forest edge, abandoned fields, roadsides and open wetlands. However, they will move into forest understories and dominate wherever there has been disturbance.

Problem:

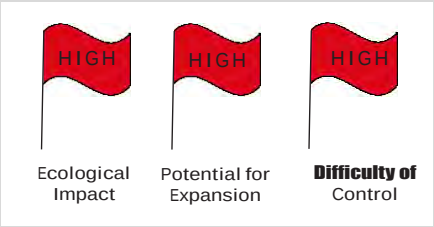
Asian bush honeysuckles grow so densely they shade out everything on the forest floor, often leaving nothing but bare soil. This means a great reduction in the food and cover available for birds and other animals. Serious infestations can inhibit tree regeneration, essentially stopping forest succession. Higher rates of nest predation have been found in Amur honeysuckle than in native shrubs due to nests being more exposed to predators. Some bush honeysuckle species also release chemicals into the soil to inhibit other plant growth, effectively poisoning the soil.

Origin:

The Asian bush honeysuckles originate in Eurasia (Japan, China, Korea, Manchuria, Turkey and southern Russia). They were introduced as ornamentals, for wildlife cover and for soil erosion control. However, their aggressive domination of native communities make them a bad choice for these purposes.
See back for alternative species.

Picture By: J. H. Miller @ www.invasive.org.

IPSAWG Ranking:



IPSAWG Recommendation:

- Do not buy, sell or plant Asian bush honeysuckle in Indiana
- Help by eradicating Asian bush honeysuckle on your property.

This ranking illustrates the results of an assessment conducted by the **Invasive Plant Species Assessment Working Group** (IPSAWG), which is made up of many organizations and agencies concerned about invasive plant species. IPSAWG's goal is to assess which plant species may threaten natural areas in Indiana and develop recommendations to reduce their use in the state.

For more information about IPSAWG and the assessment tool used to rank invasive species, visit their website:

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ALTERNATIVES to Asian bush honeysuckles:

Dogwoods
(*Cornus sericea, C. amomum, and C. racemosa)*

Chokeberry
(*Aronia melanocarpa*)

Winterberry
(*Ilex verticillata*)

Northern arrowwood
(*Viburnum dentatum*)

Pictures By (Top to Bottom): D. E. Herman, U Conn, Indy Parks and D. E. Herman.

Other Alternatives:

Blackhaw
(*Viburnum prunifolium*)
Serviceberry
(*Amelanchier arborea*)

Control Methods:

Mechanical and chemical methods are the primary means of control of Asian bush honeysuckles. No biological control agents are currently available for these plants. Hand removal of seedlings or small plants may be useful for light infestations, but care should be taken not to disturb the soil any more than necessary.

Asian bush honeysuckles can also be controlled by application of a systemic herbicide, like glyphosate (e.g. Roundup), at a 1% solution, sprayed onto the foliage or applied by sponge. This should be done in fall when native species are dormant and bush honeysuckle is still green. Well-established stands of Asian bush honeysuckles are probably best managed by cutting the stems to ground level and painting or spraying the stumps with a 20-30% solution of glyphosate or 8% solution of triclopyr (e.g. Ortho Brush B-Gon concentrate). Always read and follow pesticide label directions.

Dark green dense thicket of Asian bush honeysuckle under the forest canopy. (Picture By: Indy Parks)

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4. Clean your boots before and after visiting a natural area to prevent the spread of invasive plant seeds.
5. Don't release aquarium plants into the wild.
6. Volunteer at local parks and natural areas to assist ongoing efforts to diminish the threat of invasive plants.
7. Help educate your community through personal contacts and in such settings as garden clubs and civic groups.
8. Support public policies and programs to control invasive plants.

For More Information:

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www.invasivespecies.IN.gov

On identification and control techniques:

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www.tncweeds.ucdavis.edu

On native plant alternatives and sources:

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INVASIVE PLANT SPECIES FACT SHEET

IPSAWG
Invasive Plant Species Assessment Working Group

Autumn Olive

Elaeagnus umbellata

Pictures By: G. Fewless

Invasive Plants are a Threat to:

- **Forests and wetlands**
- **Native plants**
- **Perennial gardens**
- **Wildlife**
- **Lakes and rivers**
- **Human Health**
- **Farmland**

Date Updated: 10/06

Description:

Autumn olive is a medium to large deciduous shrub. Its leaves are alternate, oval to lanceolate, untoothed and grow to 1-3 inches in length. The upper surface of the leaves is dark green to grayish-green in color, while the lower surface is covered with silvery white scales. The small, light yellow flowers are borne along twigs after the leaves have appeared early in the growing season. The fruits are small, round, juicy, reddish to pink, dotted with scales and are produced in great quantity.

Distribution:

Autumn olive is found in disturbed areas, along roadsides, in pastures, fields and sparse woodlands. It is often found in poor soils due to its nitrogen-fixing root nodules that allow it to tolerate poor conditions. It can also survive the effects of salt, drought and pHs as low as 4.0. However, it does not grow well in wet habitats or in dense forests. Autumn olive is now found over the eastern half of the United States and in all counties of Indiana.

Problem:

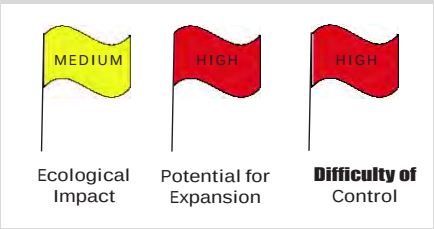
Autumn olive exhibits prolific fruiting, rapid growth, is widely dispersed by birds and can thrive in poor soil. It has the ability to produce up to 80 pounds of fruit in a single season. Due to its nitrogen fixing capabilities, it has the capacity to adversely affect the nitrogen cycle of the native communities that may depend on infertile soils. It is vigorous and competitive against native species in open communities like prairies and savannas and resprouts after cutting or burning. It also creates heavy shade which suppresses plants that require direct sunlight.

Origin:

Autumn olive is native to China, Korea and Japan. It was first introduced to United States from Japan in 1830. In Indiana, as in the rest of the country, autumn olive was often used for the revegetation of disturbed habitats. It has also been sold commercially for roadsides, landscaping and gardens.

Picture By: J. Allison @ www.invasive.org.

IPSAWG Ranking:



IPSAWG Recommendation:

- Do not buy, sell or plant autumn olive in Indiana.
- Help by eradicating autumn olive on your property.
- Also avoid Russian olive (Elaeagnus angustifolia L.); this species is considered invasive in many parts of the Midwest though not yet in Indiana.

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ALTERNATIVES to Autumn olive:

Dogwoods
(*Cornus sericea, C. amomum, and C. racemosa)*

Chokeberry
(*Aronia melanocarpa*)

Winterberry
(*Ilex verticillata*)

Northern arrowwood
(*Viburnum dentatum*)

Pictures By (Top to Bottom): D. E. Herman, U Conn, Indy Parks and D. E. Herman.

Other Alternatives:

Blackhaw
(*Viburnum prunifolium*)
Serviceberry
(*Amelanchier arborea*)

Control Methods:

Hand pulling autumn olive seedlings can be effective. However, mowing or cutting autumn olive plants can cause vigorous resprouting. Even repeated cutting is usually ineffective without treating stumps and/or resprouts with herbicide. Several herbicides have been used alone or in combination to control autumn olive, including glyphosate and triclopyr. Foliar applications of triclopyr (1-2%) or glyphosate (1-2%) are effective on resprouts following cutting during the growing season. Glyphosate (20%) can also be effective when applied directly to cut stumps. Applying 2% triclopyr mixed with a basal oil directly to the bark on the lower portion of the woody plant is also an effective control. Multiple treatments may be required. **Always read and follow pesticide label directions.**

An autumn olive plant. (Picture By: J. Miller @ www.invasive.org)

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8. Support public policies and programs to control invasive plants.

For More Information:

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On identification and control techniques:

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www.inpaws.org

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Norway Maple

(*Acer platanoides)*

Homeowners Fact Sheet

Tips for identifying, controlling, and monitoring Norway maple on your property

Background

Norway maple (*Acer platanoides*) is a tree that is native to Europe and Asia. It was first introduced to the United States in 1756 by John Bartram of Philadelphia as a street and ornamental tree. It is now one of the most common street/shade trees in the U.S. It is a fast-growing tree that is tolerant of full sun to shade, many soil types, and pollution. Several cultivars are also considered invasive.

Why Should You Care?

Norway maple leafs out early and creates dense shade that displaces native herbs, shrubs, and trees in regional habitats that are important to native animals for food and shelter. Its shallow root system also competes with native plants. The milky sap found in its leaves gums up native insect mouth parts so they cannot eat its leaves. It produces many seeds early in the year that are wind dispersed and invade forests and forest edges.

Five lobed leaf (Photo taken by Jan Samanek, State Phytosanitary Administration, www.bugwood.org)

Golden yellow autumn foliage (Photo taken by L. Mehrhoff, University of Connecticut, www.bugwood.org)

Winged samaras joined in a straight line. (Photo taken Paul Wray, IA State University, www.bugwood.org)

Identification

- Perennial tree that leafs out earlier than native trees.
- It is one of the last trees to change color in autumn; leaves turn golden yellow in autumn and then fall
- Grows 40-90 feet tall
- Paired leaves are dark green, 5”-7” with 5 lobes
- Has milky white sap in leaves, petioles, and young twigs; test by pulling a leaf off a twig
- Non-native *Acer truncatum* (Purpleblow Maple, eastern Asia) is very similar and the only other hardy maple that has milky sap. It has not yet been reported as escaped or invasive but it has potential.
- Oval or rounded crown with central leader
- Bark is grey with shallow, regular grooves
- In spring the tree is covered with small, rounded clusters of yellow-green flowers before the leaves emerge (April to May)
- Cultivars ‘Crimson King’ and ‘Schwedleri’ have dark purple autumn foliage, ‘Drummondii’ has variegated leaves, and ‘Emerald Queen’ has light green leaves.
- Fruits mature into paired winged samaras (wings join along a straight line) with seeds

Some Suggested Prevention and Control Methods

Do not plant Norway maple or any cultivars including 'Crimson King,' 'Schwedleri,' 'Emerald Queen,' 'Drummondii,' 'Dissectum,' 'Lorbergii,' 'Columnare,' and 'Pendulum' due to the potential for cross-fertilization between two 'sterile' cultivars. Replace these trees with recommended alternatives.

Mechanical Small infestations of seedlings and shallow-rooted plants can be hand-pulled when the soil is moist, but take care to remove the entire plant including all the root portions to prevent regrowth. Always wear gloves and long sleeves to protect your skin from poison ivy and barbed or spined plants.

Although this species doesn't normally spread by root sprouts, when the top is removed this species may sprout from surface roots.

Chemical

Foliar application 2% glyphosate or 1.5% triclopyr solution can be applied to leaves and green stems of trees in small thickets during late summer – early autumn. Apply enough herbicide to wet the leaves, but not have dripping. To allow for ample drying, applications should be made when rain is unlikely for about 12 hours after application and leaves should be dry prior to treatment. Wind speed should be below 8-10 mph to avoid off-site drift to non-target plants.

Basal bark application is one of the easier methods available, does not require any cutting, and uses a small amount of herbicide mix. It works best during late winter/early spring (February 15 - April 15). The base of the tree must be free of snow, ice, or water on the bark from recent rainfall before application; precipitation after application has no effect.

Mix a 20% concentration of oil-soluble triclopyr and 80% oil (mineral oil or vegetable oils). Add dye to the mixture to keep track of treated plants. Another option is to use a premixed, ready-to-use triclopyr product designed for basal bark application. Using a handheld or backpack sprayer, apply the mixture in a 12-inch wide band around the entire circumference of the tree base with no "skips." The basal bark method is generally used for trees that are less than 6 inches in diameter, though slightly larger stems may also be treated effectively by thoroughly treating bark up to 24 inches in height. Follow-up foliar application to basal sprouts and root suckers may be necessary.

Combination of chemical and mechanical

Trees that are greater than 6 inches in diameter may need to be cut down and stumps treated with a glyphosate or triclopyr -based herbicides. We recommend getting professional help with trees of this size!

Follow-up

When Norway maple is removed from the site fill that space with native or non-invasive plants by seeding or planting. Attractive native trees and shrubs are available that provide nectar, seed, and host plant material for butterflies, hummingbirds, and other wildlife. Alternatives include sugar maple (*Acer saccharum*), red maple (*Acer rubrum*), red chokeberry (*Aronia arbutifolia*), black chokeberry (*Aronia melanocarpa*), large fothergilla (*Fothergilla major*), Fothergilla 'Mt. Airy,' and 'Blue Shadow' (cultivars), Virginia sweetpire (*Itea virginica*), blackhaw (*Viburnum prunifolium*), and shining sumac (*Rhus copallinum*). Alternatives can also be found at http://www.mortonarb.org/trees-plants/tree-and-plant-finder/using-tree-and-plant-finder

Precautions

- Herbicidal contact with desirable plants should always be avoided. If native grasses are intermingled with the Norway maple, triclopyr should be used because it is selective for broad-leaved plants and will not harm grasses.
- Because triclopyr amine is a water-soluble salt that can cause severe eye damage, it is imperative that you wear protective goggles to protect yourself from splashes. Triclopyr ester is soluble in oil or water, is highly volatile, and can be extremely toxic to fish and aquatic invertebrates. It should not be used in or near water sources or wetlands and should only be applied under cool, dry, and low wind conditions. Do not use when the temperature is higher than 85˚F
- If using herbicide, be sure to follow all label instructions.

