Big Creek Watershed Stormwater Retrofit Ranking Project

Final Technical Report

Lake Erie Protection Fund SG 409-2011

Friends of Big Creek

P.O. Box 609272
Cleveland, Ohio 44109
Bob Gardin, Project Manager

This project was funded through the Lake Erie Protection Fund with matching funds provided by the Northeast Ohio Regional Sewer District and Freshwater Future. The LEPF is supported by the voluntary contributions of Ohioans who purchase the "Erie…Our Great Lake" license plate featuring the Marblehead lighthouse.

ABSTRACT

Friends of Big Creek implemented the retrofit ranking project to better select and develop stormwater retrofit projects from the 156 potential sites identified in the Big Creek Watershed Balanced Growth Plan. The primary goal of the project was to identify optimal stormwater retrofit sites in the watershed that would reduce runoff volume; reduce the stormwater peak flow rate; and improve the overall water quality. FOBC and its technical advisory committee selected Tetra Tech, Inc. to develop the project and produce a technical report.

The first task of the project included data collection, geographic information system desktop analysis, and field reconnaissance. Criteria used to conduct the first level of screening included identifying the drainage area, determining what percentage of it is impervious, estimating its pollutant load, and determining the site area that can be used to treat the drainage.

The next task included contacting the property owners, examining detailed site plans and performing field assessments on 20 of the top ranked sites. Based on additional criteria including property ownership interest, site constraints, and potential as a demonstration project, conceptual plans were developed for the three highest ranking sites. The data collected in this project will be used to develop additional sites as funding becomes available. To learn more about the project and planning for a second phase, visit: friendsofbigcreek.org.

Ohio | Lake Erie Protection Fund

Northeast Ohio Regional Sewer District
Protecting Your Health and Environment

FRESHWATER FUTURE

INTRODUCTION

The Big Creek Watershed Stormwater Retrofit Ranking Project was initiated by Friends of Big Creek to complement land use measures identified in the Big Creek Watershed Balanced Growth Plan. The community partners in the Balanced Growth Plan include the cities of Brook Park, Brooklyn, Cleveland, Parma, and Parma Heights. All data obtained from the retrofit ranking project was to be made available to each community. The project was modeled, in part, on a similar project undertaken by the Cuyahoga Soil and Water Conservation District for portions of the Euclid Creek and Rocky River watersheds. The Big Creek project sought to identify potential stormwater retrofits within the entire 38 square mile Big Creek watershed.

Project funding included $15,000 from the Ohio Lake Erie Protection Fund; $5000 from the Northeast Ohio Regional Sewer District; and $2000 from Freshwater Future. Upon award of funding for the project, FOBC formed a technical advisory committee (TAC) to provide oversight in the development and implementation of the project. A representative from each of the following entities formed the TAC: Ohio EPA, Cuyahoga Soil and Water Conservation District; Cleveland Metroparks, Northeast Ohio Regional Sewer District, Northeast Ohio Areawide Coordinating Agency, Cuyahoga County Board of Health, and Cuyahoga River Community Planning Organization/Cuyahoga River RAP.

Through a competitive process, FOBC and its TAC selected Tetra Tech, Inc. as the project consultant, with George Remias and Jennifer Olson as the team leaders. FOBC, through its project manager and the consultants, selected and FOBC hired a project intern to assist with the overall project, including data collection, geographic information system desktop analysis, and field reconnaissance. The project produced detailed analysis of the 156 potential stormwater retrofit sites identified in the Balanced Growth Plan as well as several others identified through further study and developed conceptual plans for three of the highest ranking sites.

Following is the Summary Report for the project prepared by the project consultant, Tetra Tech, Inc., followed by a conclusion to this Technical Report. The Summary Report with its appendices can be found at friendsofbigcreek.org.

SUMMARY REPORT

Project Purpose

The Big Creek Watershed Stormwater Retrofit Ranking Project (Project) was initiated to help further the work completed as part of the Big Creek Watershed Balanced Growth Plan. The primary goal of this project was to in identify the optimal stormwater retrofit sites in the watershed that would achieve the following goals:

- Reduce runoff volume
- Reduce the stormwater peak flow rate
- Improve the overall water quality

The Project included three tasks:

- Task 1: Preliminary Screening – Conduct a desktop analysis to rank potential retrofit sites identified in the 2010 Big Creek Watershed Balanced Growth Plan.
- Task 2: Field Assessment and Priority Ranking – Conduct a field assessment for 20 to 30 potential retrofit sites, then rank the sites based upon additional criteria.
- Task 3: Conceptual Design and Cost Estimates – Prepare conceptual designs and cost estimates for up to four sites.

This memorandum briefly summarizes the scope and findings during each of the three tasks of the project, as well as some suggested next steps to further support the overall goals of the Project.

Background

At nearly 39 drainage square miles, the Big Creek watershed is one of the most urbanized and impervious tributaries to the Cuyahoga River. A total of six percent (2.5 square miles) of open space remains within this watershed. The Big Creek watershed encompasses the seven communities as shown in Figure 1.

Along the nearly 12 miles of stream length, Big Creek's original drainage pattern, wetlands, floodplain, and riparian areas have been severely altered and replaced with concrete lined channelized streams, long culverted segments, spillway structures, significant development and encroachment within the floodplain. Consequently, the surface runoff has increased in total volume, peak rates, and pollutant loads while groundwater recharge and base flow conditions have decreased.

In 2006, Friends of Big Creek (FOBC), with support from the Cuyahoga River Community Planning Organization, developed a Balanced Growth Plan Big Creek Watershed. The plan discusses that a conservation or restoration strategy can include implementation of structural (e.g., stormwater basin) and non-structural (e.g., preservation) practices to improve stream health and reduce erosion and stormwater runoff. It also goes on to suggest that structural restoration practices such as stormwater retrofits are more effective in urban watersheds such as Big Creek.

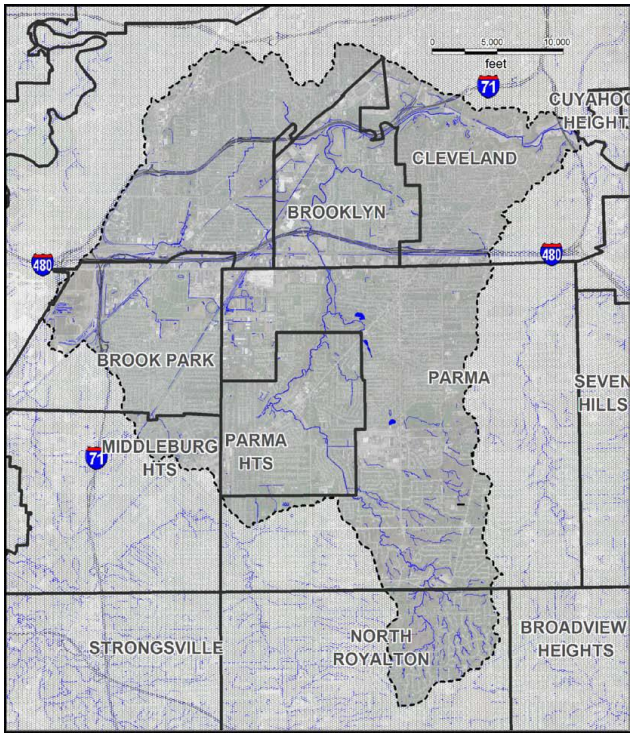


Figure 1. Big Creek Watershed (Big Creek Watershed Balanced Growth Plan, 2010)

As part of the 2010 Big Creek Watershed Balanced Growth Plan, 156 potential retrofit sites were identified and organized into four categories:

- 69 Large parking lots > 5 acres
- 35 Modified existing dry basins
- 46 New storage below outfalls
- 6 Storage areas at highway interchanges

Task 1: Preliminary Screening

Task 1 primarily focused on conducting a GIS desktop analysis of the existing 156 potential stormwater retrofit sites and identifying the top 20 to 30 sites. Because the Big Creek Watershed Balanced Growth Plan already conducted a desktop GIS analysis to identify 156 potential stormwater retrofit sites, additional criteria were defined under Task 1 to further screen the sites.

