Luers Park Stormwater Management Project

DESIGN REPORT

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UNIVERSITY OF IOWA CEE:4850

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Executive Summary

The flooding concerns facing the City of West Burlington are extensive. Roughly 80% of West Burlington drains into Luer's Park, which in turn flows into Izaak Walton Lake to the north. Izaak Walton Lake has been experiencing severe erosion problems and sedimentation build-up. In addition, the present outflow structure for Izaak Walton Lake is unable to discharge an adequate volume of water. Addressing these issues at Izaak Walton Lake is crucial for more complete stormwater management, however this report focuses on efforts that can be made further upstream in the city. The surrounding area, including nearby residential areas, has faced somewhat frequent and severe flooding due to inadequate stormwater drainage into Izaak Walton Lake. Prior stormwater projects to address these issues include the installation of permeable pavers and bank restoration of the creek at the northwest corner of Luers Park. We propose several projects to reduce, treat, and slow the stormwater that drains into Luers Park: A dry detention basin located in West Burlington Community Park,;a network of bioretention cells in the neighborhood west of Luers Park; underground R-Tank storage tanks at Pat Klein Park,;and a bioswale located in Luers Park.

The primary focus of the dry detention basin is to capture stormwater runoff coming from the south. This detention basin will be located at West Burlington Community Park, where the stormwater currently collects into a stream. The goal is to provide temporary storage of stormwater runoff and reduce the peak flow rate from the surrounding areas. In addition, a dry detention basin can provide a significant reduction in suspended sediment load downstream. Furthermore, the basin has been designed to drain between storm events so the area is available for recreation and other open space opportunities. The detention basin will provide for the storage of 4.3 acre-ft (1.4 million gallons and is expected to cost $251,500 to construct.

The goal of the bioretention cell network is to slow, treat, and reduce the runoff produced by the 115-acre area bounded by Glasgow St to E Van Weiss Blvd, and Ramsey St to W Burlington Ave. To minimize costs, the bioretention cells will be placed within the right of way of the streets. Using the minimum design criteria, a total of 115 bioretention cells will be constructed providing a storage volume of 3.4 acre-ft (1.1 million gallons at a cost of $1,792,000.

Ferguson Waterworks was selected as a third-party vendor to provide and install modular R-Tanks used for underground storage in Pat Klein Park. Ferguson Waterworks has extensive experience in stormwater management for urban areas, and their R-Tank product has been successfully used in many locations across the. Two installation options are proposed, capable of storing 2.6 acre-ft (900,000 gallons or 9.6 acre-ft (3 million gallons of stormwater. The cost of installation is $2,222,000 and $8,095,000 respectively. The first option requires minimal reconstruction of Pat Klein Park, while the second option utilizes the full park area.

Another option is the installation of a bioswale in the southwest portion of Luers Park. Bank restoration of the swale in the north most section of Luers Park has already been completed. However, further improvements to the area can help lessen flooding impacts. This bioswale will collect stormwater runoff from southeast West Burlington and will provide important water quality treatment and ease the burden on the newly restored swale that leads to Izaak Walton Lake. The bioswale will cost $30,800 and provides 0.6 acre-ft (40,000 gallons) of storage.

To provide the city of West Burlington with a range of choices based on available funding, our team outlined several combinations of these projects. The options have been grouped to achieve a 5, 10, 15 or 25% total reduction in stormwater peak flow volume. Our team recommends the package that provides a 10% reduction in storm water volume. Constructing these projects will cost an estimated $2,043,000. The other options cost an estimated $1,792,000, $4,499,500, and $10,403,300, respectively.

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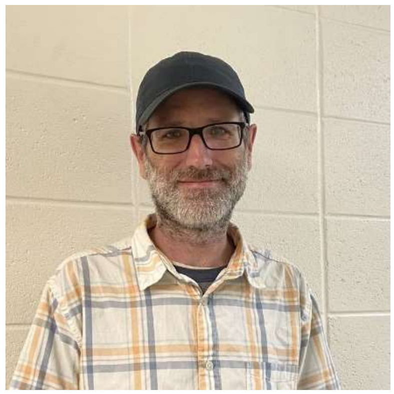
Qualifications & Experience

Our team is well qualified to address the flooding issues of the stormwater system centered on Luers Park in West Burlington, Iowa. Thomas Riggio, Daniel Boyle, and Abby Huls are a student group at the University of Iowa in our senior year of study who are excited to begin applying our studies outside of the classroom. Similar projects that members of the group have worked on include the Civil Tools Parking Lot Drainage CAD Grading Project and the Hydraulics & Hydrology Lab 3, Design of Open-Channel Weirs.

Thomas Riggio



Daniel Boyle

Abby Huls

Thomas Riggio specialized in water treatment and has worked at the Iowa City Municipal Water Treatment Plant and has prior experience doing stormwater infiltration studies at Novelis. Thomas has also taken courses such as Environmental Engineering Design and Hydraulics & Hydrology which will provide a good background for him, Thomas will be acting as Project Manager and working on the site & hydraulic modelling.

Daniel Boyle has studied general civil engineering practice. Within stormwater management, he has studied Hydraulics and Hydrology, Groundwater, and Water Resources Engineering. He has experience analyzing open-channel flow and design flood estimations. Daniel will lead the work focused on report generation and ensuring that the project works seamlessly with any transportation, utilities, and public spaces impacted.

Abby Huls has focused on water treatment and open channel hydraulics in her education. She has taken or is currently enrolled in Water Treatment, Sustainable Systems, Hydraulics and Hydrology, Sediment Transport, and Water Resource Design. Additionally, Abby has helped with wetland and stream design and maintenance through her internship at Snyder & Associates, Inc. She has also worked with utility coordination, wastewater treatment, and trail construction. Abby will be leading the site and hydraulic modeling work within the project.

Project Details

Scope

Luers Park and the surrounding area, including nearby residential areas, experience frequent and severe flooding due to lack of adequate stormwater drainage. Permeable pavers have been installed, and bank restoration of the creek at the northwest corner of Luers Park has been completed to address the flooding problem. For a complete solution to flooding concerns, it is advised that upstream stormwater structures be placed to mitigate these issues within the city limits. The project consists of several components to help reduce, treat, and slow the stormwater that drains into Luers Park. Addressing the drainage and erosion issues at Izaak Walton Lake is crucial to allowing stormwater to drain out of the city, however the goal of the project is to improve West Burlington's resilience in handling severe storm and flooding events.

The projects discussed in this report are organized based on total stormwater reduction. Each plan includes several locations and methods that would achieve either a 5, 10, 15, or 25% reduction in peak stormwater flow volume during a 2-year storm event. The sites were selected based on available space and their potential to improve stormwater runoff quality at Luers Park. These locations include SE Luers Park, Community Park, the neighborhood west of Luers Park, and Pat Klein Park (Fig. 1). The proposed structures at each site are outlined below.