Equipment & Supplies You May Need

Herbicide (glyphosate or triclopyr)

Rubber gloves and appropriate eye protection

Long pants, long sleeved shirt, socks, closed-toe shoes

Spray bottle or backpack sprayer and liquid dye (food coloring or Rit dye works)

Patience, persistence, and commitment (this will take years)

Additional Resources

Introduced Species Summary Project, Columbia University
http://www.columbia.edu/itc/cerc/danoff-burg/invasion_bio/inv_spp_summ/Acer_platanoides.html

Midwest Invasive Plant Network Control Database

http://mipncontroldatabase.wisc.edu/

Northeast Illinois Invasive Plant Partnership www.niipp.net

NIIPP

Lake County Forest Preserves
www.LCFPD.org

Callery pear

(*Pyrus calleryana)*

Homeowners Fact Sheet

Tips for identifying, controlling, and monitoring Callery pear on your property

Background

Callery pear (*Pyrus calleryana*) is a tree that is native to Asia. It has been introduced to the United States many times since the early 1900s, first as a rootstock for common pear and then for ornamental use in landscape borders and along city streets. Callery pear has several cultivars or varieties that are also invasive because they are able to breed with other cultivars. Callery pear threatens woodlands, savannas, prairies, and areas of full sun and well-drained soils.

Why Should You Care?

Callery pear displaces native shrubs and trees in regional habitats that are important to native animals for food and shelter. Birds eat its fruit and spread its seeds over long distances and the trees also spread through root suckers especially when top growth has been injured or removed. Infestations have been reported at Morton Arboretum, Midewin National Tallgrass Prairie, and in natural areas throughout DuPage County. Callery pear and its cultivars are still widely sold and planted throughout northeastern Illinois.

White Callery pear blossoms in spring. (Photo taken from Virginia Tech vTree website.)

Rounded leaf with serrated edges . (Photo taken from Virginia Tech vTree website.)

Pear bud and twig. (Photo taken from Virginia Tech vTree website.)

In late spring the tree produces small fruits that turn from green to brown. (Photo taken from Virginia

Identification

- Perennial tree that loses its leaves in autumn.
- Trees produce white flowers with five petals in March and April. Usually one of the first trees to bloom in spring. Flowers appear before the leaves.
- Leaves are alternate, 2-3 inches wide, heart-shaped to round, margins wavy with fine teeth
- Leaves stay green late in autumn and then turn scarlet or purple in late October/early November.
- Tree trunks single then branching; tree grows 30-50 feet tall with crowns 20-30 feet wide
- Fruits are round, half inch wide, and change color from green to brown as they mature.
- Trees are weak-wooded and prone to storm and ice damage; many cultivars have narrow branching angles that can exacerbate the problem.

Some Suggested Prevention and Control Methods

Do not plant Callery pear or any cultivars including 'Aristocrat', 'Autumn Blaze', 'Bradford' (the commonly planted Bradford pear), 'Capital', 'Chanticleer' (also known as 'Cleveland Select'), 'Fauriei,' 'Jaczam,' 'Jilzam,' 'New Bradford,' 'Redspire,' and 'Whitehouse.' Replace these pear trees with recommended native and non-invasive alternatives.

Mechanical Small infestations of seedlings and shallow-rooted plants can be hand-pulled when the soil is moist, but take care to remove the entire plant including all the root portions to prevent regrowth. Always wear gloves and long sleeves to protect your skin from poison ivy and barbed or spined plants.

Chemical

Foliar application 2% glyphosate or 1.5% triclopyr solution can be applied to leaves and green stems of trees in small thickets during late summer – early autumn. Because this tree holds its leaves late, foliar treatment can be done in late October (weather permitting) with minimal collateral damage to surrounding natives. Apply enough herbicide to wet the leaves, but not have dripping. Make sure the air temperature is above about 65°F (and no higher than 80°F for triclopyr) to ensure absorption of the herbicide. To allow ample drying, applications should be made when rain is unlikely for about 12 hours after application and leaves should be dry prior to treatment. Wind speed should be below 8-10 mph to avoid off-site drift to non-target plants.

Basal bark application is one of the easier methods available, does not require any cutting, and uses a small amount of herbicide mix. It works best during late winter/early spring (February 15 - April 15). The base of the tree must be free of snow, ice, or water on the bark from recent rainfall before application; precipitation after application has no effect.

Mix a 20% concentration of oil-soluble triclopyr and 80% oil (mineral oil or vegetable oils). Add dye to the mixture to keep track of treated plants. Another option is to use a premixed, ready-to-use triclopyr product designed for basal bark application. Using a handheld or backpack sprayer, apply the mixture in a 12-inch wide band around the entire circumference of the tree base with no "skips." The basal bark method is generally used for trees that are less than 6 inches in diameter, though slightly larger stems may also be treated effectively by thoroughly treating bark up to 24 inches in height. Follow-up foliar application to basal sprouts and root suckers may be necessary.

Combination of chemical and mechanical

Trees that are greater than 6 inches in diameter may need to be cut down and stumps treated with a glyphosate or triclopyr -based herbicides immediately after cutting. We recommend getting professional help with trees of this size!

Follow-up

As Callery pear is removed from the site fill that space with native or non -invasive plants by seeding or planting. Excellent substitutes for Callery pear include common serviceberry (*Amelanchier arborea*), Allegheny serviceberry (*Amelanchier laevis*), cockspur hawthorne (*Crataegus crusgalli*), green hawthorne (*C. viridis*), Pagoda Dogwood (*Cornus alternifolia*), Redbud (*Cercis canadensis*), Blackhaw (*Viburnum prunifolium*), and Sweet Crab Apple (*Malus coronaria*). There are also a variety of cultivars that have been selected for their fall color or absence of thorns: Autumn Brilliance Serviceberry (*Amelanchier* x grandiflora 'Autumn Brilliance'), Princess Diana Serviceberry (*Amelanchier* x grandiflora 'Princess Diana'), Thornless Cockspur Hawthorn (*Crataegus crusgalli* var. *inermis*), and Winter King Hawthorn (*Crataegus viridis* 'Winter King'). For late fall flowering, Common Witchhazel (*Hamamelis virginiana*) is also a very attractive small native understory tree.

Precautions

- Herbicidal contact with desirable plants should always be avoided. If native grasses are intermingled with the Callery pear, triclopyr should be used because it is selective for broad-leaved plants and will not harm grasses.
- Because triclopyr amine is a water-soluble salt that can cause severe eye damage, it is imperative that you wear protective goggles to protect yourself from splashes. Triclopyr ester is soluble in oil or water, is highly volatile, should not be used at temperatures above 80˚F, and can be extremely toxic to fish and aquatic invertebrates. It should not be used in or near water sources or wetlands and should only be applied under cool, dry, and low wind conditions. Do not use when the temperature is higher than 85˚F
- If using herbicide, be sure to follow all label instructions
- Monitor treated area and treat resprouts!

Equipment & Supplies You May Need

Herbicide (glyphosate or triclopyr)

Rubber gloves and appropriate eye protection

Long pants, long sleeved shirt, socks, closed-toe shoes

Spray bottle or backpack sprayer

Liquid dye (food coloring or Rit dye works)

Patience, persistence, and commitment (this will take years)

Additional Resources

This brochure borrowed heavily from **Plant Invaders of Mid-Atlantic Natural Areas** http://www.nps.gov/plants/alien/pubs/midatlantic/

Midwest Invasive Plant Network Control Database

http://mipncontroldatabase.wisc.edu/

Northeast Illinois Invasive Plant Partnership www.niipp.net

NIIPP

Lake County Forest Preserves
www.LCFPD.org

Purple Loosestrife

Lythrum salicaria

Iowa Aquatic Invasive Species Fact Sheet

Description: Purple loosestrife is a stout, hardy perennial most easily identified by purple to magenta flowers that appear from late June to September. Flowers are five to six-petaled and are crowded on long terminal spikes. Leaves are linear, smooth-edged, and hairy. Leaves are usually arranged in opposite pairs that alternate down the stalk at 90^{o} angles; however, they may be in whorls of three or four. Stems are stiff, four to six-sided, and angular. Plants grow up to seven feet tall. Purple loosestrife spreads primarily from seed but also from underground shoots and roots of established plants. Mature plants can produce over 2,000,000 seeds. The tiny, flat seeds can live in soil and water for many years and can be transported great distances by humans, animals, water, and wind.

Distribution: Purple loosestrife is native to Europe and Asia where it is a minor component of wetland vegetation. European settlers introduced purple loosestrife to North America in the 1800's probably as an ornamental plant. Because of its popularity as a garden plant and its prolific reproduction, purple loosestrife has spread to almost every state in the United States and all Canadian provinces. It is unknown when purple loosestrife first invaded Iowa; however, infestations are scattered across the state and on many of the islands of the Mississippi River.

Threats: Purple loosestrife is highly invasive and forms dense, monotypic stands that reduce both plant and wildlife diversity. It is not a desirable food or habitat for wildlife, provides poor spawning habitat, and clogs drainage ditches. Purple loosestrife can infest almost any shallow water site (wetlands, streambanks, lakeshores, ditches) because it is tolerant of a wide range of moisture, nutrient, and climate conditions. It adapts readily to disturbed sites such as dredged ditches or eroding streambanks.

Control: Preventing new introductions is the best method of control for purple loosestrife because it has no natural controls (insects, fungi, bacteria) in Iowa. Limiting the spread of purple loosestrife infestations and minimizing the impacts of infestations are much more difficult than preventing introductions. Purple loosestrife infestations are managed with conventional methods such as hand-pulling, cutting, burning, water level manipulation, and herbicide treatments. Most of these methods kill purple loosestrife plants but not the large seedbank in the soil that supports reestablishment; therefore; these control methods may have to be repeated on a yearly basis. Biological control agents are being evaluated for their effectiveness in controlling purple loosestrife. In Iowa, two leaf-eating beetles, *Galerucella pusilla* and *Galerucella calmariensis*, have been released at several purple loosestrife sites and are being monitored for population growth and reduction of purple loosestrife density.

Laws: Iowa law makes it illegal to 1) possess, introduce, purchase, sell, propagate, or transport aquatic invasive species in Iowa, 2) place a trailer or launch a watercraft with aquatic invasive species attached in public waters, and 3) operate a watercraft in a marked aquatic invasive species infestation. The scheduled fine is $500 for violating any of the above regulations. The law also requires the DNR to identify waterbodies infested with aquatic invasive species and post signs alerting boaters. The DNR may restrict boating, fishing, swimming, and trapping in infested waters.

Fact Sheet: Lesser Celandine

Lesser Celandine

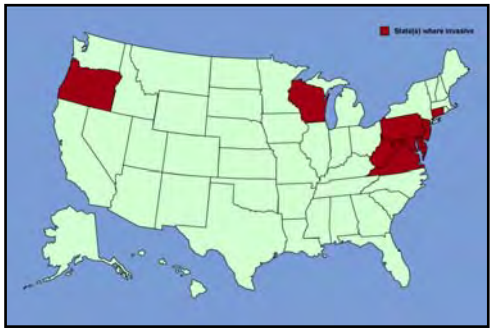
Ranunculus ficaria L.
Buttercup family (Ranunculaceae)

NATIVE RANGE
Europe

DESCRIPTION
Lesser celandine, also known as fig buttercup, is an herbaceous, perennial plant. Plants have a basal rosette of dark green, shiny, stalked leaves that are kidney- to heart-shaped. The flowers open in March and April, have eight glossy, butter-yellow petals, and are borne singly on delicate stalks that rise above the leaves. Pale-colored bulblets are produced along the stems of the above-ground portions of the plant, but are not apparent until late in the flowering period. When in bloom, large infestations of lesser celandine appear as a green carpet with yellow dots, spreading across the forest floor. There are many varieties of lesser celandine including a double-flowered form with many crowded petals and dark green leaves mottled with silvery markings.

NOTE: Lesser celandine closely resembles marsh marigold (*Caltha palustris*), a native wetland plant that occurs in the eastern United States. Marsh marigold is a robust plant with glossy, rounded or kidney-shaped leaves and flowers on stalks that are 8 in (20.3 cm) or more in height and consist of five to nine deep yellow "petals" (actually sepals). Marsh marigold does not produce tubers or bulblets, nor does it form a continuous carpet of growth. Extreme care should be taken to correctly identify lesser celandine before undertaking any control measures to avoid impacts to this plant.

ECOLOGICAL THREAT
Lesser celandine is an exotic spring ephemeral and a vigorous growing groundcover that forms large, dense patches on the forest floor, displacing and preventing native plants from co-occurring. The ecological impact of lesser celandine is primarily on the native spring-flowering plant community and the various wildlife species associated with them. Spring ephemerals complete the reproductive part of their life cycle and most of their above-ground development before woody plants leaf out and shade the forest floor. Native spring ephemerals include bloodroot, common and cut-leaved toothwort, Dutchman's breeches, harbinger-of-spring, squirrel-corn, trout lily, Virginia bluebells, and many others. Because lesser celandine emerges well in advance of the native species, it can establish and overtake areas rapidly.



