Sand Creek Subwatershed Stormwater Retrofit Assessment

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With assistance from:
The Metropolitan Landscape Restoration Program
and
The Coon Creek Watershed District

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TABLE OF CONTENTS

The Coon Creek Watershed District identified Sand Creek as a high priority water resource and partnered with the Anoka Conservation District to assess the subwatershed for stormwater retrofits in the cities of Blaine and Coon Rapids. The purpose of this project is to improve stormwater quality and reduce the volume of runoff entering the stormwater system from neighborhoods that most greatly contribute to the degradation of Sand Creek. The goal is to implement projects in a systematic way that maximizes the use of limited financial resources by identifying and prioritizing projects that provide the greatest amount of stormwater treatment per dollar spent. The Sand Creek subwatershed assessment resulted in the identification and analysis of stormwater retrofit opportunities described in this report.

The process used to assess the Sand Creek subwatershed was modified from the Center for Watershed Protection's Urban Stormwater Retrofit Practices Manual 3 (2007). Water quality monitoring in 2007 and 2008 helped identify Sand Creek as a priority and the subwatershed of greatest concern. Sand Creek has high levels of dissolved pollutants (conductivity, chlorides, salinity). Phosphorus, total suspended solids, and turbidity were not as high but increased from upstream to downstream, especially during storms. Phosphorus was selected as a target pollutant for analysis, while water quality improvement projects proposed in this report incorporate treatment of all pollutants. Monitoring data also lead to the development of a focus area within the large subwatershed. The focus area was determined to be the area of the subwatershed from University Avenue west to Sand Creek's confluence with Coon Creek because pollutant concentration increase in this area and fewer water quality improvement practices are in place.

Seven catchments were identified for retrofit projects within the focus area using GIS and field inspections. In three of the catchments, pond retrofits were determined to be the best retrofit option. The other four catchments were analyzed for rain garden retrofits to achieve multiple pollutant reduction levels. Cost effectiveness of each project was analyzed, and projects were listed by cost per pound of phosphorus treated to facilitate project ranking. The top five most cost-effective projects in terms of phosphorus reduction are:

1. SC-R7: Magnolia Street Pond Modification ($58/lb/yr)
2. SC-R6: Northdale Middle School Pond Modification ($305/lb/yr)
3. SC-R1: New Pond at Xeon Street ($420/lb/yr)
4. SC-R3: Neighborhood Rain Garden Retrofit ($758-$924/lb/yr)
5. SC-R4: Neighborhood Rain Garden Retrofit ($941/lb/yr)

A table summarizing the assessment results is on the following page.

Sand Creek Subwatershed Project Opportunities
The following table summarizes the assessment results. Treatment levels for neighborhood retrofit projects that resulted in a BMP size or number too expensive to justify installation are not included.

Catchment	Retrofit Project	Number of BMPs	% TP Reduction	TP Reduction (lb/yr)	Estimated Installation Cost	Cost/lb TP Reduction	O&M Term (years)	Annual O&M Cost per BMP	Estimated Term Cost/lb/yr (includes O&M)
SC-R1	New Pond	1	49%	9.3	$109,460	$11,770	30	$253	$420
SC-R2*	Neighborhood Retrofit	10	30%	4.9	$41,385	$8,446	10	$75	$998
SC-R2	Neighborhood Retrofit	22	50%	8.2	$89,529	$10,918	10	$75	$1,293
SC-R3	Neighborhood Retrofit	19	10%	12.1	$77,493	$6,404	10	$75	$758
SC-R3	Neighborhood Retrofit	70	30%	36.2	$282,105	$7,793	10	$75	$924
SC-R3	Neighborhood Retrofit	151	50%	60.2	$607,077	$10,084	10	$75	$1,197
SC-R4*	Neighborhood Retrofit	11	30%	5.7	$45,397	$7,964	10	$75	$941
SC-R4	Neighborhood Retrofit	24	50%	9.4	$97,553	$10,378	10	$75	$1,229
SC-R5*	Neighborhood Retrofit	10	30%	4.9	$41,385	$8,446	10	$75	$998
SC-R5	Neighborhood Retrofit	21	50%	8.2	$85,517	$10,429	10	$75	$1,235
SC-R6	Pond Modification	1	11%	13.3	$7,104	$534	10	$3,340	$305
SC-R7	Pond Modification	1	35%	16	$14,400	$900	30	$453	$58

* Slightly lower term cost/lb/yr was available for 10% TP reduction, but the resulting BMP size/number was too small to justify installation

There are many possible ways to prioritize projects, and the list provided is merely a starting point. Final project ranking for installation is the responsibility of the Coon Creek Watershed District and may include:

- Non-target pollutant reductions (TSS, volume, bacteria etc)
- Project visibility
- Availability of funding
- Total project costs
- Educational value
- Others

ABOUT THIS DOCUMENT

Sand Creek Subwatershed Assessment

Document Overview

The Sand Creek subwatershed assessment is a tool to help prioritize stormwater retrofit projects by cost effectiveness in order to install BMPs where they will be most effective. This process helps to maximize the value of each dollar spent. The document is organized into retrofit project profiles which highlight a specific project within the subwatershed.

Methods

The methods section outlines the general procedure used when assessing the Sand Creek subwatershed. It highlights retrofit scoping, the desktop analysis, retrofit reconnaissance investigation, cost/treatment analysis and project ranking.

Retrofit Profiles

Each retrofit profile is titled SC-R # to coincide with the subwatershed name (Sand Creek) and a retrofit identification code. This code is referenced when comparing projects across the subwatershed. Information found in each catchment profile is described below.

Catchment Summary/Description

Within the catchment profiles is a location map and table that summarizes basic catchment information including acres, land cover, parcels, and estimated annual pollutant load. A brief description of the land cover, stormwater infrastructure and any other important general information is also described here.

Retrofit Recommendation

The recommendation section will describe the retrofit(s) selected for the catchment area and provide a description of why the specific retrofit was chosen. If more than one retrofit option was considered, a brief explanation of the final recommendation may be included.

Cost/Treatment Analysis

Within the cost/treatment analysis section is a summary table of amount of treatment needed to achieve different levels of phosphorus reduction. Corresponding reductions of TSS and volume are also included. Cost estimates are created to match the different levels of treatment and leads to the estimated cost per pound value used to prioritize projects. A separate table may be included highlighting important modeling inputs.

Site Selection
This section highlights properties/areas suitable for retrofit projects. Additional field inspections will be required to verify project feasibility, but the most ideal locations for retrofits are identified here.

Retrofit Ranking
Retrofit ranking takes into account all of the information gathered during the assessment process to create a prioritized project list. The list is sorted by cost per pound of phosphorus treated for each project for the duration of one maintenance term (effective life). The cost per pound treatment value includes installation and maintenance costs. There are many possible ways to prioritize projects, and the list provided is merely a starting point. Final project ranking for installation may include:

- Non-target pollutant reductions
- Project visibility
- Availability of funding
- Total project costs
- Educational value
- Others

Selection of Subwatershed

Before the subwatershed assessment can begin, a process of identifying a high priority water body as a target needs to take place. Many factors need to be considered when choosing which subwatershed to assess for stormwater retrofits. Water quality monitoring data, non-degradation report modeling, and TMDL studies are just a few of the resources available to help determine which water bodies are a priority. Assessments should be supported by a Local Government Unit with sufficient capacity (staff, funding, available GIS data) to ensure the assessment will be successful.

Selection of Sand Creek

Though Sand Creek is listed as impaired for aquatic life, water quality monitoring data collected from Coon Creek lead to the selection of Sand Creek for the assessment. Monitoring in Coon Creek upstream and downstream from Sand Creek showed a significant decline in several water quality parameters. Sand Creek is the major tributary to Coon Creek in that reach. Monitoring of Sand Creek found elevated dissolved pollutants and upstream-to-downstream phosphorus and total suspended solids increases, especially during storms. The Coon Creek Watershed District, City of Blaine and City of Coon Rapids expressed interest in improving the quality of Sand Creek.

Subwatershed Assessment Methods

The process used for assessing the Sand Creek subwatershed is outlined below and was modified from the Center for Watershed Protection's Urban Stormwater Retrofit Practices Manual 3 (Schueler, 2007).

Step 1: Retrofit Scoping

Retrofit scoping includes determining the objectives of the retrofits (volume reduction, target pollutant etc) and the level of treatment desired. It involves meeting with local stormwater managers, city staff and watershed district staff to determine the issues in the subwatershed. This step also helps to define preferred retrofit treatment options (filtration, detention, infiltration) and retrofit performance criteria. In order to create a manageable area to assess in large subwatersheds, a focus area may be determined.

Sand Creek Scoping

The entire Sand Creek subwatershed is much too large for the scope of this assessment, so a focus area was determined. The portion of the subwatershed east of highway 65 was eliminated from the assessment because it was comprised of newer developments with stormwater infrastructure (mainly ponds) in place. Furthermore, monitoring data from several points in the Sand Creek system showed a decline in water quality between University Ave and the stream's confluence with Coon Creek.

This section of the subwatershed was determined to be the focus area of this assessment as BMPs have the potential of providing a higher level of benefit.

Step 2: Desktop Retrofit Analysis
The desktop analysis involves computer-based scanning of the subwatershed for potential retrofit sites. This step also identifies areas that don't need to be assessed because of existing stormwater infrastructure. Accurate GIS data are extremely valuable in conducting the desktop retrofit analysis. Some of the most important GIS layers to have include: 5-foot or finer topography, hydrology, watershed/subwatershed boundaries, parcel boundaries, high resolution aerial photography and the storm drainage infrastructure. The following table highlights some important features to look for and the associated potential retrofit project.

Subwatershed Metrics and Potential Retrofit Projects

Screening Metric	Potential Retrofit Project
Existing Ponds	Add storage and/or improve water quality by excavating pond bottom, modifying riser, raising embankment, or modifying flow routing.
Open Space	New regional treatment (pond, bioretention).
Roadway Culverts	Add wetland or extended detention water quality treatment upstream.
Outfalls	Split flows or add storage below outfalls if open space is available.
Conveyance system	Add or improve performance of existing swales, ditches and non-perennial streams.
Large Impervious Areas (campuses, commercial, parking)	Stormwater treatment on site or in nearby open spaces.
Neighborhoods	Utilize right of way, roadside ditches or curb-cut raingardens to treat stormwater before it enters storm drain network.

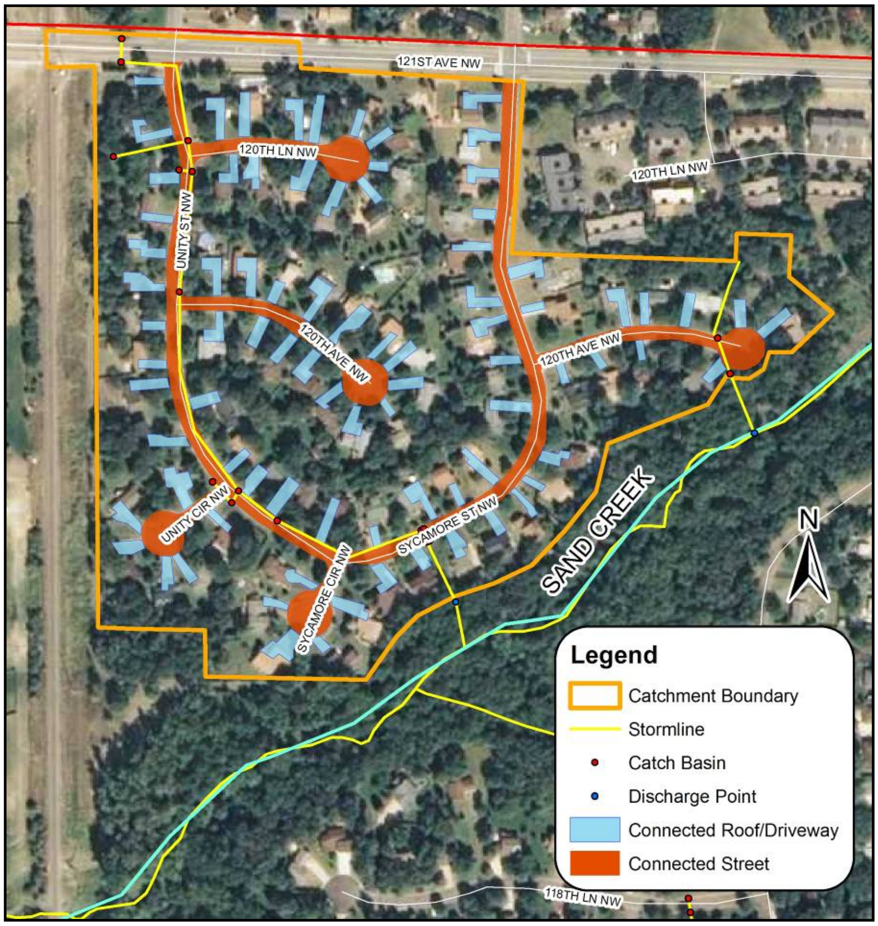
Step 3: Retrofit Reconnaissance Investigation
After identifying potential retrofit sites through the desktop search, a field investigation is conducted to evaluate each site. During the investigation, the drainage area and stormwater infrastructure mapping data are verified. Site constraints are assessed to determine the most feasible retrofit options as well as eliminate sites from consideration. The field investigation might also reveal additional retrofit opportunities that may have gone unnoticed during the desktop search.

Step 4: Treatment Analysis/Cost Estimates
Treatment analysis
The most feasible projects are taken to the concept design phase. Concepts are developed that take into account available space, site constraints and the subwatershed

treatment objectives. Projects that involve complex stormwater treatment interactions or pose a risk for upstream flooding may require the assistance of an engineer. Designs include a cost estimate and estimate of pollution reduction so projects can be prioritized.

A P8 treatment model is created for each site that estimates pollution or volume reduction. This treatment model can also be used to properly size BMP's to meet the restoration objectives. The P8 model uses conservative estimates for runoff coefficients, infiltration rates and directly/indirectly connected impervious surfaces. Because the model produces conservative estimates of pollutant reduction, installed retrofits will likely outperform the model predictions. Post-construction monitoring is needed for the most accurate treatment analysis. Modeling did not take into account any existing stormwater treatment or other BMPs such as street sweeping. The following table outlines some of the model inputs and how they are determined.

Determining P8 Model Inputs	
P8 Parameter	**Method for Determining Value**
Total Area	GIS mapping.
Pervious Area Curve Number	Values from the USDA Urban Hydrology for Small Watersheds TR-55 (1986). A composite curve number was found based on proportion of hydrologic soil group and associated curve numbers for open space in fair condition (grass cover 50%-75%).
Directly Connected Impervious Fraction	Calculated using GIS to measure the amount of rooftop, driveway and street area directly connected to the storm system (example on following page). Estimates calculated from one area can be used in other areas with similar land cover.
Indirectly Connected Impervious Fraction	Wisconsin urban watershed data (Panuska, 1998) provided in the P8 manual is used as a basis for this number. It is adjusted slightly based on the difference between the table value and calculated value of the directly connected impervious fraction.
Precipitation/Temperature Data	Rainfall and temperature recordings from 1959 were used as a representation of an average year.
Hydraulic Conductivity	A composite hydraulic conductivity rate is developed for each catchment area based on the average conductivity rate of the low and high bulk density rates by USDA soil texture class (Rawls et. al, 1998). Wet soils where practices will not be installed may be omitted.



In the figure above, GIS mapping software was used to calculate the percent of impervious surface, which is one input in the watershed model. Directly connected rooftops, driveways and street areas are all part of the calculation.

Cost Estimates

Estimates for site-specific projects are calculated on a case-by-case basis. However, estimates for residential curb-cut raingardens are more easily calculated since standardized designs can be applied in a variety of situations. Estimated costs associated with installing residential curb-cut rain gardens included materials, labor, design finalization as well as promotion and administration costs. Materials and labor for installing a single curb-cut rain garden was averaged to be $3,500. The expected range for such a practice may be between $2,500 and $5,000 depending on how much in-kind labor is included, plant container sizes, inclusion of retaining walls as well as other considerations. Appendix A has more information on specific design features. Though detailed construction plans are included with this report, modifications of the concepts to account for site specific constraints (sidewalks, utilities, trees etc.) will be required. It was estimated that approximately six hours would be required to finalize a curb-cut raingarden design to fit site specific constraints. Anoka Conservation District's

2009 rate for a Metro Conservation District Landscape Restoration Specialist ($67/hr) was used to estimate the cost of finalizing designs.

Promotion and administration costs were estimated by calculating the hours required using the formula h=25+2(n-1) where *h= estimated hours* and *n=number of rain gardens*. The value of 25 accounts for the time required to conduct promotion and administration activities for the first rain garden. Many of the activities will require very little additional time for each additional rain garden. Promotion and administration estimates were calculated at the Anoka Conservation District's 2009 rate for a Technician ($55/hr) and includes the following tasks:

- Outreach/Promotion
- Education
- Landowner agreements
- Cost share assistance
- Permits
- Contractor RFP
- Pre-bid meeting
- Pre-construction meeting
- Construction oversight
- Planting assistance

Step 5: Evaluation and Ranking
The final step in the subwatershed assessment is to conduct a cost-benefit analysis for each potential project. This is typically done by developing a cost per unit of treatment achieved. The treatment unit will likely be the pollutant of concern determined in Step 1. Once the cost-benefit analysis is complete for each project, the projects can be ranked by cost-effectiveness. Other ranking considerations include:

- Non-target pollutant reductions
- Project visibility
- Availability of funding
- Total project costs
- Educational value
- Others

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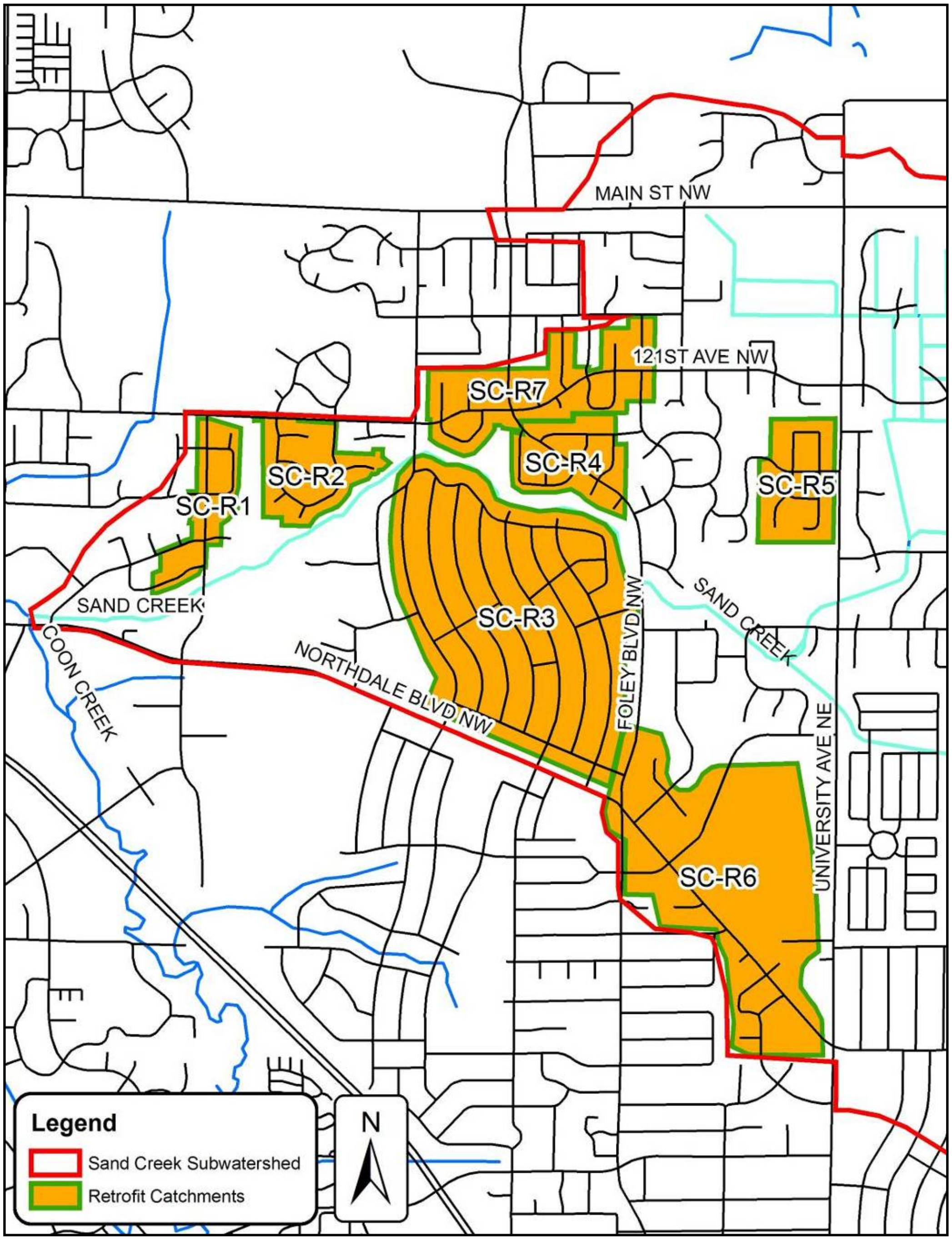
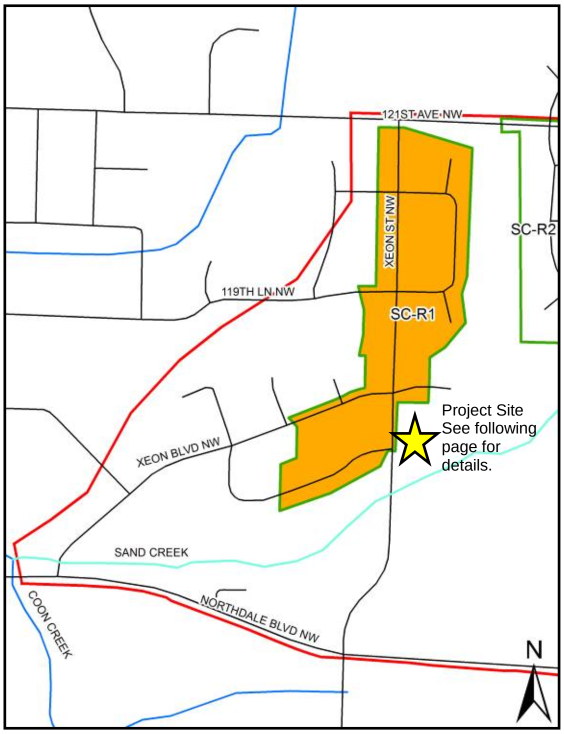
The map below shows catchment areas assessed for stormwater retrofits and outlined in the following pages.



Areas within the subwatershed not highlighted were determined to be either receiving stormwater treatment, lacking a direct connection to Sand Creek, or were too small to justify assessing when compared with the highlighted areas.

Catchment Summary	
Acres	23
Dominant Land Cover	Residential 1/4-1/3 acre lots
Parcels	105
TSS (lb/yr)	5,932
TP (lb/yr)	19.0
Volume (acre-feet/yr)	20



Description:

SC-R1 is located in the west portion of the Sand Creek subwatershed, north of the creek. The majority of the catchment area is residential single family homes. Stormwater runoff in the neighborhoods is captured in catch basins and discharged directly into Sand Creek at Xeon Street.

Retrofit Recommendation:

There is an unused lot owned by the City of Coon Rapids adjacent to Sand Creek. Current stormwater infrastructure directs stormwater past this lot and into the creek. The lot was examined as a possible site for a new stormwater pond and Wenck Engineering completed a study to determine the feasibility and effectiveness of re-directing stormwater into a new wet pond (Appendix B).

For comparison, the catchment was also assessed for rain garden retrofits. Associated costs for the same amount of TP reduction were very similar to constructing the new pond. However, the pond will be much easier to maintain and also eliminates the need to manage agreements with multiple landowners. Therefore, creating a new pond is the recommended retrofit for this catchment.

Treatment Analysis:

The following table summarizes the treatment potential and costs associated with constructing a new pond at Xeon Street.

Estimated Project Cost	$109,460
TP Reduction (lb/yr)	9.3
TP Reduction (%)	49%
TSS Reduction (lb/yr)	4,719
TSS Reduction (%)	80%
Volume Reduction (acre-feet)	0
Volume Reduction (%)	0%
Cost/lb Phosphorus (installed)	$11,770
Operation and Maintenance	$11,500
Maintenance Term (years)	30
Term Cost/lb/yr (includes O&M)	$420

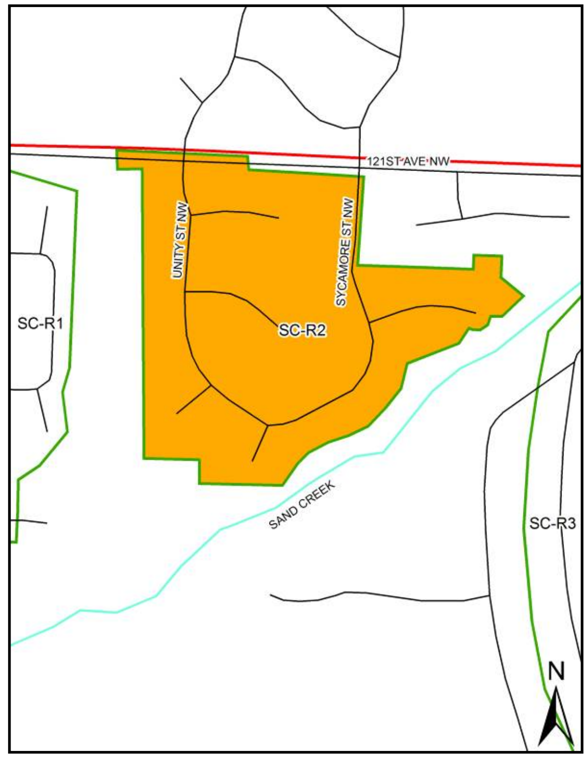
Pond operation maintenance was calculated assuming a 30 year period before maintenance is required. Maintenance includes excavation and disposal of accumulated sediment at a rate of $2,000 per 10 acres of contributing watershed. An additional $3,000 is added for mobilization and site restoration.