The Task 1 criteria used to conduct the desktop GIS analysis included:

- Drainage Area – area that drains to a retrofit site
- Impervious Area – impervious area within the drainage area
- Estimated Annual Total Suspended Solids (TSS) Loads – estimated pollutant load within the drainage area
- Treatment Area – area at the retrofit site that can be used to treat from the contributing drainage area

Each criterion was defined for each site using available GIS data. The drainage area was calculated using available GIS data sets including the 2006 Cuyahoga County topographic and aerial photo data, Northeast Ohio Regional Sewer District's (NEORSD) and available municipal stormwater GIS datasets, NEORSD's RIDE Study Big Creek watershed model catchments, and best professional judgment. Figure 2 shows an example of a drainage area delineated for one of the sites.

Impervious area was estimated within the drainage area by using NEORSD impervious data for the Big Creek watershed. Estimated annual TSS loads were estimated for each land cover type using unit area loadings as summarized in Figure 3 which also presents the land cover in the watershed.

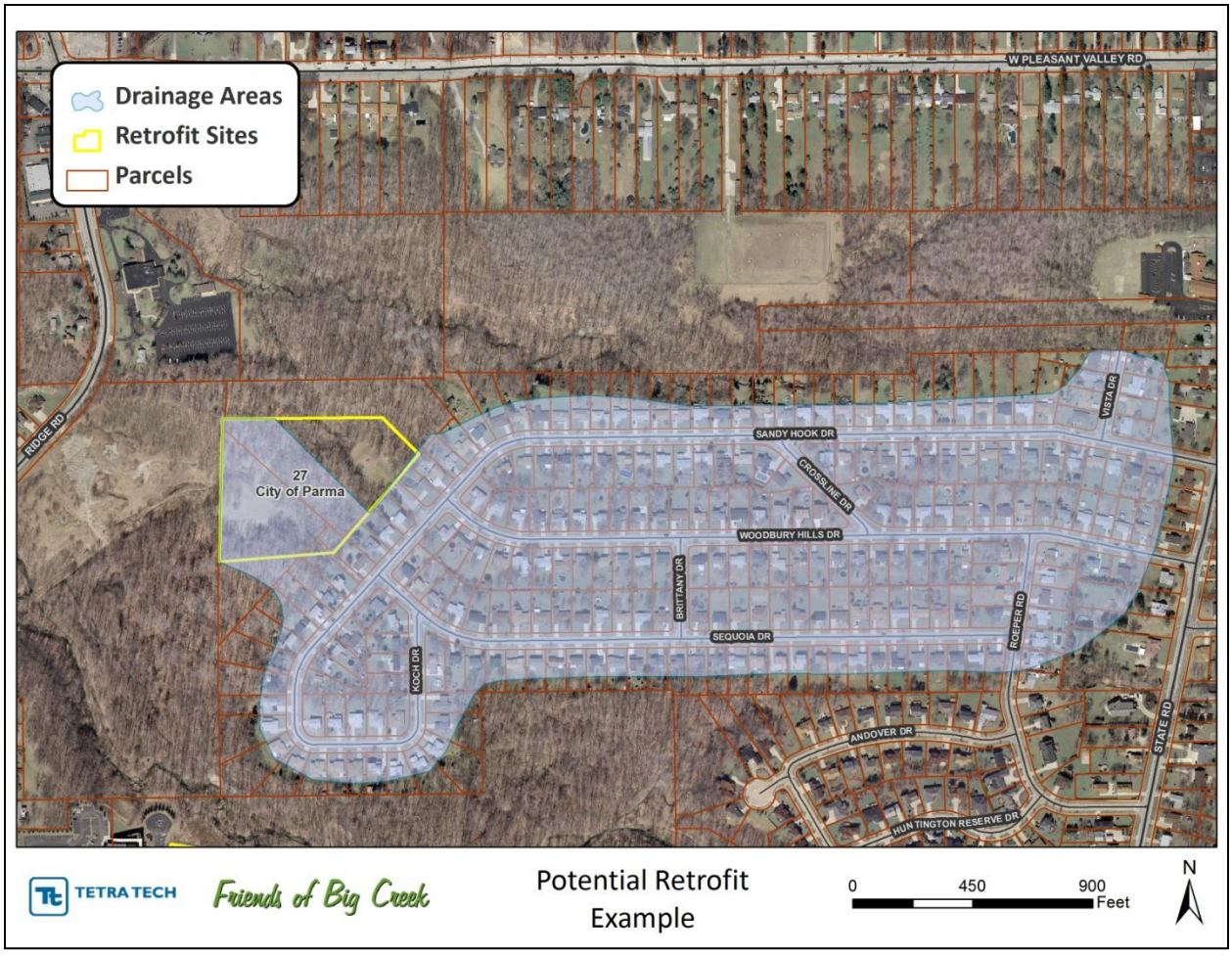


Figure 2. Drainage area delineation example.