DISTRIBUTION IN THE UNITED STATES
Lesser celandine is currently found in nineteen states in the Northeast and Pacific Northwest (USDA PLANTS). It is reported to be invasive in nine states (Connecticut, Delaware, Maryland, New Jersey, Oregon, Pennsylvania, Virginia, Wisconsin, West Virginia), and the District of Columbia (WeedUS Database).

HABITAT IN THE UNITED STATES
Lesser celandine occurs in moist forested floodplains and in some drier upland areas, and seems to prefer sandy soils.

BACKGROUND
Lesser celandine was introduced to the United States as an ornamental plant. It is still available commercially in the U.S., along with many colorful varieties. All varieties of lesser celandine should be assumed to be invasive.

BIOLOGY & SPREAD

Lesser celandine is an exotic perennial plant and spring ephemeral that spends much of the year (summer through early winter) underground as thickened, fingerlike tubers or underground stems. During the winter, leaves begin to emerge and photosynthesize in preparation for flowering. Flowering usually occurs from late winter through mid-spring (March through May), depending on conditions. Afterwards, the above-ground portions die back. Lesser celandine spreads primarily by vegetative means through abundant tubers and bulblets, each of which is ready to become a new plant once separated from the parent plant. The tubers of lesser celandine are prolific and may be unearthed and scattered by the digging activities of some animals, including well-meaning weed pullers, and transported during flood events.

MANAGEMENT OPTIONS

Lesser celandine is very difficult to control but it can be managed with persistence over time using methods that are site appropriate. While manual methods are possible for some (small) infestations, the use of systemic herbicide kills the entire plant tip to root and minimizes soil disturbance.

Biological

No biological control agents are currently available for lesser celandine.

Chemical

The window of opportunity for controlling lesser celandine is very short, due to its life cycle. In order to have the greatest negative impact to celandine and the least impact to desirable native wildflower species, herbicide should be applied in late winter-early spring (March through May). Apply a 1.5% rate of a 39 to 41% glyphosate isopropylamine salt (e.g., Rodeo® for wetland areas) mixed with water and a non-ionic surfactant to foliage, avoiding application to anything but the celandine. Glyphosate is systemic; that is, the active ingredient is absorbed by the plant and translocated to the roots, eventually killing the entire plant. The full effect on the plant may take 1-2 weeks. Applications can be made during the winter season as long as the temperature is above about 50 degrees Fahrenheit, and no rain is anticipated within 12 hours. Because glyphosate is non-specific, spray should be controlled such that it touches only lesser celandine and does not drift onto desirable plants. To minimize impacts to sensitive-skinned frogs and salamanders, some experts recommend applying herbicide in March and then switching to manual methods.

Manual

For small infestations, lesser celandine may be pulled up by hand or dug up using a hand trowel or shovel. It is very important to remove all bulblets and tubers.

Mechanical

If mechanical removal is to continue after dieback of the plants, individual plants or clumps will need to be marked with some sort of stakes or flagging because it will be impossible to relocate the plants otherwise. When conducting mechanical removal, care should be taken to minimize soil disturbance as much as possible. For this reason, mechanical control may be inappropriate for large infestations in high quality natural areas.

USE PESTICIDES WISELY: Always read the entire pesticide label carefully, follow all mixing and application instructions and wear all recommended personal protective gear and clothing. Contact your state department of agriculture for any additional pesticide use requirements, restrictions or recommendations.

NOTICE: mention of pesticide products on this page does not constitute endorsement of any material.

CONTACT

For more information on the management of lesser celandine, please contact:

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- Jil Swearingen, Integrated Pest Management Coordinator, National Capital Region, Center for Urban Ecology, National Park Service, Washington, DC, jil_swearingen at nps.gov

SUGGESTED ALTERNATIVE PLANTS

Many lovely, perennial, spring-flowering plants are available as non-invasive alternatives to lesser celandine. Some examples of plants native the eastern U.S. include wild ginger (*Asarum canadense*), Dutchman's breeches (*Dicentra cucullaria*), squirrel-corn (*Dicentra canadensis*), cutleaf toothwort (*Cardamine concatenata*), twinleaf (*Jeffersonia diphylla*), and bloodroot (*Sanguinaria canadensis*). Contact your local native plant society for additional suggestions and assistance. The Plant Conservation Alliance provides links to many groups at (http://www.nps.gov/plants).

OTHER LINKS

- http://www.invasive.org/search/action.cfm?q=Ranunculus%20ficaria
- http://www.lib.uconn.edu/webapps/ipane/browsing.cfm?descriptionid=89

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Garlic Mustard
(*Alliaria petiolata*)
Mustard Family (Brassicaceae)

DESCRIPTION

Garlic mustard is a cool-season biennial herb that ranges from 6 to 48 inches in height as an adult flowering plant. Leaves and stems emit the distinctive odor of garlic when crushed (particularly in spring and early summer), and help distinguish the plant from all other woodland members of the mustard family and from violets which they resemble somewhat in the rosette stage.

flowering plants

Height - Flowering or fruiting plants can range from a few inches to 4 feet in height. The ability of garlic mustard to produce flowers and seeds even on very small, suppressed plants, is one of the reasons for its success.

winter rosette

Leaves - The first-year plant is in the form of a rosette with kidney-shaped leaves that remain green throughout the winter. The second year, a flowering stem is produced with triangular-shaped leaves that are sharply toothed. Crushed leaves emit a garlic-like odor.

stem leaf

Flowers - The flowers appear in a cluster at the end of an erect stem that elongates as more blossoms open at the top and fruits form toward the bottom. Each small flower has four white petals; the blooming period extends from April through June. Either self-pollination or cross-pollination by bees or flies may occur.

Fruits and Seeds - The fruits are long, slender capsules that become tan in color as the seeds mature. Garlic mustard seeds do not appear to have any specialized dispersal mechanisms, most seeds fall within a few yards of the parent plant. However, the seeds are likely carried a greater distance by adhering to peoples' feet and perhaps the exterior of dogs, deer, and other animals, especially when their fur is wet. Floodwaters also distribute seeds. The dry fruiting stalks often remain standing into the winter. Seed production has been observed to range from as few as 14 to several thousand per plant.

HABITAT

Garlic mustard generally prefers some shade but occasionally grows in full sun; it can be found in upland and floodplain forests, yards, and along roadsides. It requires moist, but well-drained soil conditions and does not grow in highly acidic sites. This plant invades forests first at the edge, but progresses into the interior along streams, trails, and other corridors of disturbance.

DISTRIBUTION

Garlic mustard originated in Europe and was introduced to the United States for herbal and medicinal purposes. It was first recorded in the United States in 1868 in Long Island, New York. By 1991, garlic mustard had invaded 28 midwestern and northeastern states. Today it can be found throughout Pennsylvania.

EFFECTS OF INVASION

Garlic mustard aggressively out-competes native species in the understory of forests and woodlands. The overwintering rosettes of this plant resume growth in early spring when many native forest wildflowers are also active. As a result, garlic mustard competes with native forest floor wildflowers for sunlight at a critical time before the trees leaf out. Deer appear to favor the proliferation of garlic mustard due to their preference for native forest floor species.

Garlic mustard also affects the development of several native butterflies. Cabbage whites normally feed on toothwort, a native early spring wildflower in the Mustard Family. The butterflies have been observed laying their eggs on garlic mustard when it is abundant in the forest understory. However, larvae of cabbage whites rarely survive on garlic mustard due to the presence of feeding deterrents. Thus the garlic mustard, which is taller than toothwort, is serving as a sink for these native butterflies.

REPRODUCTION AND METHOD OF DISPERSAL

Large quantities of seed are produced and can remain viable in the soil for 4 years. The seeds are dispersed by water, animals, or humans. Garlic mustard seeds germinate in the spring, following a dormancy period that ranges from 8 to 20 months. By fall they have formed a low rosette of evergreen leaves that is visible all winter; the following spring a flowering stem develops. After the seeds mature the plant dies.

CONTROL

Mechanical - Techniques for controlling of garlic mustard include hand pulling and cutting, and are most effective on smaller infestations. Hand pulling of plants can be very effective, although labor intensive. Care must be taken to insure that the entire plant is removed and that all plant materials are bagged and moved off-site. A flowering plant can continue to mature and produce seeds even if it has been pulled up. Hand pulling and removal must continue yearly until the seed bank is exhausted.

Cutting populations of garlic mustard is effective for medium to large concentrations of plants. Stems may be cut by mowing, brush cutting, or by hand when the plants are in flower. This can result in total mortality of the plants, however it does not affect the seed bank. Cutting must also continue every year until the seed bank is exhausted. Prescribed

fire can be an effective control agent in controlling garlic mustard given the proper location and fire intensity. Repeated burns over several years are necessary.

Chemical - Foliar application of herbicide can be used to control populations of garlic mustard where mechanical methods may not be effective, such as large infestations. Glyphosate is effective, however it is not selective, so non-target species in the vicinity of the application may be affected. To minimize impact on other species, herbicide should be applied to the first year rosettes during the late fall and early spring when other plants are dormant.

Biological - Currently there are no programs in use, however research is being conducted to find a potential biological control agent.

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Internet resources - http://www.upenn.edu/paflora, http://www.invasivespecies.gov

Invasive species fact sheet prepared by:
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Appendix D
Invasive Species Management Specification

SECTION XXX

STREAM RESTORATION INVASIVE SPECIES MANAGEMENT

PART 1 – GENERAL

1.01 SUMMARY

A. The Work consists of removing select invasive species through the use of chemical treatment or mechanical removal.

B. Mechanical methods physically remove or inflict damage on the target species using machinery, power tools, or hand devices that cut, dig, pull, or till plants. Mechanical methods are effectively integrated with chemical applications to increase application accuracy and reduce product volume required for coverage and efficacy. Some species, such as Japanese knotweed, can be spread with mechanical tilling or cultivation in well-established stands. Root fragments left in soil can sprout and recolonize by such disturbance. Hand-digging and removal is an effective method of control in small infestations or around restoration plantings or existing, desirable plant material.

C. Chemical control is defined here as the use of pesticides to control targeted invasive plant species. The prescribed herbicides are pesticides designed to translocate throughout the plant, especially the root system. Options for chemical treatment of the invasive plant species allow applicators to avoid non-target species and surface soil disturbance. All herbicides shall be applied pursuant to manufacturers' specifications.

D. Species-specific considerations for chemical control were incorporated into the treatment design; these are summarized by species in the following subsections. These discussions include both an indication of the herbicides known to be effective and the chemical approaches typically employed for each species. It is important to note that the proposed treatment regimes provided below are based upon results provided in the chemical manufacturing literature relative to use and effectiveness for given species, and based upon what has been observed to be effective on other projects conducted in the field (e.g., mowing/cutting and chemical sequencing). Chemical treatments shall be integrated with mechanical treatments and habitat restoration plantings.

E. The invasive plant species occurring across the area include:

1. Japanese knotweed (*Polygonum cuspidatum*)
2. Morrow's honeysuckle (*Lonicera morrowii*)
3. Amur Honeysuckle (*Lonicera maackii*)
4. Tatarian honeysuckle (*Lonicera tatarica*)
5. Bell's honeysuckle (*Lonicera x bella*)
6. Tree of heaven (*Ailanthus altissima*)
7. Norway Maple (*Acer platanoides*)
8. Bradford Pear (*Pyrus calleryana*)
9. Garlic mustard (*Alliaria petiolata*)
10. Lesser celandine (*Ranunculus ficaria*)
11. Purple loosestrife (*Lythrum salicaria*)
12. Autumn olive (*Elaeagnus umbellate*)

F. Other invasive plant species may be treated if they are found in the area, see below for invasive lists in Indiana:
    1. http://www.entm.purdue.edu/iisc/invasiveplants.php

2. http://extension.entm.purdue.edu/CAPS/plants.html
3. http://www.in.gov/dnr/naturepreserve/6346.htm

G. If species from the lists in section E and F are found on site that are not specifically referenced in the treatment methodologies and tables below, the contractor shall refer to *The Nature Conservancy's Weed Control Methods Handbook: Tools and Techniques for Use in Natural Areas* for specific treatment methodologies and timing, which can be downloaded here: http://www.invasvie.org/gist/handbook.html. The contractor may also reference the Midwest Invasive Plant Network: http://mipncontroldatabase.wisc.edu/.

1.02 QUALITY ASSURANCE

A. Qualifications

1. Contractor shall be licensed in the state of Indiana in applicable categories for pesticide application in or near water bodies in Indiana State.

PART 2 – PRODUCTS

B. Herbicides and associated chemical compounds shall include GLYPHOSATE (Roundup or Rodeo), TRICLOPYR (Garlon 4), IMAZAPYR (Arsenal), and colorant (Bullseye, or accepted equal).

C. Tools shall include machete, chainsaw, Woodman's pal, saws, shovel, and other cutting and clearing implements. Herbicide application tools include envelope dauber, herbicide wand, and a tank/canister or backpack sprayer.