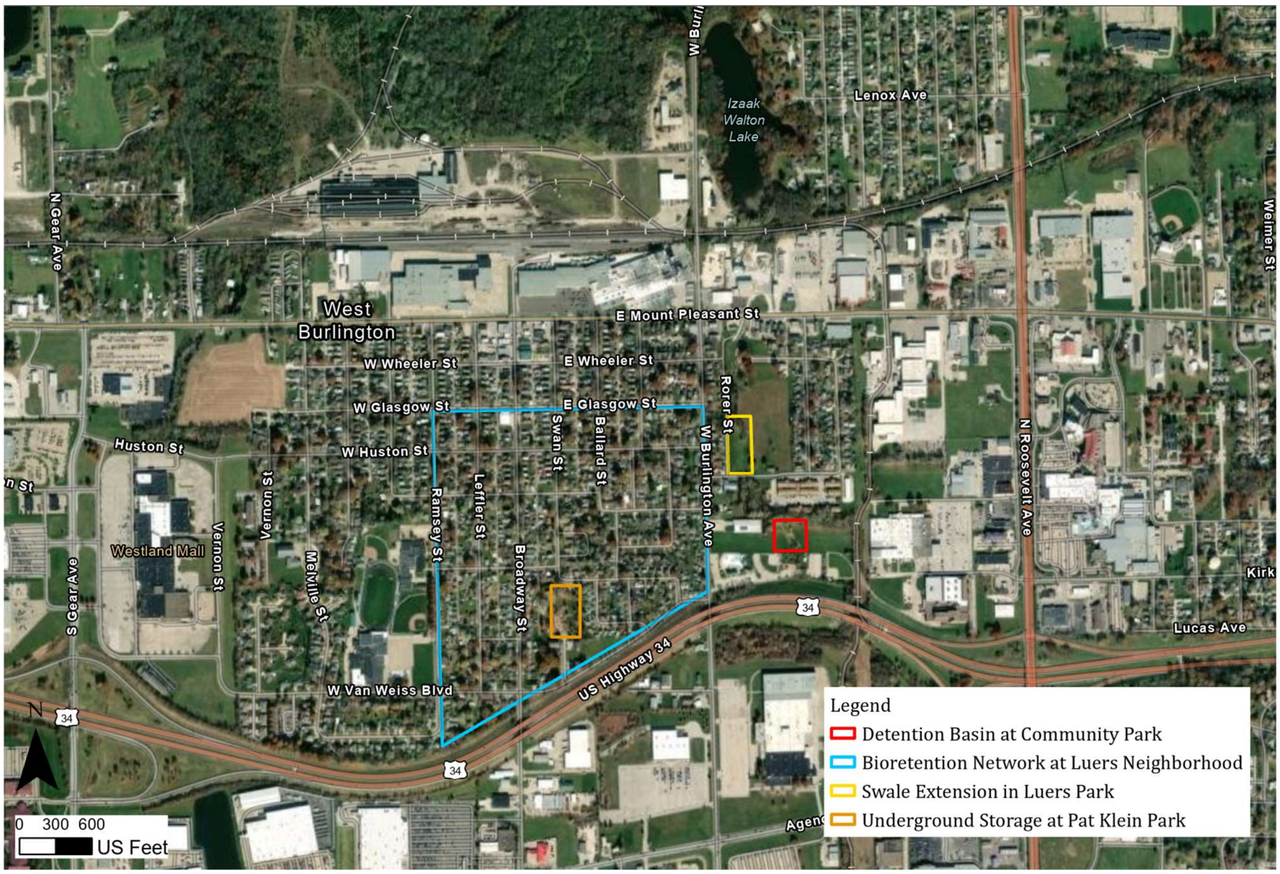


Figure 1: Locations of the various proposed projects.

A bioswale was designed to be located at Luers Park, upstream of the existing swale, to provide additional storage and treat the stormwater at the site of flow backup. The northwest section of the existing swale was recently enhanced to slow the water and encourage infiltration. Bioswales are an effective way to capture and treat stormwater runoff. They are also visually appealing, providing an added benefit to the aesthetic quality of the community. The second project design is a dry detention basin near West Burlington Community Park, just north of the park and upstream of Luers Park. The goal of the detention basin is to provide temporary storage of stormwater runoff to reduce the peak rate of runoff. Community Park is a collection point for stormwater coming from the south and east before draining into Luers Park. Furthermore, a dry detention basin was selected so the area will be dry and available for recreation and other open space opportunities between storm events. The third project proposed is a network of bioretention cells all throughout the neighborhood directly west of Luers Park. This would help reduce flooding in that area, provide water quality treatment, and reduce the flow going to Luers Park. The bioretention cells would be placed within the right of way of the streets and work alongside the existing stormwater collection system. Lastly, two different sizes of an underground storage tank were designed for Pat Klein Park to address the runoff from along Highway 34 and further to the south.

Runoff Estimation

The drainage area for Luers Park was estimated to be 447 acres. This was generated using commercial mapping software (ArcGIS Pro). Several sub basins were delineated to subdivide the watershed into manageable areas (Fig. 2). The area that drains to Pat Klein Park was roughly 52 acres. West Burlington Community Park collects runoff from an area of 39 acres. This runoff estimation does not account for the redistribution of stormwater as it is moved by the existing stormwater system.

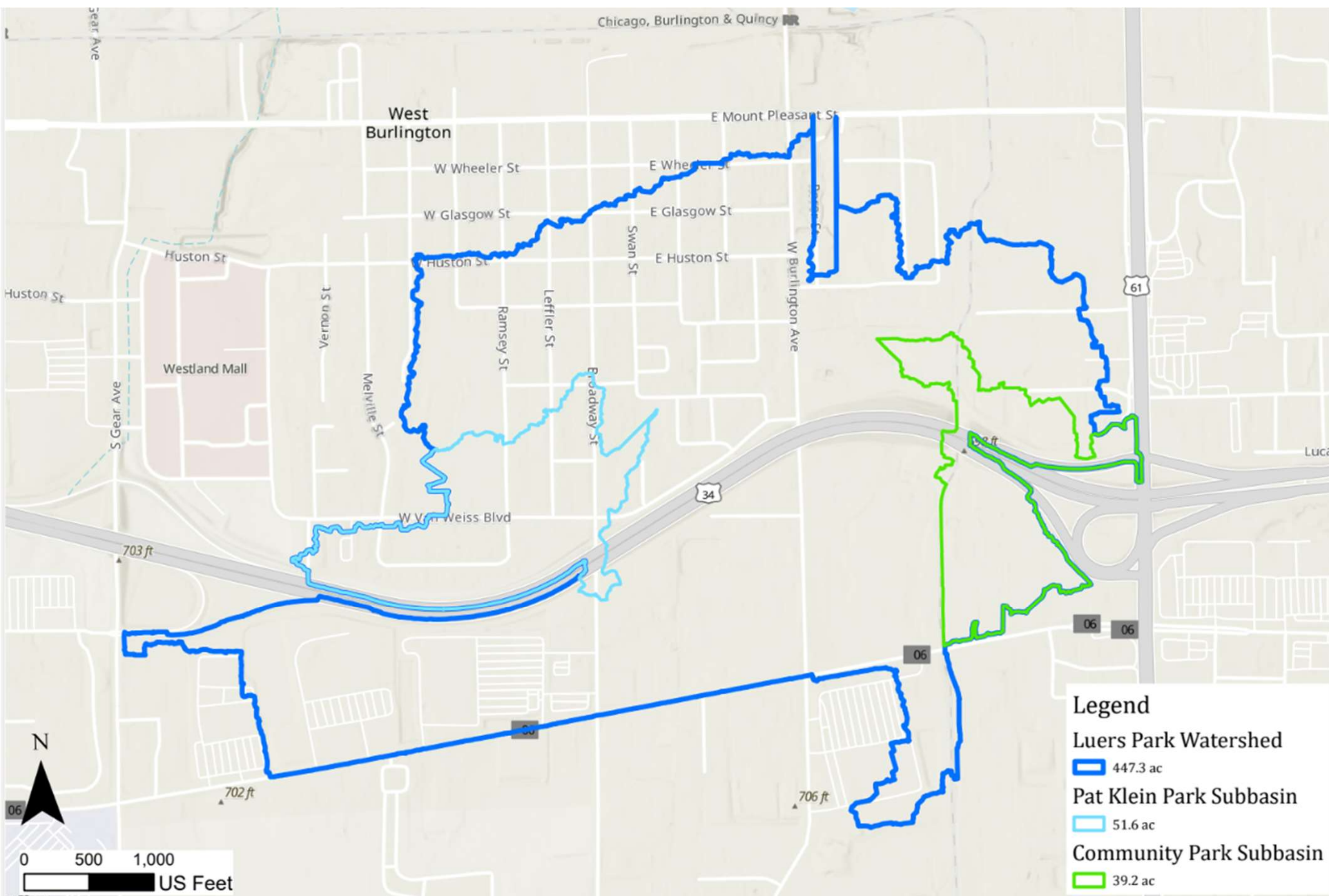


Figure 2: The Luers Park watershed and relevant subbasins.

The TR-55 Method developed by the National Resources Conservation Service (NRCS) was used to estimate the flow runoff for the Luers Park watershed (Fig. A1). From this, the runoff was calculated for a 24-hour long rain event with the magnitude of a 2-year, 10-year, and 50-year storm. Precipitation values come from the NRCS design storm Type 2 (Fig. A2). The runoff values were 1.9, 3.3, and 5.0 inches, respectively. The soil type and quality were combined with land use data to estimate the curve number (Table A1). A curve number represents how much of the rainfall becomes runoff. This data found the curve number to be approximately 88. The high clay content of the surface soil and the infrastructure density resulted in very little storage and infiltration of stormwater. The runoff volume is equal to the runoff depth times the area of the watershed. This gave runoff volumes of 72, 122, and 187 acre-ft (23, 40, and 61 million gallons) for the 2-, 10-, and 50-year storms (Table 1).

Table 1: Runoff volume estimations based on TR-55 flow depth and watershed area.

Total Watershed			
Area (acre)	447		
Storm Frequency (years)	**2**	**10**	**50**
24-hr Precipitation (in)	3.07	4.5	6.4
TR-55 Flow Estimate (cfs)	36.1	61.5	94.5
Runoff Volume (acre-ft)	71.6	122.0	187.3
Runoff Volume (million gallons)	23	40	61

Work Plan

Site visits and check-in meetings were scheduled with the client by Thomas. He also handled and all contacts with Ferguson Waterworks for R-tank product design. Preliminary data collection and planning were handled by all team members. Daniel and Abby completed the watershed delineation and runoff estimation to better understand the stormwater volume that needed to be addressed. The team worked to develop several designs to meet the needs of the city of West Burlington. The criteria used to select designs was relative cost, space availability, storage capacity, and treatment capacity. The design of bioretention cells and the Luers Park bioswale were designed by Abby. The Community Park detention basin was designed by Daniel. Underground storage sizing was completed by Thomas. The final products include the proposal, report, presentation slides, drawings, and poster. All team members worked on producing the final products (Fig. 3).