Pond Location

CATCHMENT PROFILE: SC-R2

Sand Creek Subwatershed Assessment

Catchment Summary	
Acres	32
Dominant Land Cover	Residential, ¼ acre lots
Parcels	85
TSS (lb/yr)	5,147
TP (lb/yr)	16.4
Volume (acre-feet/yr)	14.0



Description:
SC-R2 is located in the west portion of the Sand Creek subwatershed on the north side of the creek. The catchment area consists entirely of residential lots. Current stormwater infrastructure includes catch basins and two outfalls that empty into the creek.

Retrofit Recommendation:
This developed catchment area is best suited for curb-cut rain garden retrofits. Positioning the rain gardens uphill from the catch basins will capture and infiltrate stormwater runoff before it enters the storm system.

Treatment Analysis:
The following table summarizes the amount of treatment needed to achieve different levels of phosphorus reduction. Reductions assume that rain gardens are placed in ideal locations to capture the maximum amount of stormwater.

	70% TP Reduction	50% TP Reduction	30% TP Reduction	10% TP Reduction
TSS Reduction (lb/yr)	4,271	3,469	2,523	1,279
TSS Reduction (%)	83%	67%	49%	25%
TP Reduction (lb/yr)	11.5	8.2	4.9	1.6
Volume Reduction (acre-feet/yr)	9.6	7.3	4.7	1.7
Volume Reduction (%)	69%	52%	34%	12%
Live Storage Volume (cubic feet)	3,928	2,171	1,013	273
Raingardens needed	40	22	10	3
Materials/Labor	$140,000	$77,000	$35,000	$10,500
Design Finalization	$16,080	$8,844	$4,020	$1,206
Promotion, Oversight & Admin Costs	$5,665	$3,685	$2,365	$1,595
Total Project Cost	$161,745	$89,529	$41,385	$13,301
Cost/lb Phosphorus	$14,065	$10,918	$8,446	$8,313
Annual O&M	$3,000	$1,650	$750	$225
Term Cost/lb/yr (10 yr)	$1,667	$1,293	$998	$972

CATCHMENT PROFILE: SC-R2

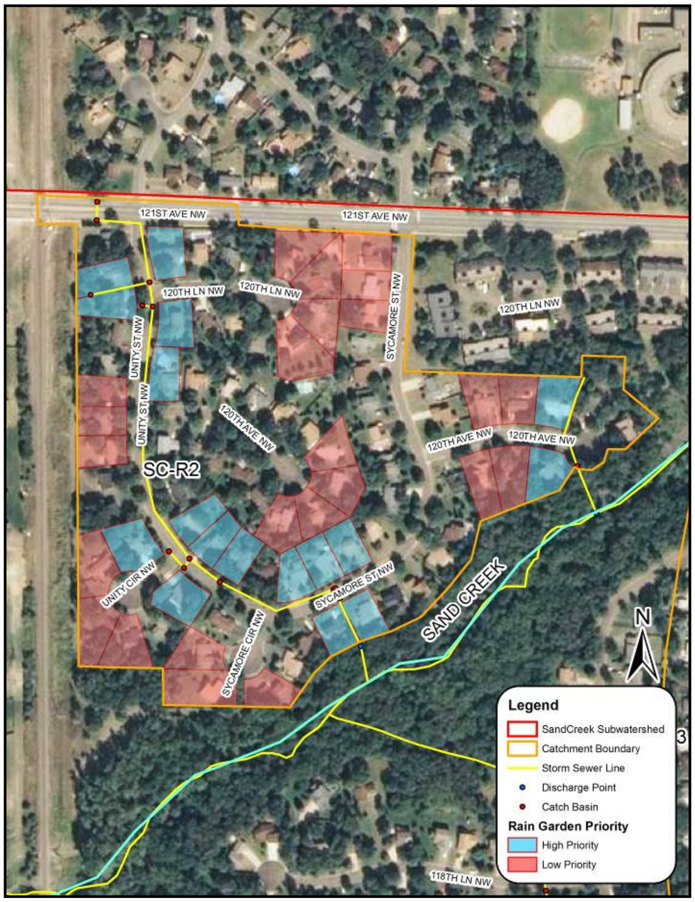
Sand Creek Subwatershed Assessment

Model Inputs:

Parameter	Input
Pervious Curve Number	50
Indirectly Connected Impervious Fraction	0.12
Directly Connected Impervious Fraction	0.21
Hydraulic Conductivity	4.17 in/hr

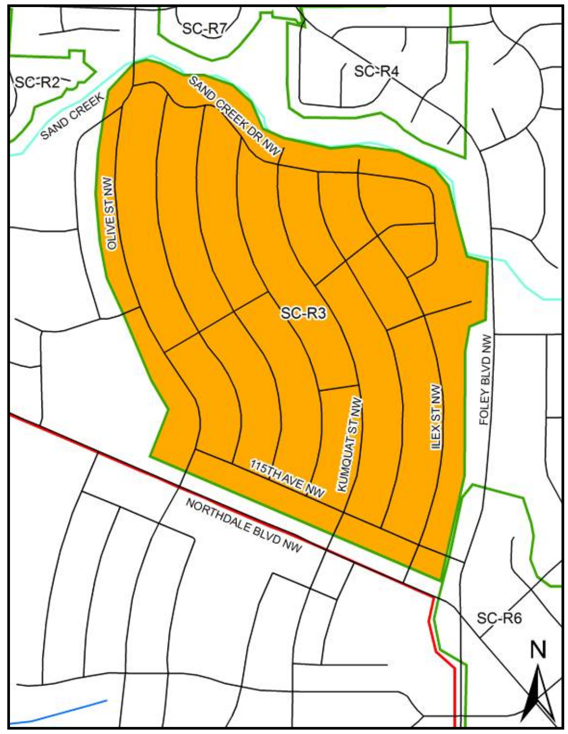
Site Selection:

In order to maximize the treatment potential of each rain garden, properties furthest “downhill” or near a catch basin should be targeted as high priority sites. A total of 17 high priority parcels were identified in this catchment. Properties near the high point in a road or immediately downhill from a catch basin are low priority because they will be less likely to intercept large amounts of stormwater. The following map highlights high and low priority properties. Properties not highlighted can be targeted for rain garden retrofits if additional treatment is desired. Lack of landowner participation and additional site constraints may eliminate some high priority properties, in which case adjacent upstream properties should be pursued. See appendix A for curb-cut rain garden site considerations and designs.



CATCHMENT PROFILE: SC-R3

Catchment Summary	
Acres	198
Dominant Land Cover	Residential, ¼ acre lots
Parcels	619
TSS (lb/yr)	37,909
TP (lb/yr)	120.5
Volume (acre-feet/yr)	102.9



Description:

SC-R3 is located in the west portion of the Sand Creek subwatershed on the south side of the creek. The catchment area contains single family homes that are underserviced by current stormwater infrastructure of catch basins and seven outfalls.

Retrofit Recommendation:

This developed catchment area is best suited for curb-cut rain garden retrofits. Positioning the rain gardens uphill from the catch basins will capture and infiltrate stormwater runoff before it enters the storm system.

Treatment Analysis:

The following table summarizes the amount of treatment needed to achieve different levels of phosphorus reduction. Reductions assume that rain gardens are placed in ideal locations to capture the maximum amount of stormwater.

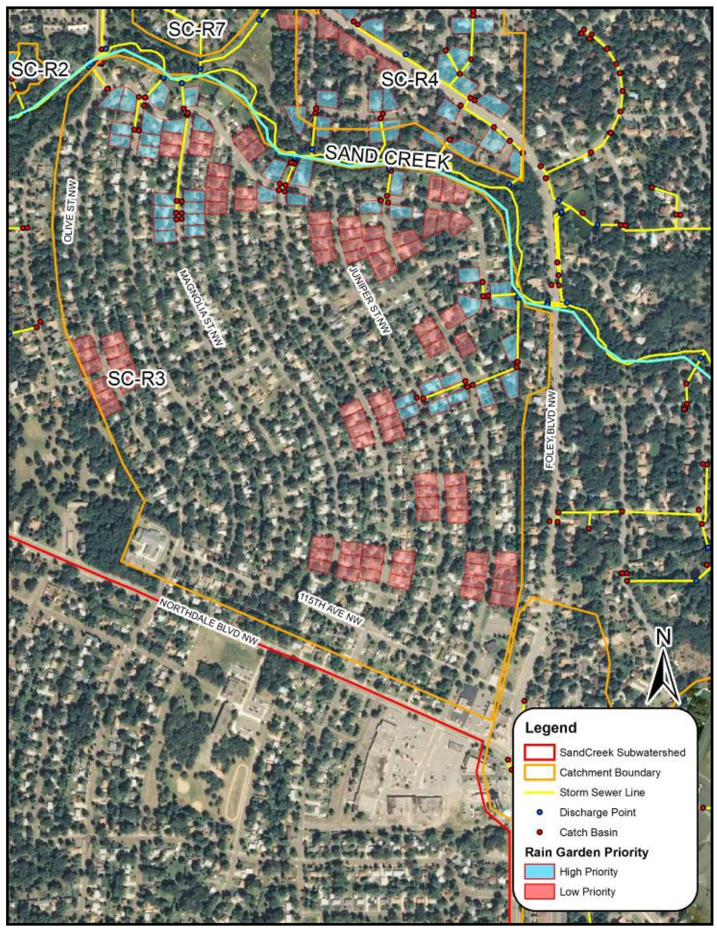
	70% TP Reduction	50% TP Reduction	30% TP Reduction	10% TP Reduction
TSS Reduction (lb/yr)	31,402	25,423	18,379	9,205
TSS Reduction (%)	83%	67%	49%	24%
TP Reduction (lb/yr)	84.4	60.2	36.2	12.1
Volume Reduction (acre-feet/yr)	71.1	53.7	35.4	12.7
Volume Reduction (%)	69%	52%	34%	12%
Live Storage Volume (cubic feet)	27,388	15,086	7,019	1,887
Raingardens needed	274	151	70	19
Materials/Labor	$959,000	$528,500	$245,000	$66,500
Design Finalization	$110,148	$60,702	$28,140	$7,638
Promotion, Oversight & Admin Costs	$31,405	$17,875	$8,965	$3,355
Total Project Cost	$1,100,553	$607,077	$282,105	$77,493
Cost/lb Phosphorus	$13,040	$10,084	$7,793	$6,404
Annual O&M	$20,550	$11,325	$5,250	$1,425
Term Cost/lb/yr (10 yr)	$1,547	$1,197	$924	$758

Model Inputs:

Parameter	Input
Pervious Curve Number	49
Indirectly Connected Impervious Fraction	0.13
Directly Connected Impervious Fraction	0.25
Hydraulic Conductivity	4.75 in/hr

Site Selection:

In order to maximize the treatment potential of each rain garden, properties furthest “downhill” or near a catch basin should be targeted as high priority sites. A total of 39 high priority parcels were identified in this catchment. Properties near the high point in a road or immediately downhill from a catch basin are low priority because they will be less likely to intercept large amounts of stormwater. The following map highlights high and low priority properties. Properties not highlighted can be targeted for rain garden retrofits if additional treatment is desired. Lack of landowner participation and additional site constraints may eliminate some high priority properties, in which case adjacent upstream properties should be pursued. See appendix A for curb-cut rain garden site considerations and designs



CATCHMENT PROFILE: SC-R4

Sand Creek Subwatershed Assessment

Catchment Summary	
Acres	31
Dominant Land Cover	Residential 1/4-1/3 acre lots
Parcels	88
TSS (lb/yr)	5,935
TP (lb/yr)	18.9
Volume (acre-feet/yr)	16.1

Description:

SC-R4 is located in the center of the Sand Creek subwatershed on the north side of the creek. The catchment area contains the Golf Terrace development of single family homes. Current stormwater infrastructure includes catch basins that outfall at four points into Sand Creek.

Retrofit Recommendation:

Curb-cut rain gardens are the best option for treating stormwater in this catchment area. The catchment is fully developed and the sandy soils are ideal for infiltration.

Treatment Analysis:

The following table summarizes the amount of treatment needed to achieve different levels of phosphorus reduction. Reductions assume that rain gardens are placed in ideal locations to capture the maximum amount of stormwater.

	70% TP Reduction	50% TP Reduction	30% TP Reduction	10% TP Reduction
TSS Reduction (lb/yr)	4,912	3,980	2,878	1,441
TSS Reduction (%)	83%	67%	49%	25%
TP Reduction (lb/yr)	13.2	9.4	5.7	1.9
Volume Reduction (acre-feet/yr)	11.1	8.4	5.5	2.0
Volume Reduction (%)	69%	52%	34%	12%
Live Storage Volume (cubic feet)	4,274	2,362	1,099	295
Raingardens needed	43	24	11	3
Materials/Labor	$150,500	$84,000	$38,500	$10,500
Design Finalization	$17,286	$9,648	$4,422	$1,206
Promotion, Oversight & Admin Costs	$5,995	$3,905	$2,475	$1,595
Total Project Cost	$173,781	$97,553	$45,397	$13,301
Cost/lb Phosphorus	$13,165	$10,378	$7,964	$7,001
Annual O&M	$3,225	$1,800	$825	$225
Term Cost/lb/yr (10 yr)	$1,561	$1,229	$941	$818

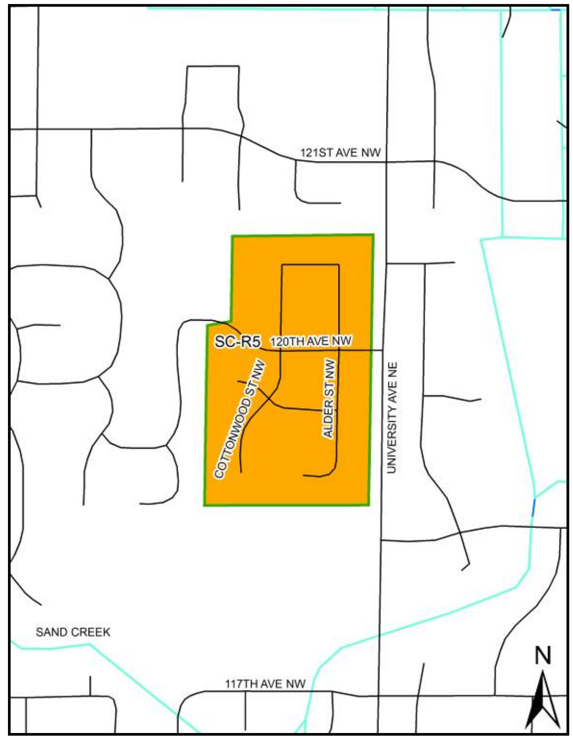
Model Inputs:

Parameter	Input
Pervious Curve Number	49
Indirectly Connected Impervious Fraction	0.13
Directly Connected Impervious Fraction	0.25
Hydraulic Conductivity	4.75 in/hr

Site Selection:

In order to maximize the treatment potential of each rain garden, properties furthest "downhill" or near a catch basin should be targeted as high priority sites. A total of 22 high priority parcels were identified in this catchment. Properties near the high point in a road or immediately downhill from a catch basin are low priority because they will be less likely to intercept large amounts of stormwater. The following map highlights high and low priority properties. Properties not highlighted can be targeted for rain garden retrofits if additional treatment is desired. Lack of landowner participation and additional site constraints may eliminate some high priority properties, and adjacent upstream properties should be pursued. See appendix A for curb-cut rain garden site considerations and designs.

Catchment Summary	
Acres	32
Dominant Land Cover	Residential, 1/4-1/3 acre lots
Parcels	78
TSS (lb/yr)	5,147
TP (lb/yr)	16.4
Volume (acre-feet/yr)	14.0



Description:
SC-R5 is located along the east border of the assessment focus area, north of Sand Creek. The catchment area contains single family homes of the Burl Oaks Estates development. Existing stormwater infrastructure consists of catch basins and one outfall into Sand Creek.

Retrofit Recommendation:
This developed catchment area is best suited for curb-cut rain garden retrofits. Positioning the rain gardens uphill from the catch basins will capture and infiltrate stormwater runoff before it enters the storm system.

Treatment Analysis:
The following table summarizes the amount of treatment needed to achieve different levels of phosphorus reduction. Reductions assume that rain gardens are placed in ideal locations to capture the maximum amount of stormwater.

	70% TP Reduction	50% TP Reduction	30% TP Reduction	10% TP Reduction
TSS Reduction (lb/yr)	4,265	3,463	2,512	1,267
TSS Reduction (%)	83%	67%	49%	25%
TP Reduction (lb/yr)	11.5	8.2	4.9	1.6
Volume Reduction (acre-feet/yr)	9.6	7.3	4.8	1.7
Volume Reduction (%)	69%	52%	34%	12%
Live Storage Volume (cubic feet)	3,826	2,120	988	266
Raingardens needed	39	21	10	3
Materials/Labor	$136,500	$73,500	$35,000	$10,500
Design Finalization	$15,678	$8,442	$4,020	$1,206
Promotion, Oversight & Admin Costs	$5,555	$3,575	$2,365	$1,595
Total Project Cost	$157,733	$85,517	$41,385	$13,301
Cost/lb Phosphorus	$13,716	$10,429	$8,446	$8,313
Annual O&M	$2,925	$1,575	$750	$225
Term Cost/lb/yr (10 yr)	$1,626	$1,235	$998	$972

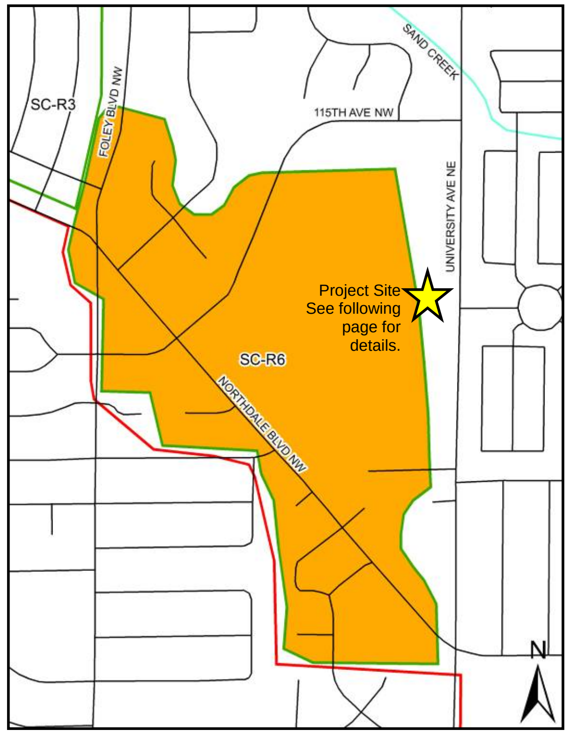
Model Inputs:

Parameter	Input
Pervious Curve Number	51
Indirectly Connected Impervious Fraction	0.12
Directly Connected Impervious Fraction	0.21
Hydraulic Conductivity	4.41 in/hr

Site Selection:

In order to maximize the treatment potential of each rain garden, properties furthest "downhill" or near a catch basin should be targeted as high priority sites. A total of 17 high priority parcels were identified in this catchment. Properties near the high point in a road or immediately downhill from a catch basin are low priority because they will be less likely to intercept large amounts of stormwater. The following map highlights high and low priority properties. Properties not highlighted can be targeted for rain garden retrofits if additional treatment is desired. Lack of landowner participation and additional site constraints may eliminate some high priority properties, and adjacent upstream properties should be pursued. See appendix A for curb-cut rain garden site considerations and designs.

Catchment Summary	
Acres	152
Dominant Land Cover	Residential, Schools, Open Space
Parcels	254
TSS (lb/yr)	35,656
TP (lb/yr)	125.0
Volume (acre-feet/yr)	158



Description:

SC-R6 is located on the east border of the assessment focus area, south of the creek. The catchment area is comprised of residential single family homes and two large school properties. Stormwater runoff in this catchment is captured in catch basins and goes through a small rate control pond on school property before being piped into Sand Creek.

Retrofit Recommendation:

The rate control pond at Northdale Middle School was identified as a potential retrofit site. An assessment of the pond done by Wenck Engineering identified the potential to improve the phosphorus removal efficiency of the pond by raising the outlet elevation of the pond 18 inches. The installation of a horizontal weir would raise the outlet elevation and provide water quality storage without causing backwater issues in the stormwater pipes. See Appendix C for the full analysis and design details. Since this project is estimated to be relatively inexpensive and would be treating a large portion of the catchment, additional retrofit opportunities were not pursued.

Treatment Analysis:

The following table provides a comparison of treatment achieved by existing conditions and treatment provided by the retrofit.

	TSS Reduction (lb/yr)	TP Reduction (lb/yr)	Volume Reduction (acre-feet/yr)
Existing Conditions	28,836	67	42
Retrofit	30,957	80	62
Difference	2,121	13	20
Improvement (%)	7%	19%	48%

The following table summarizes the treatment potential and costs associated with modifying the existing pond at Northdale Middle School. The calculations account only for the improvement provided by the implemented retrofit, not the existing feature.

Estimated Project Cost	$7,104
TP Reduction (lb/yr)	13.3
TP Reduction (%)	10%
TSS Reduction (lb/yr)	2,121
TSS Reduction (%)	6%
Volume Reduction (acre-feet/yr)	19.8
Volume Reduction (%)	13%
Cost/lb Phosphorus (installed)	$534
Annual Operation and Maintenance	$3,340
Maintenance Term (years)	10
Term Cost/lb/yr (includes O&M)	$312

Pond operation maintenance was calculated assuming a 10 year period before maintenance is required. Maintenance includes excavation and disposal of accumulated sediment at a rate of $2,000 per 10 acres of contributing watershed. An additional $3,000 is added for mobilization and site restoration.

Location of the Northdale Middle School pond.

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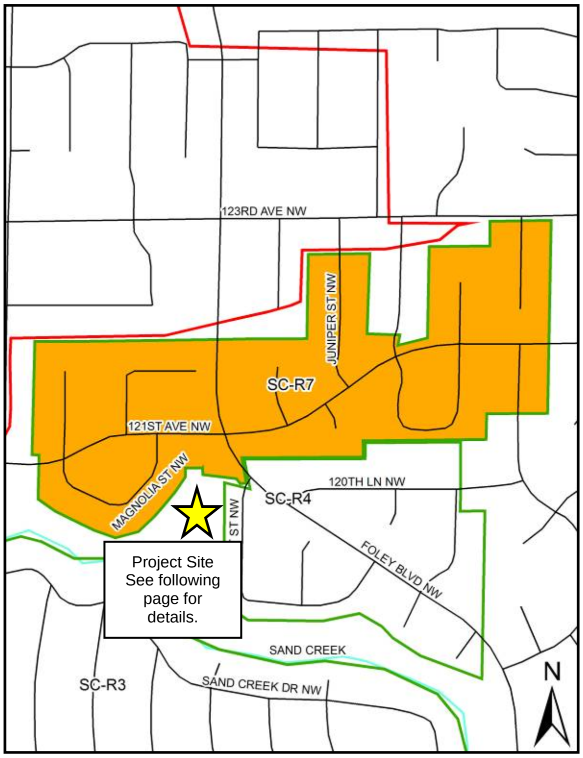
Catchment Summary	
Acres	53
Dominant Land Cover	Residential, ¼ acre lots
Parcels	196
TSS (lb/yr)	14,377
TP (lb/yr)	46.0
Volume (acre-feet/yr)	48.0



Description:

SC-R7 is located on the north central border of the assessment focus area. The catchment area is comprised of many developments of residential single family homes. Stormwater runoff in this catchment is captured in catch basins and is discharged at two outfalls to a dry pond facility before exiting into the creek.

Retrofit Recommendation:

Currently the dry pond retains very little stormwater, and settled pollutants are likely re-suspended each storm event. By relocating the outlet structure, constructing pretreatment forebays and raising the elevation of the outlet, a substantial improvement in water quality can be achieved. See Appendix D for the full analysis and additional details.

Treatment Analysis:

The following table provides a comparison of treatment achieved by existing conditions and treatment provided by the retrofit.