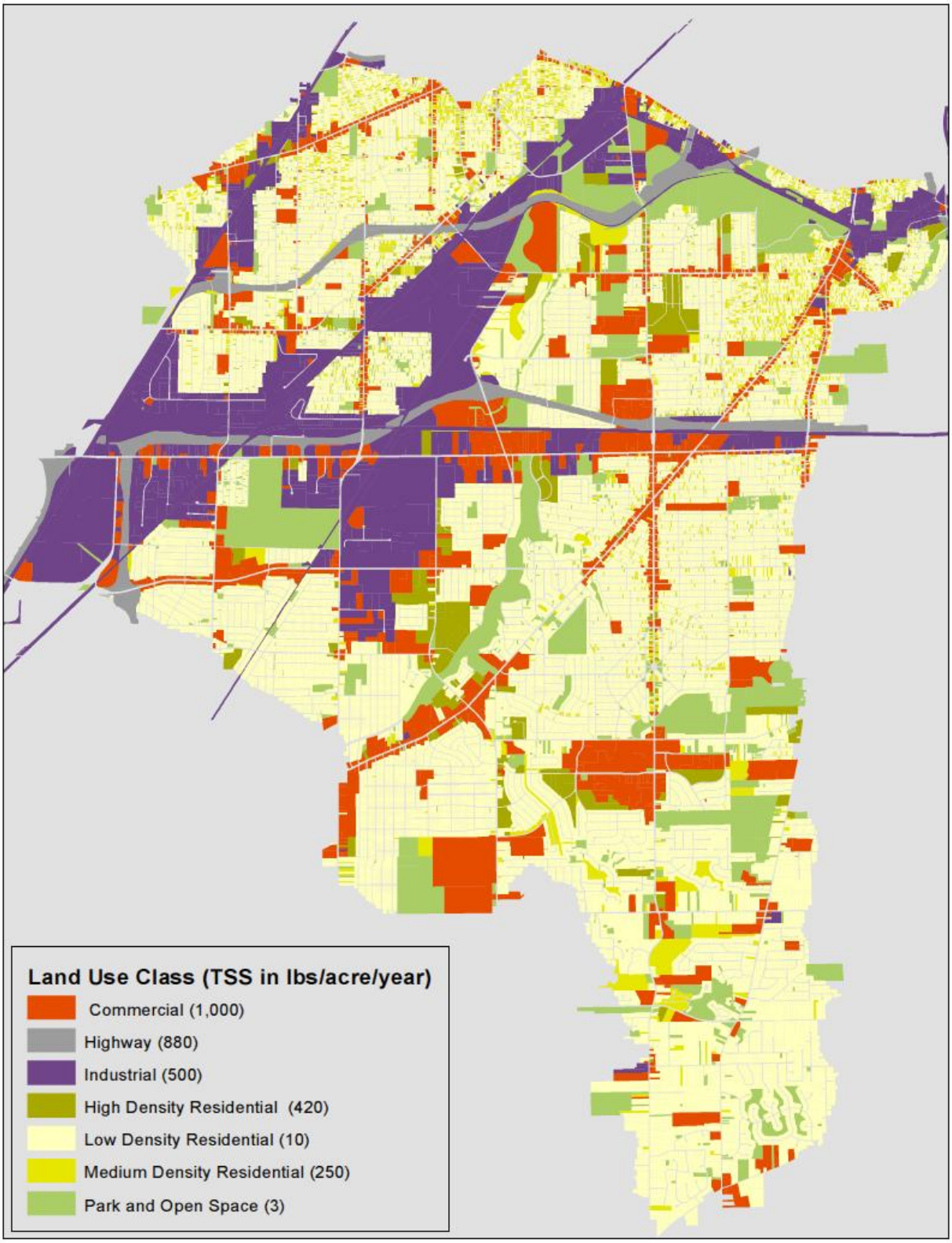


Figure 3. Land cover categories and annual TSS load estimates (land cover data provided by Cuyahoga County, TSS loading rates provided by Pollutant Removal Database, 2nd Edition, 2000).

The treatment area was calculated by looking at the available parcel area and defining the area that could be used for treatment. Some key assumptions included:

- 50 percent of the parking lot impervious area could be retrofitted
- 50 percent of existing detention ponds could be optimized for on-site treatment, since the level of treatment provided by the pond was unknown

The six storage areas at highway interchange retrofit sites are owned by ODOT. ODOT was contacted to determine level of interest in participating in any retrofit projects and it was determined that the sites in the Big Creek watershed were not a high priority for ODOT nor was there interest in pursuing a stormwater retrofit at these locations. The six sites were further excluded from consideration as Task 2 sites.

During the Task 1 evaluation, it was commonly noted that there was more than one potential retrofit on a parcel, (see Figure 4 for examples). In these cases, the overall site was evaluated in place of the specific stormwater retrofits.

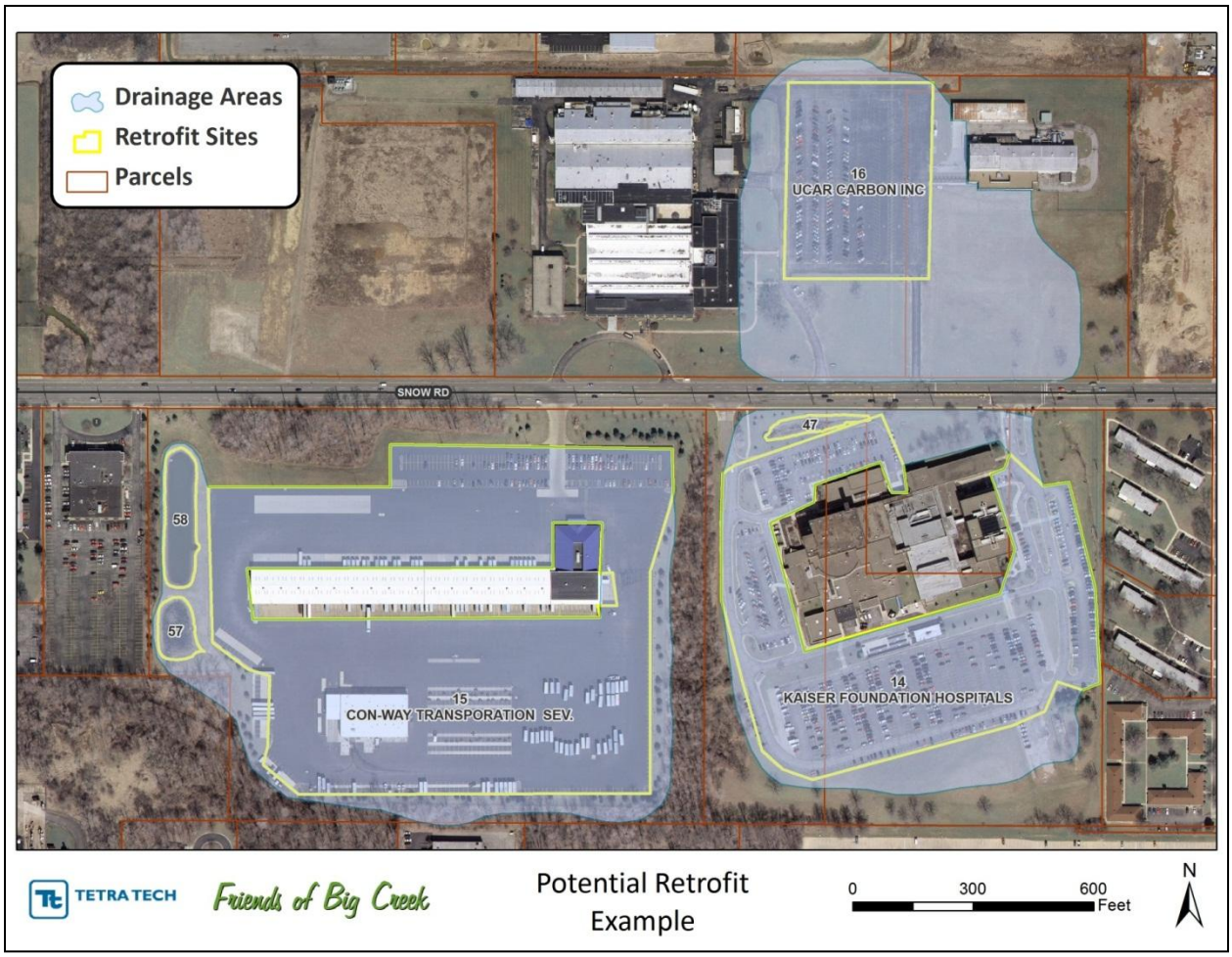


Figure 4. Example of locations that have multiple stormwater retrofit sites.

Each site was evaluated and ranked based on the Task 1 criteria. Two separate scenarios were evaluated under Task 1 including:

- Scenario 1: Equally weight the four criteria
- Scenario 2: Equally weight three criteria excluding drainage area

A second scenario was considered in addition to Scenario 1 since both drainage area and impervious area are indicators of runoff volume and peak flow rate, so considering both was considered potentially skewing the site rankings to those two water quantity-based criteria, while minimizing the water quality and treatment capacity criteria. However, the site rankings had minor variation between the two scenarios. Sites were ranked from first to last, with the highest ranking sites having the highest combined ranking of runoff volume, peak flow rate, and pollutant load, while providing the largest area to treat the runoff.