Week Date (Start of Week) Action Item	1 25-Aug	2 1-Sep	3 8-Sep	4 15-Sep	5 22-Sep	6 29-Sep	7 6-Oct	8 13-Oct	9 20-Oct	10 27-Oct	11 3-Nov	12 10-Nov	13 17-Nov	14 24-Nov	15 1-Dec	16 8-Dec
Contract Approval		★														
Receive Project Description	★															
Proposal Development																
Initial Site Visit			★													
Preliminary Planning and Data Collection		■	■													
Design and Studies																
Concept Design				■	■	■	■	■	■	■	■					
Report and Presentation																
Draft Report and Presentation Production											■	■	■			
Final Report and Presentation Production															■	■
★ Singular event																

Figure 3: Gantt chart of project timeline.

Project Characteristics

Constraints

A major constraint for this project is the size and availability of land. The site of the proposed detention basin is currently owned by Heartland Packaging; it is possible there may be difficulties in acquiring this land due to budget constraints. Detention basins are typically designed to handle 2-year through 100-year storms, but due to the limited land available at Community Park this is not possible. However, the detention basin is designed to accommodate as much runoff as possible. Due to future development planned in the Luers Park area, the land available for the construction of a bioswale is limited. Connecting the various bioretention cells to existing stormwater may pose a challenge since the existing stormwater system in the neighborhood is sparse. Finally, the existence of bedrock, groundwater, or buried utilities in the area may be a constraint. The area typically has a high water table so precaution was taken to size the project designs to be adequately shallow.

Challenges

The primary challenges come from the site location and environment. Community Park has amenities consisting of a public pool, baseball fields, and a playground. Pests, such as mosquitoes resulting from prolonged standing water, are a concern in both locations. At Community Park, a dry detention basin was selected as the primary design to prevent pest issues. However, if the alternatives of a wetland or wet detention basin are chosen, measures will be taken to prevent pest issues for the community. It is also possible the location of the dry detention basin is within an existing wetland. If this is the case, it may be that the design should be reconsidered to improve the existing wetland. Luer's Park is surrounded by neighborhoods and is relatively small compared to the size of its drainage area. It is easier to reduce the runoff volume by addressing areas further upstream.

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Societal Impact

The City of West Burlington, Iowa, is located in Des Moines County and has a population of 3,184 residents. Property lines indicate that there are plans to build a subdivision or an extension of one on the east side of Luers Park. It is imperative that flooding located in and around Luers Park be resolved to allow for the community to grow and flourish without the threat of road closures, property damage, or work closures. The city council and emergency services of the area have been called out to deal with flooding related issues including setting up pumps and diverting traffic due to flooding of streets preventing travel. Vital resources including firefighters, and ambulances have been impacted as well. Improvements through the utilization of stormwater management techniques will allow these emergency vehicles to get to their destination faster and allow the community to be more resilient to flooding events. It will allow the community to grow and allow for an aesthetically pleasing way of dealing with the challenges facing the community today.

Final Design Details

Stormwater Management Structure Sizing

The components designed include: an underground storage tank at Pat Klein Park, a system of bioretention cells in the neighborhood to the west of Luers Park, a bioswale in Luers Park, and a dry detention basin in Community Park.

The underground storage tank selected was the R-Tank, developed by Ferguson Waterworks (Fig. 4. This is a modular system with 95% void space that can store water in its lattice structure. The two systems designed would be able to hold roughly 2.5 and 10 acre-ft (815,000 and 3.3 million gallons), respectively. The first area is 0.46 acres and includes the soccer field and the open space located south of it. The second area encompasses the entire park and is a total footprint of 1.69 acres. There is a stormwater line that runs directly through Pat Klein Park that the design was made to accommodate and tie into (Fig. 5). The smaller area was selected for the recommended design to minimize the amount of reconstruction of the park and to not cross the existing stormwater pipe.

Figure 4: R-Tank being installed at a site for stormwater storage.

Figure 5: The location of the proposed R-Tank in Pat Klein Park relative to the existing stormwater system.

R-Tank options include a variety of available sizes and utilization strategies. Since there is relatively light traffic in the park, the more cost-effective HD R-Tank module has been selected for the design. This will minimize cost while still being able to take advantage of this storage option.

R-Tanks are extremely versatile in their placement as they fit together in a bricklike structure. Since their individual footprint is small, they can easily be maneuvered around pipes or natural structures located in the park while minimally reducing the amount of storage (Fig. 6). The design proposed works around the pipe, leaving space so it stays structurally sound and does not disrupt service. No other known utilities pass through the park. This will slightly reduce the amount of storage, but unlike traditional concrete chamber options, the R-Tank will be able to maneuver around these obstacles.

Figure 6: Previous use of R-Tanks for unique configurations.

The R-tank base design requires 2-ft of aggregate on the sides, 3-4" of aggregate as a base, and at least one foot between the top of the system and the ground surface using a biaxial grid (Fig. 7). An engineering fabric is also required to cover all sides of the R-tank to maintain the void space and prevent fine particles from entering the modules from the surrounding soils.

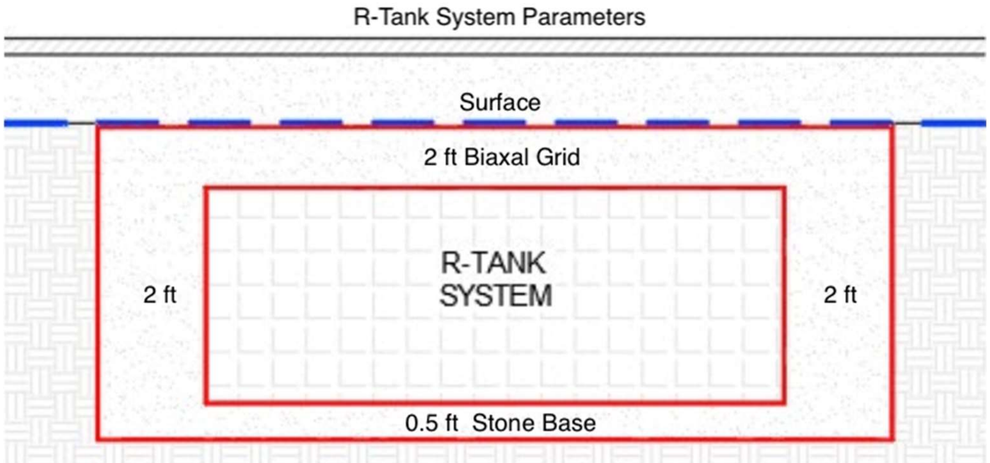

Figure 7: Design requirements for the placement of R-Tank modules.

The bioretention cells were sized according to the Iowa Stormwater Management Manual (ISWMM C5-S4*. The recommended drainage size for each sub-basin is 0.5 to 4 acres. The goal of the bioretention cell network is to slow, treat, and reduce the runoff produced by the neighborhood to the west of Luers Park. The client expressed concerns about flooding issues from Glasgow Street to East Van Weiss Boulevard. This includes everything from Ramsey Street to West Burlington Avenue. This entire area is 115 acres in size. To take advantage of existing land, the bioretention cells are to be placed within the ROW of the streets. Each bioretention cell would be based off a standard width of 10' and a length of 100.' The cells would be graded at a 4:1 slope to match existing elevations. The ROW is generally 15-20 feet wide, however 10' was selected to maintain distance from structures and to allow for grade adjustments. The Iowa DNR recommends that the bioretention cells be designed to 3-7% of impervious drainage area. Assuming a cell on average collects 1 acre of drainage each, a total of 115 bioretention cells would be needed for the area of interest (Table B4). If the bioretention cells were to be spaced every two houses, on one side of the street, the neighborhood could hold up to 130 bioretention cells of the standard dimensions.

A single bioretention cell has 0.03 acre-ft (0.001 million gallons) of storage. A network of 115 bioretention cells would provide a total of 3.4 acre-ft (1.1 million gallons). An additional 15 cells would maximize the space available and add 0.45 acre-ft (0.15 million gallons) of storage. The aggregate base, modified soil, mulch, and ponding depth all contribute to storage capacity and allow for stormwater infiltration. Further, these layers provide basic water quality treatment. An 8" perforated subdrain is in the aggregate layer to collect the stormwater. The total depth of each bioretention cell, including the ponding area, is 3.25 ft (Fig. 8). The cells were sized to have a hydraulic residence time close to 8 hours (Table B4). Some of the stormwater will be infiltrated, but the rate is heavily influenced by the soil of the area and height of the water table. Pilot tests are recommended to determine the average infiltration rate of soils within the project area. A curb cut will be needed to divert flow from the street into the bioretention cell. The recommended length of the cut is 2-4 feet and should be placed at the upstream end.