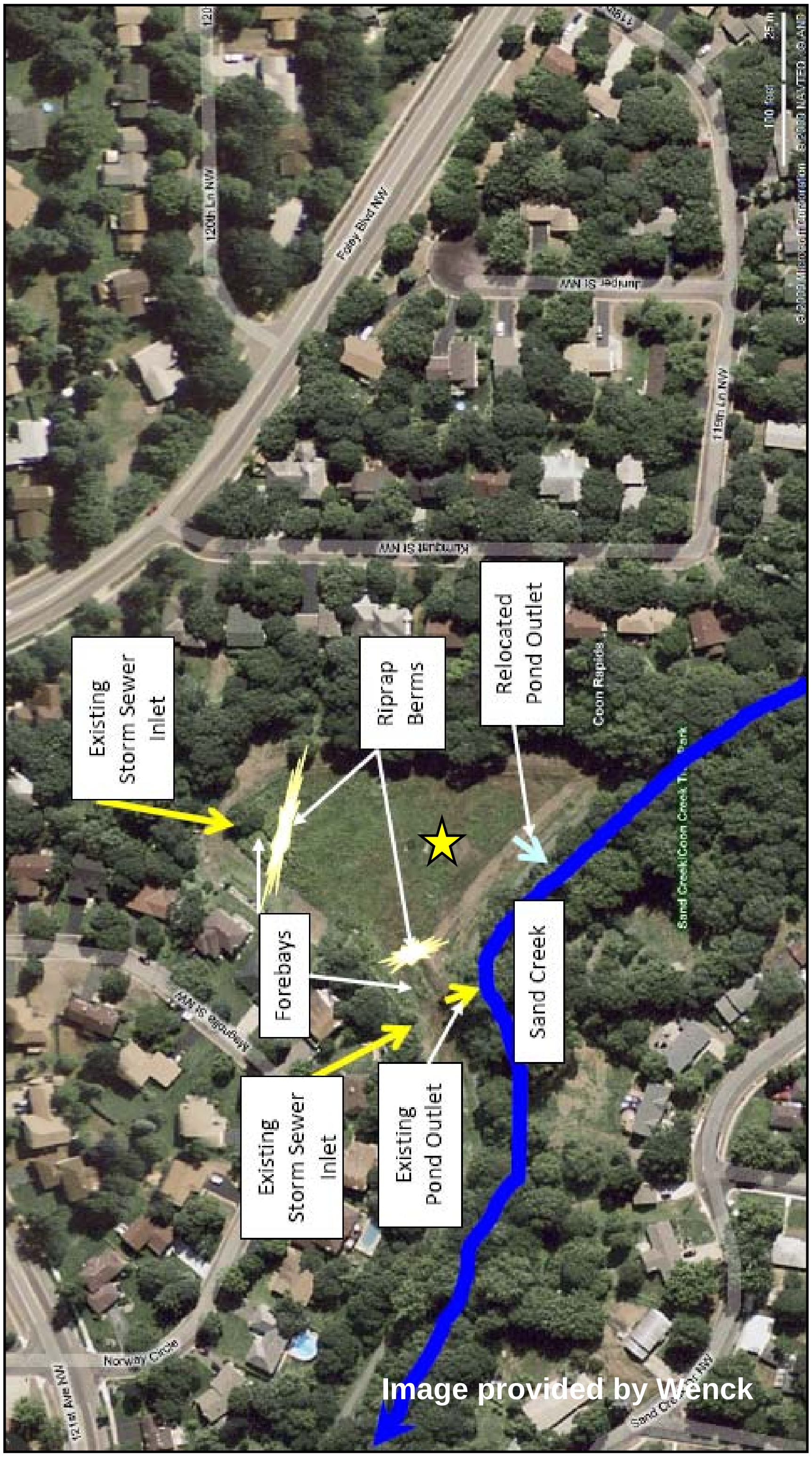
	TSS Reduction (lb/yr)	TP Reduction (lb/yr)	Volume Reduction (acre-feet/yr)
Existing Conditions	11,937	24	0
Retrofit	13,345	40	42
Difference	1,408	16	42
Improvement (%)	12%	67%	88%

The following table summarizes the treatment potential and costs associated with modifying the existing pond at Magnolia Street. The calculations account only for the improvement achieved by the implemented retrofit, not the existing feature.

Estimated Project Cost	$14,400
TP Reduction (lb/yr)	16.0
TP Reduction (%)	35%
TSS Reduction (lb/yr)	1,408
TSS Reduction (%)	10%
Volume Reduction (acre-feet/yr)	42.0
Volume Reduction (%)	88%
Cost/lb Phosphorus (installed)	$900
Annual Operation and Maintenance	$453
Maintenance Term (years)	30
Term Cost/lb/yr (includes O&M)	$58

Pond operation maintenance was calculated assuming a 30 year period before maintenance is required. Maintenance includes excavation and disposal of accumulated sediment at a rate of $2,000 per 10 acres of contributing watershed. An additional $3,000 is added for mobilization and site restoration.

Magnolia Street pond modification concept.



Retrofit Project Prioritization:
Seven catchments were identified for retrofit projects within the focus area using GIS and field inspections. In three of the catchments, pond retrofits were determined to be the best retrofit option. The other four catchments were analyzed for rain garden retrofits to achieve multiple pollutant reduction levels. Cost effectiveness of each project was analyzed, and projects were ranked by cost per pound of phosphorus treated. The top five most cost-effective projects are:

1. SC-R7: Magnolia Street Pond Modification
2. SC-R6: Northdale Middle School Pond Modification
3. SC-R1: New Pond at Xeon Street
4. SC-R3: Neighborhood Rain Garden Retrofit
5. SC-R4: Neighborhood Rain Garden Retrofit

The following table summarizes the assessment results. Treatment levels for neighborhood retrofit projects that resulted in a BMP size or number too small or too expensive to justify installation are not included.

Catchment	Retrofit Project	Number of BMPs	% TP Reduction	TP Reduction (lb/yr)	Installation Cost	Cost/lb TP Reduction	O&M Term (years)	Annual O&M Cost per BMP	Term Cost/lb/yr (includes O&M)
SC-R1	New Pond	1	49%	9.3	$109,460	$11,770	30	$253	$420
SC-R2*	Neighborhood Retrofit	10	30%	4.9	$41,385	$8,446	10	$75	$998
SC-R2	Neighborhood Retrofit	22	50%	8.2	$89,529	$10,918	10	$75	$1,293
SC-R3	Neighborhood Retrofit	19	10%	12.1	$77,493	$6,404	10	$75	$758
SC-R3	Neighborhood Retrofit	70	30%	36.2	$282,105	$7,793	10	$75	$924
SC-R3	Neighborhood Retrofit	151	50%	60.2	$607,077	$10,084	10	$75	$1,197
SC-R4*	Neighborhood Retrofit	11	30%	5.7	$45,397	$7,964	10	$75	$941
SC-R4	Neighborhood Retrofit	24	50%	9.4	$97,553	$10,378	10	$75	$1,229
SC-R5*	Neighborhood Retrofit	10	30%	4.9	$41,385	$8,446	10	$75	$998
SC-R5	Neighborhood Retrofit	21	50%	8.2	$85,517	$10,429	10	$75	$1,235
SC-R6	Pond Modification	1	11%	13.3	$7,104	$534	10	$3,340	$305
SC-R7	Pond Modification	1	35%	16	$14,400	$900	30	$453	$58

* Slightly lower cost/lb was available for 10% TP reduction, but the resulting BMP size/number was too small to justify installation

There are many possible ways to prioritize projects, and the list provided is merely a starting point. Final project ranking for installation is the responsibility of the Coon Creek Watershed District and may include:

- Non-target pollutant reductions (TSS, volume, bacteria etc)
- Project visibility
- Availability of funding
- Total project costs
- Educational value
- Others

The following sites were assessed for retrofit potential, but were eliminated from consideration.

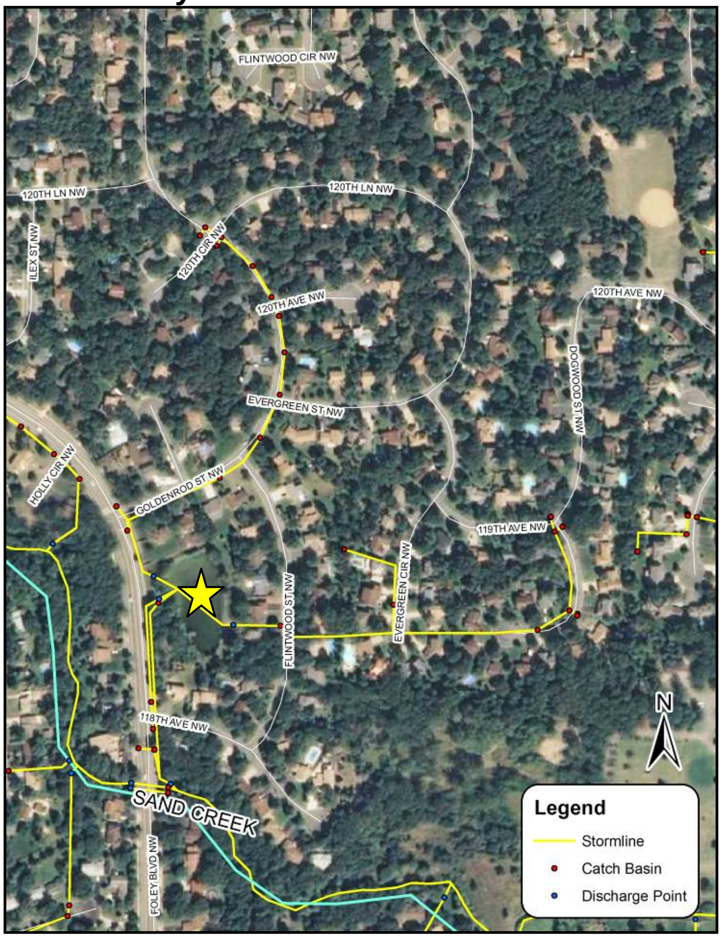
Site 1: Redwood St Pond

Potential Retrofit: The pond was investigated as a potential modification retrofit by raising the outlet elevation to provide additional storage. The residential neighborhoods were also considered for rain garden retrofits.

Cause for Elimination: It was determined during field investigation that raising the outlet elevation would risk flooding residential yards surrounding the pond. The neighborhoods are already getting adequate stormwater treatment from the pond, so rain gardens were also eliminated from consideration.

Notes: Though no retrofit opportunities were identified, the pond should be inspected for maintenance issues to ensure it is providing sufficient treatment.

Site 2: Foley Blvd Pond

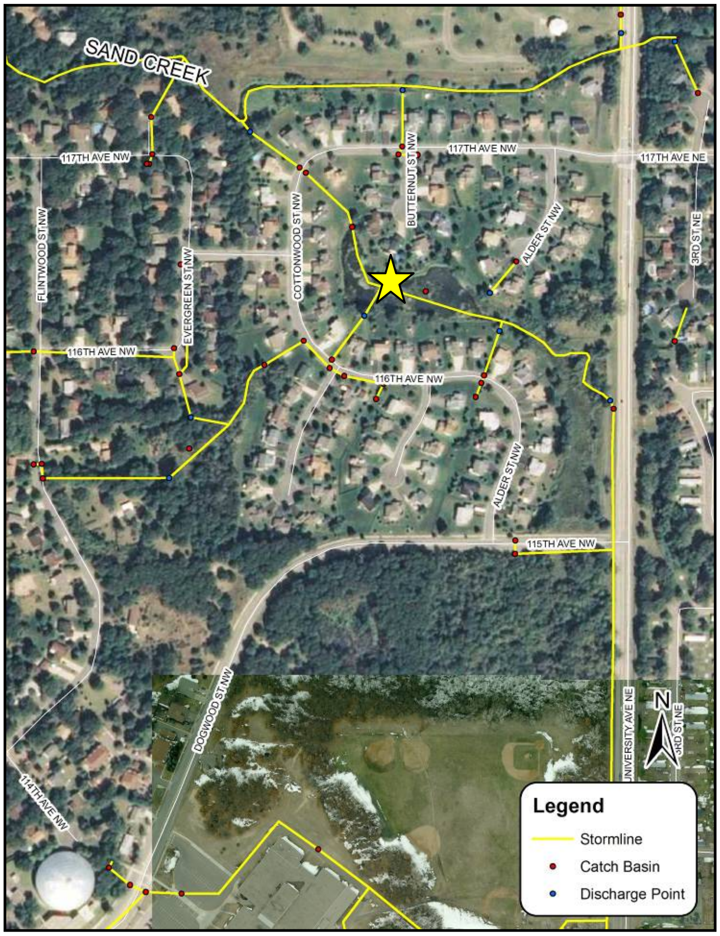


Potential Retrofit: The pond was investigated as a potential modification retrofit by raising the outlet elevation to provide additional storage.

Cause for Elimination: The pond was inspected several times during the summer with the water level being substantially lower than the current outlet elevation. The pond appeared to be sized to treat the entire area draining to it and was eliminated from retrofit consideration.

Notes: Though no retrofit opportunities were identified, the pond should be monitored. If groundwater levels rise to the point where the pond elevation could reach the outlet elevation, an outlet modification retrofit may be appropriate.

Site 3: Alder St Pond



Potential Retrofit: The pond was investigated as a potential modification retrofit by raising the outlet elevation to provide additional storage.

Cause for Elimination: Field investigation of the pond revealed that the pond is a flow-through system and raising the outlet elevation would pose a serious risk of upstream flooding.

Notes: This pond treats runoff from a large area and should be inspected regularly for maintenance (dredging).

Panuska, J. 1998. “Drainage System Connectedness for Urban Areas”. Memo. Wisconsin Dept of Natural Resources. Madison, WI.

Rawls et. al. 1998. Use of Soil Texture, Bulk Density, and Slope of the Water Retention Curve to Predict Saturated Hydraulic Conductivity. Transactions of the ASAE. Vol 41(4): 983-988. St. Joseph, MI.

Schueler et. al. 2007. Urban Stormwater Retrofit Practices. Manual 3. Center for Watershed Protection. Ellicott City, MD.

USDA. 1986. Urban Hydrology for Small Watersheds TR-55. Second Edition. Washington, DC.

Curb-Cut Rain Garden Guidebook

ANOKA COUNTY CURB-CUT RAINGARDENS

Photo: Barr Engineering

Drawing rainwater from the street gutter reduces runoff and pollutants to local water bodies

Prepared by the Anoka Conservation District in association with the Metropolitan Conservation Districts

URBAN RAINWATER: SLOW IT DOWN AND SOAK IT UP

Under natural conditions the majority of rainwater falling on Anoka County would infiltrate the soil surface to be absorbed by plants or percolate more deeply into the soil to feed groundwater recharge and provide steady base-flow to streams and rivers. As land development has expanded more and more land is covered with impervious surfaces such as roads, parking lots and buildings. This conversion from native vegetation to impervious structure has greatly altered the hydrologic cycle and surface water ecology by greatly increasing runoff rates and effectively washing nutrient laden sediments and other pollutants into local surface waters. Treating and infiltrating urban rainwater as close to the point where it falls as possible is recognized as a vital and effective method for augmenting groundwater resources and reducing surface water quality impacts.

In dense residential ***sub-watersheds*** there is limited suitable public land on which to treat and infiltrate rainwater. In these situations utilizing private land and easements along roadways for treatment becomes an important tool for improving water quality. The curb and gutter system that channels rainwater quickly from your neighborhood can be disconnected with a ***curb-cut*** that directs rainwater from the street into a depressed ***raingarden***. This allows rainwater falling within the catchment area of the raingarden to return to the natural hydrologic cycle of ***infiltration*** and ***evapotranspiration***, effectively reducing downstream flooding, erosion and ***non-point source pollution***. An individual curb-cut raingarden may only mitigate for a small portion of urban runoff, however the treating the rainwater runoff close to its source is an essential strategy in hydrologic restoration and cumulatively curb-cut gardens can actualize significant benefits within an urbanized ***sub-watershed***.

The Anoka Conservation District has designed a set of curb-cut raingardens that can be applied to the physical conditions of your property and to your preference of garden shapes and plant selections. Each garden is designed to provide a water storage capacity of 100 cubic feet. Anoka Conservation

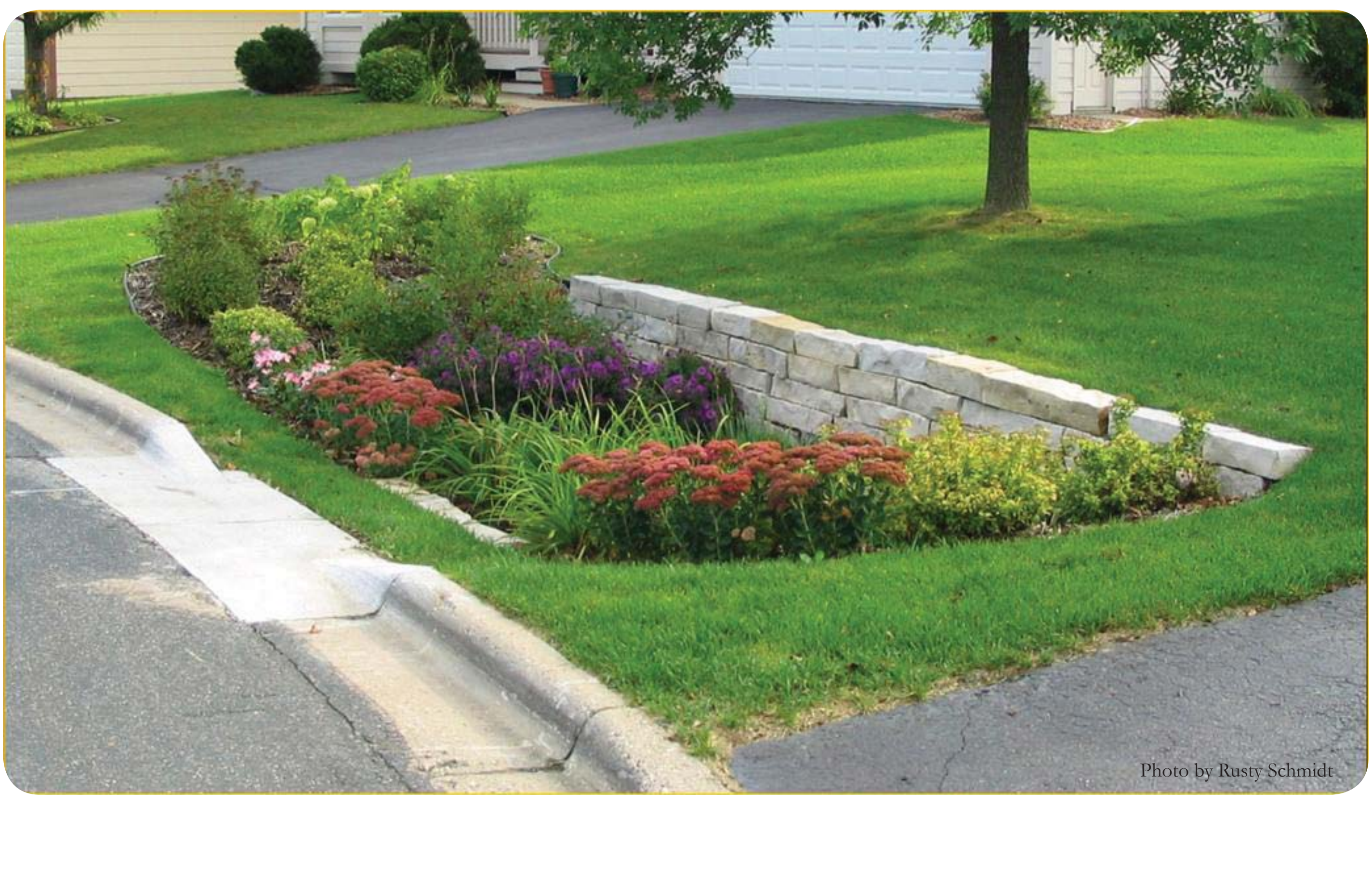


Photo by Rusty Schmidt

District has also designed a modular pretreatment box to be placed at the raingarden inlet to capture sediment and debris prior to water entering the garden. This pretreatment box is a vital component to the longevity and functionality of your raingarden.

Please utilize the key on page 4 to determine the basic design needs of your property and continue to the designated page to select your choice of plant palettes. Plant images are shown of pages 20 and 21.

curb-cut: A section of curb and gutter that has been reconstructed to convey stormwater into a filter strip, rain garden, or other stormwater management strategy.

evapotranspiration: The transfer of liquid water from the earth's surface to atmospheric water vapor as result of transpiration by plants and evaporation by solar energy and diffusion. Evapotranspiration can constitute a significant water "loss" from a watershed.

infiltration: Water moving through a permeable soil surface by the force of gravity and soil capillary action. The rate of infiltration is highly dependent on soil type. Infiltration rates within the Anoka Sand Plain are generally very high.

non-point source pollution: Rainwater runoff that has accumulated pollutant loads (nutrients, sediments, petrochemicals etc.) over a large dispersed area. As opposed to point source pollution that has a defined single source.

raingarden: A landscaped garden in a shallow depression that receives rainwater runoff from nearby impervious surfaces such as roofs, parking lots or streets. The purpose of a raingarden is to reduce peak runoff flows, increase groundwater recharge and improve water quality in our lakes, streams and wetlands. Peak flow reduction is achieved by temporarily staging runoff within the raingarden basin until it infiltrates into the soil surface or evaporates (typically within 24 hours). This process also increases the quantity and movement of soil water that may feed groundwater recharge. Infiltrated water quality is improved by reducing sediment, nutrient and other chemical pollutant loads through chemical and biological processes in the soil. Downstream water quality is improved in kind by offsetting erosive peak flows and by capturing and treating pollutants higher in the watershed.

sub-watersheds: A discreet portion of a larger watershed, typically less than 1000 acres. Sub-watersheds can be more effectively analyzed and managed for water quality with site scale treatments.

CHOOSE YOUR RAINGARDEN DESIGN

1

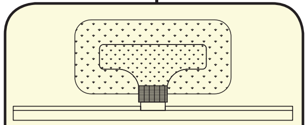
- **Property rises less than 1 foot above the top of curb hieght within 16 feet of the curb** → Retaining not needed
- **Property rises greater than 1 foot above the curb hieght within 16 feet of the curb** → Retaining wall needed

2

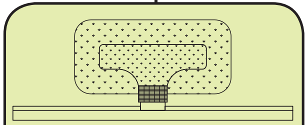
Retaining not needed:
- Garden site recieves greater than 4 hours of full sun between 10 am and 4 pm → Sun garden
- Garden site recieves less than 4 hours of full sun between 10 am and 4 pm → Shade garden

Retaining wall needed:
- Garden site recieves greater than 4 hours of full sun between 10 am and 4 pm → Sun garden
- Garden site recieves less than 4 hours of full sun between 10 am and 4 pm → Shade garden