Figure 5 presents the results of Task 1 site ranking and Appendix A includes the tabular results. The top 28 potential stormwater retrofits (within 16 sites due to multiple potential stormwater retrofits being on the same parcel for a few locations) were chosen for further evaluation under Task 2. Additional information on Task 1 is described in the FOBC Big Creek Watershed Stormwater Retrofit and Ranking Project memorandum titled: “GIS Data Needs”.

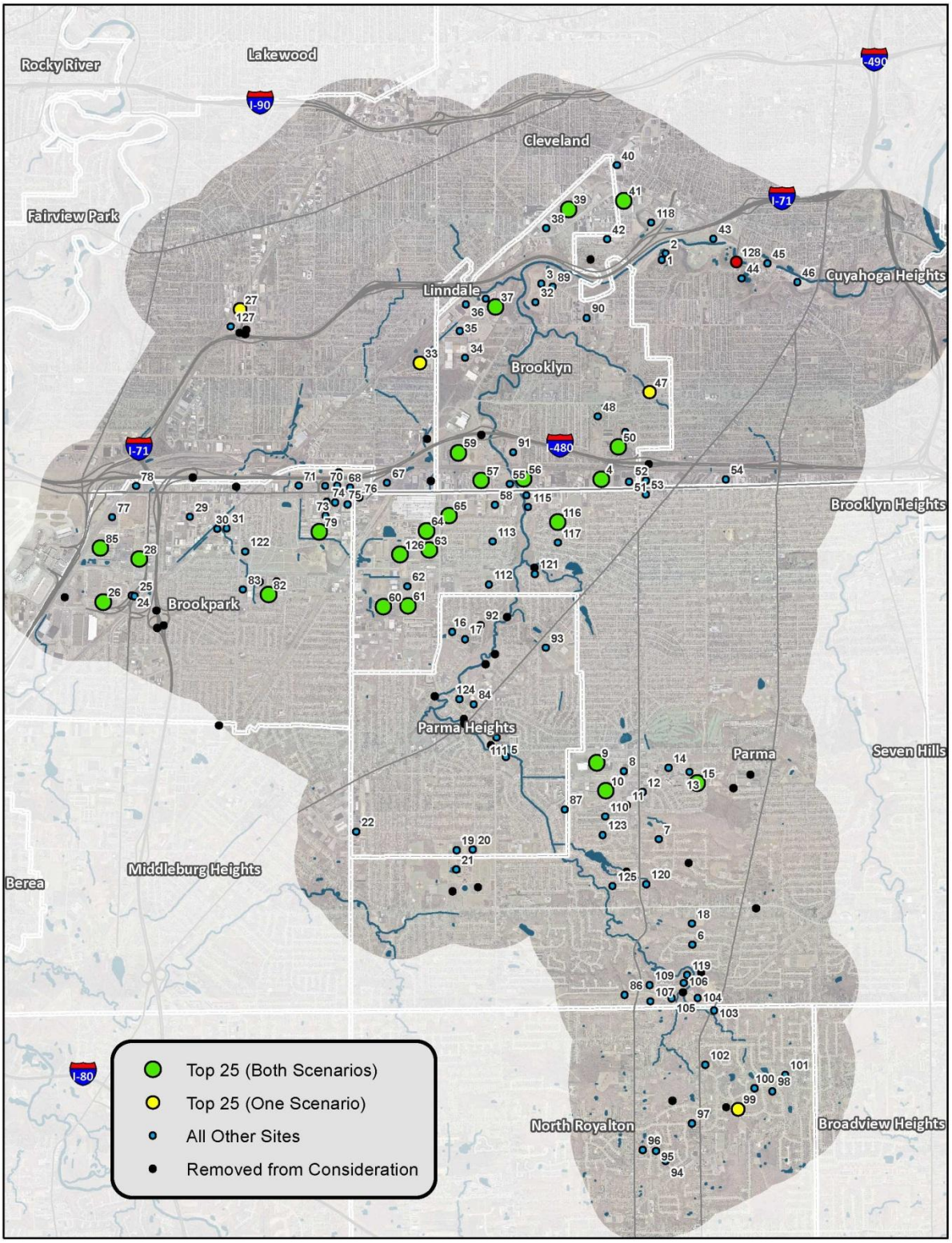


Figure 5. Task 1 site rankings.

Task 2: Field Assessment and Priority Ranking

Task 2 focused on the following general activities:

- Conduct field reconnaissance of 20 to 30 sites
- Define additional criteria to compare and prioritize each of the X sites being further evaluated
- Develop and implement a methodology to rank the Task 2 sites

Prior to field reconnaissance, the majority of property owners were contacted to discuss the goals and purpose of the Project, request access to their property, collect additional information regarding the site (including drainage plans and/or utility plans), and discuss interest in participating in the Project. Property owners who indicated no interest in granting property access were replaced with additional retrofit sites evaluated under Task 1. Field reconnaissance was conducted at 16 locations that included 27 potential stormwater retrofit sites (Appendix B). Figure 6 presents an example of the field form filled out for each Task 2 site.

The primary criteria used to consider Task 2 sites included:

- Estimated percent of on-site Ohio EPA water quality treatment
- Estimated percent of on-site flood treatment
- Potential demonstration project site

The percent of on-site Ohio EPA water quality treatment and on-site flood treatment was estimated by reviewing available design drawings, plan reviews, stakeholder information, date of construction, on-site field assessment, and best professional judgment. The potential as a demonstration project site was defined in coordination with FOBC and the TAC.

Additional factors used to consider each site included:

- Property ownership interest
- Site constraints
- Environmental constraints
- If retrofits were needed to address maintenance or performance issues

The Task 2 sites were given an initial recommendation by the Consultants by considering the factors described above, while strong consideration to the current treatment on-site:

- Strong Recommendation
- Fair Recommendation
- Limited Recommendation

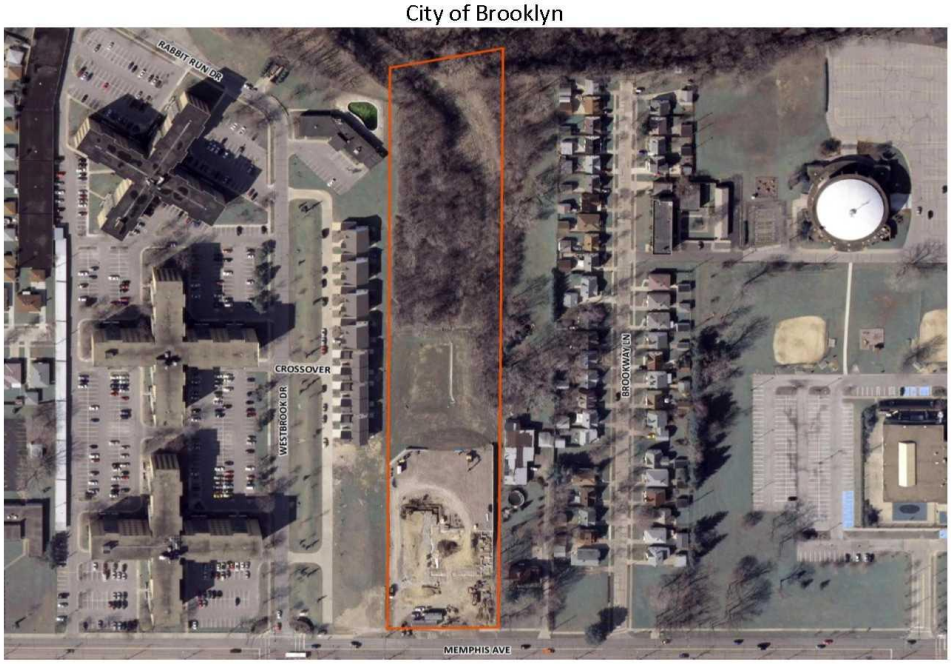
Appendix C includes the field summary for the Task 2 sites and their initial Consultant prioritization recommendation.