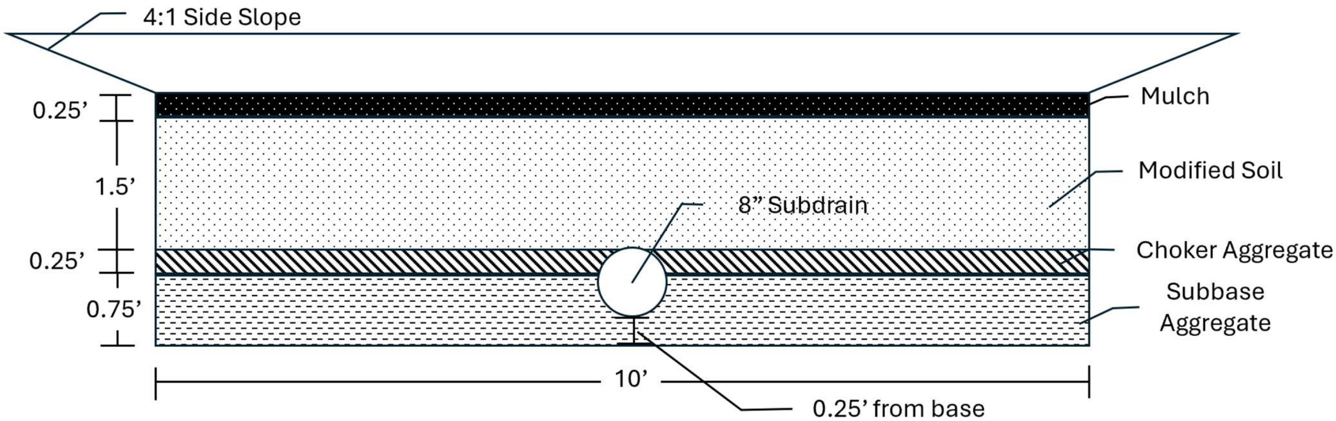

Figure 8: Cross-section of a typical bioretention cell with various layers for infiltration and storage.

The bioswale at Luers Park would provide water quality treatment for the runoff from the southeast portion of West Burlington. The storage added is minimal, since bioswales are not designed to retain volume. However, since the space is available at the location of flooding, the bioswale would be valuable in easing the stormwater load on the existing restored swale in Luers Park. The bioswale would collect runoff locally, as well as connecting to the existing stormwater system (Fig. 9).

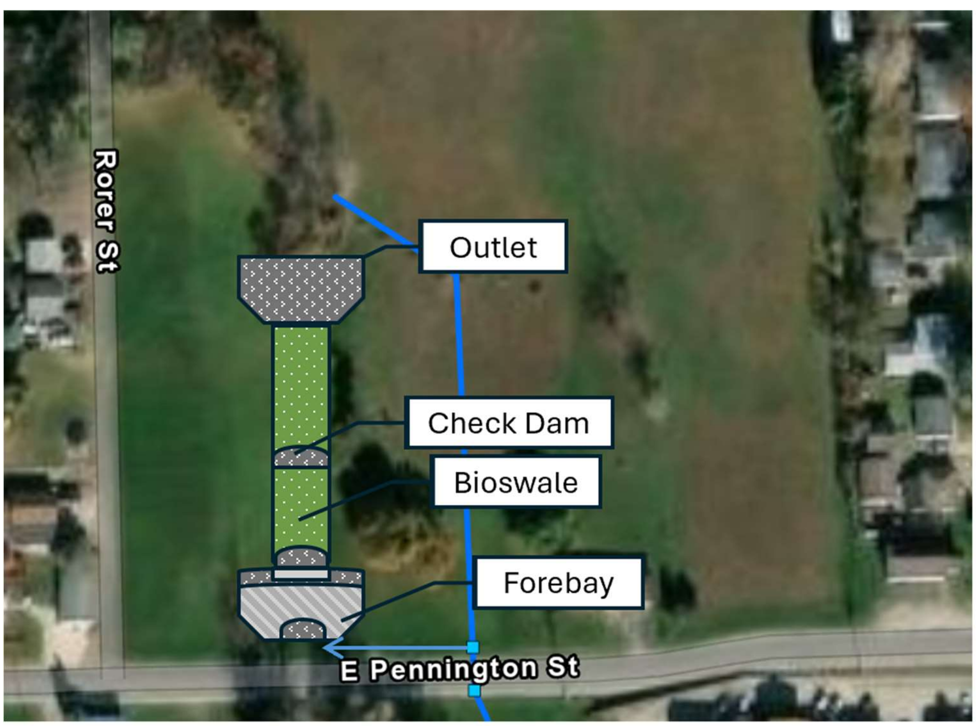

Figure 9: Approximate size and location of the proposed bioswale.

A forebay is included for sediment pretreatment and to maintain an acceptable flow rate into the bioswale (Figure B1). A width of 8' for the base of the bioswale was selected to maximize the space available. The design side slope is 4:1 (H:V) to connect the bioswale to the existing grade. The bed slope was assumed to match the existing slope at the site. A total of two rock check dams are included in the bioswale to slow flow passing through. Additionally, riprap was placed at the inlet and outlet of the structure to mitigate potential erosion from an overload on the bioswale system. Like the bioretention cells, the bioswale has a base layer of modified soil and aggregate base to improve infiltration (Fig. 10). The bioswale length was set to 228 feet to maintain a residence time of at least 10 minutes (Table B6).

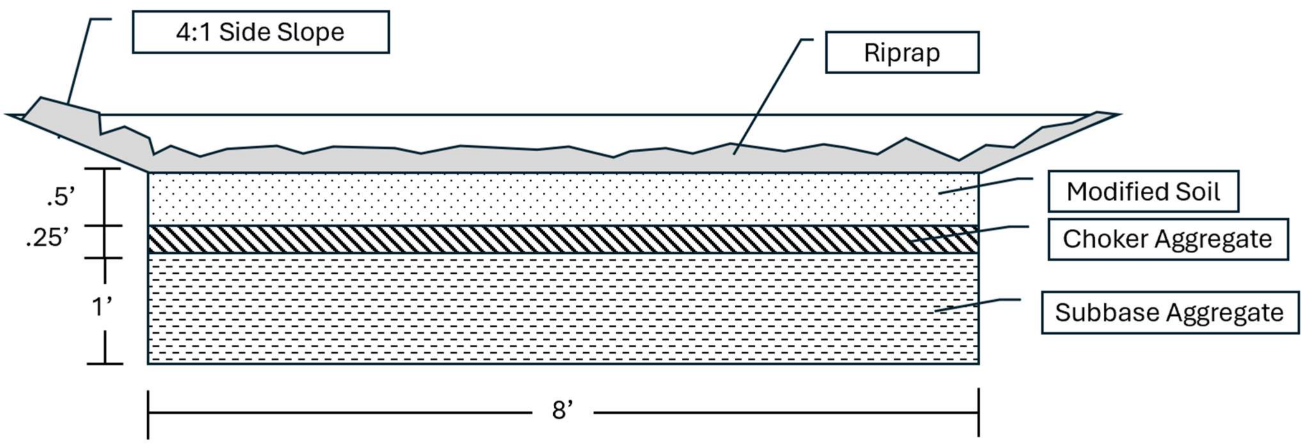

Figure 10: Typical bioswale cross-section showing rock check dam and modified base.

The storage added by the bioswale system, including the forebay and modified base, is approximately 0.16 acre-ft (0.044 million gallons). For this preliminary design, it was assumed that the drainage area does not include Community Park and that a diversion structure would allow for overflow to continue in the existing stormwater pipe when the bioswale is at flow capacity. To fully treat the flow from this drainage area it is recommended to do further design to see what can be done to expand treatment.

The detention basin located in West Burlington Community Park will be constructed to the east of the existing creek encompassing an area of roughly 1.7 acres. It has been designed to a depth of 8 ft, with side slopes of 4:1 (H:V), a length of 390 ft, and a width of 180 ft (Fig. 11). Allowing for one foot of freeboard, the basin will have a storage volume capacity of 4.3 acre-ft (1.4 million gallons) of stormwater. After a storm the collected water will be released into the existing creek to the west of the basin.

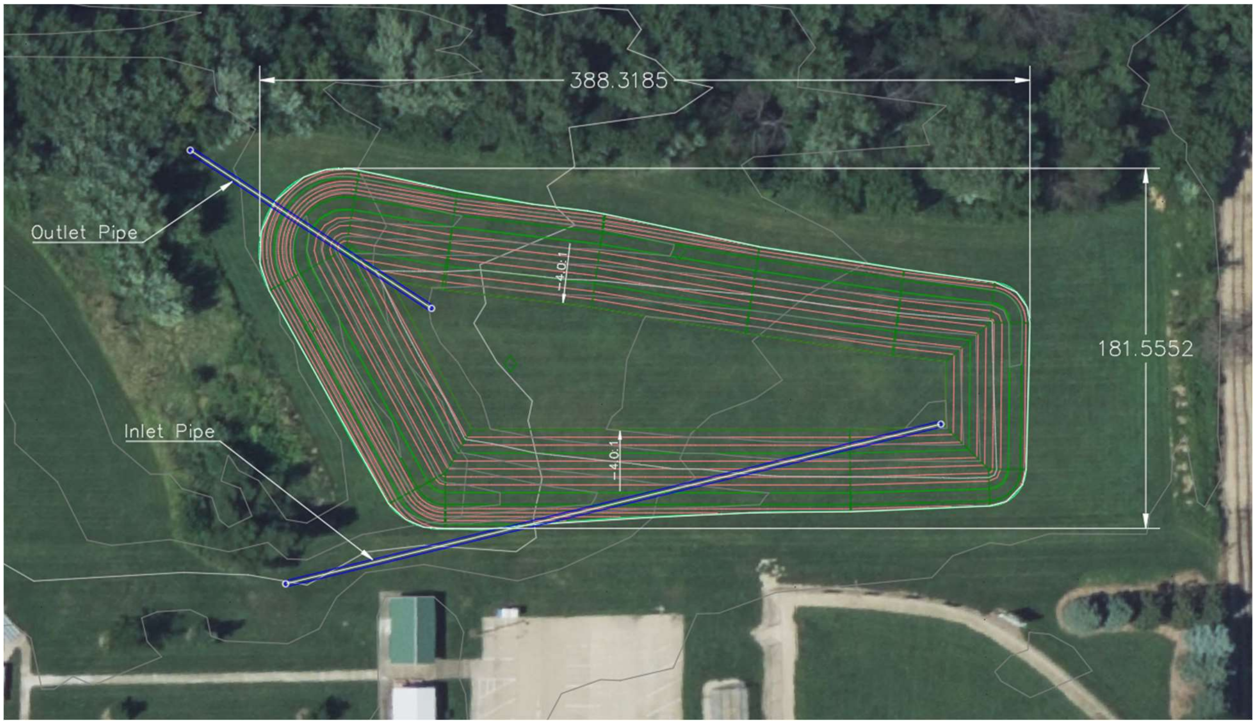

Figure 11: Detention basin design layout and dimensions.