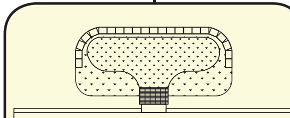
3



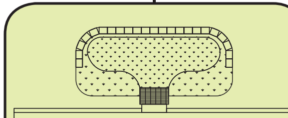
I. Rectangle
Sun, No Wall
pg. 8



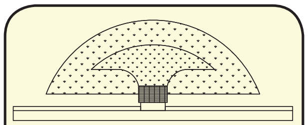
IV. Rectangle
Shade, No Wall
pg. 11



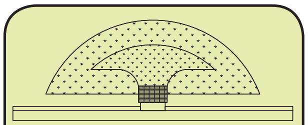
VII. Rectangle
Sun, with Wall
pg. 14



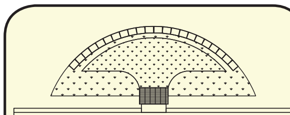
X. Rectangle
Shade, with Wall
pg. 17



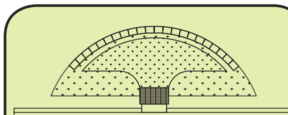
II. Arc
Sun, No Wall
pg. 9



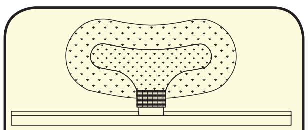
V. Arc
Shade, No Wall
pg. 12



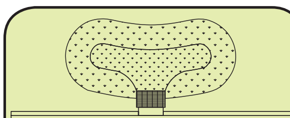
VIII. Arc
Sun, with Wall
pg. 15



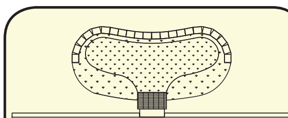
XI. Arc
Shade, with Wall
pg. 18



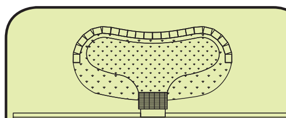
III. Curvilinear
Sun, No Wall
pg. 10



VI. Curvilinear
Shade, No Wall
pg. 13

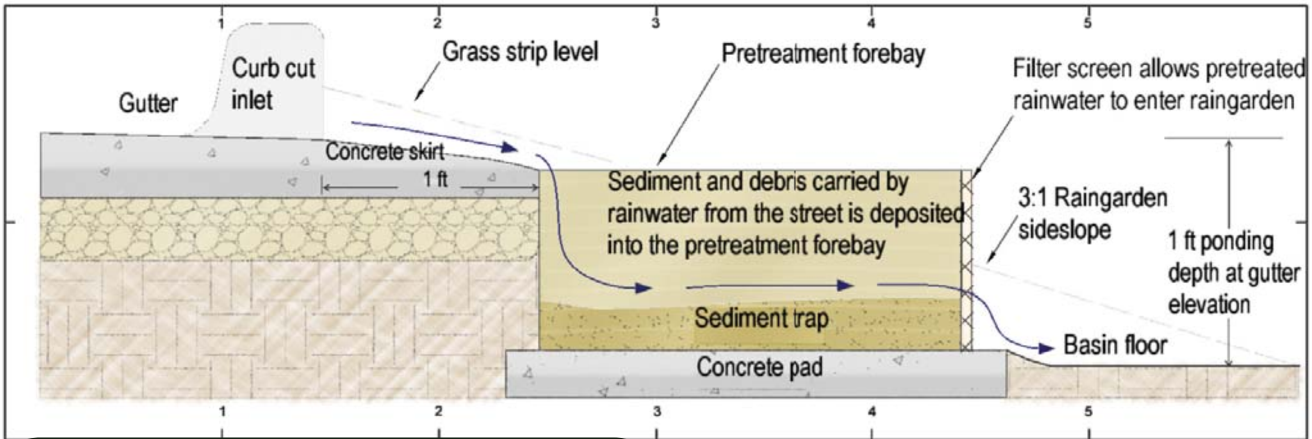


IX. Curvilinear
Sun, with Wall
pg. 16

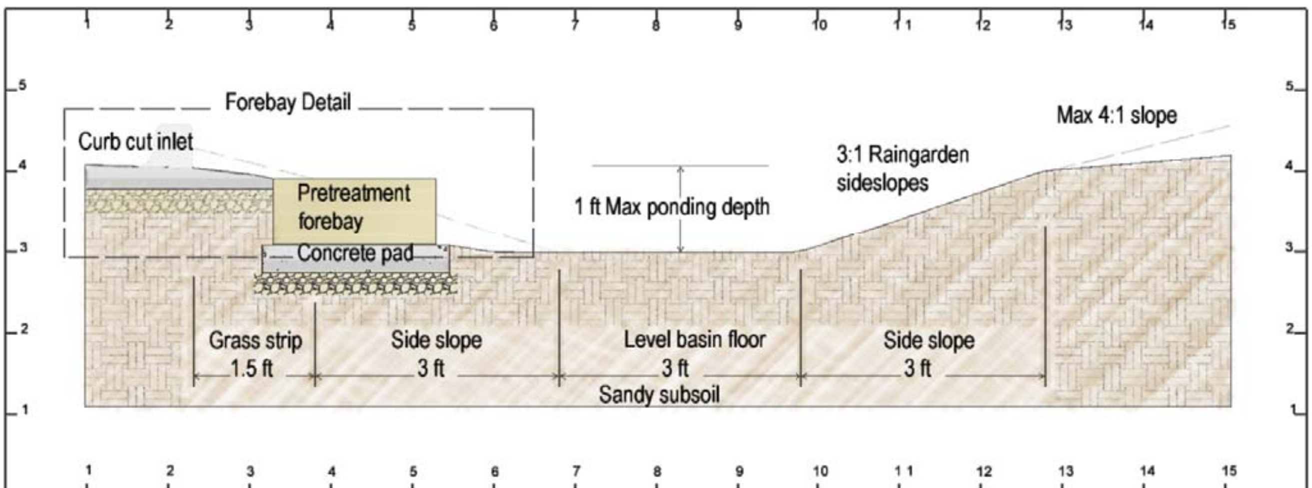


XII. Curvilinear
Shade, With Wall
pg. 19

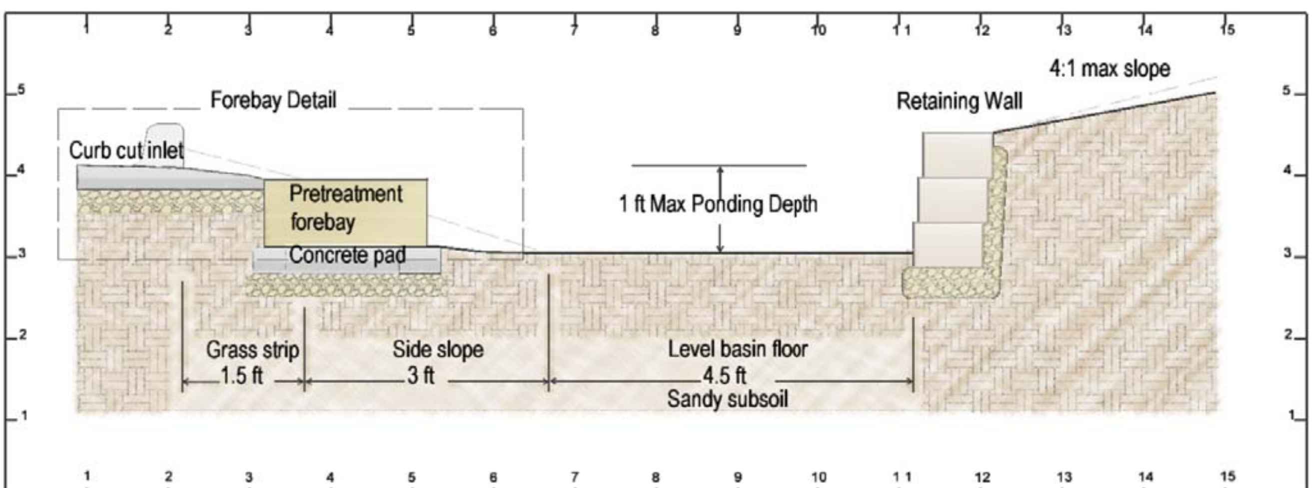
ANATOMY OF A CURB-CUT RAINGARDEN



PRETREATMENT FOREBAY

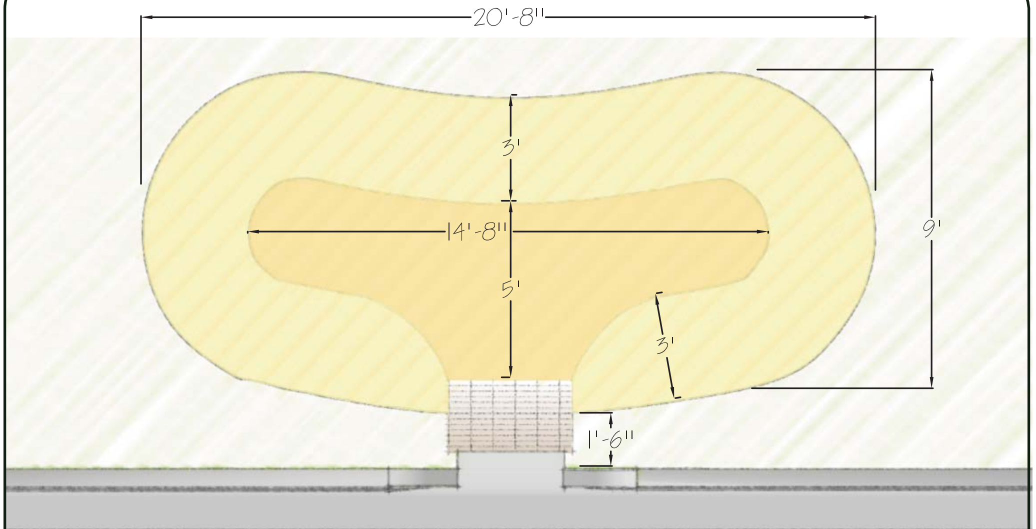


RAINGARDEN WITHOUT RETAINMENT

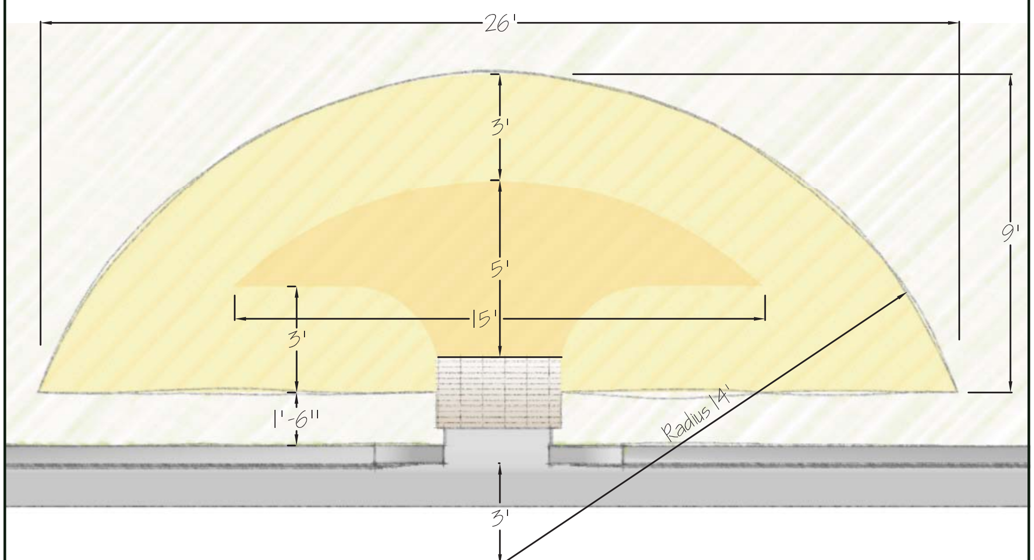


RAINGARDEN WITH RETAINING WALL

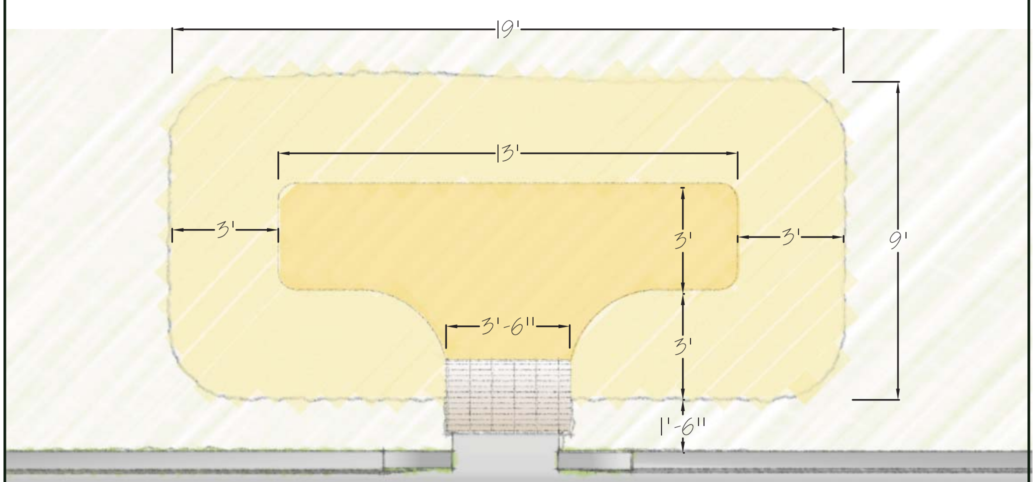
Raingarden Dimensions without a Retaining Wall



Curvilinear Garden



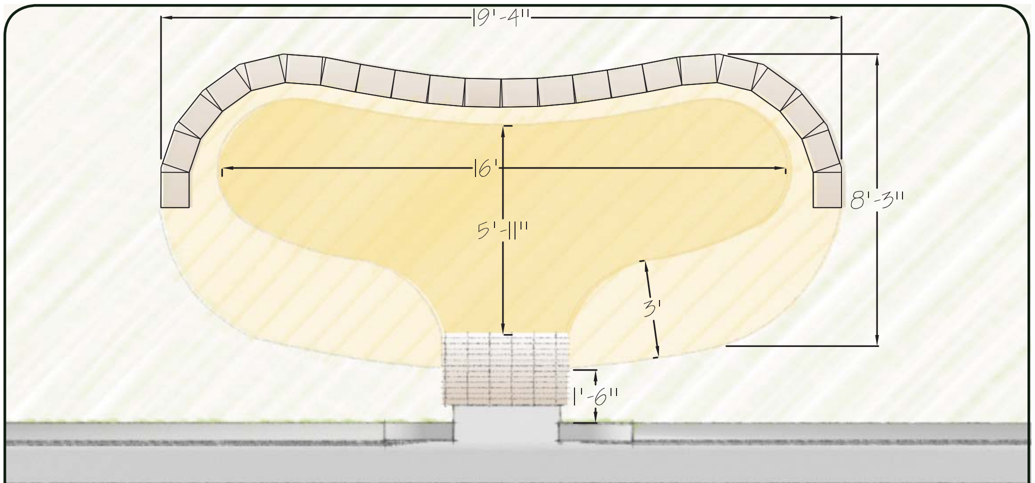
Arc Garden

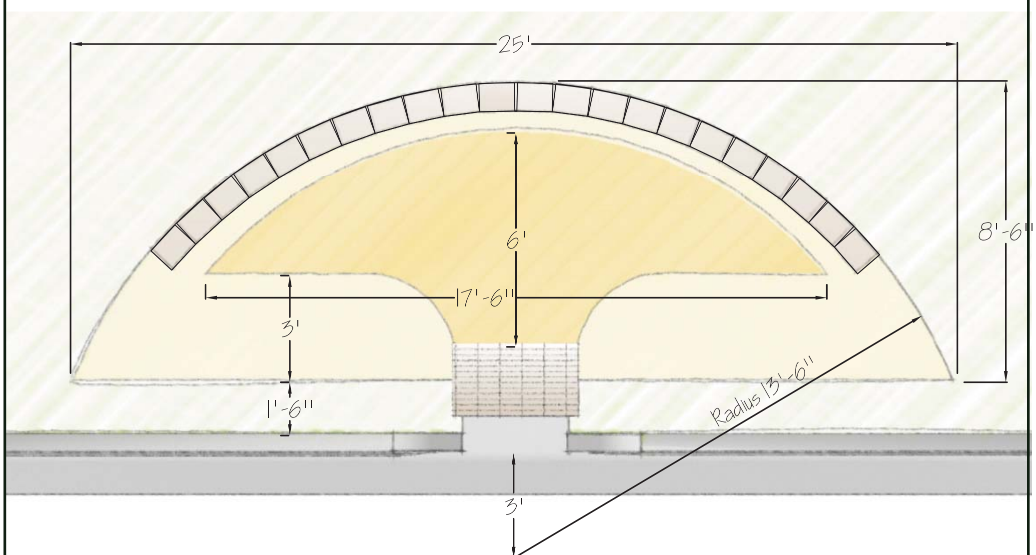


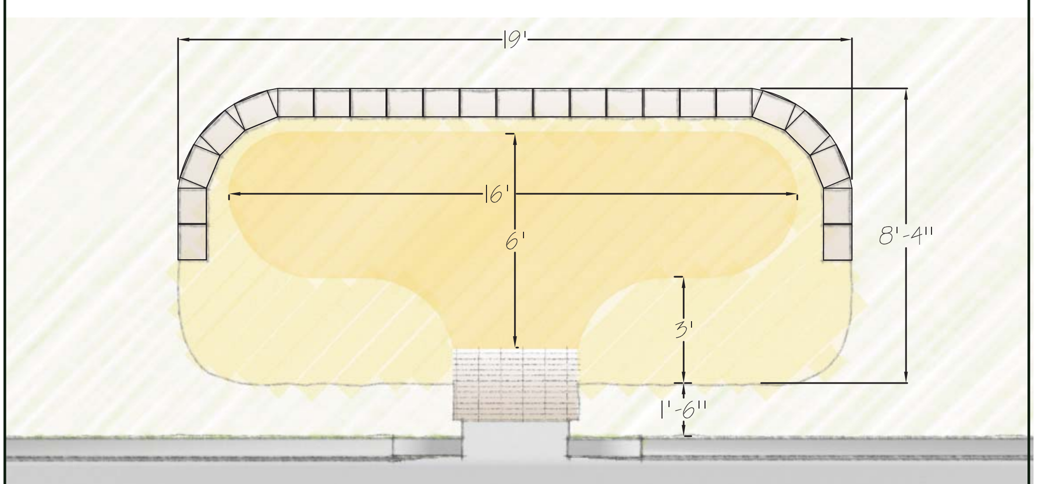
Rectangle Garden

The dimensions given are the minimum dimensions needed to achieve the storage volume required by this stormwater retrofit program. The level basin floor needs to be set 1 foot below the gutter elevation. The entire planting area should be covered with 3 inches of shredded hardwood mulch.

Raingarden Dimensions with a Retaining Wall

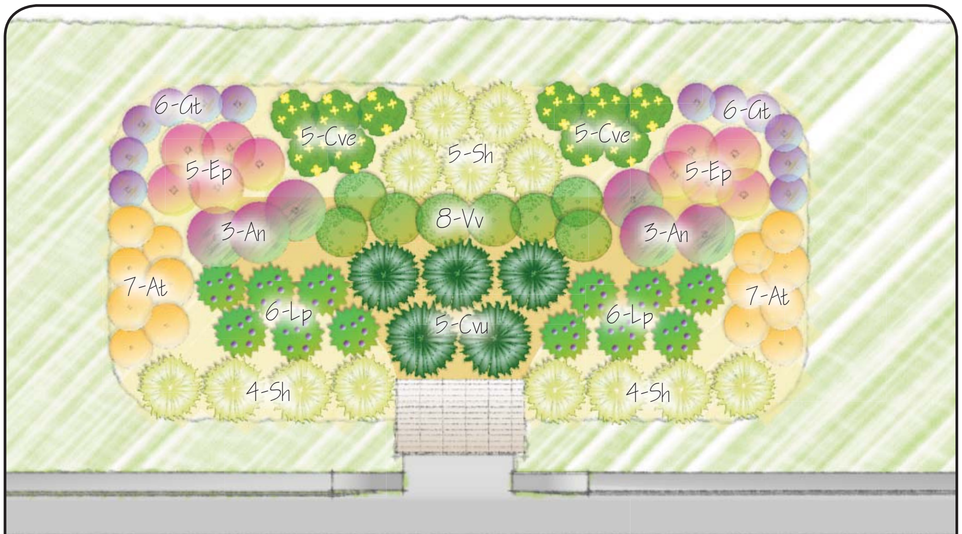




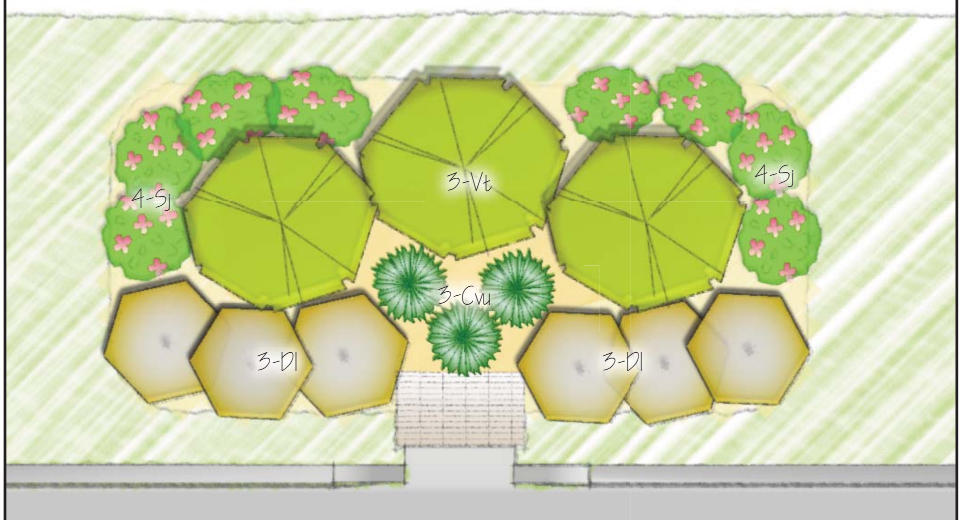


The dimensions given are the minimum dimensions needed to achieve the storage volume required by this stormwater retrofit program. The level basin floor needs to be set 1 foot below the gutter elevation. The entire planting area should be covered with 3 inches of shredded hardwood mulch.

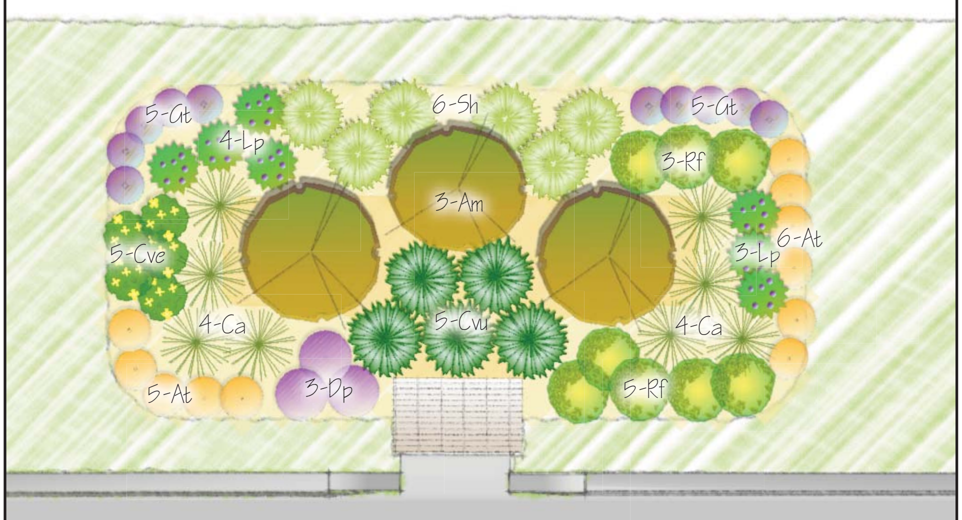
I. Rectangle Garden - Sunny Site - No Retaining Wall



Flowering Perennial Garden



Shrub Garden

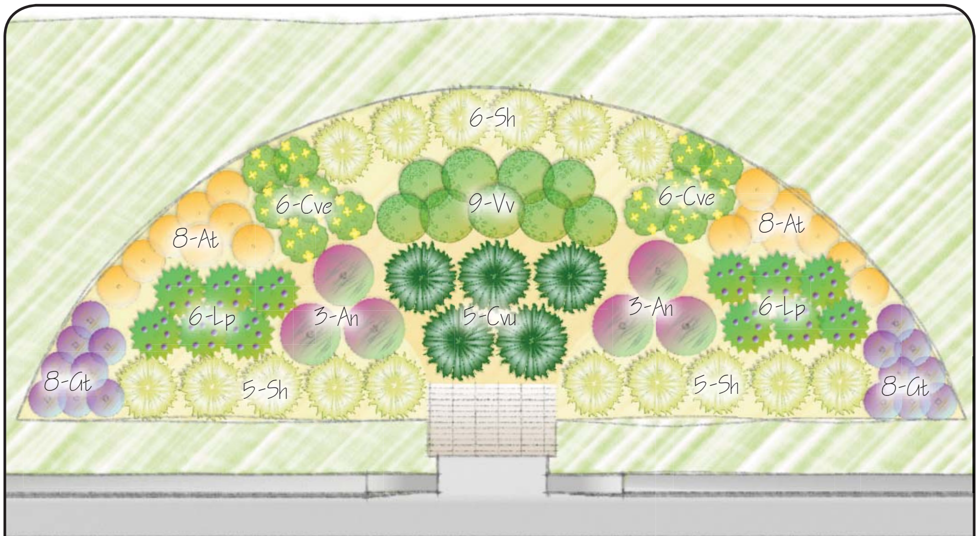


Mixed Shrub/Flower Garden

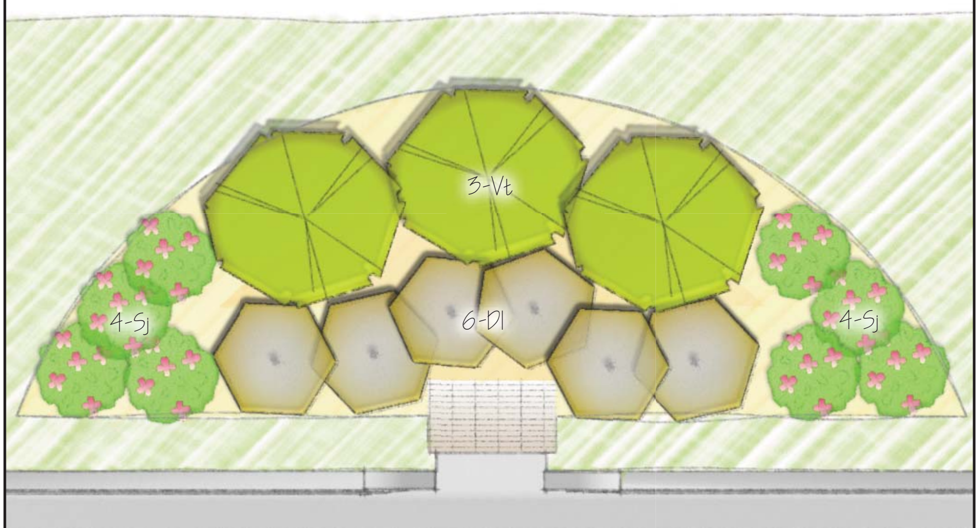
Plant Key

Am	BLACK CHOKEBERRY *Aronia melonocarpa*
At	BUTTERFLY MILKWEED *Asclepias tuberosa*
An	ASTER 'PURPLE DOME' *Aster novae-angliae 'Purple Dome'*
Ca	KARL FORESTER GRASS *Calamagrostis acutifolia*
Cvu	FOX SEDGE *Carex vulpinoidea*
Cve	COREOPSIS 'MOONBEAM' *Coreopsis verticillata 'Moonbeam'*
Dp	PURPLE PRARIE CLOVER *Dalea purpurea*
Dl	DWARF BUSH HONEYSUCKLE *Diervilla lonicera*
Ep	PURPLE CONEFLOWER *Echinacea purpurea*
Gt	PRAIRIE SMOKE *Geum trifolium*
Lp	PRAIRIE BLAZING STAR *Liatris pycnostachya*
Rf	GOLDSTRUM BLACK-EYED SUSAN *Rudbeckia fulgida*
Sj	DART'S RED SPIRAEA *Spiraea japonica*
Sh	PRAIRIE DROPSEED *Sporobolis heterolepsis*
Vv	CULVERS ROOT *Veronicastrum virginicum*
Vt	CRANBERRYBUSH VIBURNUM *Viburnum trilobum 'compactum'*

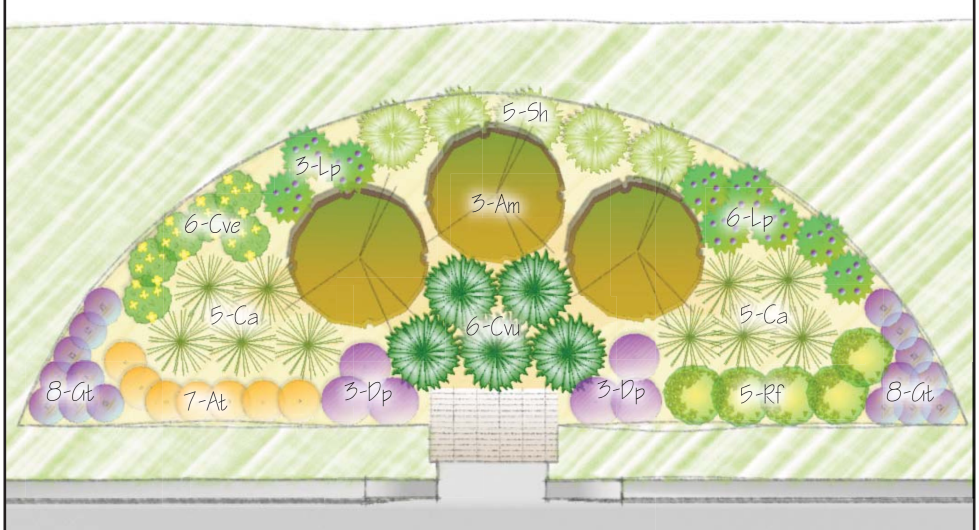
II. Arc Garden - Sunny Site - No Retaining Wall