The Task 2 sites were presented to the TAC for further consideration and three primary sites were selected to develop conceptual plans (Table 1). Three alternate sites were also selected in case any primary site was not considered viable upon further evaluation.

Table 1. Selected sites for Task 3

Primary Sites	Alternate Sites
Site 47 (Biddulph Plaza)	Site 15 (Upper Ridgewood Lakes Basin)
Site 113 (Fern Hill West Bank)	Site 57 (Home Depot)
Site 65 (GM East Parking Lot)	Site 64 (GM South Parking Lot)

FOBC Big Creek Watershed Stormwater Retrofit Ranking Project: Task 2 Site Prioritization
Site 90: Brooklyn Fire Station
City of Brooklyn



Drainage Acres	**2.6**	Flood Treatment	**100 %**
Impervious Acres	**1.7**	Water Quality Treatment	**100 %**
TSS in Pounds	**2,645**	Demonstration Project?	**No**
General Findings: Site was recently renovated. Swale/basin in the rear appears to provide flood control and water quality treatment to the fire station runoff. Outflow is trying to carve stream channel into the valley to the north.			

View of swale from parking lot

View downhill from swale

Proposed SW Retrofit Recommendation: **3**

Comment: Site has potential to be a zero runoff site with modifications to the basin. Need a rigid stream design to safely convey basin outlet discharges to main tributary.

Note: **1** – Strong Recommendation **2** – Fair Recommendation **3** – Limited Recommendation

Figure 6. Example field form.

Task 3: Conceptual Designs and Cost Estimates

Task 3 consisted of developing conceptual designs and cost estimates for three sites.

Figure 7 presents the summary of what sites conceptual plans were prepared under Task 3, as well as the general rankings of remaining sites.

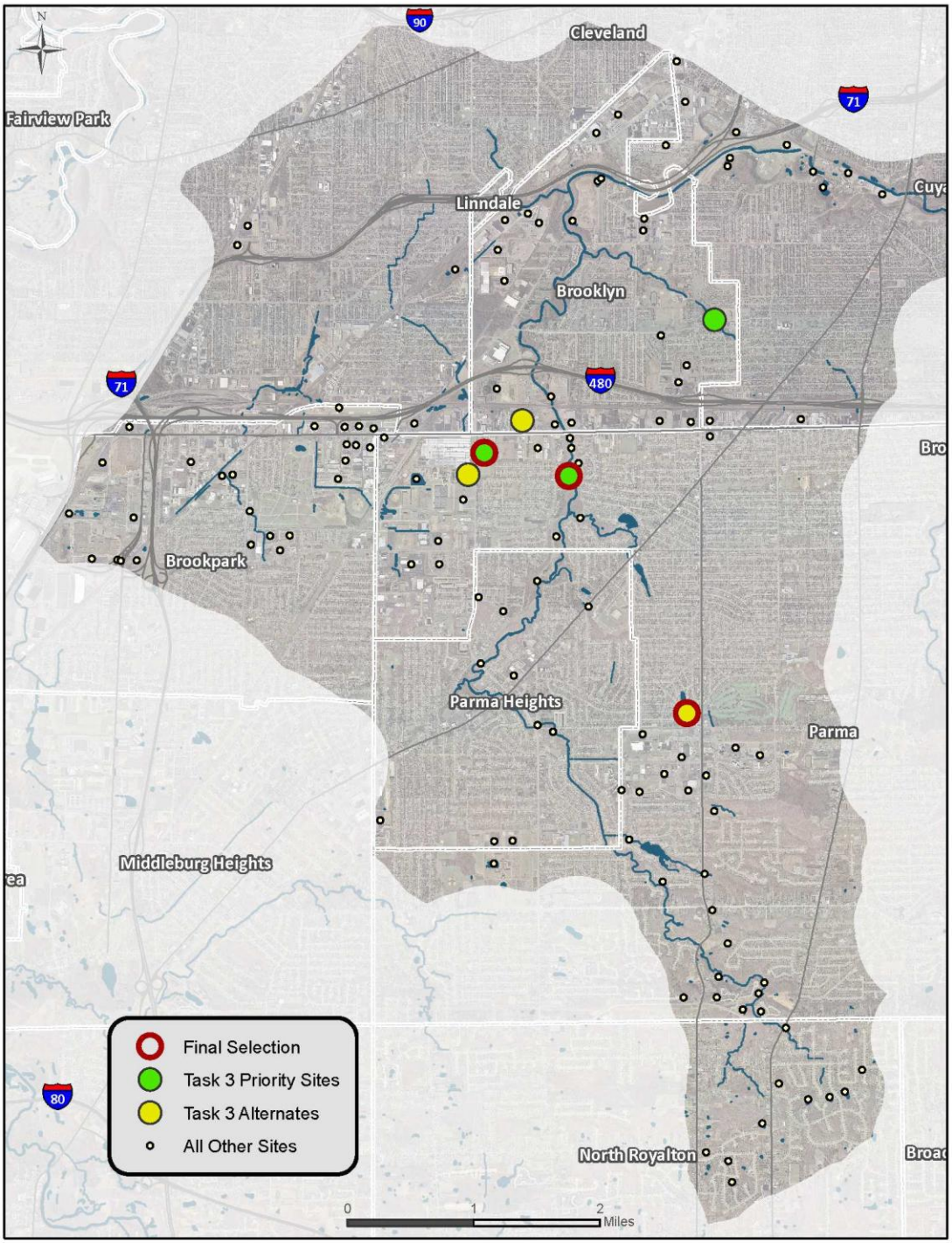


Figure 7. Final Site Rankings.

Prior to developing conceptual plans, the property owner for each of the three primary sites was again contacted to determine their willingness to proceed with the concept plan, request available information, and discuss overall interest in the eventual construction of the retrofit. Primary Site 47 (Biddulph Plaza) was replaced with Site 15 (Upper Ridgewood Lakes Basin) due to lack of response by the property owner.

Development of the conceptual plans included evaluating the effectiveness of a suite of potential best management practices which could be used to retrofit each site. In addition, site and environmental constraints and usefulness as a demonstration project were considered as well as co-benefits that could be achieved through the design such as increasing safety and providing shade.

A draft conceptual plan was developed and shared with FOBC, TAC, and the property owner prior to finalization. Figures 8, 9, and 10 present the proposed conceptual plans with several attributes including:

- Existing conditions
- Proposed conditions
- Retrofit description
- Cost estimate

Each site is discussed below including features of the proposed stormwater retrofits, cost estimates, and assumptions.