A multi-stage outlet structure (Fig. 12) will release the stored volume of water into the existing creek that runs north into Luers Park. In order to accommodate flow during a large-scale storm event, an emergency spillway at the northwest point of the basin will allow water to flow into an open-channel culvert that will empty into the creek. A diversionary inlet structure (Fig. 13) will be placed at the south entrance to the creek. This will direct flow into the detention basin during a small-storm event, while allowing flow into the creek under normal conditions. Concrete pipes with a 36-in diameter will convey stormwater into and out of the basin. The size of these pipes has been selected to allow for an outflow of 0.6 cfs, which is equivalent to the peak runoff flow of a 2-year 24-hr storm based on pre-development conditions of the surrounding area. This will ensure that downstream erosion of the existing creek will be limited.

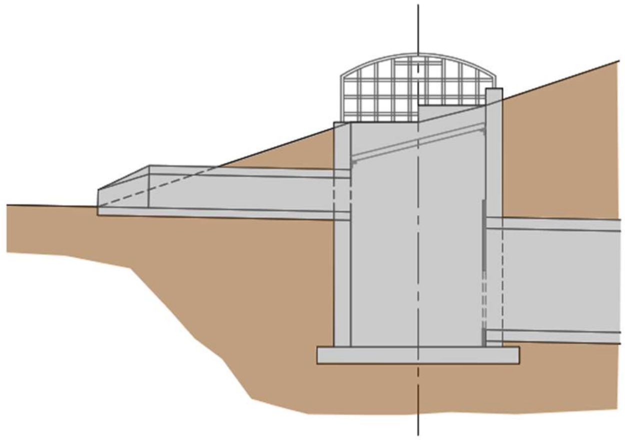

Figure 12: A typical design of a multi-stage outlet structure (Figure 9.09-1-2 ISWMM).

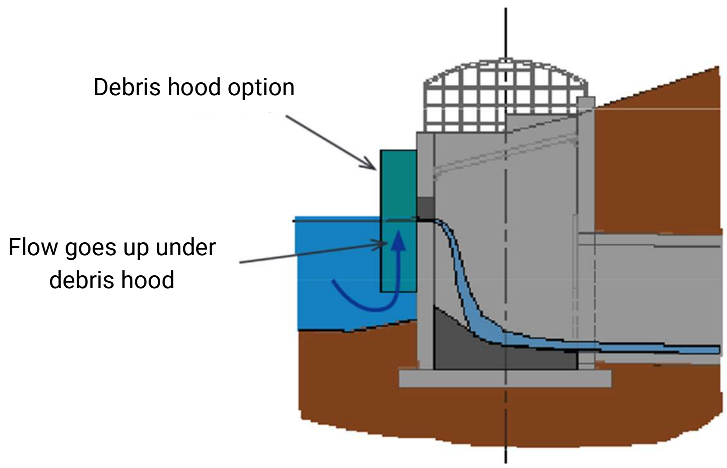

Figure 13: A typical design of a subsurface diversionary inlet structure (Figure 9.04-6-1 ISWMM)

The construction of the detention basin calls for an excavation of 3,200 cubic yards (CY) of earth. This will provide the needed 3,050 CY of fill. An excess of 150 CY of earth will be produced.

After construction the basin will be seeded with conventional grasses, allowing for recreational use between storm events. If desired, the interior slopes may be seeded with filter vegetation, and the basin floor seeded with a bioswale vegetation to provide for increased water treatment.

An array of design components were developed and explored to maximize the storage capacity of stormwater with the space available in the area. In all, each component adds roughly 2-4 acre-ft of storage (Table 2). The exceptions are the Luers Park bioswale, only adding 0.16 acre-ft of storage, and the R-tank 6' deep and covering all of Pat Klein Park, which adds an additional 9.3 acre-ft.

Table 2: Summary of storage capacity.

Design Component	Storage Volume (acre-ft)	Storage Volume (mgal)
R-tank 0.43 acre, 6' depth	2.6	0.73
R-tank 1.7 acre, 6' depth	9.3	2.60
Bioretention Network (115 cells)	3.4	0.95
Bioretention Network (130 cells)	3.9	1.09
Community Park Detention Basin	4.3	1.20
Luers Park Bioswale	0.16	0.04

Design Recommendations

A plan to reduce stormwater draining to Luers Park by 10% was selected as the main design recommendation for balancing costs with storage capacity. The 10% reduction plan was selected for reducing a reasonable portion of the runoff volume, in addition to having the lowest cost per acre-ft of storage added among the plans (Table 3). This plan includes the implementation of 130 bioretention cells in the neighborhood to the west of Luers Park to reduce flow coming from the west and the detention basin at Community Park to handle flow from the south. These components combined would add 6.6 acre-ft of storage for runoff to reduce the peak runoff at Luers Park, and consequently the culvert at Izaak Walton Lake. The bioretention cells will help treat runoff and encourage infiltration for storm events of all sizes. The detention basin allows for the diversion of flow when flood conditions are expected. While this plan would not protect against severe storm events, it would mitigate regular flooding for typical storm events.

Table 3: Cost per acre-ft for each percentage reduction of stormwater plan.

Reduction Plan	5%	10%	15%	25%
Cost per acre-ft of storage	$527,000	$267,000	$430,000	$602,000

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Alternative Solutions

Three alternative designs that were developed included plans to reduce the stormwater runoff in West Burlington by 5%, 15% and 25%, respectively. Refer to the cost estimate section for pricing of all the developed plans. The 5% plan includes the installation of only the bioretention system (115 cells total) in the neighborhood west of Luers Park. This plan was chosen for its ability to tackle the flooding issue at the point of highest impact. The retention basins provide temporary storage, water treatment, and increased infiltration. This plan would store 3.4 acre-ft of storage in total. The 15% reduction plan includes the construction of 130 bioretention cells, a detention basin at Community Park, and R-Tank modules 6’ deep over an area of 0.43 acres. This design addresses runoff across all the West Burlington. The 25% plan utilizes a combination of 130 bioretention cells, the Community Park detention basin, R-Tank modules placed under the whole Pat Klein Park, and the bioswale in Luer’s Park (Table 4). These options combined will encompass the entire city and work in tandem with each other to mitigate the flooding at Luers Park. The bioretention cells capture the rain coming from the neighborhood to the west, the R-Tank modules will store much of the water coming from along the highway. The bioswale will help treat and provide runoff storage alongside the detention basin in Community Park for flow coming from the southeast portion of West Burlington.

Stormwater Reduction Plan	115 Bioretention Cells	130 Bioretention Cells	Community Park Detention Basin	Luers Park Bioswale	R-tank, 0.46 acres, 6'	R-tank, 1.70 acres, 6'
5%	X					
15%		X	X		X	
25%		X	X	X		X

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Engineer's Cost Estimate

Each design component has an individual cost estimate to allow for different combinations of methods (Table C1). A total construction cost estimation was completed for all four stormwater management plans for reducing runoff volume at Luers Park (Table 5). Multiple plans were developed to account for budget needs, and total stormwater volume reduction goals. The 10% reduction plan is the recommended final design since it provides the most reduction per unit cost.

Table 5: Summary of cost estimate for all volume reduction plans.