Flowering Perennial Garden



Shrub Garden

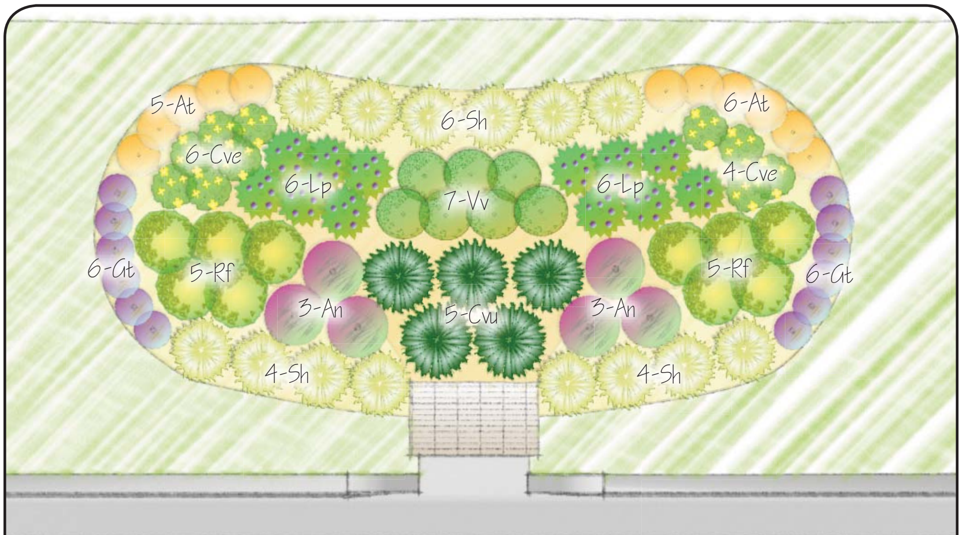


Mixed Shrub/Flower Garden

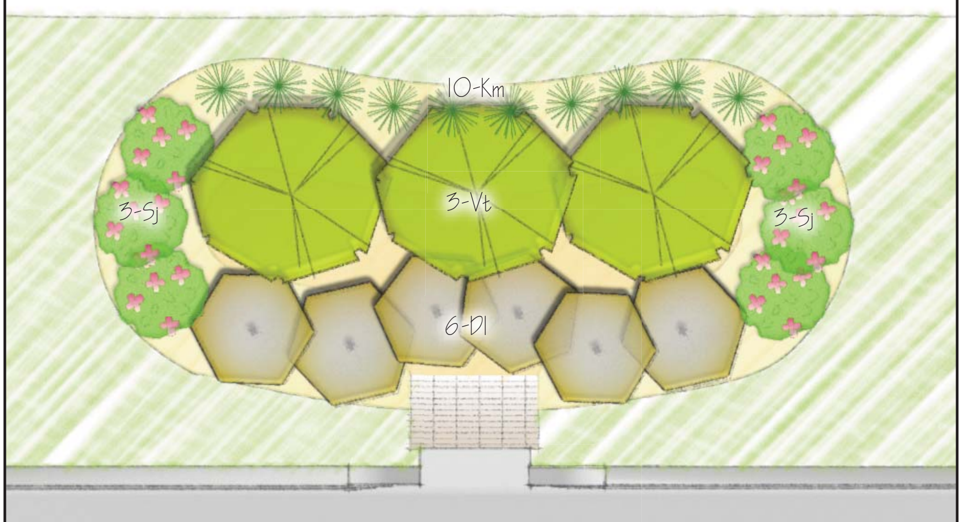
Plant Key

Am	BLACK CHOKEBERRY *Aronia melonocarpa*
At	BUTTERFLY MILKWEED *Asclepias tuberosa*
An	ASTER 'PURPLE DOME' *Aster novae-angliae 'Purple Dome'*
Ca	KARL FORESTER GRASS *Calamagrostis acutifolia*
Cvu	FOX SEDGE *Carex vulpinoidea*
Cve	COREOPSIS 'MOONBEAM' *Coreopsis verticillata 'Moonbeam'*
Dp	PURPLE PRARIE CLOVER *Dalea purpurea*
Dl	DWARF BUSH HONEYSUCKLE *Diervilla lonicera*
Ep	PURPLE CONEFLOWER *Echinacea purpurea*
Gt	PRAIRIE SMOKE *Geum trifolium*
Lp	PRAIRIE BLAZING STAR *Liatris pycnostachya*
Rf	GOLDSTRUM BLACK-EYED SUSAN *Rudbeckia fulgida*
Sj	DART'S RED SPIRAEA *Spiraea japonica*
Sh	PRAIRIE DROPSEED *Sporobolis heterolepsis*
Vv	CULVERS ROOT *Veronicastrum virginicum*
Vt	CRANBERRYBUSH VIBURNUM *Viburnum trilobum 'compactum'*

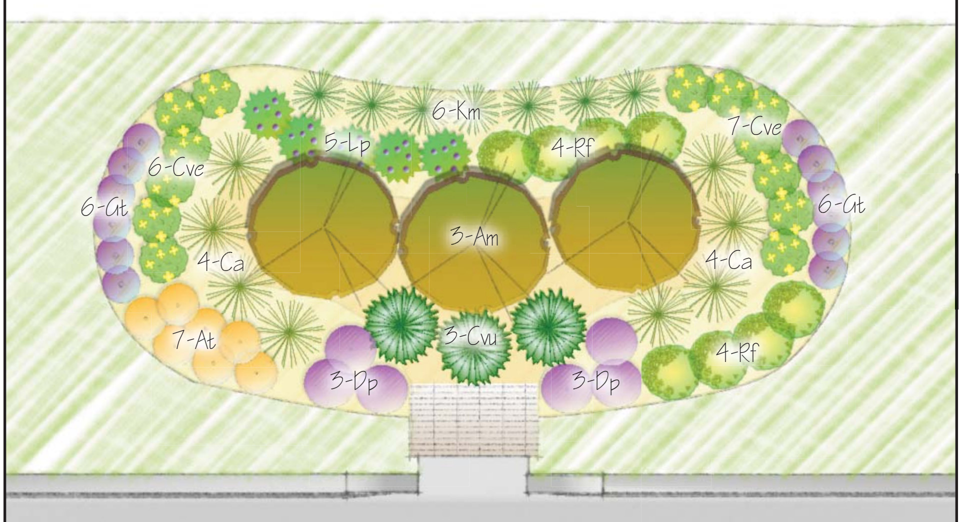
III. Curvilinear Garden - Sunny Site - No Retaining Wall



Flowering Perennial Garden



Shrub Garden

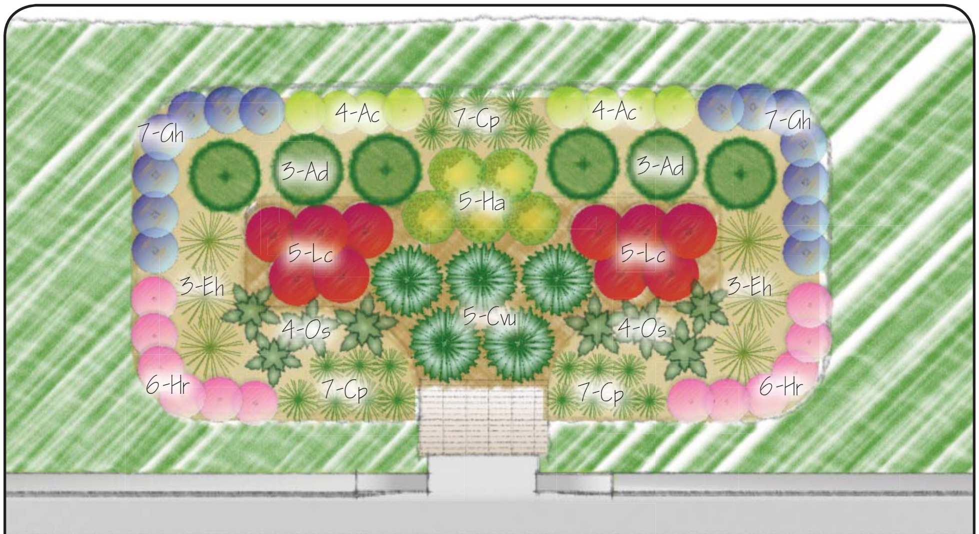


Mixed Shrub/Flower Garden

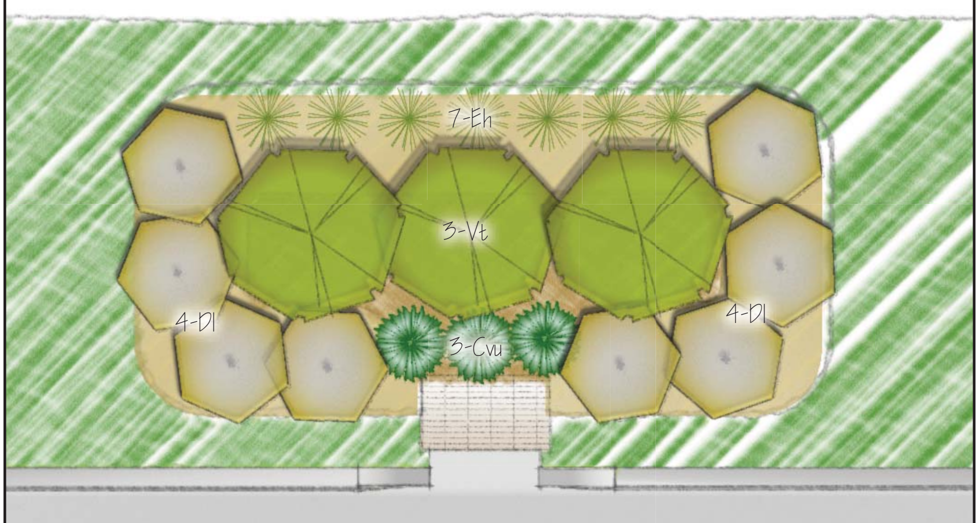
Plant Key

Am	BLACK CHOKEBERRY *Aronia melonocarpa*
At	BUTTERFLY MILKWEED *Asclepias tuberosa*
An	ASTER 'PURPLE DOME' *Aster novae-angliae 'Purple Dome'*
Ca	KARL FORESTER GRASS *Calamagrostis acutifolia*
Cvu	FOX SEDGE *Carex vulpinoidea*
Cvu	COREOPSIS 'MOONBEAM' *Coreopsis verticillata 'Moonbeam'*
Dp	PURPLE PRARIE CLOVER *Dalea purpurea*
Dl	DWARF BUSH HONEYSUCKLE *Diervilla lonicera*
Gt	PRAIRIE SMOKE *Geum trifolium*
Km	JUNE GRASS *Koeleria macrantha*
Lp	PRAIRIE BLAZING STAR *Liatris pycnostachya*
Rf	GOLDSTRUM BLACK-EYED SUSAN *Rudbeckia fulgida*
Sj	DART'S RED SPIRAEA *Spiraea japonica*
Sh	PRAIRIE DROPSEED *Sporobolis heterolepsis*
Vv	CULVERS ROOT *Veronicastrum virginicum*
Vt	CRANBERRYBUSH VIBURNUM *Viburnum trilobum 'compactum'*

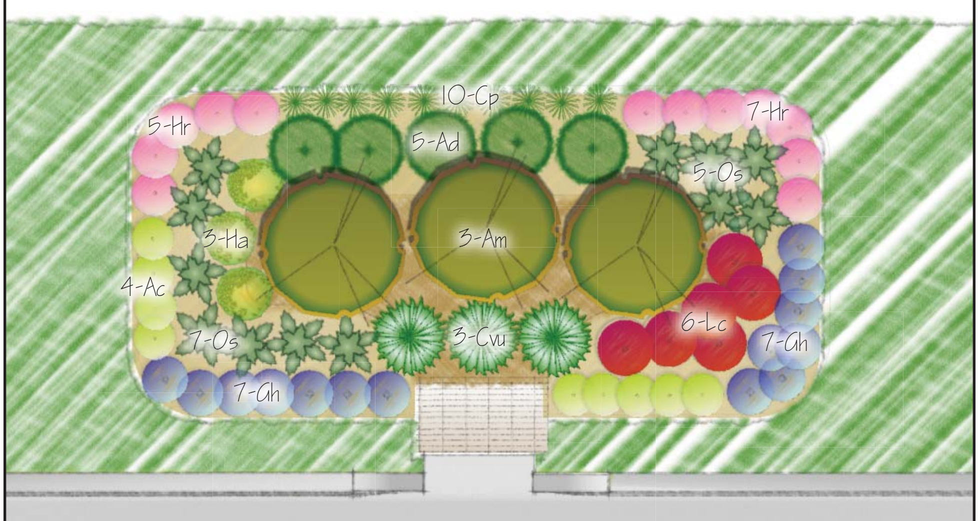
IV. Rectangle Garden - Shady Site - No Retaining Wall



Flowering Perennial Garden



Shrub Garden

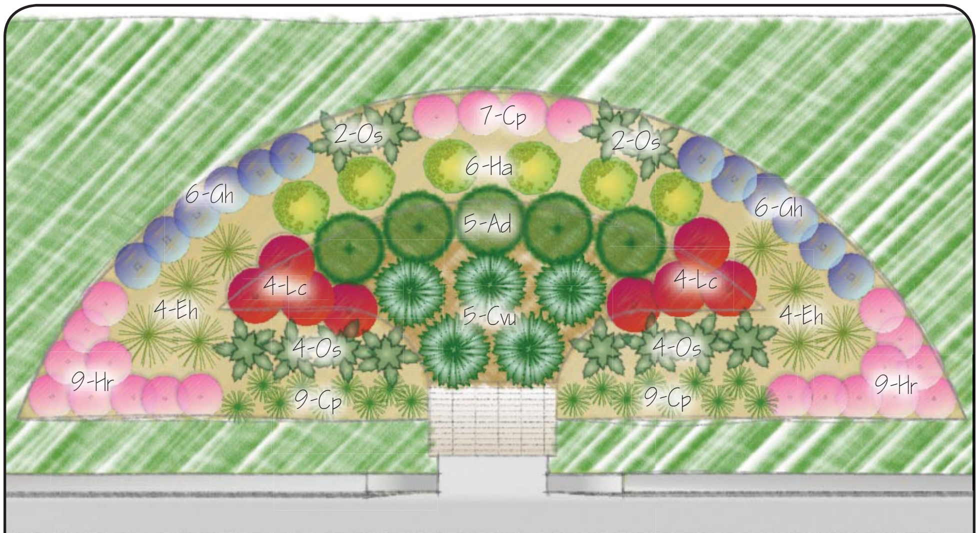


Mixed Shrub/Flower Garden

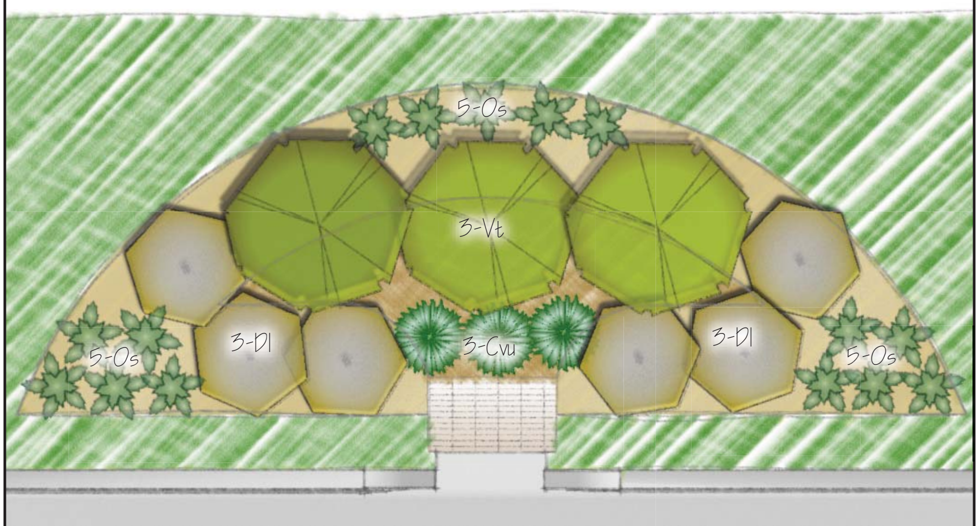
Plant Key

Am	BLACK CHOKEBERRY *Aronia melonocarpa*
Ac	CANADA ANEMONE *Anemone canadensis*
Ad	GOAT'S BEARD *Aruncus diocius*
Cp	PENNSYLVANIA SEDGE *Carex pennsylvanica*
Cvu	FOX SEDGE *Carex vulpinoidea*
Dl	DWARF BUSH HONEYSUCKLE *Diervilla lonicera*
Cve	BOTTLEBRUSH GRASS *Eylmus histrix*
Gh	GERANIUM 'JOHNSON BLUE' *Geranium himalayense x pratense*
Ha	SNEEZEWEED *Helenium autumnale*
Hr	ALUMROOT *Heuchera richardsonii*
Lc	CARDINAL FLOWER *Lobelia cardinalis*
Os	SENSITIVE FERN *Onoclea sensibilis*
Vt	CRANBERRYBUSH VIBURNUM *Viburnum trilobum 'compactum'*

V. Arc Garden - Shady Site - No Retaining Wall



Flowering Perennial Garden



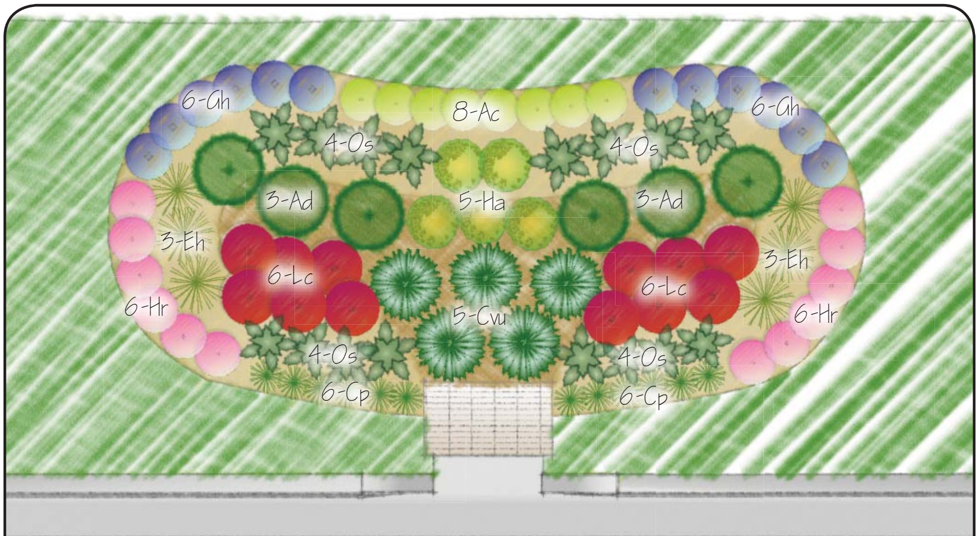
Shrub Garden

Mixed Shrub/Flower Garden

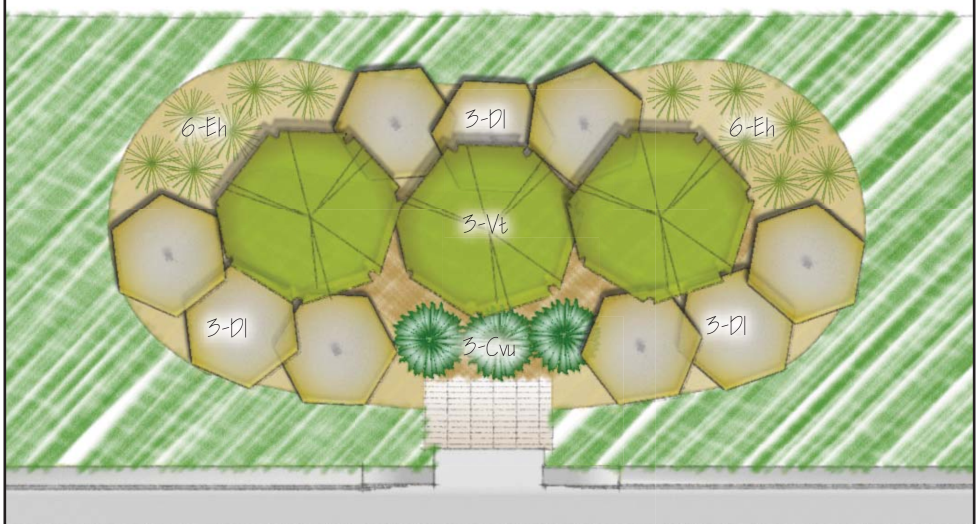
Plant Key

Am	BLACK CHOKEBERRY *Aronia melonocarpa*
Ac	CANADA ANEMONE *Anemone canadensis*
Ad	GOAT'S BEARD *Aruncus diocius*
Cp	PENNSYLVANIA SEDGE *Carex pennsylvanica*
Cvu	FOX SEDGE *Carex vulpinoidea*
Dl	DWARF BUSH HONEYSUCKLE *Diervilla lonicera*
Cve	BOTTLEBRUSH GRASS *Elymus histrix*
Gh	GERANIUM 'JOHNSON BLUE' *Geranium himalayense x pratense*
Ha	SNEEZEWEED *Helenium autumnale*
Hr	ALUMROOT *Heuchera richardsonii*
Lc	CARDINAL FLOWER *Lobelia cardinalis*
Os	SENSITIVE FERN *Onoclea sensibilis*
Vt	CRANBERRYBUSH VIBURNUM *Viburnum trilobum 'compactum'*

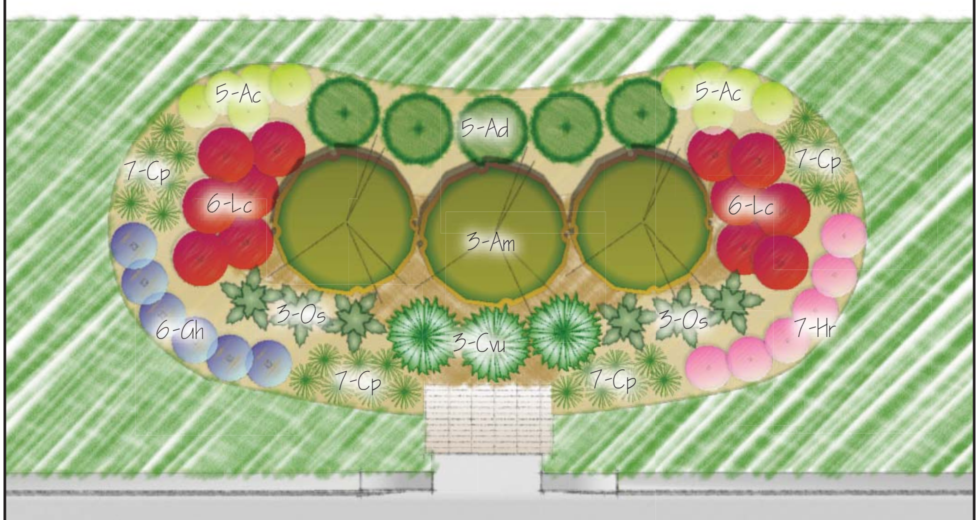
VI. Curvilinear Garden - Shady Site - No Retaining Wall



Flowering Perennial Garden



Shrub Garden

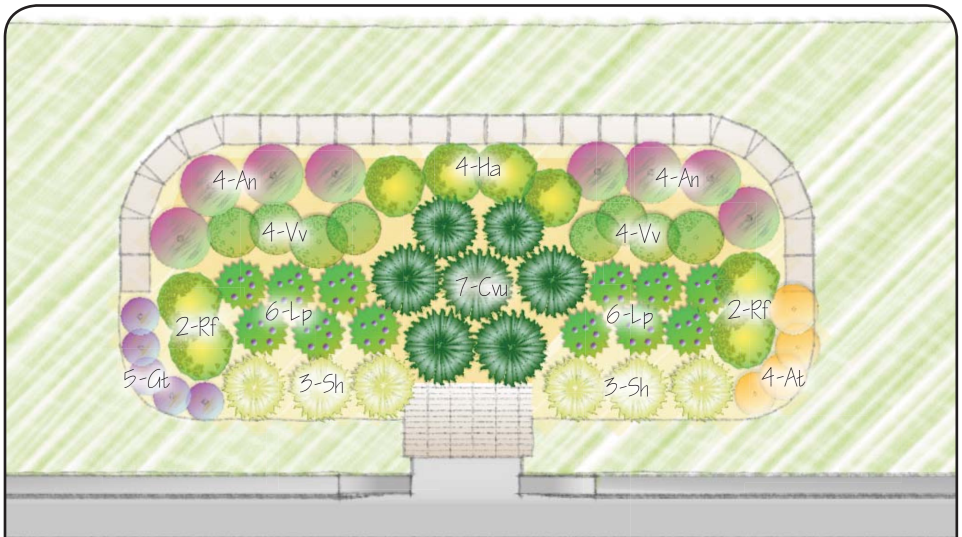


Mixed Shrub/Flower Garden

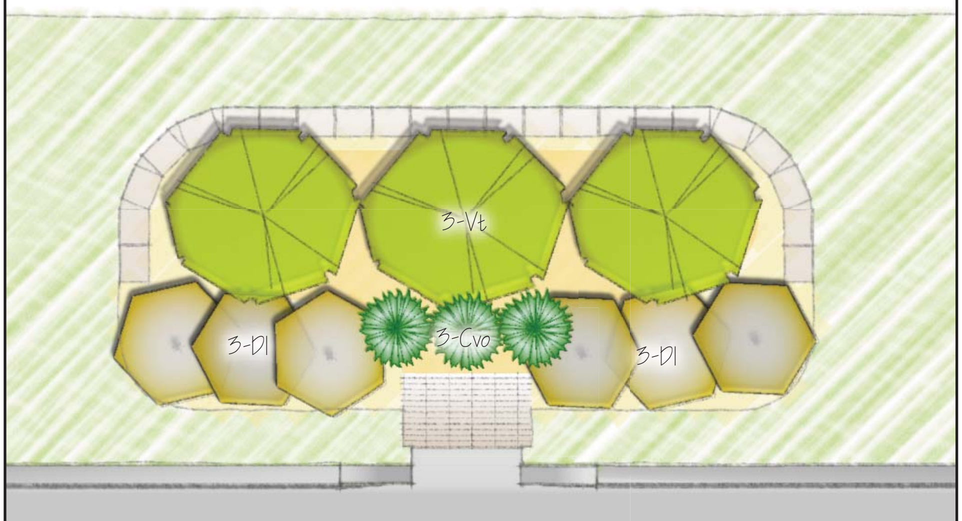
Plant Key

Am	BLACK CHOKEBERRY	*Aronia melonocarpa*
Ac	CANADA ANEMONE	*Anemone canadensis*
Ad	GOAT'S BEARD	*Aruncus diocius*
Cp	PENNSYLVANIA SEDGE	*Carex pennsylvanica*
Cvu	FOX SEDGE	*Carex vulpinoidea*
Dl	DWARF BUSH HONEYSUCKLE	*Diervilla lonicera*
Cve	BOTTLEBRUSH GRASS	*Elymus histrix*
Gh	GERANIUM 'JOHNSON BLUE'	*Geranium himalayense x pratense*
Ha	SNEEZEWEED	*Helenium autumnale*
Hr	ALUMROOT	*Heuchera richardsonii*
Lc	CARDINAL FLOWER	*Lobelia cardinalis*
Os	SENSITIVE FERN	*Onoclea sensibilis*
Vt	CRANBERRYBUSH VIBURNUM	*Viburnum trilobum 'compactum'*