PART 3 - EXECUTION

3.01 GENERAL

A. Treatment of invasive species shall be in accordance with Indiana Department of Environmental Management, National Pollutant Discharge Elimination System, Pesticide General Permit for Point Source Discharges to Waters of the State from the Application of Pesticides, Permit Number ING87001 (2011-2016)..
1. Only the GLYPHOSATE-based herbicide Rodeo that is approved for use in aquatic systems may be used in, or within 25 feet of, any wetlands (to be marked in the field) or river. The targeted invasive species (both individuals and patches) shall be identified and marked in the field.
2. The Contractor shall transport and handle (including storage) the herbicide materials in accordance with the manufacturer's recommendations, and store materials in a secure place in the original container. Any spills or leaks shall be cleaned-up immediately.
3. Application of herbicides shall be performed in accordance with Indiana State and Federal regulations. The Contractor must have a current pesticide applicators license in order to perform the work and all applicators must at least be trained servicepersons or hold an applicators license. The Contractor shall submit a copy of the license to the CMT for review prior to initiating work.
4. Herbicide shall not be applied when it is raining or when rain is forecasted within 24 hours of expected application, or in winds exceeding 5 miles per hour (foliar application only).
5. Herbicides shall be applied directly to targeted plants. Care shall be taken to avoid all non-target plant material from contact with the herbicide.

3.02 INSTALLATION

A. Specific Treatment Approaches

1. Two eradication and control techniques shall be utilized for invasive species management within Work Limits. These correspond to STEM/STUMP CUT TREATMENT and FOLIAR APPLICATION. The STEM/STUMP CUT TREATMENT shall be used for tree species (Tree-of-Heaven and Norway maple) and for all targeted woody species with stems one-inch or greater in basal diameter. Woody stems of the targeted species less than one-inch in basal diameter may be treated by the FOLIAR APPLICATION technique due to the potential high number of multiple, small stems that are difficult to treat by the STEM/STUMP CUT TREATMENT
2. Japanese knotweed concentration areas shall specifically be treated by the FOLIAR APPLICATION technique. Cut the mass of knotweed in late May and wait approximately 2 months for application of herbicides. The mass of Japanese knotweed must be treated before any clearing and grubbing begins.
3. Small infestations or individual plants of purple loosestrife can easily be hand pulled, ideally before the plant goes to seed.

B. The Contractor shall treat the identified species of concern in accordance with the tables below.

1. Stem/Stump Cut Treatment
   STEM/STUMP CUT means cutting the stems of targeted invasive species followed by an herbicide application to the remaining stem or stump. The Contractor shall cut all above ground portions of the invasive plants as close to the ground surface as possible using a machete, chainsaw, saws or other appropriate cutting devices. This shall occur prior to herbicide application. All the cut material shall be collected and bagged or containerized and shipped off-site for disposal in an accepted waste disposal facility (landfill or incinerator). The Contractor shall apply herbicide solution mixed with a colorant to the entire cross section (cambium) of the cut stem or stump within 30 minutes of cutting the plant. Use an envelope dauber, herbicide wand, or low-pressure hand-held sprayer (following directions for cut stump method) to apply herbicide. Avoid dripping on non-target plants. *This treatment should take place in fall or early spring when native vegetation is dormant.*
   The Contractor shall apply herbicide (a 25-50 percent solution of GLYPHOSATE) mixed with a colorant (a 1% Bullseye solution, or equivalent) to the entire cross section of the cut stem or stump within 30 minutes of cutting the plant. The Contractor shall wait a minimum of 21 days to remove the stumps and as much of the below-ground (roots & rhizomes) of the invasive plants as possible. The removed material shall be disposed of in an accepted off-site waste disposal facility.
2. Foliar Application.
   FOLIAR APPLICATION means a spray application to the foliage (leaf surfaces) of the targeted plants. Application shall be performed using a spray bottle, backpack sprayer, or canister pump sprayer to thoroughly cover the leaf surfaces of the plants to the point where the leaves are wet, but it does not start to run off of the leaves. Use a low-pressure and coarse spray pattern to reduce spray drift and damage to non-target species.
   The Contractor shall apply herbicide (a two percent solution of GLYPHOSATE) mixed with a colorant (a 0.5 percent Bullseye solution, or equivalent) to the target species. Avoid over-spray or drift onto non-target species.
   Air temperature should be above 65°F to ensure absorption of herbicides.
   Application should be done using a spray bottle, backpack sprayer, or canister pump to thoroughly wet all leaves. Use a low pressure and coarse spray pattern to reduce spray drift damage to non-target species.
   This treatment times are listed in the tables below.

3. Physical Removal
   PHYSICAL REMOVAL means removal of the entire plant including stems, roots, leaves, and flowering/fruiting parts. Care should be taken not to fragment the plant or spread seeds. The physical removal technique specific to small stands of garlic mustard, tree seedlings and small honeysuckle species involves pulling of the entire plant by hand. This shall occur in the spring to coincide with flowering and is to be completed before seed-set

Tree-of-Heaven, Norway Maple and Bradford Pear

Herbicide Treatment Application Table

Herbicide	**BRAND NAMES**	**MIXTURE RATES**	**APPLICATION TIME**
GLYPHOSATE	Roundup or Rodeo	**For StumpCut treatment:** Glyphosate (20-25%) solution or Triclopyr (50%) solution, with 1% solution of Bullseye	June 15 to September 15
TRICLOPYR	Garlon 3A or 4		

Japanese Knotweed and Purple Loosestrife

Herbicide Treatment Application Table

Herbicide	**BRAND NAMES**	**MIXTURE RATES**	**APPLICATION TIME**
GLYPHOSATE	Roundup or Rodeo	**For Foliar Application:** Glyphosate or Triclopyr (2%) solution, with 0.5% solution of Bullseye	July 31 through September 30 (follows a late May cutting for knotweed)
TRICLOPYR	Garlon 3A or 4		

Honeysuckle species and Autumn Olive.

Herbicide Treatment Application Table

Herbicide	**BRAND NAMES**	**MIXTURE RATES**	**APPLICATION TIME**
GLYPHOSATE	Rondup or Rodeo	**For Foliar Application:** Glyphosate or Triclopyr (2%) solution, with 0.5% solution of Bullseye	Fall
TRICLOPYR	Garlon 3A or 4	**For StumpCut treatment:** Glyphosate (20-25%) solution or Triclopyr (50%) solution, with 1% solution of Bullseye	Late summer, early fall or dormant season

Large Garlic Mustard and Lesser Celandine Infestations.

Herbicide Treatment Application Table

Herbicide	**BRAND NAMES**	**MIXTURE RATES**	**APPLICATION TIME**
GLYPHOSATE	Rondup or Rodeo	**For Foliar Application:** Glyphosate or Triclopyr (2%) solution, with 0.5% solution of Bullseye	April-May at temperatures above 40 degrees F and no rain within 12 hours of application
TRICLOPYR	Garlon 3A or 4		

C. Clean Up

1. During execution of invasive species management, all areas shall be kept neat, clean and free of all trash and debris, and all reasonable precautions shall be taken to avoid damage to existing non-target plants, grass, structures, and other property. Final cleanup shall be the responsibility of the Contractor and consist of removing all trash and materials incidental to the project and disposing of them off-site.

D. Site Inspection

1. The CMT shall make a final inspection with the Contractor to ensure all areas shown on the plans and marked in the field for invasive species management during construction have been treated according to the Special Provisions and drawings. The Contractor shall be responsible for correcting all deficiencies within seven (7) calendar days of the inspection. The CMT and the Contractor prior to final completion shall perform a final inspection of the corrected actions.

END OF SECTION

Appendix E
Beaver Paint Specification

Procedures for Beaver Trees

WEAR YOUR SAFETY GOGGLES AND PARTICLE MASK

Ingredients:

1. ½ of a 5 gallon bucket of paint (KM880-D, Harley Rumble)
2. ¼ bag of a 50lb play sand
3. Toner if needed to match color of tree exactly. (There is no specific amount, use your own judgment for matching).

Supplies Needed:

1. (1)Drill (Check out)
2. (1)Mixing bit (Check out)
3. Paint (KM880-D, Harley Rumble)
4. (1)Mixing bucket
5. Play sand
6. (1)Air Compressor
7. (1) Can of Gas (Unleaded)
8. (2)Paint brush (if needed)
9. (1-2)Utility knife
10. (2)Spray gun
11. (2)Spray gun hose
12. (2)Hopper for spray gun

Directions:

Mixing

1. Take 1 empty mixing bucket and pour ½ of a 5 gallon bucket of paint into it.
2. Take the two buckets that are half full of paint and pour ¼ bag of 50lb play sand into each.
3. Put the mixing drill bit on the drill and mix the paint and sand together.
4. Add toner to each mixture until it matches the exact color of the tree.

Adding to spray gun

1. Check gas, oil, filters in air compressor and make sure it is on even ground otherwise it will not start.
2. Turn on air compressor (you may have a hard time getting it to start, but be patient it will start eventually)
3. Attach sprayer hoses to air compressor and to spray gun.
4. Attach hopper to spray gun, making sure it is on tightly so it won't wiggle off.
5. Pour paint mixture into each hopper by resting the paint gun on the ground.

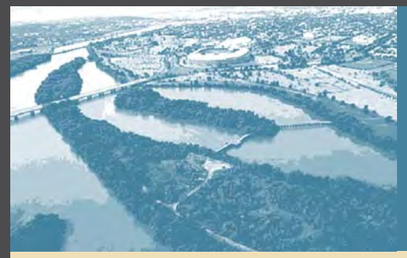
Spraying

1. Turn red switch by the lower part of paint sprayer to start spraying.
2. Pull on trigger to allow paint to flow out of sprayer.
3. Spray tree 2-3 feet off of the base of tree.
4. Also if there is chicken wire on the tree please remove and recycle.
5. When spraying trees they need to be within 50 yards of the river or body of H2O.
6. Also, the tree width needs to be 6 inches or more

Clean Up STILL WEAR YOUR SAFETY GLASSES

1. CLEAN EVERYTHING IN WASH BAY
2. Rinse out the mixing bucket in the wash bay and throw away empty paint buckets.
3. Clean paint from sprayers, hoppers & drill mixer
4. Check back items removed from tool room
5. Place all other items to dry and put them back in storage area. (Under seed storage area).

Appendix F
Interpretative Signage



Riparian Buffers: Forests Standing Guard for Our Streams

NATURAL, VEGETATED AREAS ALONGSIDE WATERWAYS WORK HARD TO PROTECT OUR STREAM SYSTEMS.

What do riparian buffers do?

- Slow down and filter polluted stormwater and agriculture runoff
- Provide habitat for wildlife in and along the water
- Stabilize streambanks to prevent erosion
- Shade and cool the water so more things can live in it
- Help protect our communities from flooding
- Improve water quality
- Provide beauty and nature, even in the middle of cities

Take care of them, and they take care of us.

Like an army of plants deployed by nature, riparian buffers are the first line of defense for our rivers and streams, so it is important that we keep them healthy.

Enemies of Riparian Buffers

- Building in floodplains
- Grazing livestock
- Agricultural and stormwater runoff
- Hardened shorelines
- Paved surfaces
- Mowing to the water's edge
- Invasive species

Be Nature's Ally: Protect Riparian Buffers

- **Plant native grasses, shrubs, and trees**
- **Remove invasive species that take over our native plants**
- **Support local policies that protect riparian buffers**
- **Volunteer with the Tri-state Watershed Alliance**

riverfront FORT WAYNE
envision our possibilities

Biohabitats
GREAT LAKES BIOREGION

Appendix G
Riparian Buffer Manager Equipment List Memo

Biohabitats
GREAT LAKES BIOREGION
2026 Murray Hill Road, Room 102
Cleveland, OH 44106
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MEMORANDUM

Date: February 24, 2015

To: Sherese Fortriede, AICP, City of Fort Wayne Community Development

From: Kevin Grieser, Biohabitats, Inc.

RE: Riparian Management Plan
Subject: River Maintenance position salary range and equipment list

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Biohabitats was requested to provide information to the City of Fort Wayne regarding a future River Maintenance position, including salary range and potential equipment and costs needed for the position. In the future we will develop a detailed job description, but our understanding at this point is the position would involve maintenance activities in and along the streams and rivers within the City of Fort Wayne, with the majority of the focus on the St. Marys, St. Joseph and Maumee Rivers. Maintenance actions would include removal of trash and problematic woody debris (both on land and in water), invasive species, maintaining viewsheds through selective pruning and vegetation removal, geese management (egg addling), streambank stabilization, bio-engineering harvesting and installation, tree and shrub plantings, coordinating and leading volunteer efforts (plantings and invasive mgmt.), streambank stability assessments (bank erosion hazard index), and assisting in the pursuit of funding for restoration efforts.

Based on other natural resource maintenance positions, in addition to the volunteer component of the position, an initial salary range for this position is approximately $45k-55k per year depending on qualifications.

Potential list of equipment required for position:

- Work boat (multiple options, Cleveland received a $435,160 EPA grant to fund 2 tandem boats: Jetsam-w/attached crane and Flotsam-w/attached excavator. Price ranges vary greatly based on used vs. custom boats. Options with a mini-excavator allows for greater flexibility given the mini-excavator can be off loaded and used on land.)
    - Option 1: Jetsam ex. from Cleveland: motorized barge w/attached crane and trailer (~$100-200k)
    - Option 2: Motorized barge (~$75k-100) w/mini-excavator (~$25-35k) and trailer (~$5k)
    - Option 3: Non-motorized barge (~$35-50k) & work/push boat ($35-75k) w/mini-excavator (~$25-35k) and trailer (~$5k)

Boat Related Equipment:

- Life jackets ($50 ea.)
- Whistle/blast horn ($25 ea.)
- Boat fenders (~$200 per boat)
- Anchor w/rope (~$150 ea.)
- Fire extinguishers ($75 ea.)
- Boat tool kit ($75 ea.)