5% Volume Reduction		
	Storage Volume (acre-ft)	**Cost**
115 Bioretention Cells	3.4	$1,792,000
TOTAL	**3.4**	**$1,792,000**
10% Volume Reduction		
	Storage Volume (acre-ft)	**Cost**
115 Bioretention Cells	3.4	$1,792,000
Community Park Detention Basin	4.3	$251,500
TOTAL	**7.7**	**$2,043,500**
15% Volume Reduction		
	Storage Volume (acre-ft)	**Cost**
130 Bioretention Cells	3.6	$2,026,000
R-tank, 0.46 acres, 6'	2.6	$2,222,000
Community Park Detention Basin	4.3	$251,500
TOTAL	**10.5**	**$4,499,500**
25% Volume Reduction		
	Storage Volume (acre-ft)	**Cost**
130 Bioretention Cells	3.6	$2,026,000
Community Park Detention Basin	4.3	$251,500
Luers Park Bioswale	0.16	$30,800
R-tank, full Pat Klein, 6'	9.3	$8,095,000
TOTAL	**17.4**	**$10,403,300**

Conclusions

The options provided by our team aim to help the City of West Burlington address their considerable stormwater issues. The options were selected with space, budget, and effectiveness in mind. The erosion at Izaak Walton Lake would be reduced as a result of the smaller peak flow and slowed velocity. Additionally, the sedimentation will be addressed upstream with the bioretention cells and bioswales, while the reduction of erosion will produce less local sedimentation. Further, the storage provided by the design components will help to hold flow and reduce the severity of flooding for typical floods. The options outlined above will help reduce the amount of stormwater going into Luer’s Park. These plans are not complete stormwater management plans, but provide a starting point to improve the resilience and capacity of West Burlington’s stormwater infrastructure.

Sincerely,

Thomas Riggio, Daniel Boyle, Abby Huls

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Appendix A: Stormwater Volume Calculations

Table A1: USGS soil type and associated area within Luers Park watershed.

MUSYM	Soil Rating	Total Area (acre)	Pervious Area (acre)
279	D	209.7	130.5
280	C/D	183.7	107.9
281B	C	12.3	8.5
74	C/D	0.1	0.0
75	C/D	8.8	5.5
76B	C	22.4	13.0
76C	C	16.7	12.3
4000	Urban Land	28.1	
	Total (acre)	481.7	277.7
	Total Soil Type D (acre)	243.8	
	Total Soil Type C (acre)	33.8	
	Total Impervious Area (acre)	176.0	

TR 55 Worksheet 2: Runoff Curve Number and Runoff

Project: Luers Park Stormwater Management Designed By: Abby Huls Date: 10/18

Location: West Burlington, IA Checked: Date:

Check one: ☐ Present ☐ Developed

1. Runoff curve number (CN)

** Note: Calculations may run a step behind. **
Type in a text field and press "Tab" to update.

Soil name and hydrologic group (Appendix A)	Cover description (Cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN [1/]			Area ☑ acres ☐ mi^2 ☐ %	Product of CN x area
		Table 2-2	Fig. 2-3	Fig. 2-4		
C/D	Impervious areas (paved streets, roads, and structures)	98			127.0	12,446.0
C	Open space, fair condition	79			33.8	2,670.2
D	Open space, fair condition	84			243.8	20,479.2
C/D	Urban land, commercial	96			28.1	2,697.6
				Totals =	432.7	38,293.0

[1/] Use only one CN source per line.

CN (weighted) = total product / total area = 38,293.0 / 432.7 = 88   Use CN = 88

(If CN is less than 30, further calculations will not be made)

2. Runoff

	Storm #1	Storm #2	Storm #3
Frequency .... years	2	10	50
Rainfall, P (24 hour) .... in.	3.1	4.5	6.4
Runoff, Q .... in.	1.9	3.3	5.0

(Use P and CN with Table 2-1, Figure 2-1, or equations 2-3 and 2-4.)

Figure A1: NRCS TR-55 worksheet for runoff estimation.

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PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.379** (0.332-0.444)	**0.446** (0.390-0.522)	**0.554** (0.482-0.649)	**0.642** (0.556-0.754)	**0.761** (0.637-0.907)	**0.852** (0.698-1.02)	**0.941** (0.748-1.14)	**1.03** (0.788-1.27)	**1.14** (0.845-1.44)	**1.23** (0.889-1.56)
10-min	**0.555** (0.486-0.650)	**0.653** (0.570-0.764)	**0.811** (0.706-0.950)	**0.940** (0.814-1.10)	**1.11** (0.933-1.33)	**1.25** (1.02-1.50)	**1.38** (1.10-1.68)	**1.51** (1.15-1.86)	**1.68** (1.24-2.10)	**1.80** (1.30-2.29)
15-min	**0.677** (0.592-0.792)	**0.796** (0.696-0.932)	**0.989** (0.861-1.16)	**1.15** (0.993-1.35)	**1.36** (1.14-1.62)	**1.52** (1.25-1.83)	**1.68** (1.34-2.04)	**1.84** (1.41-2.27)	**2.04** (1.51-2.57)	**2.20** (1.59-2.79)
30-min	**0.937** (0.819-1.10)	**1.11** (0.969-1.30)	**1.39** (1.21-1.63)	**1.61** (1.40-1.89)	**1.92** (1.60-2.28)	**2.14** (1.76-2.57)	**2.36** (1.88-2.88)	**2.59** (1.98-3.19)	**2.87** (2.12-3.60)	**3.08** (2.22-3.91)
60-min	**1.21** (1.06-1.42)	**1.42** (1.24-1.66)	**1.75** (1.52-2.05)	**2.04** (1.76-2.39)	**2.44** (2.05-2.92)	**2.76** (2.27-3.32)	**3.08** (2.45-3.76)	**3.41** (2.62-4.23)	**3.87** (2.86-4.87)	**4.22** (3.04-5.35)
2-hr	**1.49** (1.31-1.73)	**1.72** (1.51-2.00)	**2.12** (1.85-2.46)	**2.46** (2.14-2.87)	**2.96** (2.51-3.54)	**3.37** (2.79-4.05)	**3.79** (3.05-4.62)	**4.24** (3.28-5.24)	**4.86** (3.63-6.10)	**5.35** (3.89-6.74)
3-hr	**1.66** (1.46-1.92)	**1.90** (1.67-2.20)	**2.32** (2.04-2.70)	**2.71** (2.37-3.15)	**3.28** (2.81-3.93)	**3.76** (3.14-4.53)	**4.28** (3.46-5.21)	**4.83** (3.76-5.97)	**5.61** (4.21-7.03)	**6.24** (4.55-7.84)
6-hr	**1.96** (1.74-2.26)	**2.24** (1.99-2.58)	**2.76** (2.43-3.18)	**3.23** (2.84-3.73)	**3.95** (3.40-4.72)	**4.56** (3.83-5.46)	**5.22** (4.25-6.34)	**5.94** (4.66-7.31)	**6.97** (5.27-8.69)	**7.80** (5.73-9.74)
12-hr	**2.27** (2.02-2.59)	**2.64** (2.35-3.02)	**3.30** (2.93-3.78)	**3.90** (3.44-4.47)	**4.79** (4.13-5.66)	**5.52** (4.66-6.55)	**6.30** (5.15-7.58)	**7.15** (5.63-8.71)	**8.33** (6.33-10.3)	**9.28** (6.86-11.5)
24-hr	**2.63** (2.35-2.98)	**3.07** (2.75-3.49)	**3.85** (3.43-4.37)	**4.53** (4.02-5.16)	**5.54** (4.80-6.48)	**6.36** (5.39-7.49)	**7.23** (5.94-8.62)	**8.16** (6.46-9.87)	**9.46** (7.23-11.6)	**10.5** (7.81-12.9)
2-day	**3.08** (2.78-3.48)	**3.53** (3.17-3.98)	**4.32** (3.87-4.87)	**5.02** (4.48-5.68)	**6.06** (5.29-7.05)	**6.92** (5.90-8.09)	**7.84** (6.48-9.29)	**8.82** (7.03-10.6)	**10.2** (7.85-12.4)	**11.3** (8.47-13.8)
3-day	**3.37** (3.04-3.78)	**3.84** (3.46-4.31)	**4.65** (4.18-5.23)	**5.38** (4.81-6.06)	**6.44** (5.63-7.45)	**7.32** (6.26-8.51)	**8.24** (6.83-9.71)	**9.22** (7.37-11.0)	**10.6** (8.18-12.9)	**11.7** (8.79-14.2)
4-day	**3.60** (3.26-4.03)	**4.10** (3.70-4.58)	**4.95** (4.46-5.55)	**5.70** (5.11-6.40)	**6.78** (5.94-7.81)	**7.67** (6.56-8.88)	**8.59** (7.14-10.1)	**9.57** (7.66-11.4)	**10.9** (8.46-13.2)	**12.0** (9.05-14.6)
7-day	**4.24** (3.85-4.71)	**4.79** (4.35-5.33)	**5.72** (5.18-6.38)	**6.53** (5.88-7.29)	**7.67** (6.73-8.76)	**8.59** (7.38-9.87)	**9.54** (7.96-11.1)	**10.5** (8.47-12.4)	**11.9** (9.24-14.3)	**12.9** (9.82-15.6)
10-day	**4.83** (4.40-5.36)	**5.44** (4.95-6.03)	**6.45** (5.85-7.16)	**7.31** (6.60-8.13)	**8.52** (7.49-9.67)	**9.49** (8.17-10.8)	**10.5** (8.76-12.1)	**11.5** (9.27-13.5)	**12.9** (10.0-15.4)	**14.0** (10.6-16.8)
20-day	**6.60** (6.04-7.26)	**7.38** (6.75-8.12)	**8.66** (7.90-9.55)	**9.73** (8.83-10.8)	**11.2** (9.88-12.6)	**12.3** (10.7-14.0)	**13.5** (11.3-15.5)	**14.7** (11.9-17.1)	**16.2** (12.7-19.2)	**17.4** (13.3-20.8)
30-day	**8.09** (7.43-8.86)	**9.06** (8.31-9.93)	**10.6** (9.72-11.7)	**11.9** (10.8-13.1)	**13.6** (12.1-15.2)	**15.0** (13.0-16.8)	**16.3** (13.7-18.6)	**17.6** (14.3-20.3)	**19.2** (15.1-22.7)	**20.5** (15.8-24.4)
45-day	**9.97** (9.19-10.9)	**11.2** (10.3-12.3)	**13.2** (12.1-14.5)	**14.8** (13.5-16.2)	**16.9** (15.0-18.8)	**18.5** (16.1-20.7)	**20.0** (16.9-22.7)	**21.5** (17.5-24.7)	**23.3** (18.4-27.3)	**24.7** (19.1-29.2)
60-day	**11.6** (10.7-12.6)	**13.1** (12.1-14.3)	**15.5** (14.3-16.9)	**17.4** (15.9-19.0)	**19.9** (17.6-21.9)	**21.6** (18.8-24.1)	**23.3** (19.7-26.3)	**25.0** (20.4-28.6)	**26.9** (21.3-31.4)	**28.3** (22.0-33.5)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Figure A2: NRCS design storm precipitation for design storm Type II.