Site 15 - City of Parma: Upper Ridgewood Lakes Basin, Parma, Ohio

Site 15 is a proposed retrofit of an existing detention basin located in the City of Parma. Using the Ohio EPA water quality volume sizing criteria, the existing 3.4-acre detention basin appears to provide the Ohio EPA water quality volume in addition to providing minor flood control. The goal of the retrofit is to increase flood control, maintain water quality treatment, naturalize the basin, and provide increased accessibility for maintenance.

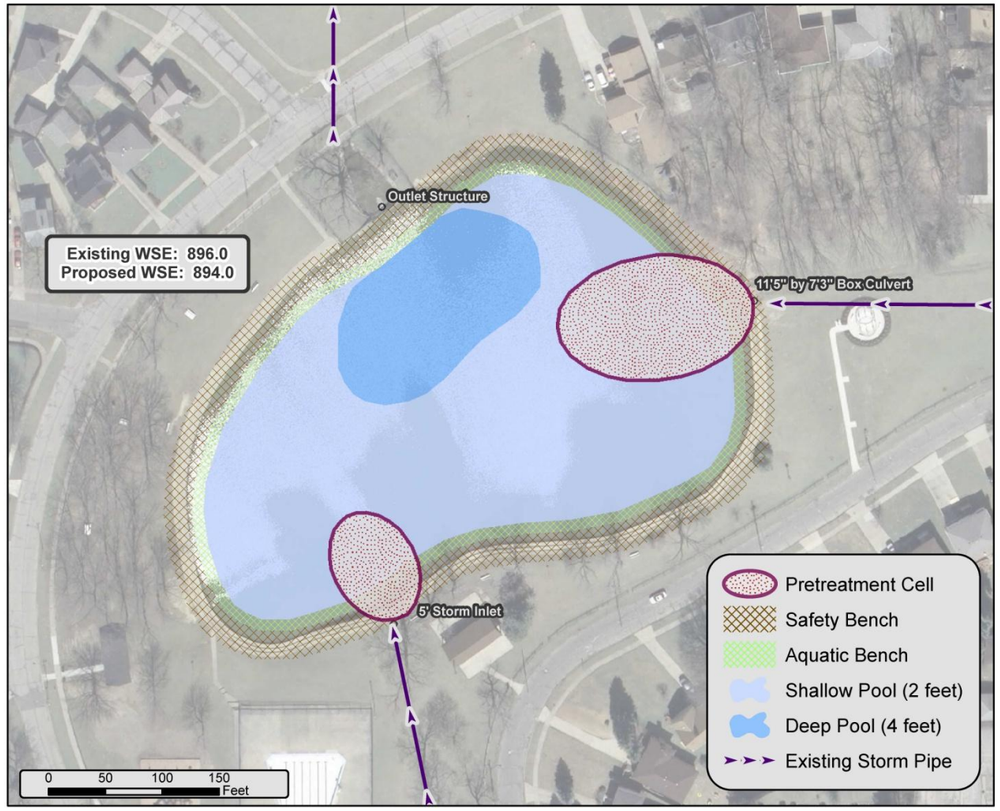
The proposed retrofit includes lowering the current water elevation by two feet while still maintaining the Ohio EPA water quality control requirement, while providing nearly double the amount of flood control compared to existing conditions (Figure 8). The retrofit includes pretreatment cells to focus sedimentation and allow for routine maintenance. In addition, the retrofit includes removing the existing concrete steps around the basin perimeter and replacing it with a safety bench and an aquatic bench to improve water quality.

The conceptual planning level cost estimate for this stormwater retrofit ranges between $1.1M and $1.9M, and includes probable construction costs, design, survey, permitting, minor sediment testing, and a 25 percent contingency. The largest unknown is regarding the existing sediment volume and environmental makeup of the sediment, which is a large majority of the cost. The lower cost range assumes 2feet of sediment removal (approximately 8,600 cubic yards) is required at a cost of approximately $430,000, while the upper cost range assumes 4 feet of sediment removal (approximately 17,100 cubic yards) at approximate cost of $860,000. Both cost estimates assume the sediment is clean and does not require special handling or disposal. The overall cost per square foot for this stormwater retrofit conceptual planning level cost estimate ranges from $9.13 to $16.11 per square foot.

Friends of Big Creek: Big CreekWatershed Stormwater Retrofit and Ranking Project
Conceptual Plan
Site 15 (Ridgewood Lake): Wet Extended Detention Basin and Aquatic Bench

Friends of Big Creek

TETRA TECH



Existing Conditions			
Drainage Acres	683.3	TN Load (lbs/year)	1,238.4
Impervious Acres	150.2	TP Load (lbs/year)	184.8
Flood / Water Quality Treatment	33 / 95 %	TSS Load (lbs/year)	110,173

General Finding: The pond receives a massive amount of water from a box culvert and 60" pipe. The reservoir appears to hold most of the drainage and has several feet of additional storage, but does overflow during exceptional storm events.

Proposed Conditions			
Existing Storage Volume (ac-ft)	10.6	Pretreatment Cells (SF)	4,566
Proposed Storage Volume (ac-ft)	16.1	Pool Area (SF)	115,527
Proposed Ohio EPA Water		Aquatic Bench (SF)	13,649
Quality Volume Met (%)	100%	Safety Bench (SF)	36,897
Additional Flood Control		TSS Load Reduction (lbs/year)	11,017
Volume (ac-ft)	5.2	in addition to current treatment conditions	

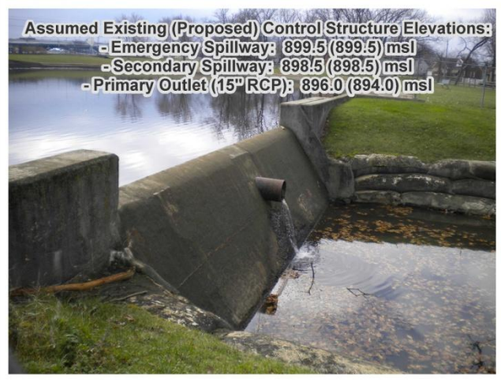
Retrofit Description

Two large inlets that feed into the detention pond will enter pretreatment cells, which will allow sediment to settle and provide vehicle access for targeted maintenance areas. The concrete steps that line the pond will be replaced with a smooth, earthen gradient, leading to an aquatic bench supporting various types of wetland vegetation. The pond will be excavated and the outlet structure modified to lower the permanent pond elevation, while providing 2 to 4 feet of depth and preserving the functionality of the overflow spillway.

Planning Level Cost Estimate*	Lower Range	Upper Range
Total Cost	$1.1 million	$1.9 million
Sediment Removal Only	$430,000	$860,000
Cost per Square Foot	$9.13	$16.11

*Includes probable construction costs, design, survey, permitting, sediment testing, and a 25% contingency.

View of basin from western edge.



Overflow structure.