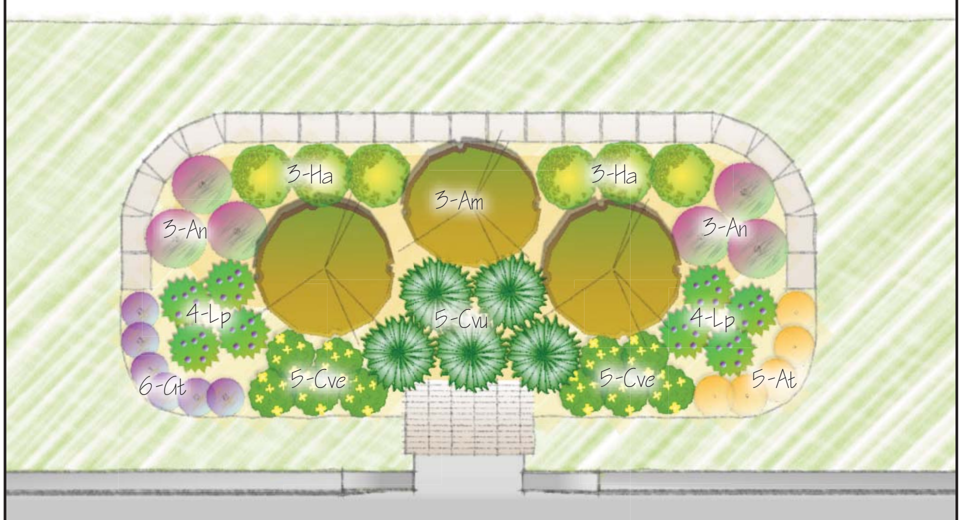
VII. Rectangle Garden - Sunny Site - Retaining Wall



Flowering Perennial Garden



Shrub Garden

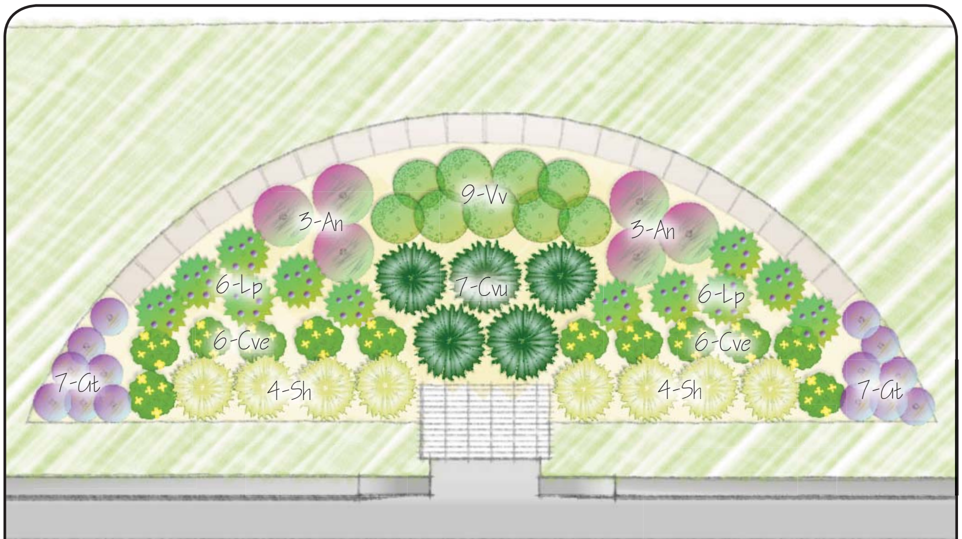


Mixed Shrub/Flower Garden

Plant Key

Am	BLACK CHOKEBERRY *Aronia melonocarpa*
At	BUTTERFLY MILKWEED *Asclepias tuberosa*
An	ASTER 'PURPLE DOME' *Aster novae-angliae 'Purple Dome'*
Cvu	FOX SEDGE *Carex vulpinoidea*
Cve	COREOPSIS 'MOONBEAM' *Coreopsis verticillata 'Moonbeam'*
Dl	DWARF BUSH HONEYSUCKLE *Diervilla lonicera*
Gt	PRAIRIE SMOKE *Geum trifolium*
Ha	SNEEZEWEED *Helenium autumnale*
Lp	PRAIRIE BLAZING STAR *Liatris pycnostachya*
Rf	GOLDSTRUM BLACK-EYED SUSAN *Rudbeckia fulgida*
Sh	PRAIRIE DROPSEED *Sporobolis heterolepsis*
Vv	CULVERS ROOT *Vronicastrum virginicum*
Vt	CRANBERRYBUSH VIBURNUM *Viburnum trilobum 'compactum'*

VIII. Arc Garden - Sunny Site - Retaining Wall



Flowering Perennial Garden

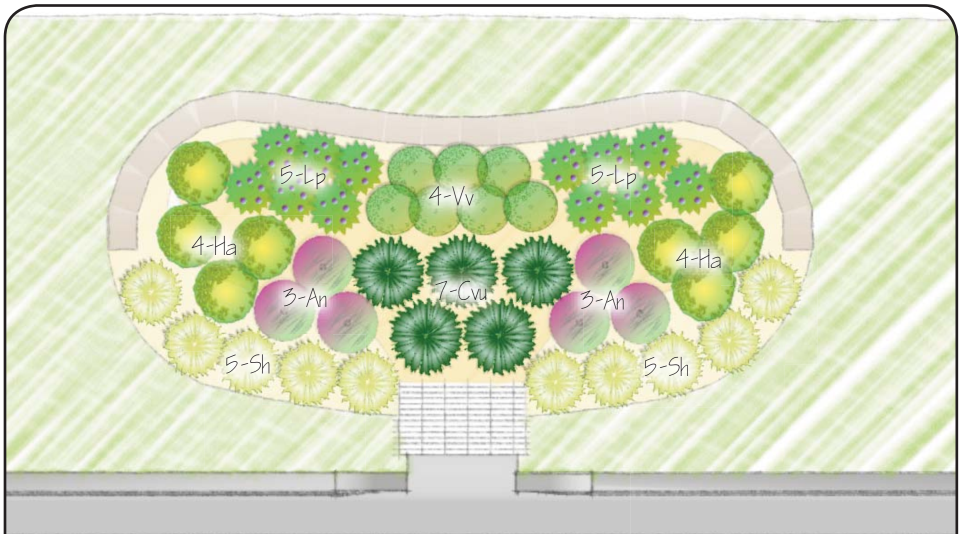
Shrub Garden

Mixed Shrub/Flower Garden

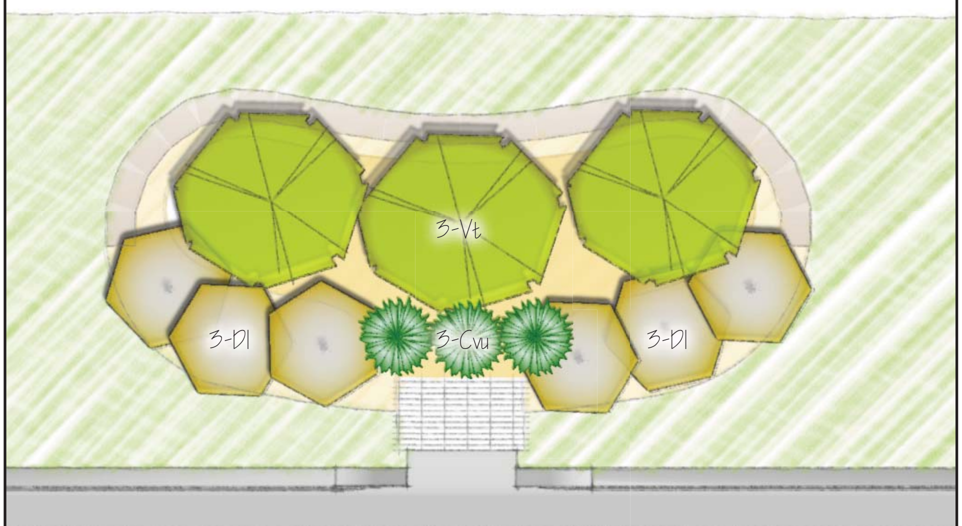
Plant Key

- **Am** – BLACK CHOKEBERRY, *Aronia melonocarpa*
- **At** – BUTTERFLY MILKWEED, *Asclepias tuberosa*
- **An** – ASTER 'PURPLE DOME', *Aster novae-angliae 'Purple Dome'*
- **Ca** – KARL FORESTER GRASS, *Calamagrostis acutifolia*
- **Cvu** – FOX SEDGE, *Carex vulpinoidea*
- **Cve** – COREOPSIS 'MOONBEAM', *Coreopsis verticillata 'Moonbeam'*
- **Dl** – DWARF BUSH HONEYSUCKLE, *Diervilla lonicera*
- **Gt** – PRAIRIE SMOKE, *Geum trifolium*
- **Lp** – PRAIRIE BLAZING STAR, *Liatris pycnostachya*
- **Sj** – DART'S RED SPIRAEA, *Spiraea japonica*
- **Sh** – PRAIRIE DROPSEED, *Sporobolis heterolepsis*
- **Vv** – CULVERS ROOT, *Veronicastrum virginicum*
- **Vt** – CRANBERRYBUSH VIBURNUM, *Viburnum trilobum 'compactum'*

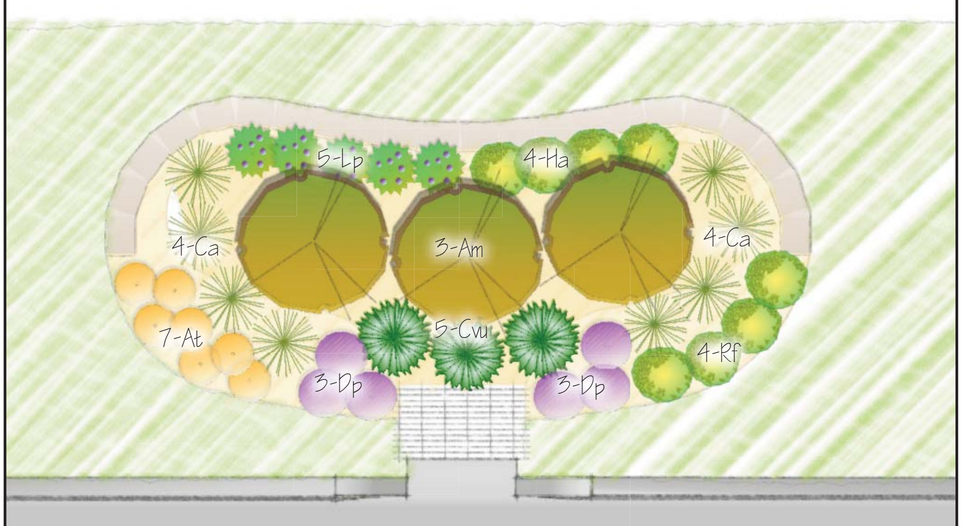
IX. Curvilinear Garden - Sunny Site - Retaining Wall



Flowering Perennial Garden



Shrub Garden



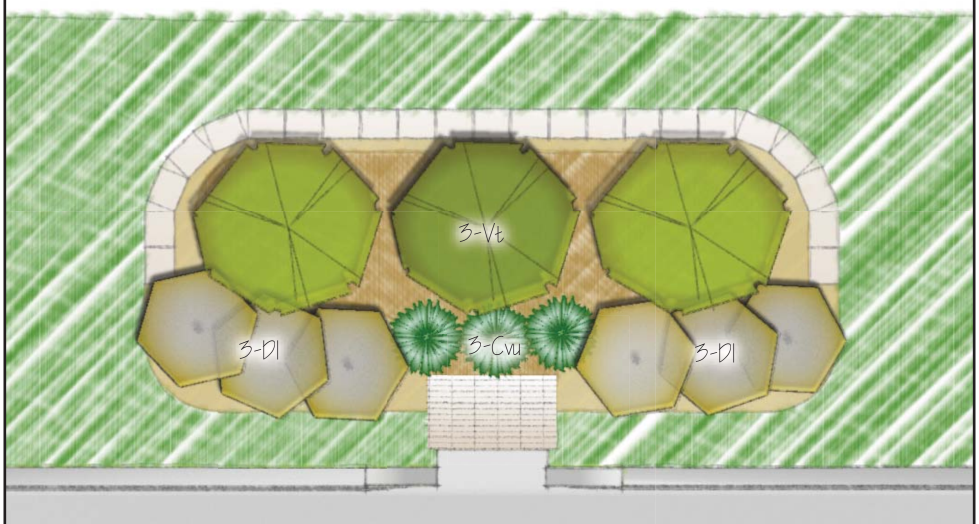
Mixed Shrub/Flower Garden

Plant Key

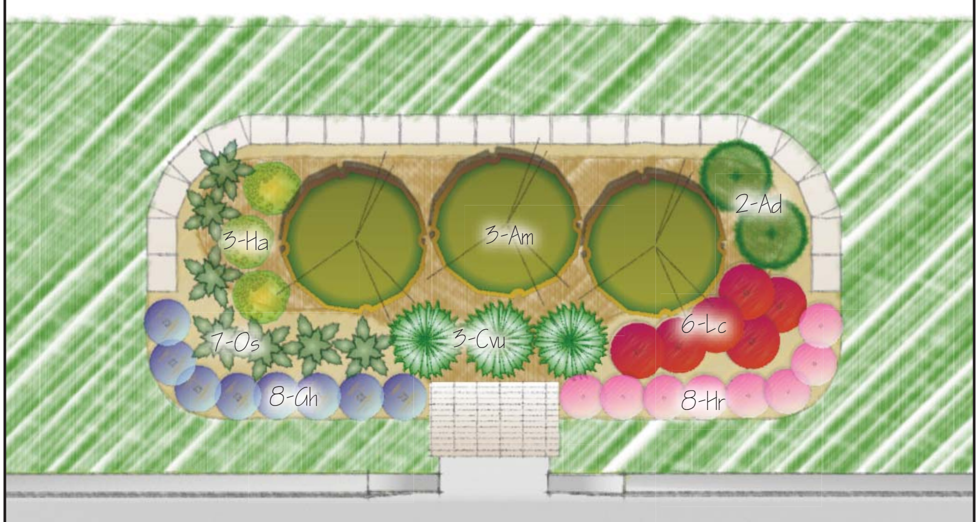
Am	BLACK CHOKEBERRY *Aronia melonocarpa*
At	BUTTERFLY MILKWEED *Asclepias tuberosa*
An	ASTER 'PURPLE DOME' *Aster novae-angliae 'Purple Dome'*
Ca	KARL FORESTER GRASS *Calamagrostis acutifolia*
Cvu	FOX SEDGE *Carex vulpinoidea*
Dl	DWARF BUSH HONEYSUCKLE *Diervilla lonicera*
Ha	SNEEZEWEED *Helenium autumnale*
Lp	PRAIRIE BLAZING STAR *Liatris pycnostachya*
Rf	GOLDSTRUM BLACK-EYED SUSAN *Rudbeckia fulgida*
Sh	PRAIRIE DROPSEED *Sporobolis heterolepsis*
Vv	CULVERS ROOT *Vronicastrum virginicum*
Vt	CRANBERRYBUSH VIBURNUM *Viburnum trilobum 'compactum'*

X. Rectangle Garden - Shady Site - Retaining Wall

Flowering Perennial Garden



Shrub Garden

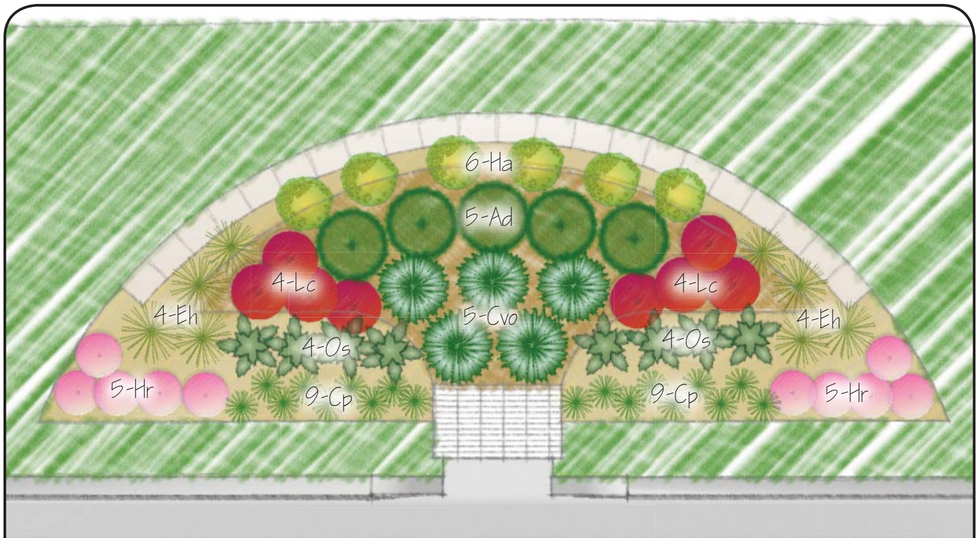


Mixed Shrub/Flower Garden

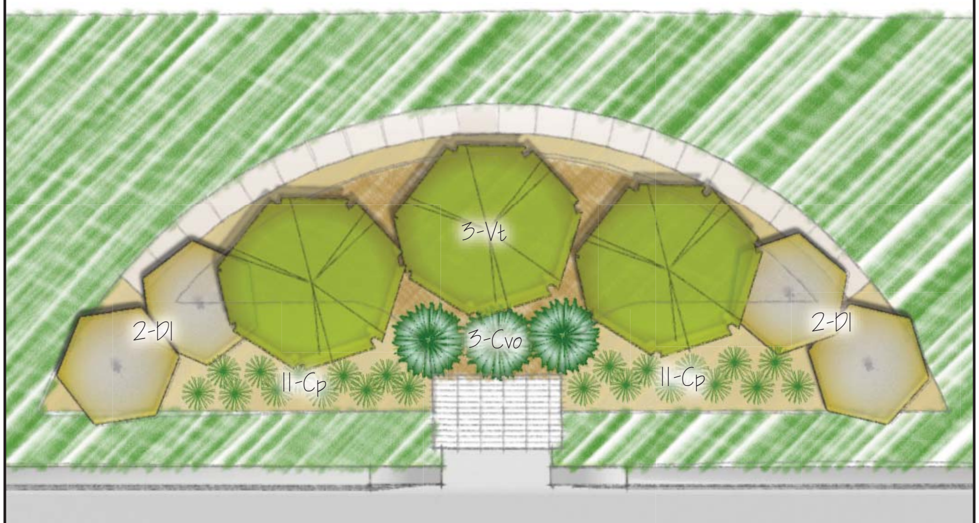
Plant Key

Am	BLACK CHOKEBERRY *Aronia melonocarpa*
Ad	GOAT'S BEARD *Aruncus diocius*
Cp	PENNSYLVANIA SEDGE *Carex pennsylvanica*
Cvu	FOX SEDGE *Carex vulpinoidea*
Dl	DWARF BUSH HONEYSUCKLE *Diervilla lonicera*
Cve	BOTTLEBRUSH GRASS *Elymus histrix*
Gh	GERANIUM 'JOHNSON BLUE' *Geranium himalayense x pratense*
Ha	SNEEZEWEED *Helenium autumnale*
Hr	ALUMROOT *Heuchera richardsonii*
Lc	CARDINAL FLOWER *Lobelia cardinalis*
Os	SENSITIVE FERN *Onoclea sensibilis*
Vt	CRANBERRYBUSH VIBURNUM *Viburnum trilobum 'compactum'*

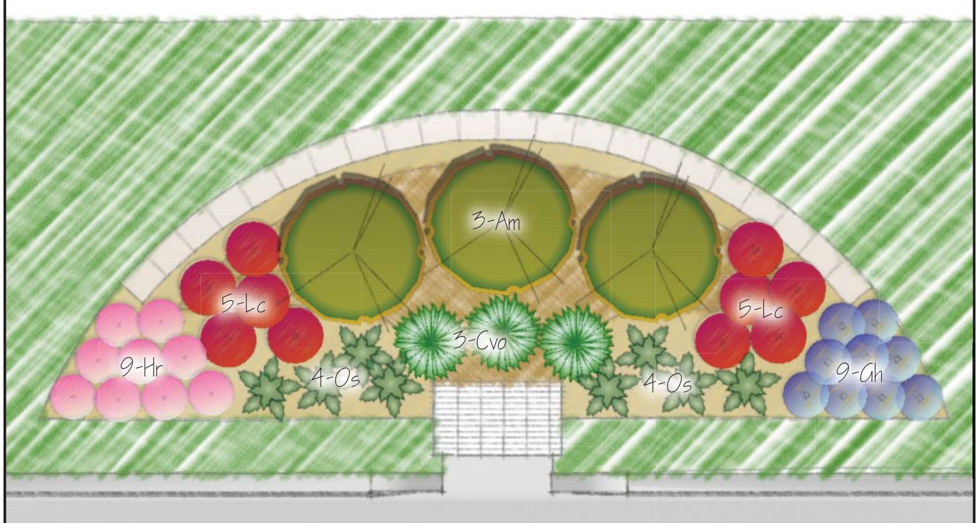
XI. Arc Garden - Shady Site - Retaining Wall



Flowering Perennial Garden



Shrub Garden

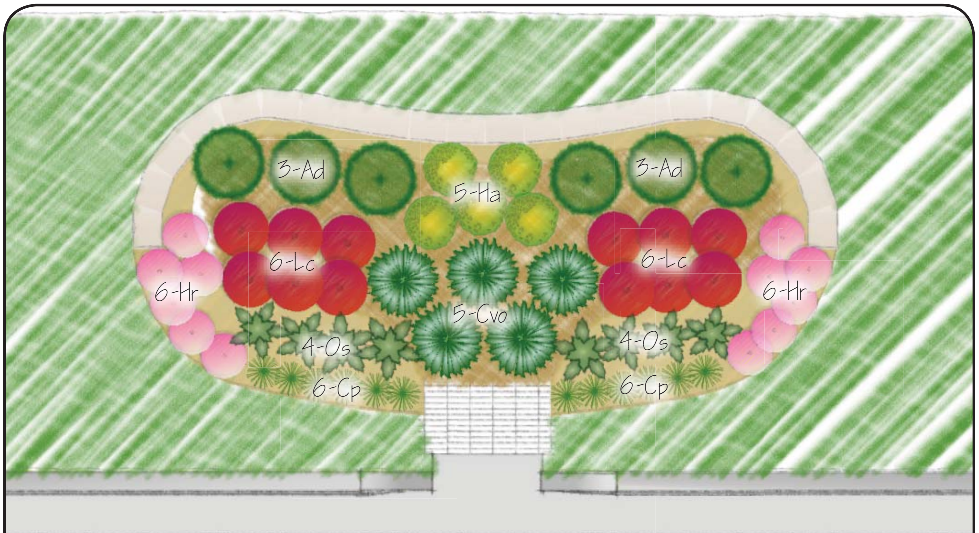


Mixed Shrub/Flower Garden

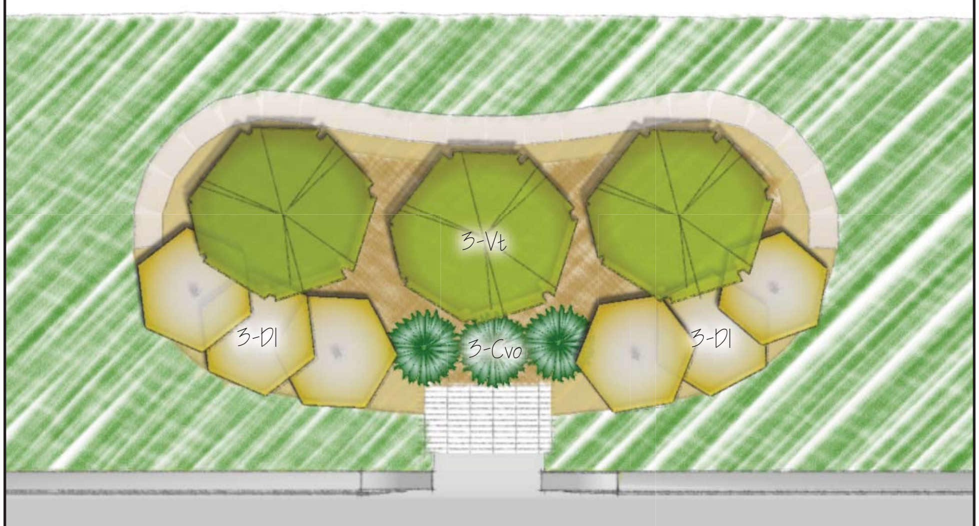
Plant Key

Am	BLACK CHOKEBERRY *Aronia melonocarpa*
Ad	GOAT'S BEARD *Aruncus diocius*
Cp	PENNSYLVANIA SEDGE *Carex pennsylvanica*
Cvo	FOX SEDGE *Carex vulpinoidea*
Dl	DWARF BUSH HONEYSUCKLE *Diervilla lonicera*
Cve	BOTTLEBRUSH GRASS *Elymus histrix*
Gh	GERANIUM 'JOHNSON BLUE' *Geranium himalayense x pratense*
Ha	SNEEZEWEED *Helenium autumnale*
Hr	ALUMROOT *Heuchera richardsonii*
Lc	CARDINAL FLOWER *Lobelia cardinalis*
Os	SENSITIVE FERN *Onoclea sensibilis*
Vt	CRANBERRYBUSH VIBURNUM *Viburnum trilobum 'compactum'*