Table A2: Runoff based on storm frequency.

Total Watershed			
Area (acre)	447		
Storm Frequency (years)	**2**	**10**	**50**
24-hr Precipitation (in)	3.07	4.5	6.4
TR-55 Flow Estimate (cfs)	36.1	61.5	94.5
Runoff Volume (acre-ft)	71.6	122.0	187.3
Runoff Volume (mgal)	23	40	61

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Appendix B: Structure Design Details

Table B1: R-Tank parameters and basic calculations.

R-Tank 6 Ft Soccer Field + Open Space (0.46 Acres)	
Area (Square Feet)	200037.6
Depth (ft)	8.5
Storage Volume (acre-ft)	2.3
Storage Volume (mgal)	0.73

Table B2: Bioretention cell materials and respective depth.

Bioretention Cell Materials Depth	
Ponding Depth (ft)	0.5
Mulch (ft)	0.25
Modified Soil Layer (ft)	1.5
Choker Aggregate Layer (ft)	0.25
Base Aggregate Layer (ft)	0.75
Total Depth (ft)	3.25

Table B3: Design calculations for bioretention system in neighborhood west of Luers Park.

Bioretention System Design Calculations	
Calculate WQv	
DA (ac)	1
I (%)	36
P (Typical) (in)	1.25
Rv	0.374
WQv (CF)	1697
Q,p 2-yr storm (cfs)	0.84
Select Subdrain Size	
Check if V,o < 10 fps	
V,0 8" pipe (fps)	2.41
Diversion weir elevation	
h (ft)	0.25
Diversion weir width (ft)	4.00
Q,p 10 yr (cfs)	1.43
high water level, h (ft)	0.23
Q pipe, 10 yr (cfs)	0.48
Cross Section Design	
Af (ft^2)	1000
3-7% DA, impervious (ft^2)	470-1098
Between 3-7%, OK	
Subdrain System Design	
Q, drain (cfs)	0.023148148
8" subdrain has sufficient capacity	
L, subdrain (ft)	50
Check HRT	
D,iws (ft)	2
V,iws (ft^3)	700
HRT (hrs)	8.4
V, pond (ft^3)	600
V, total (ft^3)	1300

Table B4: Summary of design parameters for bioretention cells in neighborhood west of Luers Park.

Bioretention Cell Design Summary	
Area (ft²)	1000
L (ft)	100
W (ft)	10
Ponding Depth (ft)	0.5
Mulch Depth (ft)	0.25
Modified Soil (ft)	1.5
Choker Aggregate (ft)	0.25
Base Aggregate (ft)	0.75
Side Slope	4:1
D, subdrain (in)	8
Q, subdrain (cfs)	0.023
L, subdrain (ft)	50
Channel slope to match street slope	
Height of Curb (ft)	3.25
Elevation of Weir (ft)	0.25

Table B5: Design calculations for bioswale at Luers Park.

Bioswale Design Calculations			
Storm Event	**Rainfall depth (ft)**	**Peak Rate (cfs)**	**Volume (CF)**
Typical	0.10	1.2	102,094
2-yr 24-hr	0.16	1.8	156,816
10-yr	0.38	4.3	367,538
25-yr	0.46	5.2	452,480
Forebay Sizing			
Minimum Volume (CF)	4900.5		
Volume Selected (CF)	5250		
Dimensions:	W=30', L=50', D=3.5'		
Feasible, OK			

Check Entrance velocity is <5 fps			
H (ft)	0.195		
V, inlet (fps)	1.456		
Design Parameters			
Trapezoidal channel			
Slope (assumed)	0.01		
Bottom Width (ft)	8		
Side Slope (H:V)	4:1		
Modified Soil Depth (ft)	0.5		
Choker Aggregate (ft)	0.25		
Subbase Aggregate (ft)	1		
Check Peak Flow Velocity (Typical Storm Event)			
n	0.12		
Depth (ft)	0.33		
A (ft^2)	3.11		
P (ft)	10.75		
Q (cfs)	1.18		
V, peak, channel (fps)	0.38		
	V channel <1, so OK		
Check Length Needed			
T,res (min)	10		
L,swale (ft)	228		
Check Velocity for 25-yr event			
n	0.115		
Q (cfs)	5.24		
H	0.22		
V (fps)	1.56		
	V<5, so OK		
	Assuming a weir length of 15 ft.		
Soil Infiltration			
k (in/hr)	1		
A (ft^2)	1825.2		
Q,inf (cfs)	0.0422		

Table B6: Design parameters for Luers Park bioswale.

Luers Park Bioswale Design Summary	
Bottom Width (ft)	8
W, forebay (ft)	30
L, forebay (ft)	50
D, forebay (ft)	3.5
L, swale (ft)	228
Side Slope	4:1
Estimated Bed Slope	0.01
Check Dam Spacing (ft)	100
Subdrain Pipe Diameter (in)	6
Modified Soil Depth (ft)	0.5
Choker Aggregate Depth (ft)	0.25
Subbase Aggregate Depth (ft)	1
Assuming diversion weir to split flow. Weir length of 15'	
Notes: This calculation assumes that the community park detention basin diverts the flow from the Community Park subbasin and it does not contribute to the drainage area. Further, it is assumed that only half of the peak flow will be routed to the bioswale. This was done to keep sizing reasonable. If this design is to be pursued further, it is strongly recommended the flow volume estimation should be redone with more accuracy.	