- Bilge pump/bailer ($25 ea.)
- Boat hooks ($25 ea.)
- Rope bag w/throw line ($50 ea.)
- Dry bag ($50 ea.)

Vehicles and Related Equipment:

- Pick-up truck w/tow package ($25-35k, unless the City already has a suitable vehicle)
- Gator utility vehicle ($10k) (*Note a Bobcat Toolcat [~$35-50k] could be substituted for the Gator and the Mini-skid steer)*
- Mini-skid steer w/attachments (~$25k)
- Mini-excavator (~$25-35k, note this is included in some work boat options)
- Utility trailer (~$2,500-5k depending on size and enclosed vs. open, needed to haul mini-skid steer and mini-excavator)
- Wood chipper/shredder and gas can ($2-5k depending on capacity)
- ATV sprayer/waterer ($400)

Miscellaneous Tools and Equipment:

- Chainsaw ($400) & associated equipment ($300: chaps, helmet/shield, ear muffs, gas cans, bar oil, extra chains, maint. tools)
- Loppers ($75 ea.)
- Pruners ($25 ea.)
- Shovels ($50 ea.)
- Wheel barrel ($75 ea.)
- Bow saw ($25)
- Machete ($25)
- Dibble bar ($50 ea.)
- Tree spade ($50 ea.)
- Folding saw ($50)
- Pole saw ($150)
- Tree planting bags ($35 ea.)
- Cum-a-long ($200)
- Safety vest ($50)
- Weather proof clipboard ($25)
- Tape measure ($25)
- Waders ($100)
- GPS unit ($2k)
- Binoculars ($50)
- Trash bags/bins ($25)
- Steel toe knee boots ($75)
- Rain gear ($150)
- Work gloves ($50)
- Volunteer work gloves ($15 ea.)
- First aid kit ($50)
- Back pack sprayer ($100)
- Leatherman ($75)
- Water proof camera ($100)
- Sledge hammer ($25)
- Rubber mallet ($25)
- Large dip net ($75)
- Rope ($100)
- Gas powered trimmer with brush blade and gas can ($100)
- Water pump w/hose ($750)
- Herbicide applicator Personal Protective Equipment ($150: long rubber gloves, goggles, respirator)

Appendix H
Riparian Buffer and River Management Task List (2015-2017)

River Maintenance

2015:

- Develop a Riparian and River Management Plan (if completed begin implementation)
- Identify desired viewsheds to enhance
    - Invasive species removal
    - Tree pruning (winter and summer)
    - Supplemental native plantings (spring and fall)
        - Potted material (spring and/or fall)
        - Bio-engineering material (early spring and/or late fall)
- Identify streambank erosion problem areas (conduct a Bank Erosion Hazard Index)
    - Identify root causes of bank erosion and remedy
    - Install bank stabilization measures
        - Install native plantings (spring and/or fall)
        - Install bio-engineering measures (early spring and/or late fall)
            - Harvest dogwoods & willows locally if desired (early spring and/or late fall)
- Identify and remove invasive species (3 main species listed below)
    - Tree of Heaven
        - Pull very small seedlings
        - Larger trees: stump cut herbicide treatment from mid-June through mid-September
    - Honeysuckle species
        - Pull small shrubs
        - Larger shrubs: foliar herbicide treatment in fall or stump cut herbicide treatment in late summer, early fall or dormant season
    - Japanese Knotweed
        - Cut/mow in late May and followed by August herbicide treatment
- Identify and prioritize areas for native plant restoration
    - Typically where invasives were removed
    - Guldlin Park
    - Install native plantings (spring and fall)
        - Install bio-engineering measures (early spring or late fall)
        - Harvest dogwoods & willows locally if desired (early spring or late fall)
- Identify and remove hazard trees
- Identify and protect critical trees in beaver areas (St. Joseph River)
    - Wire cage (double tree diameter) or sand paint
- Remove garbage
- Remove large woody debris threatening infrastructure
- Add large woody debris in slack water areas for habitat

- Addle goose eggs found in nests in and around rivers (early spring)
    - Register with USFWS for permission
- Install native vines in rip-rap planters along the St. Joseph River (fall)
- Potential cover crop seeding of exposed banks after fall drawdown
- Identify snow storage locations that negatively impact the river and move the following year
- Encourage bio-engineering and native species for future streambank and riparian buffer work
- Do not mow the Spy Run delta, Guldlin Park floodplain, or to the edge of any rivers or streams
    - Create vegetated buffer
    - Allow native grasses and woody species to take hold
- Identify funding sources for restoration, invasive species removal, etc. and submit grants
    - LARE, GLRI, etc.
    - Wetland creation at Guldlin Park
- Develop riparian buffer ordinance to limit built and hardened structures in riparian corridor
- Develop interpretative signage
- Identify locations for observation platforms to promote ecotourism & showcase signage

<u>2016-2017:</u>

- Implement Riparian and River Management Plan
- Viewshed maintenance
- Streambank stabilization
- Invasive species management
    - Follow-up treatment
- Hazard tree maintenance
- Tree protection
- Garbage removal
- Large woody debris removal threatening infrastructure
- Native vegetation plantings
- Addle goose eggs
- Post drawdown cover crop seeding
- Encourage bio-engineering and native species within the corridor
- Continue with no mow policy
- Remove low head dams on Spy Run
- Add large woody debris in channel slack water areas
- Implement grant restoration projects that were won
- Continue to pursue additional funding for restoration
- Implement riparian buffer ordinance
- Install interpretative signage
- Install observation platforms

Appendix I
Streambank Erosion Memo: Old Fort & Headwaters Park Sites

Biohabitats
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MEMORANDUM

Date: June 16, 2015

To: Sherese Fortriede, City of Fort Wayne and Doug Nusbaum, IDNR

From: Kevin Grieser, Biohabitats, Inc.

RE: Streambank Restoration
Subject: Restoration locations/options within the City of Fort Wayne

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While developing the City of Fort Wayne's Riparian Management Plan, Biohabitats was asked to identify potential streambank stabilization/restoration locations within the study area for possible inclusion in an IDNR program targeted at stabilizing severely eroding streambanks. Each specific reach is not to exceed 300 linear feet as per IDNR requirements.

During field work for both the Riverfront Redevelopment Plan and Riparian Management Plan, Biohabitats staff evaluated and characterized streambank and riparian conditions on all major waterbodies in the study area including the St. Marys, St. Joseph and Maumee Rivers, as well as, Spy Run. Biohabitats also conducted a Bank Erosion Hazard Index (BEHI) as part of our field work to evaluate any severely eroding streambanks. Streambank conditions vary widely from low floodplain forests and vegetated banks to armored rip-rap. Below is a brief synopsis on bank conditions for each waterbody with potential restoration sites further detailed afterwards.

- St. Joseph River – This portion of the river within the study reach is heavily armored by rip-rap that was installed by the USACE. There is no bank erosion within this reach.
- Maumee River – The small portion of the Maumee within the study reach includes a small stretch of rip-rap and floodplain forest. There is no bank erosion within this reach.
- Spy Run – This tributary exhibited very little bank erosion as the majority of the reach was forested. There is one small stretch of rip-rap, but the majority of the reach is a combination of floodplain forest and stable vegetated banks with small localized erosion, typically occurring near bridge abutments.
- St. Marys – As a whole, the majority of the banks of the St. Marys within the project reach are fairly stable. They include several floodplain forests and low floodplain benches that have been partially cleared in addition to steeper banks, both vegetated and a combination of rubble/debris and vegetation. However, two specific areas were identified that exhibit severe streambank erosion that would warrant stabilization and restoration. The first is an approximate 300 feet stretch adjacent to the Old Fort on the left bank of the St. Marys roughly between the pedestrian bridge and observation platform. The second is an approximate 125 feet stretch on the right bank of the St. Marys at the southeast corner of Headwaters Park. It is located adjacent to the turnaround on S. Barr Street beginning at the new CSO outfall and extending up river and paralleling the adjacent sidewalk.

Old Fort Location – St. Marys River

As noted above, this reach constitutes the largest area of severely eroding streambanks within the entire project reach at approximately 300 linear feet. The reach begins approximately 75 feet downstream of the Spy Run-St. Marys confluence viewing platform and continues ~300 feet downstream, approaching the pedestrian bridge (Figure 1).

Figure 1. Old Fort - Streambank erosion location.

Bank and erosion height in this location are approximately 8 feet in height with a bank angle of 90 degrees as the banks are near vertical. The reach is located on an outside bend, thus the water is deeper and velocity faster so erosion is greater. In many places woody vegetation has already slumped off into the river, where it has either washed downstream or remains as a debris sink as large woody debris gathers on and around this remaining vegetation. Further compounding the issue is the mowing that occurs right to the water's edge, thus limiting the regeneration of woody vegetation which could provide some bank stability. There are several large mature cottonwood trees growing just off the bank that are providing some stability, but the majority of the bank within this reach is either bare or contains smaller woody vegetation.

Figure 2. Bank erosion as viewed from the St. Marys.

Figure 3. Bank erosion as viewed from shore.

Figure 4. Extent of area that could be used to regrade slope.

Given the frequency of flooding, water drawdowns, ice flows, mowing, herbivory and outside bend position, this streambank will not recover on its own and will continue to further erode as woody vegetation will continue to slump off into the river. Of particular concern are the large cottonwood trees within and adjacent to this reach that could create an even worse situation if they were uprooted and/or felled (herbivory from beaver is common in the City and cottonwood are a preferred tree). In order to address this issue, the approximate 300 feet reach would need to be stabilized and restored. In discussing this project with our Senior Stream Specialist, we concurred the most logical approach to this restoration project is to provide some type of boulder toe protection in combination with bio-engineering and then taper the banks to a stable angle and vegetate. The boulder toe protection and vegetation would provide a more aesthetically appealing alternative to typical rip-rap as this is a highly visible area with views from both sides of the river and the pedestrian bridge. The boulder toe would be comprised of footer rocks (below the stream bed) and top rocks (above the stream bed) and would extend above base flow. Behind the top rocks would be a series of bio-engineered soil lifts with live branch layering, consisting of willow and dogwood shrub species. After several lifts, the slope would be graded to a stable slope, covered with coir fiber matting to provide stability, and planted with native trees and shrubs.

It is assumed this project could be constructed from the top of bank, although the river should be in a drawdown state. A footer trench would be dug paralleling the existing bank and filled with rip-rap. Using rip-rap as footer rocks instead of boulders is a cheaper alternative as the footer rocks will be completely buried and not seen. The depth of the trench will depend on further analysis and field work, but one could expect a 5-10 foot deep trench based on similar projects. Once the footer rocks are in place, the boulder toe is then installed. This rock can be round or square, although square rocks are much easier to install. As previously noted, coir fiber matting would then be used to create soil lifts and would “sandwich” rows of live branches. Over several years the live branches, consisting of native willow and dogwood shrub species, will grow to form a mass of shrubs paralleling the river that will not only provide further bank protection, but habitat as well. Behind the live branch layering the bank will slope back and tie into existing grade at a stable slope (3:1 or greater). The figures below shows this application on a smaller stream in northeast Ohio called Bear Creek from construction to 3 years post construction. Obviously the restoration would need to be designed and scaled to the St. Marys system accordingly as the Bear Creek example is a much smaller system.

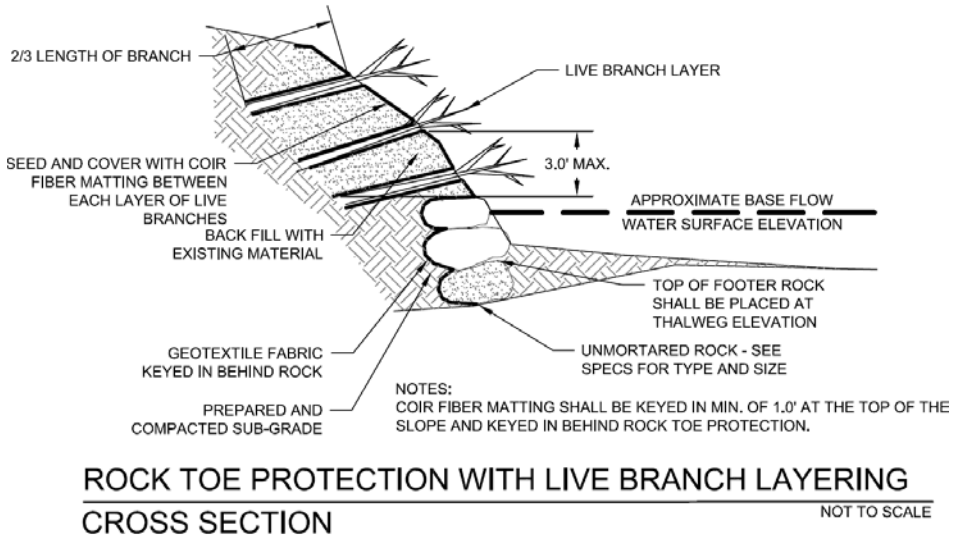


Figure 5. Bear Creek construction detail.

Figure 6. Bear Creek during construction.

Figure 7. Bear Creek 3 years post construction.

Headwaters Park – St. Marys River

This reach constitutes approximately 125 linear feet of eroding streambank in the southeast corner of Headwaters Park near the ice rink. This reach is bound by a new stormwater outfall on the downstream end and then extends upstream 125 feet (Figure 8).

Figure 8. Headwaters Park – Streambank erosion location.