XII. Curvilinear Garden - Shady Site - Retaining Wall



Flowering Perennial Garden



Shrub Garden

Mixed Shrub/Flower Garden

Plant Key

Am	BLACK CHOKEBERRY *Aronia melonocarpa*
Ad	GOAT'S BEARD *Aruncus diocius*
Cp	PENNSYLVANIA SEDGE *Carex pennsylvanica*
Cvo	FOX SEDGE *Carex vulpinoidea*
Dl	DWARF BUSH HONEYSUCKLE *Diervilla lonicera*
Gh	GERANIUM 'JOHNSON BLUE' *Geranium himalayense x pratense*
Ha	SNEEZEWEED *Helenium autumnale*
Hr	ALUMROOT *Heuchera richardsonii*
Lc	CARDINAL FLOWER *Lobelia cardinalis*
Os	SENSITIVE FERN *Onoclea sensibilis*
Vt	CRANBERRYBUSH VIBURNUM *Viburnum trilobum 'compactum'*

FLOWERING PERENNIAL
Plant pallette

CANADA ANEMONE
Anemone canadensis

GOAT'S BEARD
Aruncus diocius

BUTTERFLY MILKWEED
Asclepias tuberosa

ASTER 'PURPLE DOME'
Aster novae-angliae 'Purple Dome'

COREOPSIS 'MOONBEAM'
Coreopsis verticillata 'Moonbeam'

PURPLE PRARIE CLOVER
Dalea purpurea

PURPLE CONEFLOWER
Echinacea purpurea

GERANIUM 'JOHNSON BLUE'
Geranium himalayense x pratense

PRAIRIE SMOKE
Geum trifolium

SNEEZEWEED
Helenium autumnale

ALUMROOT
Heuchera richardsonii

PRAIRIE BLAZING STAR
Liatris pycnostachya

CARDINAL FLOWER
Lobelia cardinalis

SENSITIVE FERN
Onoclea sensibilis

GOLDSTRUM BLACK-EYED SUSAN
Rudbeckia fulgida

CULVERS ROOT
Veronicastrum virginicum

SHRUB
Plant pallette

BLACK CHOKEBERRY
Aronia melonocarpa

DWARF BUSH HONEYSUCKLE
Diervilla lonicera

DART'S RED SPIRAEA
Spiraea japonica

CRANBERRYBUSH VIBURNUM
Viburnum trilobum 'compactum'

GRASSES
Plant pallette

KARL FORESTER GRASS
Calamagrostis acutifolia

PENNSYLVANIA SEDGE
Carex pennsylvanica

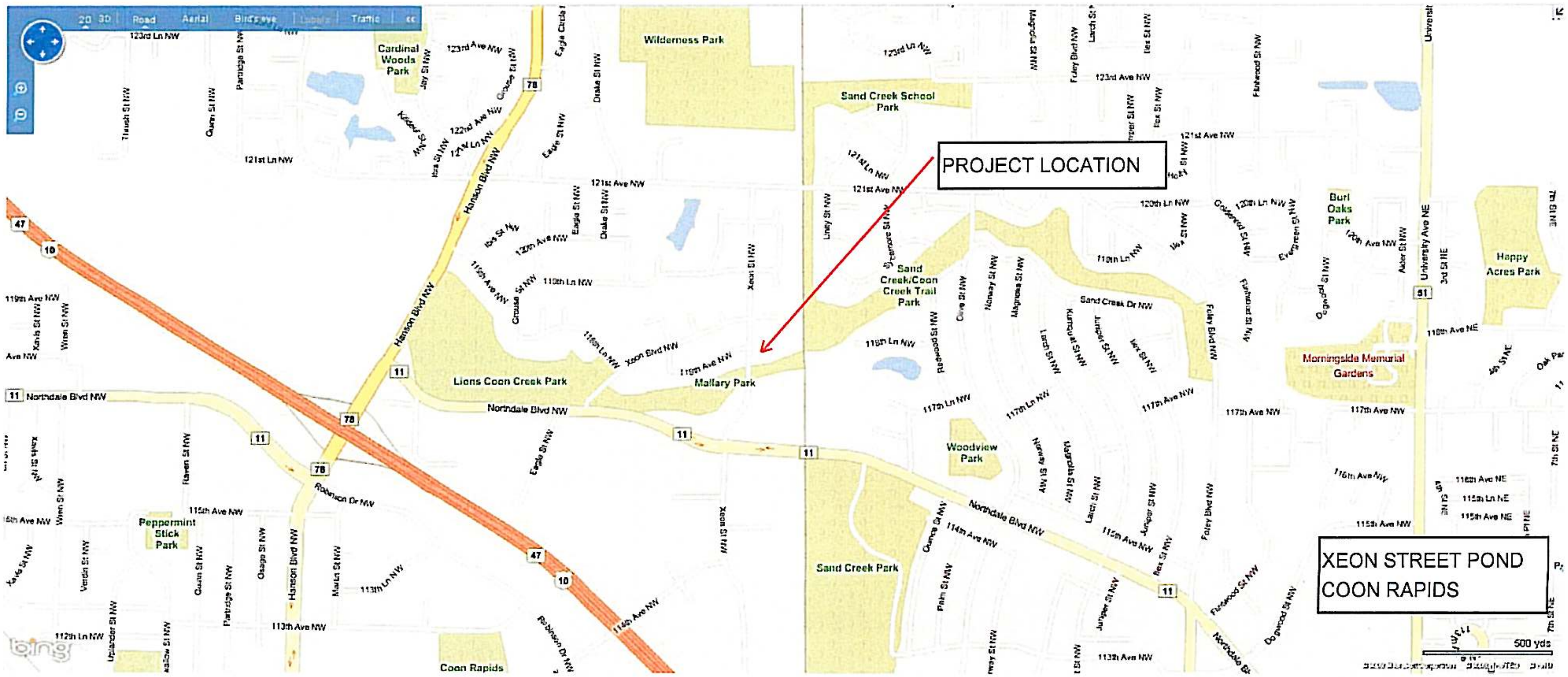
FOX SEDGE
Carex vulpinoidea

BOTTLEBRUSH GRASS
Elymus histrix

JUNE GRASS
Koeleria macrantha

PRAIRIE DROPSEED
Sporobolis heterolepsis

Xeon Street Pond Analysis
(SC-R1)



PROJECT LOCATION
XEON STREET POND
COON RAPIDS
Wilderness Park
Sand Creek School Park
Cardinal Woods Park
Lions Coon Creek Park
Mallary Park
Sand Creek/Coon Creek Trail Park
Woodview Park
Sand Creek Park
Peppermint Stick Park
Burl Oaks Park
Happy Acres Park
Morningside Memorial Gardens
Coon Rapids
Northdale Blvd NW
Hanson Blvd NW
University Ave NE
Xeon St NW
Xeon Blvd NW
119th Ave NW
121st Ave NW
117th Ave NW
500 yds

2D
3D
Road
Aerial
Bird's eye
Labels
Traffic
Sand Creek/Coon Creek Trail Park
119th Ave NW
Xeon St NW
Xeon St NW
Xeon St NW
Xeon St NW
Xeon Blvd NW
119th Ln NW
Xeon Blvd NW
Sand Creek/Coon Creek Trail Park
Mallary Park
bing

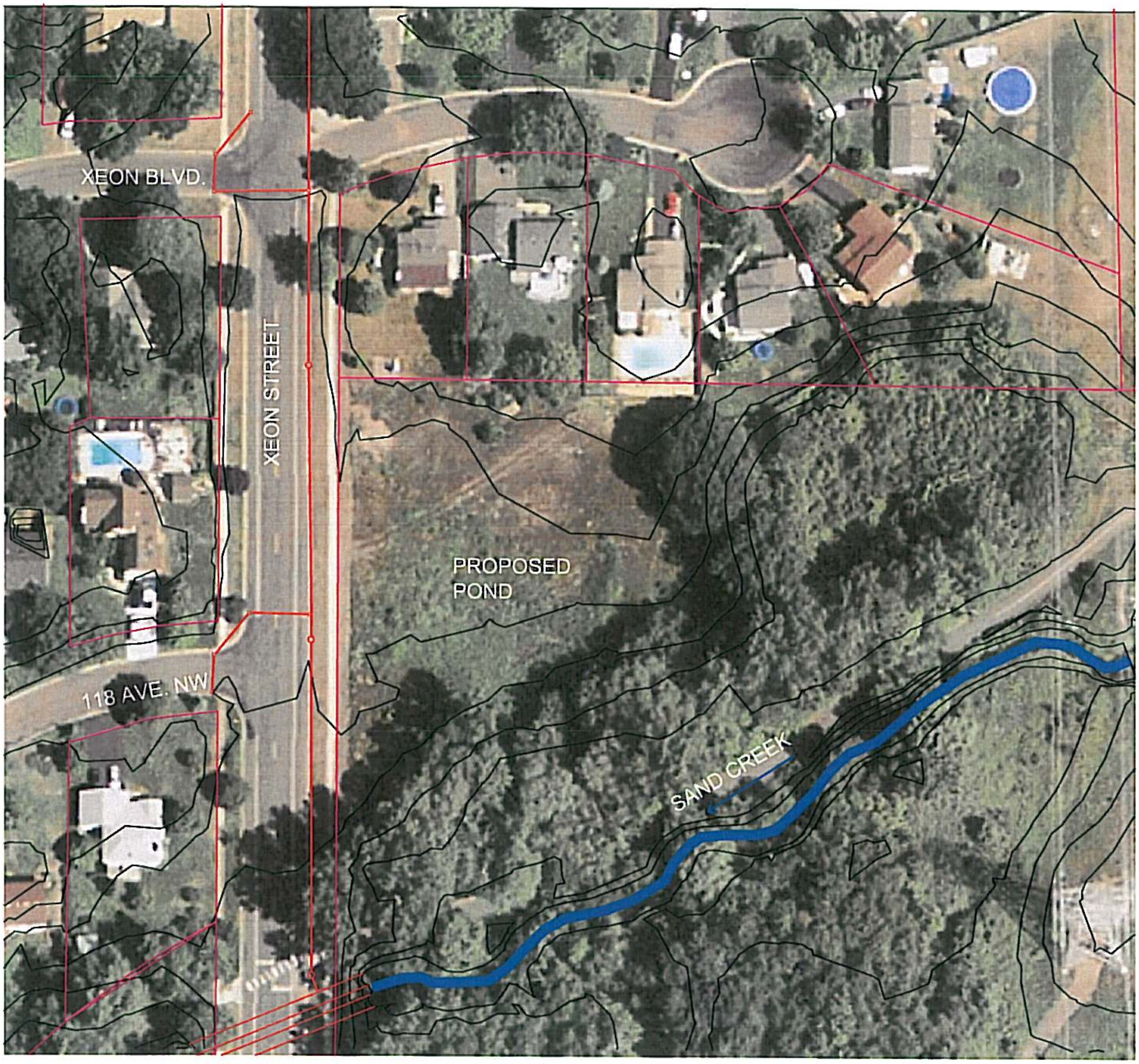


FIGURE 1.
EXISTING CONDITIONS
XEON STREET POND

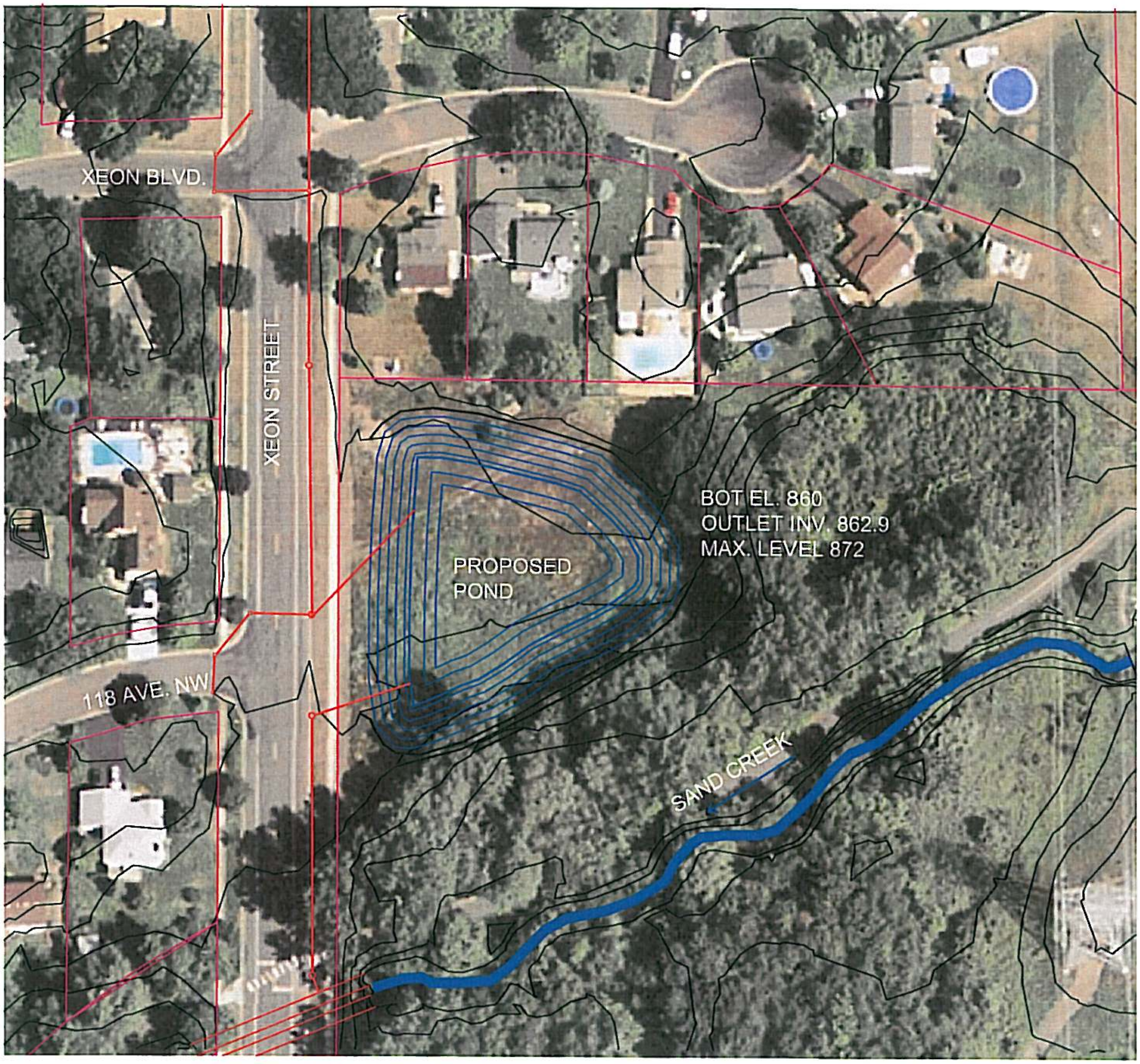


FIGURE 2.
PROPOSED CONDITIONS
XEON STREET POND

Xeon stormwater retrofit jwt 10/1/09
Project # 1239-41

Pond Volume comps.

Elevation	Area (sqft)	Area (acres)	Inc. Volume (acft)	Cul. Volume (acft)
860.0	8725	0.20	0	
861.9	11930	0.27	0.45	
862.9	16810	0.39	0.33	0.78
872.0	33500	0.77	5.26	6.04

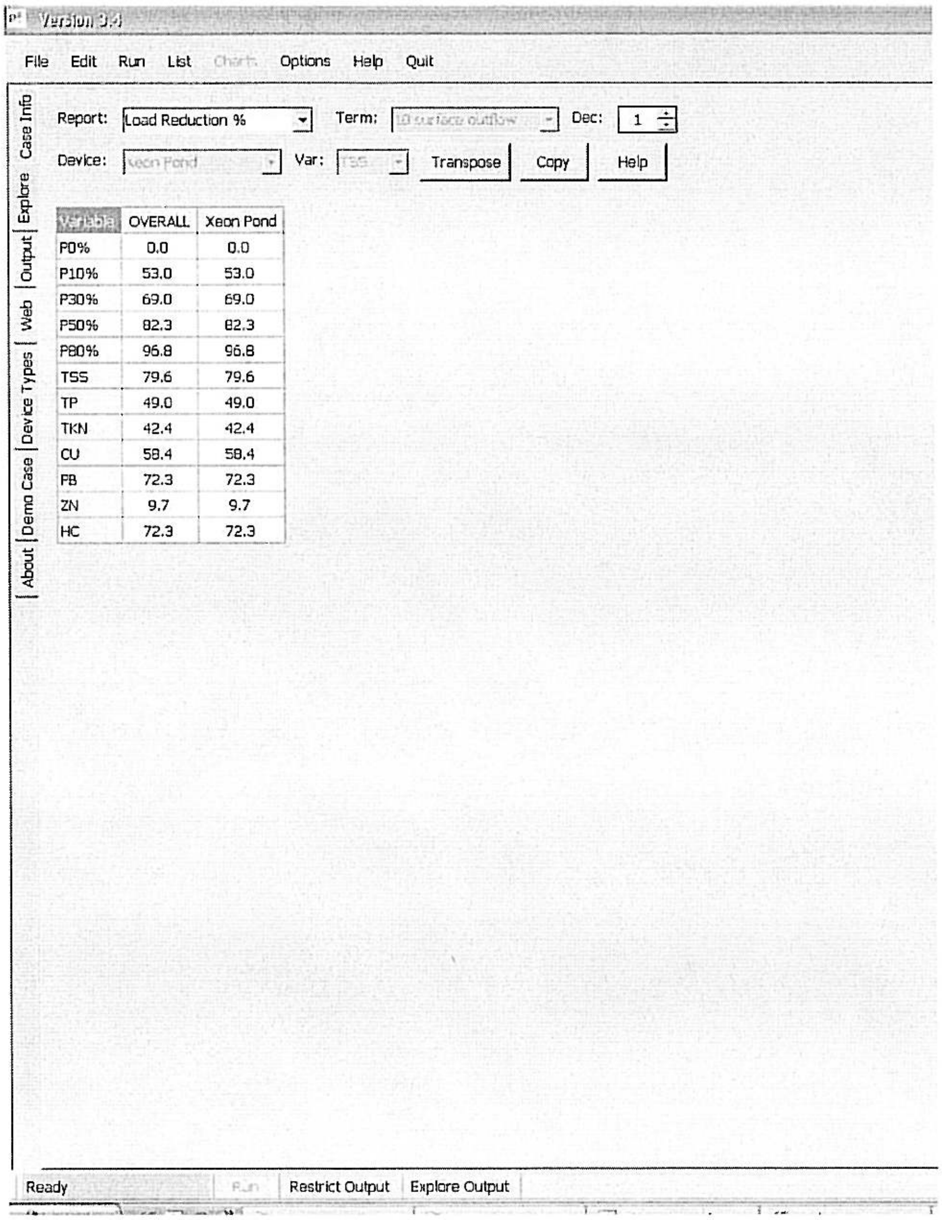
P8 Input data

Watershed area		
Watershed from north	19	acres
Watershed from south'	4.4	
	23.4	acres total

Pervious CN (between 1/4 and 1/3 acre lots, B soil) Use 74

Percent impervious	35	percent

Pond data		
Bottom elevation	860.0	
Bottom area	0.20	acres
Perm. pool elev.	862.9	
Perm. pool area	0.39	acres
Perm. pool vol.	0.78	acft
Flood pool elev.	872.0	
Flood pool area	0.77	acres
Flood pool vol.	6.04	acft



Variable	OVERALL	Xeon Pond
P0%	0.0	0.0
P10%	53.0	53.0
P30%	69.0	69.0
P50%	82.3	82.3
P80%	96.8	96.8
TSS	79.6	79.6
TP	49.0	49.0
TKN	42.4	42.4
CU	58.4	58.4
PB	72.3	72.3
ZN	9.7	9.7
HC	72.3	72.3

Budget Cost Estimate
Xeon stormwater retrofit
Project # 1239-41

jwt 10/2/09

Description	Quantity	Unit	Unit Price	Extension
Mobilization	1	LS	$7,000	$7,000
Excavation	9700	CY	$6	$58,200
21" RCP	170	LF	$45	$7,650
21" RCP Apron	2	Ea	$450	$900
Install Manhole	2	Ea	$2,000	$4,000
Abandon pipe (66' and manhole)	1	LS	$2,000	$2,000
Erosion Control	1	LS	$2,000	$2,000
Pavement repair	1	LS	$2,000	$2,000
Restoration	0.3	Ac	$1,500	$450
				$84,200
	Contingency	30%		$25,260
			Total	$109,460

Version 3.4

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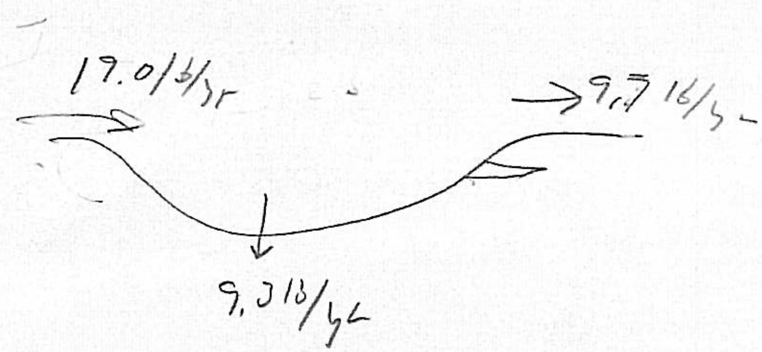
Case Info | Explore | Output | Web | Device Types | Demo Case | About

Report: Mass Balance Term: 10 surface outflow Dec: 1

Device: Xeon Pond Var: TP Transpose Copy Help

Term	Flow ac-ft	Load lbs	Conc ppm	Flow cfs	Load lbs/yr
01 watershed inflows	1610.2	1547.2	0.4	0.0	19.0
03 infiltrate	0.6	0.3	0.2	0.0	0.0
04 exfiltrate	0.6	0.0	0.0	0.0	0.0
05 filtered	0.0	0.3		0.0	0.0
06 normal outlet	1607.8	781.0	0.2	0.0	9.6
07 spillway outlet	1.8	7.1	1.4	0.0	0.1
08 sedimen + decay	0.0	758.2		0.0	9.3
09 total inflow	1610.2	1547.2	0.4	0.0	19.0
10 surface outflow	1609.6	788.1	0.2	0.0	9.7
11 groundw outflow	0.6	0.0	0.0	0.0	0.0
12 total outflow	1610.2	789.1	0.2	0.0	9.7
13 total trapped	0.0	758.5		0.0	9.3
14 storage increase	0.0	0.6		0.0	0.0
15 mass balance check	0.0	0.0		0.0	0.0
Load Reduction %	0.0	49.0			
Mass Balance Error %	0.0	0.0			

TP 49% reduction



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Version 3.4

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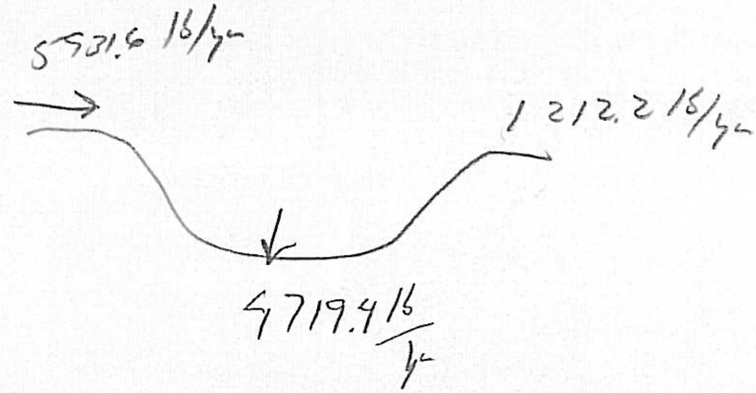
Case Info | Explore | Output | Web | Device Types | Demo Case | About

Report: Mass Balance Term: 10 surface outflow Dec: 1

Device: Xeon Pond Var: TSS Transpose Copy Help

Term	Flow ac-ft	Load lbs	Conc ppm	Flow cfs	Load lbs/yr
01 watershed inflows	1610.2	482221.9	110.2	0.0	5931.6
03 infiltrate	0.6	37.1	24.6	0.0	0.5
04 exfiltrate	0.6	0.0		0.0	0.0
05 filtered	0.0	37.1		0.0	0.5
06 normal outlet	1607.8	96413.7	22.1	0.0	1185.9
07 spillway outlet	1.8	2139.4	434.3	0.0	26.3
08 sedimen + decay	0.0	383580.1		0.0	4718.2
09 total inflow	1610.2	482221.9	110.2	0.0	5931.6
10 surface outflow	1609.6	98553.1	22.5	0.0	1212.2
11 groundw outflow	0.6	0.0		0.0	0.0
12 total outflow	1610.2	98553.1	22.5	0.0	1212.2
13 total trapped	0.0	383617.2		0.0	4718.7
14 storage increase	0.0	51.7		0.0	0.6
15 mass balance check	0.0	0.0		0.0	0.0
Load Reduction %	0.0	79.6			
Mass Balance Error %	0.0	0.0			

TSS 79.6% reduction



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Northdale Middle School
Pond Analysis
(SC-R6)

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E-mail: wenckmp@wenck.com

TECHNICAL MEMORANDUM

TO: Nate Zwonitzer, Tim Kelly

FROM: Ed Matthiesen, P.E**,** Todd Shoemaker, P.E.