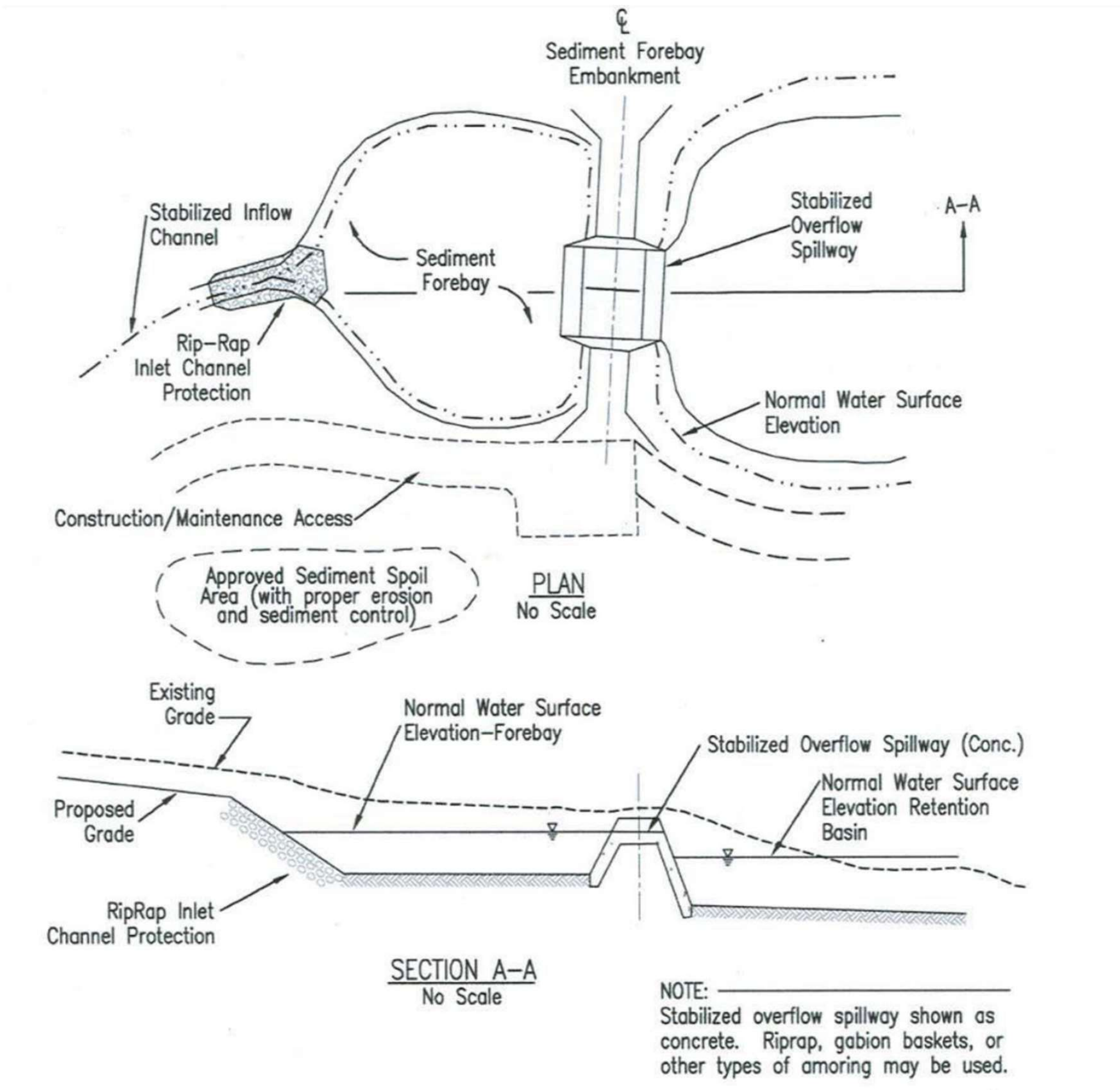

Figure B1: Typical sediment forebay plan and profile (Figure C3-S11-3 ISWMM).

Table B7: Selected design criteria for dry detention basin in Community Park.

Dry Detention Design Criteria	
Length (ft)	390
Width (ft)	190
Depth (ft)	8
Side Slope (H:V)	4:1
Footprint Area (acre)	1.7
Storage Volume (acre-ft)	4.3
Storage Volume (mgal)	1.4

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Appendix C: Cost Estimates

Table C1: Cost estimation breakdown.

Detention Basin					
Item No.	**SUDAS Bid Items**	**Unit Price**	**Units**	**Quantity**	**Cost**
2010-A	Clearing and grubbing	5790	ACRE	2	$11,580.00
2010-E	Excavation, Class 10	7	CY	3750	$26,250.00
9010-A	Conventional Seeding	1200	AC	2	$2,400.00
9040-J	Rip Rap, Class C	97	TON	4	$388.00
9040-N-1	Silt Fence	2	LF	1265	$2,530.00
11,020-A	Mobilization	5000	LS	1	$5,000.00
4020	Stormwater pipe, concrete, D = 36 in	380	LF	530	$201,400.00
4040-D-1	Pipe outlet and connections	553.77	EA	3	$1,661.31
TOTAL					**$251,209.31**
Bioretention System (Per Unit Cell)					
Item No.	**SUDAS Bid Items**	**Unit Price**	**Units**	**Quantity**	**Cost**
2010-A	Clearing and grubbing	5790	ACRE	0.03	$173.70
2010-E	Excavation, Class 10	7	CY	195	$1,365.00
9010-A	Fine Shredded Hardwood Mulch	1000	AC	0.03	$30.00
-	Modified Soil Layer	144.3	CY	56	$8,081.36
-	Choker aggregate (3/8" chip)	65	CY	10	$624.00
2010-J	Aggregate Subbase	35	CY	28	$973.00
4040-A	Subdrain, PVC (or PE), 8"	22.5	LF	100	$2,250.00
4040-C-1	Subdrain Cleanout, Type 2-a, 8"	450	EA	1	$450.00
4040-D-1	Subdrain Outlets and Connections, PVC, 8"	500	EA	3	$1,500.00
7030-B	Curb cut	50	EA	1	$50.00
9010-A	Native Seeding Mix	0.248	SY	157	$38.94
TOTAL					**$15,536.00**
R-tank (0.46 ac, 6 ft depth)					
Item No.	**SUDAS Bid Items**	**Unit Price**	**Units**	**Quantity**	**Cost**
2010-A	Clearing and grubbing	5790	ACRE	0.5	$2,895.00
11,020-A	Mobilization	6000	LS	1	$6,000.00
2010-E	Excavation, Class 10	7	CY	7260	$50,820.00
9040-N-1	Silt Fence	2	LF	5010	$10,020.00
9040-T-2	Inlet protection	1	EA	313	$313.00
7011-A-6	Engineering Fabric	2.75	SF	170320	$468,380.00
-	R-Tank	14	CF	120230	$1,683,220.00
9020-A	Sodding	65	SQ	7300	$474,500.00

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2010-J	Aggregate Subbase	35	CY	375	$13,125.00
TOTAL					**$2,221,648.00**
		Luers Bioswale			
Item No.	**SUDAS Bid Items**	**Unit Price**	**Units**	**Quantity**	**Cost**
2010-A	Clearing and grubbing	5790	ACRE	0.11	$636.90
11,020-A	Mobilization	5000	LS	1	$5,000.00
-	Modified Soil Layer	144.31	CY	34	$4,906.54
-	Choker aggregate (3/8" chip)	65	CY	17	$1,105.00
2010-J	Aggregate Subbase	35	CY	68	$2,380.00
9040-J	Rip Rap, Class C	97	TON	6	$582.00
2010-E	Excavation, Class 10	7	CY	707	$4,949.00
9040-N-1	Silt Fence	2	LF	5563	$11,126.00
9010-A	Type 2 Seeding Native Seeding	0.248	SY	273	$67.70
TOTAL					**$30,753.14**
		Bioretention System (115 Cells)			
Item No.	**SUDAS Bid Items**	**Unit Price**	**Units**	**Quantity**	**Cost**
2010-A	Clearing and grubbing	5790	ACRE	3.45	$19,975.50
2010-E	Excavation, Class 10	7	CY	22425	$156,975.00
9010-A	Fine Shredded Hardwood Mulch	1000	AC	3.45	$3,450.00
-	Modified Soil Layer	144.31	CY	6440	$929,356.40
-	Choker aggregate (3/8" chip)	65	CY	1104	$71,760.00
2010-J	Aggregate Subbase	35	CY	3197	$111,895.00
4040-A	Subdrain, PVC (or PE), 8"	22.5	LF	11500	$258,750.00
4040-C-1	Subdrain Cleanout, Type 2-a, 8"	450	EA	115	$51,750.00
4040-D-1	Subdrain Outlets and Connections, PVC, 8"	500	EA	345	$172,500.00
7030-B	Curb cut	50	EA	115	$5,750.00
9010-A	Native Seeding Mix	0.248	SY	18055	$4,477.64
11,020-A	Mobilization	5000	LS	1	$5,000.00
TOTAL					**$1,791,639.54**
		Bioretention System (130 Cells)			
Item No.	**SUDAS Bid Items**	**Unit Price**	**Units**	**Quantity**	**Cost**
2010-A	Clearing and grubbing	5790	ACRE	3.9	$22,581.00
2010-E	Excavation, Class 10	7	CY	25350	$177,450.00
9010-A	Fine Shredded Hardwood Mulch	1000	AC	3.90	$3,900.00
-	Modified Soil Layer	144.31	CY	7280	$1,050,576.80
-	Choker aggregate (3/8" chip)	65	CY	1248	$81,120.00
2010-J	Aggregate Subbase	35	CY	3614	$126,490.00
4040-A	Subdrain, PVC (or PE), 8"	22.5	LF	13000	$292,500.00
4040-C-1	Subdrain Cleanout, Type 2-a, 8"	450	EA	130	$58,500.00
4040-D-1	Subdrain Outlets and Connections, PVC, 8"	500	EA	390	$195,000.00

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7030-B	Curb cut	50	EA	130	$6,500.00
9010-A	Native Seeding Mix	0.248	SY	20410	$5,061.68
11,020-A	Mobilization	6000	LS	1	$6,000.00
TOTAL					**$2,025,679.48**
R-tank (1.69 ac, 6 ft depth)					
Item No.	**SUDAS Bid Items**	**Unit Price**	**Units**	**Quantity**	**Cost**
2010-A	Clearing and grubbing	5790	ACRE	1.7	$9,843.00
11,020-A	Mobilization	6000	LS	1	$6,000.00
2010-E	Excavation, Class 10	7	CY	23400	$163,800.00
7030-A-1	Removal of Sidewalk	10.5	SY	300	$3,150.00
9040-N-1	Silt Fence	2	LF	18520	$37,040.00
9040-T-2	Inlet protection	4	EA	313	$1,252.00
7011-A-6	Engineering Fabric	2.61	SF	703500	$1,836,135.00
-	Basketball Court Rebuild	10	SF	3615	$36,150.00
-	Park Rebuild	1	LS	50000	$50,000.00
-	R-Tank	14	CF	425084	$5,951,176.00
9020-A	Sodding	65	SQ	8820	$8,885.00
2010-J	Aggregate Subbase	35	CY	13030	$456,050.00
TOTAL					**$8,094,546.00**