Bank height is approximately 11 feet in this location with an erosion height of 4 feet and a bank angle of 80 degrees as the banks are near vertical. The reach is located on an outside bend, thus the water is deeper and velocity faster so erosion is greater. The lower portion of the bank has eroded away and causing an overhanging vegetation condition. The weight of the overhanging vegetation leaves it very susceptible to further slumpage and falling into the river, thus jeopardizing the adjacent sidewalk which could eventually create a severe safety hazard with a now unvegetated and exposed vertical bank.

Figure 9. New stormwater outfall.

Figure 10. Looking at erosion across the river.

Figure 11. Bank erosion below sidewalk.

Given the frequency of flooding, water drawdowns, ice flows, mowing, outside bend position and herbivory, this streambank will not recover on its own and will continue to further erode as woody vegetation will continue to slump off into the river. Of particular concern are the adjacent sidewalk and the potential safety hazard this bank can become if it continues to erode. In order to address this issue, the approximate 125 feet reach would need to be stabilized and restored. In discussing this project with our Senior Stream Specialist, we concurred the most logical approach to this restoration project is to provide some type of boulder toe protection placed adjacent to the bank and wedged under the existing vegetation. In this scenario, the existing vegetation could be saved as it is providing some stability. Given the proximity of the sidewalk to the streambank it is most likely not feasible to taper the bank to a stable angle without relocating the sidewalk as there is barely 15 feet of width between the edge of water and the sidewalk. The boulder toe protection also provides a more aesthetically appealing alternative to typical rip-rap as this is a highly visible area with views from both sides of the river and the pedestrian bridge. The boulder toe would be comprised of footer rocks (below the stream bed) and top rocks (above the stream bed). Given the composition of the existing vegetation and further evaluation, it may be necessary to continue the boulder toe up the entire bank. If the boulder toe is continued to the top of bank, then opportunities would present themselves to create a scenic overlook on the river by creating a viewing area that could be further enhanced with native plantings, seating, interpretative signage, in addition to, some type of fencing given the proximity to the stream.

It is assumed this project could not be constructed from the top of bank given the intent to save the vegetation and high banks. A rock ramp would need to be constructed in a drawdown state at the new outfall located at the downstream end of the project reach. From the bottom of the ramp, a narrow rip-rap road would be constructed at the base of the slope for the entire length of the project. This road would provide construction access, but would also serve as the footer for the boulder toe with construction beginning at the upstream end. The boulder toe would be stacked into the bank cavity so the existing overhanging vegetation can be supported and saved. If the vegetation could not be saved and the boulder toe had to extend to the top of bank, then it may be possible to construct the structure entirely from the top of bank and avoid building the access ramp. Both structures are very similar to the Bear Creek construction detail (Figure 5), but minus the live branch layering and plantings and scaled accordingly to the St. Marys system.

Given these two potential projects, our recommendation would be to first pursue the Headwaters Park project given the proximity to the sidewalk and potential safety hazard it poses if the bank erodes any further. Given the lack of vegetation at the toe, outside bend position and frequency of ice dams, it can be assumed that this bank will continue to erode until it finds a stable angle, which would take it well past the adjacent sidewalk. From an aquatic and terrestrial habitat standpoint, the Old Fort provides more habitat and does address an ongoing

erosion issue that is also not going away. Ideally this project could be pursued in a subsequent year if funding remains available. One last additional thought is design-build vs. design-bid-build, as a design-build project would give you more flexibility and typically provides more cost savings since changes can be made in the field instead of re-bidding and/or change orders. If you have any further questions or comments feel free to contact us at your convenience.

Costs below were later added after the memo was originally submitted:

Initial cost estimates for the Old Fort site based on a design-build project are ~$100k for construction work alone with at least another $25k for design, construction oversight, permitting and bonds.

Estimates for the Headwaters Park site are ~$27k for construction, leaving only $15k for design, construction oversight, permitting and bonds given the $42k project cost limits.

Appendix J
Model Riparian Setback Ordinance

MODEL ORDINANCE FOR THE ESTABLISHMENT OF RIPARIAN SETBACKS

PLEASE NOTE

- The following model riparian setback ordinance is recommended as part of a community's storm water management program for flood control, erosion control, and water quality protection.
- This model ordinance MUST BE TAILORED TO THE SPECIFIC NEEDS OF EACH COMMUNITY. Text throughout the model indicates decision points with a ☞ symbol. It is also IMPORTANT THAT COMMUNITIES DEVELOP A MAP OF POTENTIAL RIPARIAN SETBACKS. Please contact CRWP for assistance in tailoring this model to your community's needs and in developing such maps.
- Throughout this model duties are assigned to the "Community." These should be assigned to specific staff and departments.

WHEREAS, flooding is a significant threat to property and public health and safety, and vegetated riparian areas lessen the damage from flooding by slowing the water velocity, enabling water to soak into the ground, and by providing temporary storage of overbank flood flow; and,

WHEREAS, streambank erosion is a significant threat to property and public health and safety, and vegetated riparian areas stabilize streambanks and provide resistance to erosive forces both within streams and on adjacent lands; and,

WHEREAS, the protection of riparian areas results in the presence of plants best suited to each individual environment along a stream, with proven capability for survival and regeneration at no cost; and,

WHEREAS, vegetated riparian areas filter and trap sediments, chemicals, salts, septic discharge, and other pollutants from runoff and floodwaters, thus protecting surface and ground water quality; and,

WHEREAS, vegetated riparian areas can provide a dense tree canopy that helps to maintain and improve the stability of watercourse temperatures, thus protecting aquatic ecosystems, and helps to reduce the presence of aquatic nuisance species; and,

WHEREAS, the protection of riparian areas can result in a diverse and interconnected riparian corridor that provides habitat to a wide array of wildlife; and,

WHEREAS, the woody debris from fallen, damaged, and cut trees increases flood levels and damage to bridges in ***[community]*** and neighboring communities; and,

WHEREAS, sedimentation of eroded soil adversely affects aquatic communities and incurs removal costs to downstream communities; and,

WHEREAS, there are watershed-wide efforts to minimize flooding and streambank erosion in the ***[watersheds to which community belongs]*** watersheds and to protect and enhance the water resources of the ***[major watercourses to which community drains]*** and its tributaries and ***[community]*** recognizes its obligation as a part of these watersheds to minimize flooding and streambank erosion by controlling runoff within its borders; and,

WHEREAS, the ***[state scenic rivers if applicable]***, including that portion which flows through the ***[community]***, has been designated as an "Ohio Scenic River" in recognition of the fact that its watershed harbors an extraordinary array of wildlife, including fish, freshwater mussels, birds, mammals, reptiles, and amphibians; and,

☞ ***This whereas clause should only be used in INCORPORATED communities establishing riparian setbacks along designated Ohio Scenic Rivers.***

WHEREAS, the Chagrin River Watershed Partners, Inc.; the Cuyahoga Soil and Water Conservation District; the Geauga Soil and Water Conservation District; the Lake County Soil and Water Conservation District; the Natural Resource Conservation Service of the U.S. Department of Agriculture; the Northeast Ohio Areawide Coordinating Agency; the Ohio Department of Natural Resources, Division of Natural Areas and Preserves; the Ohio Environmental Protection Agency; and the U.S. Environmental Protection Agency recommend riparian setbacks as a valuable tool in an overall management program for flood risk reduction, erosion control, water quality control, and aquatic habitat protection; and,

WHEREAS, studies undertaken by, and reviewed by, the Ohio Environmental Protection Agency and other independent scientific bodies recommend the minimum widths for riparian setbacks; and,

WHEREAS, the Council of the ***[community]*** has reviewed and adopted the recommendations of the above government agencies, and the Council finds that in order to minimize encroachment on watercourses and the need for costly engineering solutions to protect structures and reduce property damage and threats to the safety of watershed residents; to protect and enhance the scenic beauty of the ***[community]***; and to preserve the character of the ***[community]***, the quality of life of the residents of the ***[community]***, and corresponding property values, it is necessary and appropriate to regulate structures and uses within a riparian setback along the banks of designated watercourses in the ***[community]*****;** and,

WHEREAS, Article XVIII, Section 3 of the Ohio Constitution grants municipalities the legal authority to adopt land use and control measures for promoting the peace, health, safety, and general welfare of its citizens; and,

WHEREAS, 40 C.F.R. Parts 9, 122, 123, and 124, referred to as NPDES Storm Water Phase II, require designated communities, including ***[community],*** to develop a Storm Water Management Program to address the quality of storm water runoff during and after soil disturbing activities.

☞ ***Remove this whereas clause if your community is not designated under the NPDES Phase II regulation.***

NOW, THEREFORE, BE IT ORDAINED by the Council of the ***[community],*** County of ***[county],*** State of Ohio, that:

SECTION 1: Codified Ordinance ***Chapter XXXX Riparian Setbacks***, is hereby adopted to read in total as follows:

CHAPTER XXXX
RIPARIAN SETBACKS

***XXXX*.01 PURPOSE AND SCOPE**

A. It is hereby determined that the system of rivers, streams, and other natural watercourses within the ***[community]*** contributes to the health, safety, and general welfare of the residents of the ***[community]***. The specific purpose and intent of this regulation is to regulate uses and developments within riparian setbacks that would impair the ability of riparian areas to:

1. Reduce flood impacts by absorbing peak flows, slowing the velocity of flood waters, and regulating base flow.

2. Assist stabilizing the banks of watercourses to reduce woody debris from fallen or damaged trees, streambank erosion, and the downstream transport of sediments eroded from watercourse banks.

3. Reduce pollutants in watercourses during periods of high flows by filtering, settling, and transforming pollutants already present in watercourses.

4. Reduce pollutants in watercourses by filtering, settling, and transforming pollutants in runoff before they enter watercourses.

5. Provide watercourse habitats with shade and food.

6. Reduce the presence of aquatic nuisance species to maintain a diverse aquatic system.

7. Provide habitat to a wide array of wildlife by maintaining diverse and connected riparian vegetation.

8. Benefit the ***[community]*** by minimizing encroachment on watercourse channels and the need for costly engineering solutions such as gabion baskets and rip rap to protect structures and reduce property damage and threats to the safety of watershed residents; and by contributing to the scenic beauty and environment of the ***[community]***, and thereby preserving the character of the ***[community]***, the quality of life of the residents of the ***[community]***, and corresponding property values.

B. The following regulation has been enacted to protect and enhance these functions of riparian areas by providing reasonable controls governing structures and uses within a riparian setback along designated watercourses in the ***[community]***.

XXXX.02 APPLICABILITY, COMPLIANCE & VIOLATIONS

A. This regulation shall apply to all zoning districts.

B. This regulation shall apply to all structures and uses on lands containing a designated watercourse as defined in this regulation, except as provided herein.

C. No approvals or permits shall be issued by the ***[community]*** without full compliance with the terms of this regulation.

XXXX.03 CONFLICTS WITH OTHER REGULATIONS & SEVERABILITY

A. Where this regulation imposes a greater restriction upon land than is imposed or required by any other provision of law, regulation, contract, or deed, the provisions of this regulation shall

control.

B. This regulation shall not limit or restrict the application of other provisions of law, regulation, contract, or deed, or the legal remedies available thereunder, except as provided in ***Section XXXX.03 (A)*** of this regulation.

C. If any clause, section, or provision of this regulation is declared invalid or unconstitutional by a court of competent jurisdiction, validity of the remainder shall not be affected thereby.

XXXX.04 DEFINITIONS

For the purpose of this regulation, the following terms shall have the meaning herein indicated:

A. COMMUNITY: Throughout this regulation, this shall refer to the ***[community]*** or its designated representatives, boards, or commissions.

B. DAMAGED OR DISEASED TREES: Trees that have split trunks; broken tops; heart rot; insect or fungus problems that will lead to imminent death; undercut root systems that put the tree in imminent danger of falling; lean as a result of root failure that puts the tree in imminent danger of falling; or any other condition that puts the tree in imminent danger of being uprooted or falling into or along a watercourse or onto a structure.

C. DESIGNATED WATERCOURSE: A watercourse within the ***[community]*** that is in conformity with the criteria set forth in this regulation.

D. FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA): The agency with overall responsibility for administering the National Flood Insurance Program.

E. IMPERVIOUS COVER: Any paved, hardened, or structural surface regardless of its composition including but not limited to buildings, roads, driveways, parking lots, loading/unloading areas, decks, patios, and swimming pools.

F. IN-LINE POND: A permanent pool of water created by impounding a designated watercourse.

G. NOXIOUS WEED: Any plant species defined by the Ohio Department of Agriculture as a “noxious weed” and listed as such by the Department. For the purposes of this regulation, the most recent version of this list at the time of application of this regulation shall prevail.

H. 100-YEAR FLOODPLAIN: Any land susceptible to being inundated by water from a base flood. The base flood is the flood that has a one percent or greater chance of being equaled or exceeded in any given year.

I. OHIO ENVIRONMENTAL PROTECTION AGENCY: Referred throughout this regulation as the "Ohio EPA."

J. ORDINARY HIGH WATER MARK: The point of the bank or shore to which the presence and action of surface water is so continuous as to leave a district marked by erosion, destruction or prevention of woody terrestrial vegetation, predominance of aquatic vegetation, or other easily recognized characteristic. The ordinary high water mark defines the bed of a watercourse.

K. RIPARIAN AREA: Land adjacent to watercourses that, if appropriately sized, helps to stabilize streambanks, limit erosion, reduce flood size flows, and/or filter and settle out runoff pollutants, or performs other functions consistent with the purposes of this regulation.