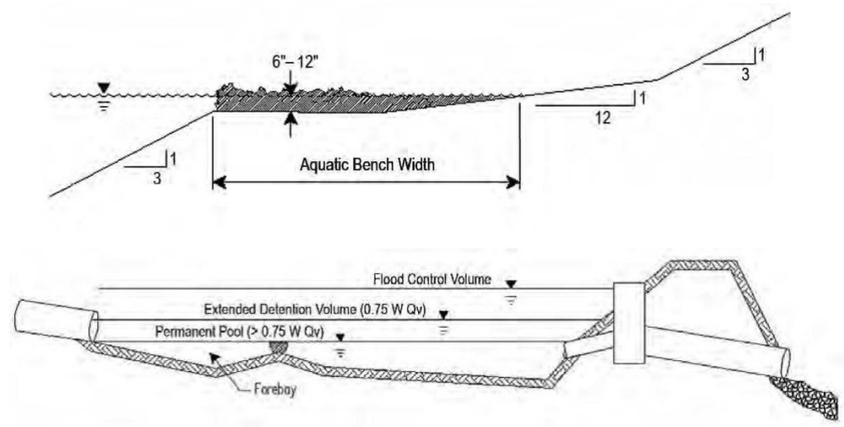
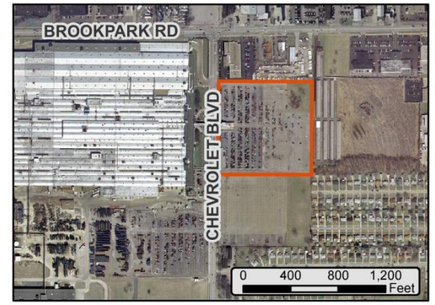


Figure 8. Site 15 –Upper Ridgewood Lake concept plan.

Friends of Big Creek: Big CreekWatershed Stormwater Retrofit and Ranking Project
Conceptual Plan
Site 65 (General Motors Employee Parking Lot): Bioswales/Bioretention and Green Pavers



Existing Conditions			
Drainage Acres	24.3	TN Load (lbs/year)	114.0
Impervious Acres	20.3	TP Load (lbs/year)	31.5
Flood / Water Quality Treatment	0 / 0 %	TSS Load (lbs/year)	12,124

General Finding: Parking lot receives no treatment.

Proposed Conditions			
Existing Storage Volume (ac-ft)	0	Bioswale/Bioretention (SF)	104,973
Proposed Storage Volume (ac-ft)	2.41	Green Paver (SF)	105,131
Proposed Ohio EPA Water		Parking Spaces (SF)	149,275
Quality Volume Met (%)	100%	TSS Load Reduction (lbs/year)	10,973
Additional Flood Control		TN Load Reduction (lbs/year)	59.7
Volume (ac-ft)	1.75	TP Load Reduction (lbs/year)	20.5

Retrofit Description

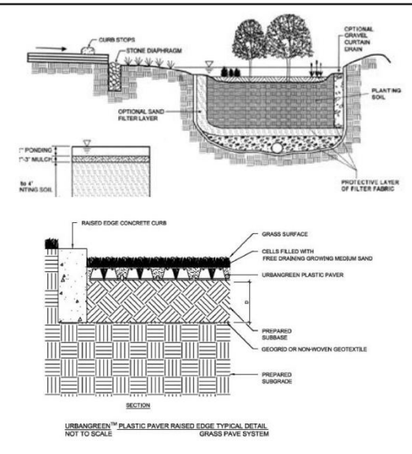
The parking spaces will be aligned to improve safety for workers as they enter the facility. Bioswales, lined with trees and located between parking spaces, will guide stormwater runoff into numerous bioretention areas. The rear section of the parking lot will be surfaced with green pavers, allowing water to percolate directly into the ground. The proposed site includes over 800 parking spaces.

Planning Level Cost Estimate*	Lower Range	Upper Range
Total Cost	$5.5 million	$7.0 million
Cost per Square Foot	$6.21	$7.96

*Includes probable construction costs, design, survey, permitting, sediment testing, and a 25% contingency.

View of parking lot from east side, looking at employee entrance.

View of parking lot from east side, looking toward the back of the lot.

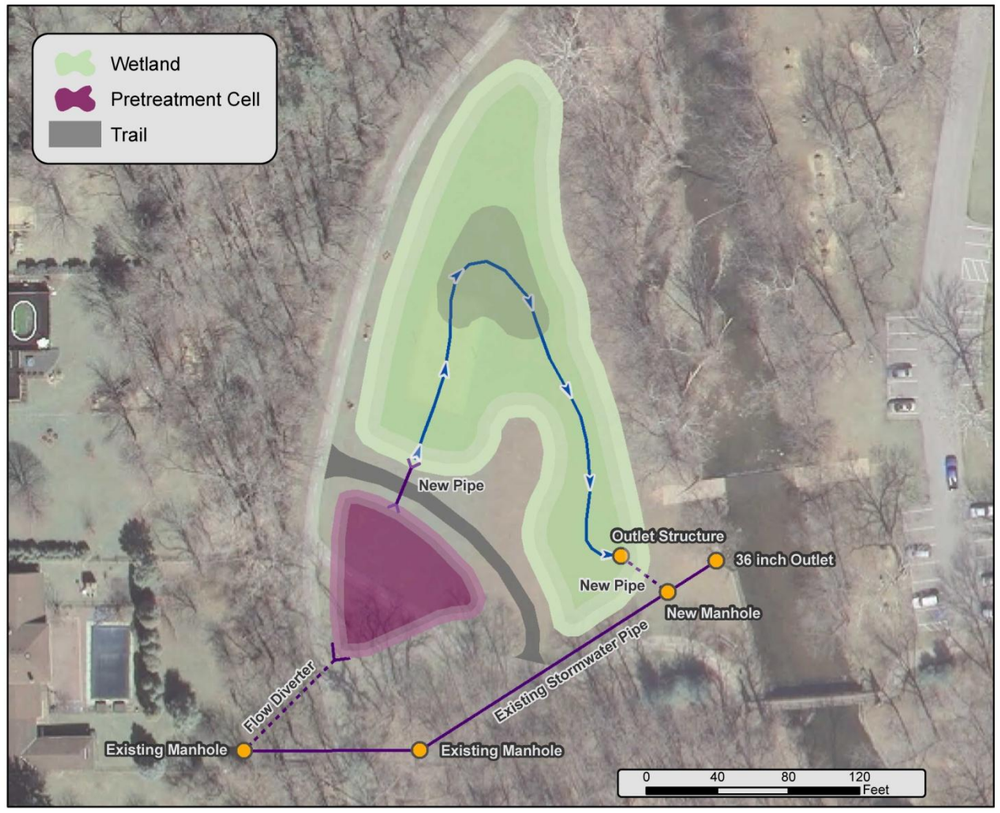


TETRA TECH

Friends of Big Creek

Figure 9. Site 65 – GM East parking lot concept plan.

Friends of Big Creek: Big CreekWatershed Stormwater Retrofit and Ranking Project
Conceptual Plan
Site 113 (Cleveland Metroparks Upper Fern Hill - West Bank): Constructed Wetland



Existing Conditions			
Drainage Acres	50.8	TN Load (lbs/year)	136.1
Impervious Acres	15.2	TP Load (lbs/year)	20.2
Flood / Water Quality Treatment	0 / 0 %	TSS Load (lbs/year)	12,945

General Finding: 36 inch pipe enters directly into Big Creek just downstream of the bridge. There is a manhole on private property that would provide access to the pipe.

Proposed Conditions			
Existing Storage Volume (ac-ft)	0	Pretreatment Cell (SF)	5,701
Proposed Storage Volume (ac-ft)	0.77	Wetland (SF)	27,807
Proposed Ohio EPA Water		TSS Load Reduction (lbs/year)	10,744
Quality Volume Met (%)	100%	TN Load Reduction (lbs/year)	35.4
Additional Flood Control		TP Load Reduction (lbs/year)	8.7
Volume (ac-ft)	0.06		

Retrofit Description

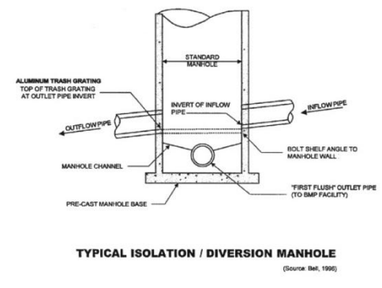
Runoff associated with small storm events will be diverted from an existing pipe into a pretreatment cell, which will allow sediment to fall out of suspension. Water will then meander through a constructed wetland, whose depth will be maintained by a flow control structure that empties into the existing stormwater pipe. Vehicle access will be provided to ensure ease of maintenance.

Planning Level Cost Estimate*	Lower Range	Upper Range
Total Cost	$192,000	$304,000
Cost per Square Foot	$5.73	$9.08

*Includes probable construction costs, design, survey, permitting, sediment testing, and a 25% contingency.

View of the site from trail.

Manhole leading to the underground pipe that will be diverted to treatment areas.



TYPICAL ISOLATION / DIVERSION MANHOLE

(Source: Bell, 1996)

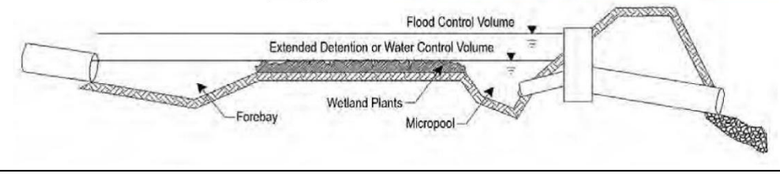


Figure 10. Site 113 - Fernhill wetland concept plan.

Site 65 - General Motors: East Parking Lot, Parma, Ohio

Site 65 is a proposed stormwater retrofit of an existing General Motors parking lot that is over 20-acres in size (Figure 9). There is currently no water quality treatment, flood control, or rate control on-site. The goals of the retrofit project include reducing impervious area, providing water quality treatment and volume control, providing shade for the parking lot to minimize thermal impacts, and improving the safety for pedestrians. The proposed design would fully provide the Ohio EPA water quality volume, as well as provide significant on-site flood control treatment.

The concept design includes realigning the parking spaces so the employees have parking lanes that allow for a direct route from their cars to the entrance to the Chevy Boulevard employee entrance, thereby reducing the time it takes to walk from the cars and improving pedestrian safety. The parking spaces will be separated by green space that includes bioswales which includes trees. Three larger bioretention areas are also proposed to treat runoff being delivered via bioswales. The proposed retrofit also includes providing green pavers in the east side of the parking lot to serve parking overflow.105,000 square feet of bioretention and bioswales are included in the concept design, as well as an additional 105,000 square feet of green pavers. The remaining 674,000 square feet of parking spaces is assumed to be either resurfaced or entirely reconstructed.

The conceptual planning level cost estimate for this proposed stormwater retrofit ranges between $5.5M and $7.0M and includes probable construction costs, design, survey, permitting, and a 25 percent contingency. The lower cost estimate assumes the existing parking surface remains and that asphalt only requires resurfacing, whereas the higher cost estimate assumes reconstruction of the parking surface. The overall cost per square foot for this stormwater retrofit conceptual planning level cost estimate ranges from $6.21 to $7.96 per square foot based upon the 20.3-acre parking lot retrofit.

Site 113 - Cleveland Metroparks: Fernhill Wetland, Parma, Ohio

Site 113 is a proposed stormwater retrofit at the downstream outlet of a 50.8 acre watershed which currently has no known water quality, flood control, or rate control treatment (Figure 10). The goal of the retrofit is to provide water quality treatment meeting the Ohio EPA's water quality volume while creating a public amenity adjacent to Big Creek. A stormwater wetland retrofit was chosen as it represents a habitat that would be common adjacent to a stream and provides for a demonstration opportunity of this habitat type in the city, which is fairly uncommon.

The retrofit includes modification to an existing 36-inch storm sewer that discharges directly to Big Creek. The proposed retrofit includes diverting the first ¾-inch of rainfall to a newly constructed pretreatment basin and wetland within the Cleveland Metroparks property prior to discharging back into the existing 36-inch storm sewer. A trail between the pretreatment cell and wetland is proposed to connect to existing trails and provide for maintenance access.

The conceptual planning level cost estimate for this stormwater retrofit ranges between $192,000 and $304,000 and includes probable construction costs, design, survey, permitting, and a 25 percent contingency. The lower cost range assumes a riprap-lined pre-treatment cell bottom, a minor flow diversion structure, and a mix of seed and plugs for the wetland planting. The upper cost range assumes a concrete-lined pretreatment cell bottom, more extensive flow diversion structure, and plugs for the majority of wetland plantings. The overall cost per square foot for this stormwater retrofit conceptual planning level cost estimate ranges from $5.73 to $9.08 per square foot based upon the size of the wetland and pre-treatment cell.

CONCLUSION

The Big Creek Watershed Stormwater Retrofit Ranking Project provides a comprehensive data base for use by the project partners, Balanced Growth community partners, and private land owners where applicable. The data has also been made available on the FOBC website: friendsofbigcreek.org.

The project was able to evaluate and rank the 156 potential sites noted in the Balanced Growth Plan as well as several additional sites identified during Task 1 of the project. However, funding limited the number of sites we were able to conduct Task 2 field assessments and further prioritization of those sites. Funding for a second phase of the project will be sought in 2013 for this purpose, in addition to developing additional conceptual design work.

During the next phase, the consultant recommended that different types of stormwater retrofits under Task 1 be considered such as through source control retrofits rather than below outfalls or in basins. These could include rain garden and down-spout disconnect programs, and bioswale, curb cut and porous pavement projects. These target areas could also benefit from the Northeast Ohio Regional Sewer District's new Regional Stormwater Management Program credit program. Such smaller scale projects could also allow for a larger variety of funding opportunities. Additional coordination with local municipalities and stakeholders was also recommended, so new data, projects, and funding initiatives are shared. FOBC will be implementing these suggestions in the second phase of the project.

The conceptual design work for the three highest ranking projects was well received by the primary stakeholders. The City of Parma has expressed interest in the Upper Ridgewood Lake Basin retrofit. Upon further analysis however, they agreed that improving control measures upstream from the basin beforehand would be a better approach. General Motors has continued interest in the parking lot recommendations and is examining funding opportunities for previous paving on the rear section of the lot.

The Fern Hill Constructed Wetland project was well received by the City of Parma and Cleveland Metroparks and both entities partnered with FOBC for funding for construction of the project through the Ohio EPA's Surface Waters Improvement Fund (SWIF). The funding was awarded in 2012 and design and construction will begin in 2013.

The Big Creek Watershed Stormwater Retrofit Ranking Project has proved to be of value to its stakeholders as a tool to identify the most effective retrofit sites within the watershed to reduce runoff volume, reduce the stormwater peak flow rate, and improve the overall water quality within the Big Creek watershed. It is also anticipated that this project will act an excellent model for watershed stewardship in similar urbanized watersheds.