L. RIPARIAN SETBACK: The real property adjacent to a designated watercourse located in the area defined by the criteria set forth in this regulation.

M. SOIL AND WATER CONSERVATION DISTRICT: An entity organized under Chapter 1515 of the Ohio Revised Code referring to either the Soil and Water Conservation District Board or its designated employee(s), hereinafter referred to as ***[county]*** SWCD.

N. SOIL DISTURBING ACTIVITY: Clearing, grading, excavating, filling, or other alteration of the earth's surface where natural or human made ground cover is destroyed and which may result in, or contribute to, erosion and sediment pollution.

O. SUBSTANTIAL DAMAGE: Damage of any origin sustained by a structure whereby the cost of restoring the structure to its before damaged condition would be equal to, or would exceed, 50% of the market value of the structure before the damage occurred.

P. WATERCOURSE: Any brook, channel, creek, river, or stream having banks, a defined bed, and a definite direction of flow, either continuously or intermittently flowing.

Q. WETLAND: Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions, including swamps, marshes, bogs, and similar areas. (40 CFR 232, as amended).

XXXX.05 ESTABLISHMENT OF DESIGNATED WATERCOURSES AND RIPARIAN SETBACKS

A. Designated watercourses shall include those watercourses meeting any ONE of the following criteria:

1. All watercourses draining an area greater than ½ square mile, OR

2. All watercourses draining an area less than ½ square mile and having a defined bed and bank. In determining if watercourses have a defined bed and bank, the ***[community]*** may consult with a representative of the ***[county]*** SWCD or other technical experts as necessary. Any costs associated with such consultations may be assessed to the applicant.

B. Riparian setbacks on designated watercourses are established as follows:

1. A minimum of 300 feet on either side of all watercourses draining an area greater than 300 square miles.

2. A minimum of 120 feet on either side of all watercourses draining an area greater than 20 square miles and up to 300 square miles.

3. A minimum of 75 feet on either side of all watercourses draining an area greater than ½

square mile and up to 20 square miles.

4. A minimum of 25 feet on either side of all watercourses draining an area less than ½ square mile and having a defined bed and bank as determined by the ***[community]*** in ***Section XXXX.05*** of this regulation.

C. Riparian Setback Guide Map. The ***[community]*** shall create a guide map identifying designated watercourses and their riparian setbacks. Said guide map is attached hereto and made part of this regulation and is identified as Exhibit A. The following shall apply to the Riparian Setback Guide Map:

1. It shall be used as a reference document and the information contained therein shall be believed to be accurate.

2. It shall be a guide only.

☞ ***Communities should add the following disclaimer language to this map. "This map was prepared as a Riparian Setback Map by the [community] in accordance with Section XXXX.05 of Chapter XXXX. [Community] digital data is a representation of recorded plats, surveys, deeds, and other collected information for use within a Geographic Information System for purposes of analysis. These and other digital data do not replace or modify land surveys, deeds, and/or other legal instruments defining land ownership or use. The [community] assumes no legal responsibility for this information."***

3. Nothing herein shall prevent the ***[community]*** from amending the Riparian Setback Guide Map from time to time as may be necessary.

4. If any discrepancy is found between the Riparian Setback Guide Map and this regulation, the criteria set forth in ***Section XXXX.05 (A) and (B)*** shall prevail.

D. The following conditions shall apply in riparian setbacks:

1. Riparian setbacks shall be measured in a horizontal direction outward from the ordinary high water mark of each designated watercourse, except for in-line ponds as addressed in Section XXXX.05.

2. Except as otherwise provided in this regulation, riparian setbacks shall be preserved in their natural state.

3. Where the 100-year floodplain is wider than a minimum riparian setback on either or both sides of a designated watercourse, the minimum riparian setback shall be extended to the outer edge of the 100-year floodplain. The 100-year floodplain shall be defined by FEMA. If a FEMA defined floodplain does not exist for a designated watercourse, the ***[community]*** may require a site-specific floodplain delineation in conformance with standard engineering practices and approved by the ***[community]***. Any costs associated with reviewing this site-specific floodplain delineation may be assessed to the applicant.

☞ ***In many communities, extension of the riparian setback to the outer edge of the 100-year floodplain will represent a stronger standard than that found in a community's Flood Damage Prevention Ordinance as required for participation in the National Flood Insurance Program***

(NFIP). The standards required by NFIP are MINIMUM STANDARDS and communities are encouraged by FEMA and the ODNR Floodplain Management Division to enact stronger standards. A Riparian Setback Ordinance is such a standard.

☞ ***The building standards set forth in a community's Flood Damage Prevention Ordinance may be used to guide variances granted in the riparian setback.***

4. Where a wetland is identified within a minimum riparian setback, the minimum riparian setback width shall be extended to the outermost boundary of the wetland. ***In addition, wetlands within riparian setbacks shall be protected to the extent detailed in the Community's Wetland Setback Ordinance (cite appropriate code if Community has adopted such an ordinance).*** Wetlands shall be delineated through a site survey prepared by a qualified wetlands professional retained by the landowner using delineation protocols accepted by the U.S. Army Corps of Engineers at the time an application is made under this regulation. Any costs associated with reviewing these delineations may be assessed by the ***[community]*** to the applicant.

☞ ***Expansion of the riparian setback to include wetlands will help to maintain the functions of the riparian area. However, because wetlands provide flood control, erosion control, and water quality protection regardless of location, CRWP recommends that communities adopt a separate Wetland Setback Ordinance. Please contact CRWP for a copy of the Wetland Setback Model.***

5. The minimum riparian setback on an in-line pond existing at the time of application of this regulation shall be measured from the ordinary high water mark of the designated watercourse as it enters said pond and through the impoundment along the centerline of the designated watercourse as it flows through the in-line pond. Riparian setbacks on in-line ponds existing at the time an application is made under this regulation shall be expanded to include wetlands and floodplains as detailed in Section XXXX.05. The creation of new in-line impoundments shall not be permitted under these regulations.

XXXX.06 APPLICATIONS AND SITE PLANS

☞ ***The following application and site plan requirements are one suggested option for communities to implement riparian setbacks. The goal of these requirements is that riparian setbacks be considered early in the site design process and be shown on all applicable documents. The assumption inherent in this section is that the information required is necessary for other components of the development process and generally already required. Communities implementing riparian setbacks through this model must review Section XXXX.06 and tailor to their internal procedures and requirements. CRWP is available to provide alternative language for this section.***

A. The applicant shall be responsible for delineating riparian setbacks as required by this regulation and shall identify such setbacks on a site plan included with all subdivision plans, land development plans, and/or zoning permit applications submitted to the ***[community]***. The site plan shall be prepared by a professional engineer, surveyor, landscape architect, or such other qualified professional as determined by the ***[community]*** and shall be based on a survey of the affected land. Two (2) copies of the site plan shall be submitted. The site plans shall include the following information:

1. The boundaries of the lot with dimensions.
2. The locations of all designated watercourses.
3. The limits, with dimensions, of the riparian setbacks.
4. The existing topography at intervals of two (2) feet.
5. The location and dimensions of any proposed structures or uses, including proposed soil disturbance, in relationship to all designated watercourses.
6. North arrow, scale, date, and stamp bearing the name and registration number of the qualified professional who prepared the site plan.
7. Other such information as may be necessary for the ***[community]*** to ensure compliance with this regulation.

B. The ***[community]*** may, in reviewing the site plan, consult with the ***[county]*** SWCD or other such experts. Any costs associated with this review may be assessed to the applicant.

C. If soil disturbing activities will occur within 50 feet of the outer boundary of the applicable riparian setback as specified in this regulation, the riparian setback shall be clearly identified by the applicant on site with construction fencing as shown on the site plan. Such identification shall be completed prior to the initiation of any soil disturbing activities and shall be maintained throughout soil disturbing activities.

D. No approvals or permits shall be issued by the ***[community]*** prior to identification of riparian setbacks on the affected land in conformance with this regulation.

XXXX.07 USES PERMITTED IN RIPARIAN SETBACKS

☞ ***Communities should review, and modify as necessary, the following lists of permitted and prohibited uses for consistency with existing codes and community concerns.***

A. By Right Uses Without a Permit. Open space uses that are passive in character shall be permitted in riparian setbacks, including, but not limited to, those listed in this regulation. No use permitted under this regulation shall be construed as allowing trespass on privately held lands.

1. Recreational Activity. Hiking, fishing, hunting, picnicking, and similar passive recreational uses, as permitted by federal, state, and local laws.

2. Removal of Damaged or Diseased Trees. Damaged or diseased trees may be removed.

3. Revegetation and/or Reforestation. Riparian setbacks may be revegetated and/or reforested with native, noninvasive plant species.

B. By Conditional Use Permit Granted by the ***Planning and Zoning Commission***: When granting Conditional Use Permits for the following uses, the ***Planning and Zoning Commission*** may, for good cause, attach such conditions as it deems appropriate. Permits issued under this regulation are issued to the applicant only, shall not be transferred, and shall be void if not implemented within one (1) year of issuance.

1. Crossings: Crossings of designated watercourses through riparian setbacks with roads, driveways, easements, bridges, culverts, utility service lines, or other means may be permitted provided such crossings minimize disturbance in riparian setbacks and mitigate any necessary disturbances. Such crossings shall only be undertaken upon approval of a

Crossing Plan by the ***Planning and Zoning Commission***. Any costs associated with review of Crossing Plans may be assessed to the applicant.

If work will occur below the ordinary high water mark of the designated watercourse, proof of compliance with the applicable conditions of a US Army Corps of Engineers Section 404 Permit (either a Nationwide Permit, including the Ohio State Certification Special Conditions and Limitations, or an Individual Permit, including Ohio 401 water quality certification), shall also be provided to the ***[community]***. Proof of compliance shall be the following:

a. A site plan showing that any proposed crossing conforms to the general and special conditions of the applicable Nationwide Permit, or

b. A copy of the authorization letter from the U.S. Army Corps of Engineers approving activities under the applicable Nationwide Permit, or

c. A copy of the authorization letter from the U.S. Army Corps of Engineers approving activities under an Individual Permit.

2. Streambank Stabilization Projects. Streambank stabilization projects along designated watercourses may be allowed, provided that such measures are ecologically compatible and substantially utilize natural materials and native plant species to the maximum extent practicable. Such streambank stabilization measures shall only be undertaken upon approval of a Streambank Stabilization Plan by the ***Planning and Zoning Commission***. Any costs associated with review of Streambank Stabilization Plans may be assessed to the applicant.

If streambank stabilization work is proposed below the ordinary high water mark of the designated watercourse, proof of compliance with the applicable conditions of a US Army Corps of Engineers Section 404 Permit (either a Nationwide Permit, including the Ohio State Certification Special Conditions and Limitations, or an Individual Permit, including Ohio 401 water quality certification) shall be provided to the ***[community].*** Proof of compliance shall be the following:

a. A site plan showing that any proposed crossing conforms to the general and special conditions of the applicable Nationwide Permit, or

b. A copy of the authorization letter from the U.S. Army Corps of Engineers approving activities under the applicable Nationwide Permit, or,

c. A copy of the authorization letter from the U.S. Army Corps of Engineers approving activities under an Individual Permit.

3. Landscaping: The removal of natural vegetation within a riparian setback and the subsequent cultivation of lawns, landscaping, shrubbery, or trees may be allowed provided that such cultivation is done in conformance with a Landscaping Plan approved by the ***Planning and Zoning Commission***. Any costs associated with review of Landscaping Plans may be assessed to the applicant. Landscaping Plans shall meet the following criteria:

a. Maintain trees in the riparian setback larger than nine (9) inches in caliper (diameter) as measured fifty-four inches above the ground to the maximum extent practicable.

b. Maintain trees, shrubbery, and other non-lawn, woody vegetation in the riparian setback to the maximum extent practicable.

XXXX.08 USES PROHIBITED IN RIPARIAN SETBACKS

Any use not authorized under this regulation shall be prohibited in riparian setbacks. By way of example, the following uses are specifically prohibited, however, prohibited uses are not limited to those examples listed here:

A. Construction. There shall be no buildings or structures of any kind.

B. Dredging or Dumping. There shall be no drilling, filling, dredging, or dumping of soil, spoils, liquid, or solid materials, except for noncommercial composting of uncontaminated natural materials and except as permitted under this regulation.

C. Fences and Walls**:** There shall be no fences or walls, except as permitted under this regulation.

D. Roads or Driveways. There shall be no roads or driveways, except as permitted under this regulation.

E. Disturbance of Natural Vegetation: There shall be no disturbance of natural vegetation within riparian setbacks except for the following:

1. Maintenance of lawns, landscaping, shrubbery, or trees existing at the time of passage of this regulation.

2. Cultivation of lawns, landscaping, shrubbery, or trees in accordance with an approved Landscaping Plan submitted in conformance with this regulation.

3. Conservation measures designed to remove damaged or diseased trees or to control noxious weeds or invasive species.

F. Parking Spaces or Lots and Loading/Unloading Spaces for Vehicles: There shall be no parking spaces, parking lots, or loading/unloading spaces.

G. New Surface and/or Subsurface Sewage Disposal or Treatment Areas. Riparian setbacks shall not be used for the disposal or treatment of sewage, except as necessary to repair or replace an existing home sewage disposal system and in accordance with recommendations of the ***[county]*** Board of Health.

XXXX.09 NON-CONFORMING STRUCTURES OR USES IN RIPARIAN SETBACKS

☞ ***Communities may want to remove this section if non-conforming structures and uses are addressed elsewhere in their codes.***

A. A non-conforming use, existing at the time of passage of this regulation and within a riparian

setback, that is not permitted under this regulation may be continued but shall not be changed or enlarged unless changed to a use permitted under this regulation.

B. A non-conforming structure, existing at the time of passage of this regulation and within a riparian setback, that is not permitted under this regulation may be continued but shall not have the existing building footprint or roofline expanded or enlarged.

C. A non-conforming structure or use, existing at the time of passage of this regulation and within a riparian setback, that has substantial damage and that is discontinued, terminated, or abandoned for a period of six (6) months or more may not be revived, restored, or re-established.

XXXX.10 VARIANCES WITHIN RIPARIAN SETBACKS

☞ ***Sections XXXX.10 and XXXX.11 assign the authority to review and grant variances in the riparian setback to the Planning and Zoning Commission (P&Z), a role traditionally filled by the Board of Zoning Appeals. This role for the P&Z, developed by the City of Kirtland, is recommended because P&Z will be the body developing the riparian setback ordinance and recommending it to Council. Through this process of ordinance development, the members of P&Z become familiar with the intent of riparian setbacks, the technical issues involved, and the importance of adjusting other setbacks, such as side yard and rear yard, to ensure buildability while maintaining riparian areas. For this reason, the members of P&Z may be better able to grant reasonable riparian setback variances. Communities should consult their law director regarding this modification of authorities.***

A. The ***Planning and Zoning Commission*** may grant a variance to this regulation as provided herein. In granting a variance, the following conditions shall apply:

1. In determining whether there is unnecessary hardship with respect to the use of a property or practical difficulty with respect to maintaining the riparian setback as established in this regulation, such as to justify the granting of a variance, the ***Planning and Zoning Commission*** shall consider the potential harm or reduction in riparian functions that may be caused by a proposed structure or use.

2. The ***Planning and Zoning Commission*** may not authorize any structure or use in a Zoning District other than those authorized in the Zoning Code.

3. Variances shall be void if not implemented within one (1) year of the date of issuance.

B. In making a determination under ***Section XXXX***.10 (A) of this regulation, the ***Planning and Zoning Commission*** may consider the following:

1. The natural vegetation of the property as well as the percentage of the parcel that is in the 100-year floodplain. The criteria of ***Chapter XXXX Flood Damage Prevention*** may be used as guidance when granting variances in the 100-year floodplain.

2. The extent to which the requested variance impairs the flood control, erosion control, water quality protection, or other functions of the riparian setback. This determination shall be based on sufficient technical and scientific data.

3. The degree of hardship, with respect to the use of a property or the degree of practical

difficulty with respect to maintaining the riparian setback as established in this regulation, placed on the landowner by this regulation and the availability of alternatives to the proposed structure or use.

4. Soil-disturbing activities permitted in the riparian setback through variances should be implemented to minimize clearing to the extent possible and to include Best Management Practices necessary to minimize erosion and control sediment.

5. The presence of significant impervious cover, or smooth vegetation such as maintained lawns, in the riparian setback compromises its benefits to the ***[community]***. Variances should not be granted for asphalt or concrete paving in the riparian setback. Variances may be granted for gravel driveways when necessary.

6. Whether a property, otherwise buildable under the ordinances of the ***[community]***, will be made unbuildable because of this regulation.

C. In order to maintain the riparian setback to the maximum extent practicable, the ***Planning and Zoning Commission*** may consider granting variances to other area or setback requirements imposed on a property by the Zoning Code. These may include, but are not limited to, parking requirements, requirements for the shape, size, or design of buildings, or front, rear, or side lot setbacks.

D. In granting a variance under this regulation, the ***Planning and Zoning Commission***, for good cause, may impose such conditions that it deems appropriate to maintain the purposes of this regulation and to mitigate any necessary impacts in the riparian setbacks permitted by variance. In determining appropriate mitigation, the ***Planning and Zoning Commission*** may consult with the ***[community]*** Engineer or other agencies including ***[county]*** SWCD.

XXXX.11 PROCEDURES FOR VARIANCES & APPEALS

A. Any applicant seeking a variance to the conditions imposed under this regulation or an appeal to an administrative decision made under this regulation, other than a decision by the ***Planning and Zoning Commission***, may apply to or appeal to the ***Planning and Zoning Commission.*** The following conditions shall apply:

1. When filing an application for an appeal to an administrative decision, the applicant shall file a notice of appeal specifying the grounds therefor with the administrative official within ***20 days*** of the administrative official's decision. Upon determining that the application is complete and upon receipt of the required fee of ***$100***, the administrative official shall transmit to the ***Planning and Zoning Commission*** the application and a transcript constituting the record from which the administrative decision subject to appeal was based. This transmission shall occur no less than fourteen (14) days prior to a regularly scheduled meeting of the ***Planning and Zoning Commission*** in order to be placed on the agenda for that meeting.

2. When applying for a variance, the applicant shall file a variance request with the ***Planning and Zoning Commission***.

3. Applications for appeals or variances made under this regulation shall contain the following information:

a. The name, address, and telephone number of the applicant;

b. Proof of ownership or authorization to represent the property owner.

c. The location of the property, including street address and permanent parcel number.

d. The current zoning of the property.

e. A description of the project for which the appeal or variance is sought.

f. A description of the administrative decision being appealed or the conditions of the regulation from which a variance is sought.

g. Names and addresses of each property owner within 500 feet as shown in the current records of the ***[county]*** Auditor typed on gummed labels.

4. Applications for variances or appeals of administrative decisions shall not be resubmitted to the ***Planning and Zoning Commission*** within one (1) year of the date of a final decision by the ***Planning and Zoning Commission*** on the original application, unless the applicant shows the ***Planning and Zoning Commission*** either of the following:

a. Newly discovered evidence that could not have been presented with the original submission, or

b. Evidence of a substantial change in circumstances since the time of the original submission.

B. A decision by the ***Planning and Zoning Commission*** in response to an application for a variance request or an appeal of an administrative decision filed pursuant to this regulation shall be final.

***XXXX*.12 INSPECTION OF RIPARIAN SETBACKS**

The identification of riparian setbacks shall be inspected by the ***[community]***:

A. Prior to soil disturbing activities authorized under this regulation. The applicant shall provide the ***[community]*** with at least two (2) working days written notice prior to starting such soil disturbing activities.

B. Any time evidence is brought to the attention of the ***[community]*** that uses or structures are occurring that may reasonably be expected to violate the provisions of this regulation.

***XXXX*.99 PENALTY**

A. Any person who shall violate any section of this regulation shall be guilty of a misdemeanor of first degree and, upon conviction thereof, shall be subject to punishment as provided in ***Chapter XXXX*** and shall be required to restore the riparian setback through a restoration plan approved by the ***Planning and Zoning Commission***.

B. The imposition of any other penalties provided herein shall not preclude the ***[community]*** from instituting an appropriate action or proceeding in a Court of proper jurisdiction to prevent an unlawful development, or to restrain, correct, or abate a violation, or to require compliance with the provisions of this regulation or other applicable laws, ordinances, rules, or regulations, or the orders of the ***[community]*** Zoning Inspector.

Appendix K
Bathymetry Maps

St. Mary's River Fort Wayne
Allen County, Indiana
Survey Area Area: 46 Acres
Survey Date: August 25, 2015
HUCs:041000040606
- St. Mary's River Section 2

2 foot contours

N

1:4,500

0 170 340 680
Feet

Indiana Department of Natural Resources
Division of Fish and Wildlife
Lake and River Enhancement Program (LARE)
2005 Orthophotography
A. Haviland

DNR Division of Fish and Wildlife

St. Mary's River Fort Wayne
Allen County, Indiana
Survey Area Area: 46 Acres
Survey Date: August 25, 2015
HUCs:041000040606
- St. Mary's River Section 1

2 foot contours

N

1:4,500

0 170 340 680
Feet

Indiana Department of Natural Resources
Division of Fish and Wildlife
Lake and River Enhancement Program (LARE)
2005 Orthophotography
A. Haviland

DNR Division of Fish and Wildlife

St. Mary's River Fort Wayne
Allen County, Indiana
Survey Area Area: 46 Acres
Survey Date: August 25, 2015
HUCs:041000030806
- St. Joe River Section

2 foot contours

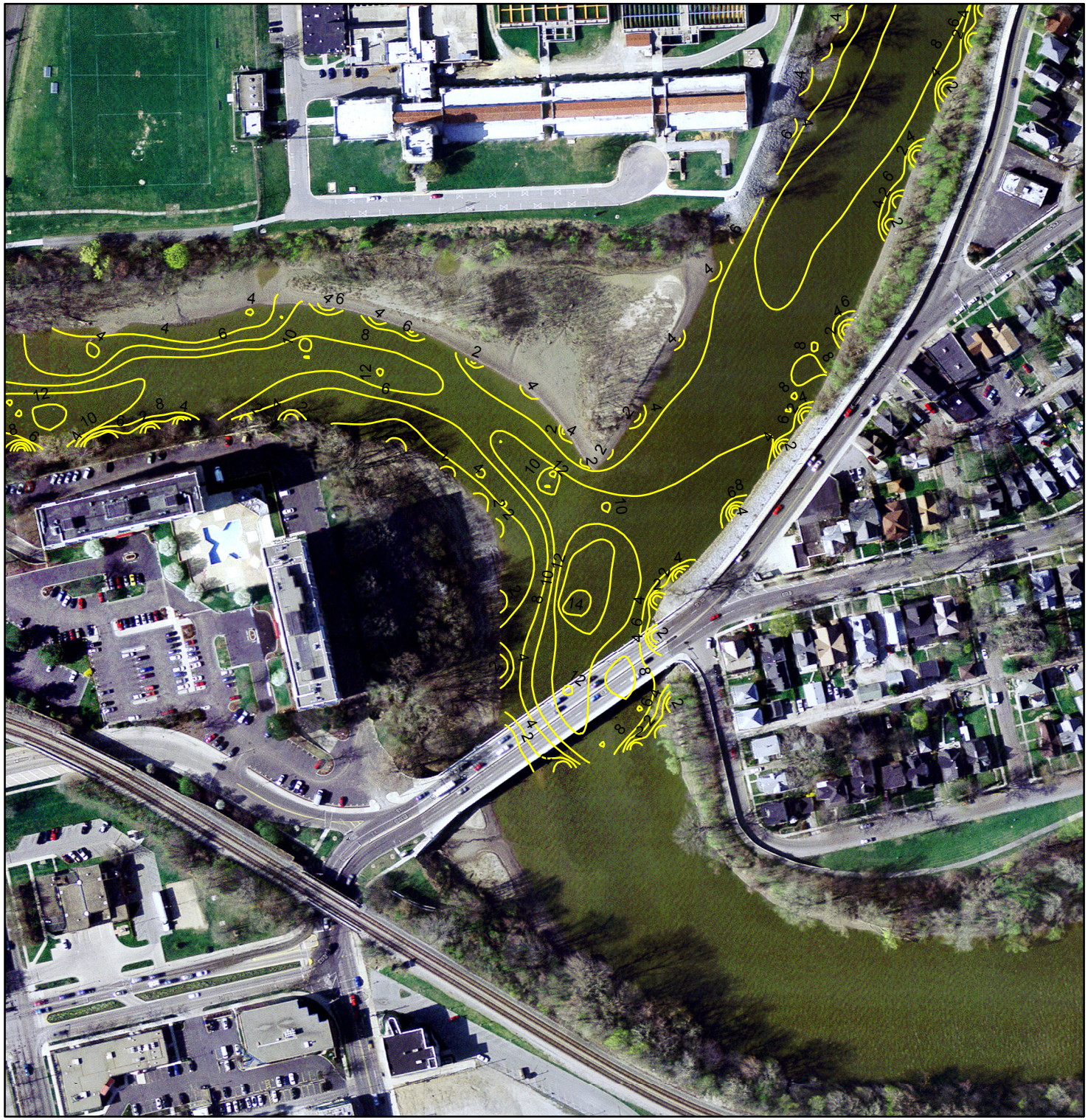
N

1:3,500

0 130 260 520
Feet

Indiana Department of Natural Resources
Division of Fish and Wildlife
Lake and River Enhancement Program (LARE)
2005 Orthophotography
A. Haviland

DNR Division of Fish and Wildlife



St. Mary's River Fort Wayne
Allen County, Indiana
Survey Area Area: 46 Acres
Survey Date: August 25, 2015
HUCs:041000050102
- Head waters Maumee Section

2 foot contours

N

1:3,500

0 95 190 380
Feet

Indiana Department of Natural Resources
Division of Fish and Wildlife
Lake and River Enhancement Program (LARE)
2005 Orthophotography
A. Haviland

DNR Division of Fish and Wildlife

St. Mary's River Fort Wayne
Allen County, Indiana
Survey Area Area: 46 Acres
Survey Date: August 25, 2015
HUCs:041000040606
041000050102
041000030806

2 foot contours

N

1:11,500

0 435 870 1,740
Feet

Indiana Department of Natural Resources
Division of Fish and Wildlife
Lake and River Enhancement Program (LARE)
2005 Orthophotography
A. Haviland

DNR Division of Fish and Wildlife