DATE: September 1, 2009

SUBJECT: Northdale Middle School Pond water quality evaluation, hydraulic design and design

Cc:

Introduction

The purpose of this project is to evaluate the water quality benefit of raising the outlet elevation on the Northdale Middle School pond to create a permanent water pool. The work consists of evaluating the water quality benefits with the P8 model, determining if there are any flooding issues caused by raising the outlet with the XP-SWMM model and to prepare sketches and a construction cost estimate. The Anoka Conservation District and the Coon Creek Watershed District will use this information to determine if this project will be pursued through construction.

Analysis

Storm sewer mapping was obtained through Doug Vierzba at the City of Coon Rapids. Topographic mapping was acquired through Anoka County GIS and plotted at Wenck Associates.

The first task calculated the total phosphorus removal of providing a permanent water pool 1' or 2' deep with the outlet restricted from 24" to 4" and allowing for infiltration across the bottom of the basin at 0.1in/hr and 0.4in/hr above the permanent pool. A P8 model was constructed and run for 1999 through 2008. This showed an annual average reduction from 125lb/yr to 78lb/yr 71lb/yr. It was determined in a phone conversation between Ed Matthiesen and Nate Zwonitzer that this was significant enough reduction with the understanding that the outlet design may change as a result of evaluating the hydraulics to continue the analysis.

The next step calculated the changes in water surface elevations at 13 intersections and the pond to see if raising the outlet would result in flooding. An XP-SWMM model was built for the storm sewer system and showed a 0.1' stage increase for the 100-year event at the catch basin on Dogwood at the school entrance and a 0.1' stage increase at the catch basin at the intersection of Dogwood and Northdale Blvd. by raising the outlet 18" and keeping the existing 24" RCP as the outlet. The modeling and comparison to the topographic map showed that a pipe restriction was not possible because the 100-year flood elevation would exceed the top elevation of the pond.

The P8 model was rerun with the revised outlet configuration derived from the hydraulic limitations resulting from the XP-SWMM modeling. This led the design to an 84" diameter horizontal weir attached to the end of the existing 24" RCP. One 6'-24" RCP transition section is needed to connect the end of the existing pipe to the new inlet. This modeling shows the resulting phosphorus capture going from 6.7lb/yr to 8.0lb/yr or a 19.4% increase in efficiency.

Cost Estimate

The estimated construction including a 20% contingency is $7,100. Over 10-year period this results in removal cost of $560/lb phosphorus.

Recommendations

The analysis and optimization runs show the outlet modification to consist of installing new outlet at the end of the existing pipe to raise the permanent pool from 889.9 to 890.4. This will result in an approximately 20% increase in phosphorus removal efficiency.

Attachments
Model inputs – 1 page
P8 model output results, Preliminary results, current condition 2’ outlet, 1’ outlet diameter – 1 page
P8 model output results, Existing Northdale Pond and Proposed Northdale Pond - 1 page
XP-SWMM map – 1 page
XP-SWMM model results, existing and proposed conditions – 1 page
Design details - 4 pages
Construction cost estimate - 1 page

Existing Pond

Elev. [ft]	Area (acres)	Volume (ac-ft)		
882.6	0.19			Dead Storage
888.6	0.45	1.88	NWL	1.88
890	1.46	1.27		Live Storage
892	1.64	3.10		4.37

Planimeter Conversion:

1	in =	30.00	ft		
1	in^2 =	900.00	ft^2 =	0.02	acres

Elev [ft]	Plan Area [in^2]	Area [ft^2]	Area [acres]
882.6	9.25	8325.00	0.19
888.6	22.00	19800.00	0.45
890	70.50	63450.00	1.46
892	79.50	71550.00	1.64

1999-2008
No Pond Watershed TP Runoff

Device	OVERALL	Current Pond
Flow ac-ft	1402.4	1402.4
Load lbs	1110.3	1110.3
Conc ppm	0.3	0.3
Flow cfs	0.2	0.2
Load lbs/yr	124.8	124.8

Current Condition 2' Outlet

Load Reduction 1999-2008

Variable	OVERALL	Current Pond
P0%	15.2	15.2
P10%	28.6	28.6
P30%	48.6	48.6
P50%	68.9	68.9
P80%	94.6	94.6
TSS	67.1	67.1
TP	37.3	37.3
TKN	33.8	33.8
CU	50.2	50.2
PB	61	61
ZN	18.9	18.9
HC	61	61

TP Inflow

Device	OVERALL	Current Pond
Flow ac-ft	1402.419	1402.419
Load lbs	1110.261	1110.261
Conc ppm	0.291	0.291
Flow cfs	0.218	0.218
Load lbs/yr	124.776	124.776

TP Outlfow

Device	OVERALL	Current Pond
Flow ac-ft	1165.069	1165.069
Load lbs	689.681	689.681
Conc ppm	0.218	0.218
Flow cfs	0.181	0.181
Load lbs/yr	77.51	77.51

1' Outlet Diameter

Load Reduction 1999-2008

Variable	OVERALL	Current Pond
P0%	16.6	16.6
P10%	32.2	32.2
P30%	56	56
P50%	79.4	79.4
P80%	97.5	97.5
TSS	72.5	72.5
TP	42.5	42.5
TKN	38.4	38.4
CU	54.4	54.4
PB	65.9	65.9
ZN	21	21
HC	65.9	65.9

TP Inflow

Device	OVERALL	Current Pond
Flow ac-ft	1402.419	1402.419
Load lbs	1110.261	1110.261
Conc ppm	0.291	0.291
Flow cfs	0.218	0.218
Load lbs/yr	124.776	124.776

TP Outlfow

Device	OVERALL	Current Pond
Flow ac-ft	1143.696	1143.696
Load lbs	631.314	631.314
Conc ppm	0.203	0.203
Flow cfs	0.177	0.177
Load lbs/yr	70.95	70.95

Existing Northdale Pond - outlet = 889.89

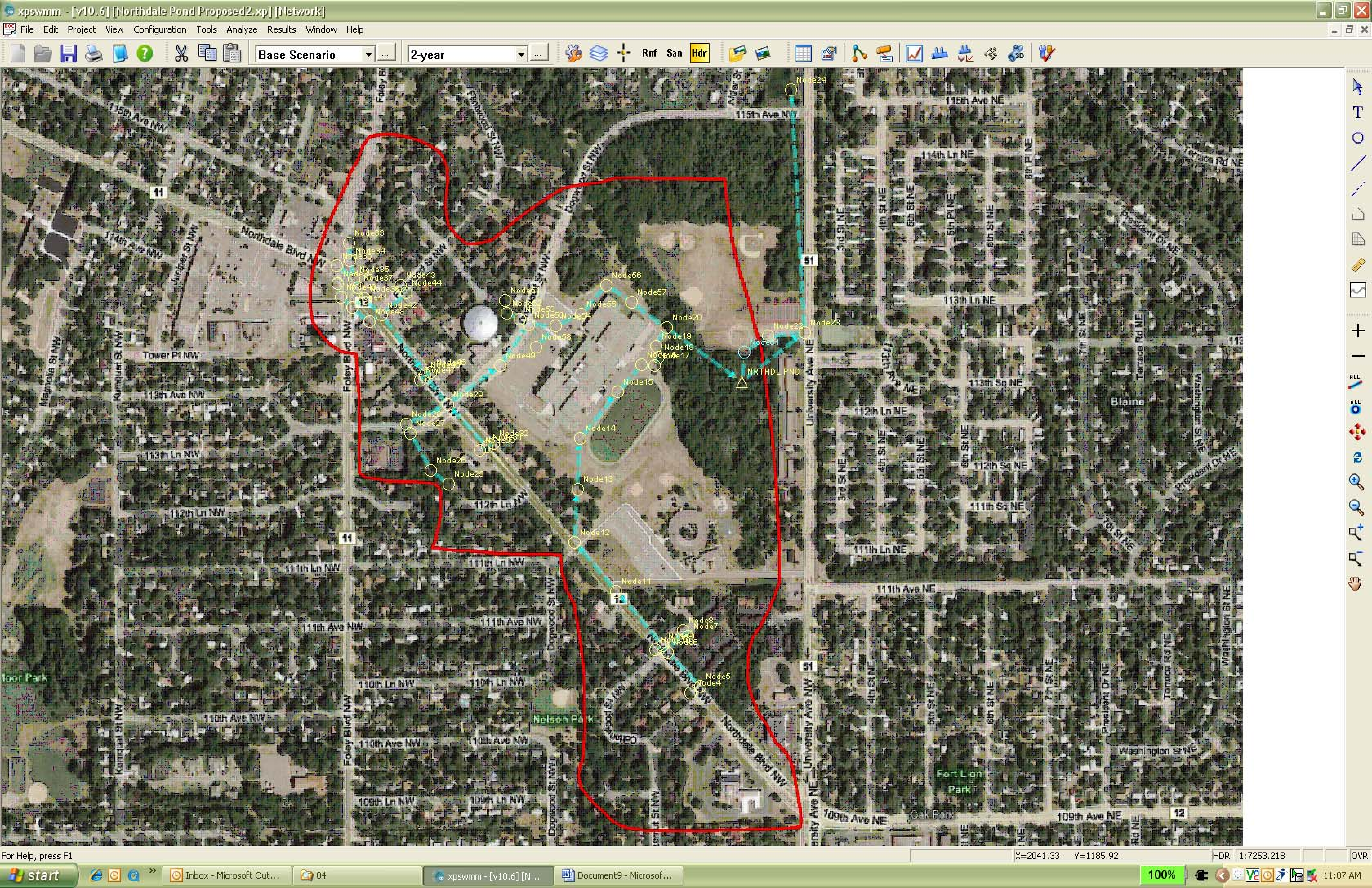
Term	Flow ac-ft	Load lbs	Conc ppm	Flow cfs	Load lbs/yr
01 watershed inflows	1402.4	1110.3	0.3	0.2	124.8
03 infiltrate	377.6	151.9	0.1	0.1	17.1
04 exfiltrate	377.6	10.2	0	0.1	1.1
05 filtered	0	141.7		0	15.9
06 normal outlet	1024.8	505	0.2	0.2	56.8
08 sedimen + decay	0	453.4		0	50.9
09 total inflow	1402.4	1110.3	0.3	0.2	124.8
10 surface outflow	1024.8	505	0.2	0.2	56.8
11 groundw outflow	377.6	10.2	0	0.1	1.1
12 total outflow	1402.4	515.2	0.1	0.2	57.9
13 total trapped	0	595.1		0	66.9
14 storage increase	0	0		0	0
15 mass balance check	0	0		0	0
Load Reduction %	0	53.6			
Mass Balance Error %	0	0			

Proposed Northdale Pond - outlet = 890.4

Term	Flow ac-ft	Load lbs	Conc ppm	Flow cfs	Load lbs/yr
01 watershed inflows	1402.4	1110.3	0.3	0.2	124.8
03 infiltrate	555.9	202.8	0.1	0.1	22.8
04 exfiltrate	555.9	15	0	0.1	1.7
05 filtered	0	187.9		0	21.1
06 normal outlet	846.6	386.7	0.2	0.1	43.5
08 sedimen + decay	0	520.8		0	58.5
09 total inflow	1402.4	1110.3	0.3	0.2	124.8
10 surface outflow	846.6	386.7	0.2	0.1	43.5
11 groundw outflow	555.9	15	0	0.1	1.7
12 total outflow	1402.4	401.6	0.1	0.2	45.1
13 total trapped	0	708.7		0	79.6
14 storage increase	0	0		0	0
15 mass balance check	0	0		0	0
Load Reduction %	0	63.8			
Mass Balance Error %	0	0			

Pond Data (both models)

Contour	Area (ac)	Vol (AF)
882.6	0.19	0
888.89	0.45	2
890.4	1.037	3.1
891	1.27	3.8
893	1.45	6.6
895	1.63	9.5
897	10.33	21.6



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Tower Pl NW
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Foley Blvd NW
University Ave NE
Dogwood St NW
Nelson Park
Fort Lion Park
Oak Park
Blaine
NRTHDL PND
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Northdale Pond Modification
City of Coon Rapids, MN
by Wenck Associates, Inc.
8/31/2009

Existing Conditions: NWL = 889.89
Outlet = 24" RCP

Proposed Conditions: NWL = 890.39
New 7' internal weir = 890.39
New horizontal orifice = 892.0 (overflow)
Primary outlet pipe = 24" RCP at 889.89

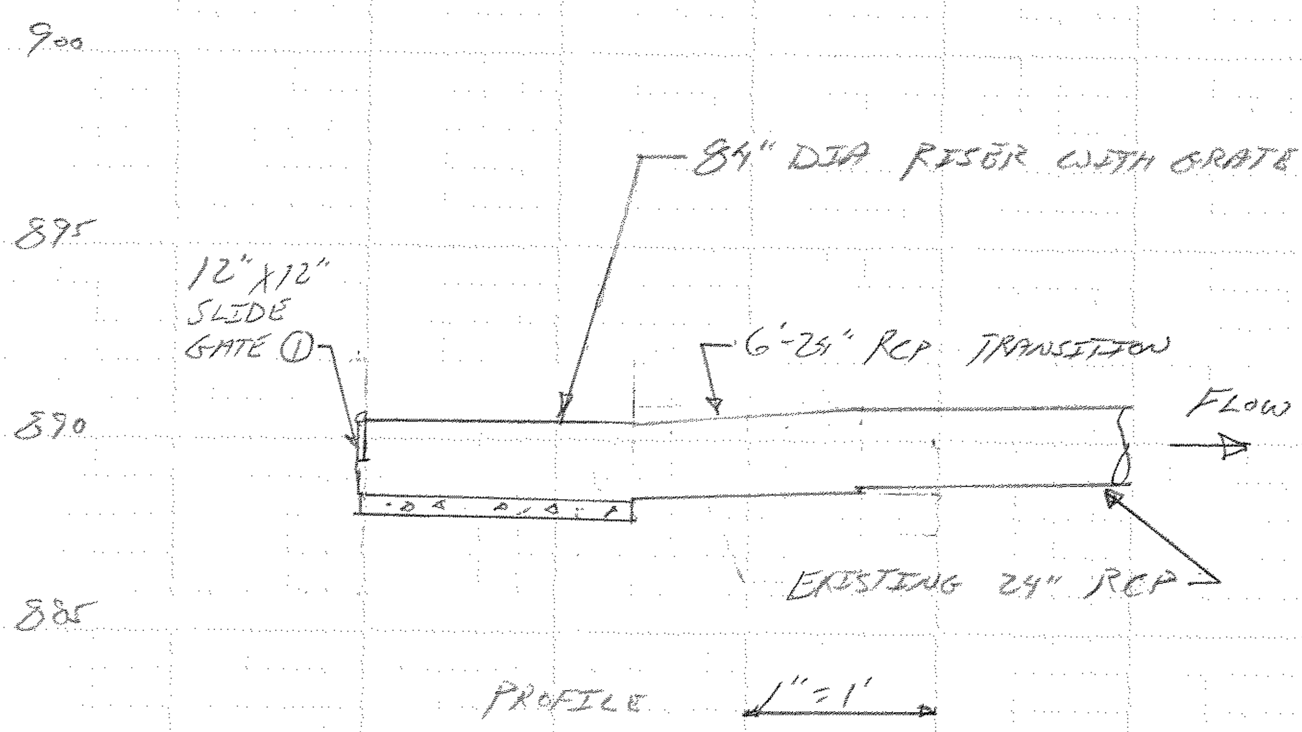
			2-Year Event		10-Year Event		100-Year Event	
Location	**Node ID**	**Rim Elevation**	**Existing**	**Proposed**	**Existing**	**Proposed**	**Existing**	**Proposed**
Northdale Pond	Nrthdl Pnd	896.0	892.9	893.8	895.0	895.8	895.9	896.6
Northdale & 111th	Node 12	902.6	902.9	902.8	903.7	903.7	904.3	904.4
Northdale & Butternut	Node 5	904.1	905.3	905.3	906.3	906.3	907.0	907.0
School & Dogwood	Node 50	900.3	899.4	899.1	900.5	900.4	901.3	901.4
Northdale & Dogwood	Node 29	899.8	899.1	899.0	899.9	899.9	900.4	900.5
Dogwood	Node 28	898.0	898.8	898.8	899.5	899.5	900.0	900.0
112th Backyard	Node 25	899.5	899.5	899.5	900.0	900.0	900.5	900.5
Watertower	Node 51	899.7	899.5	899.2	899.9	899.9	900.2	900.2
Northdale North	Node 45	898.7	899.3	899.3	900.0	900.0	900.5	900.5
Northdale & Foley	Node 37	900.7	900.9	900.9	901.4	901.4	901.8	901.8
Foley North	Node 35	900.3	900.8	900.8	901.2	901.2	901.6	901.6
Flintwood	Node 44	900.4	900.9	900.9	901.8	901.8	902.5	902.5
Foley South	Node 41	901.0	901.0	901.0	901.4	901.4	901.8	901.8
Northdale South	Node 31	898.6	898.8	898.7	899.5	899.5	900.2	900.2

(light cyan)	Rim Elevation Exceeded
(light blue)	Proposed Elevation Greater than Existing

By CAM Date 9-1-09 Client CCWD Sheet 1 of 4
Chkd. By ____ Description NORTHDALE MIDDLE SCHOOL Job No. 1239.

POND

T: 1239\cim
Northdale



NOTES: 1. 12"x12" SLIDE GATE NORMALLY IN CLOSED AND LOCKED POSITION, USED FOR DEWATERING

Wenck

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Fax (763) 479-4242

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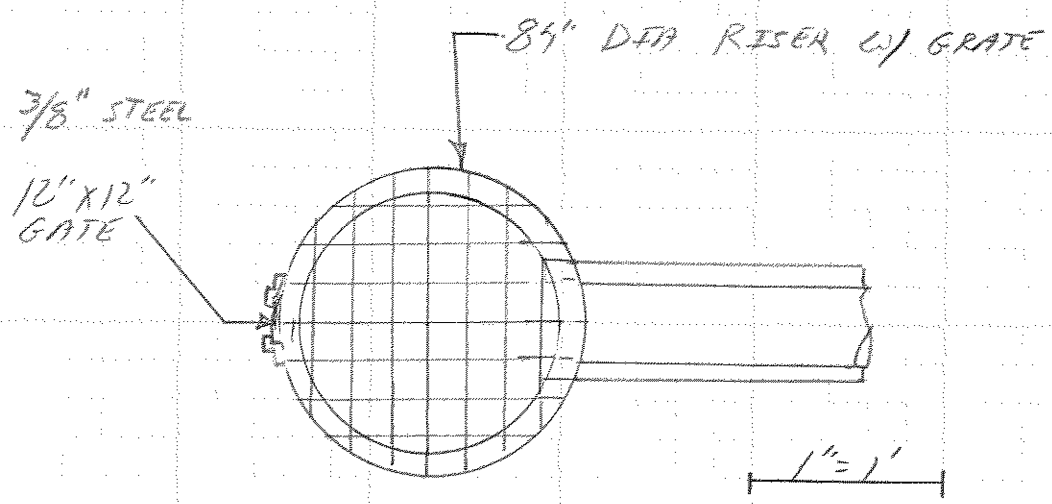
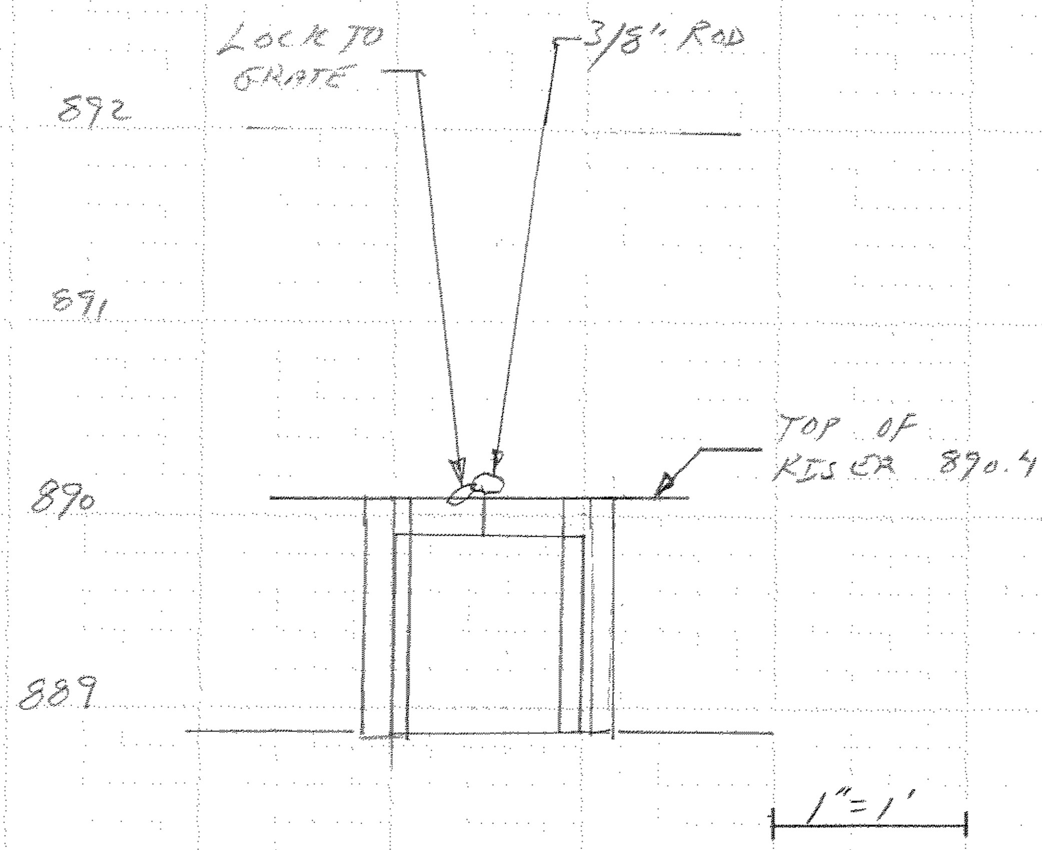
Maple Plain, MN 55359-0249

By EAM Date 9-1-09 Client CCWD Sheet 2 of 4

Chkd. By ____ Description NORTHDALE MIDDLE SCHOOL POND Job No. ____





Wenck

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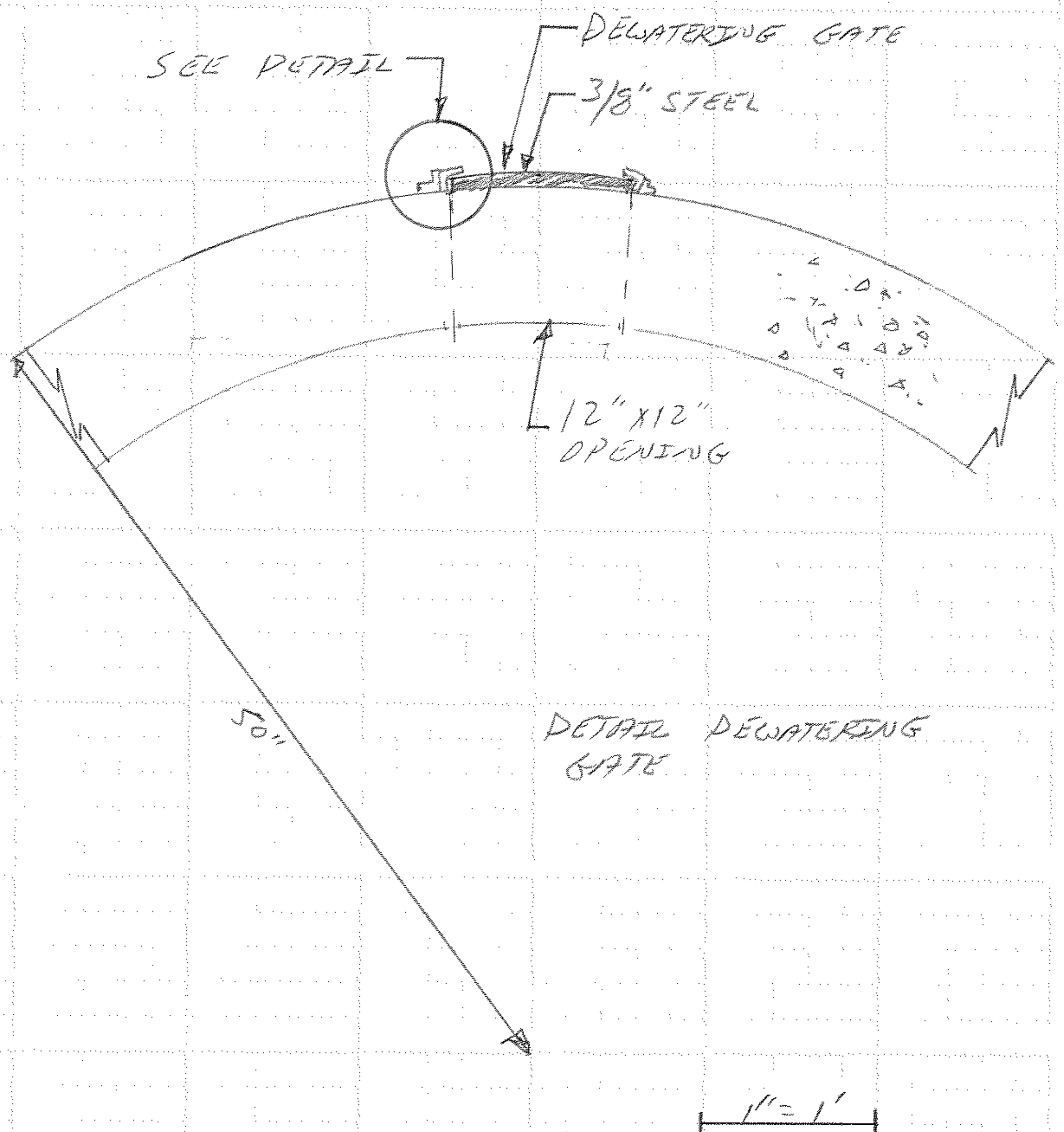
Maple Plain, MN 55359-0249

By BAM Date 9-1-09 Client CCWD Sheet 3 of 4

Chkd. By Description NORTHDALE MIDDLE SCHOOL POND Job No.



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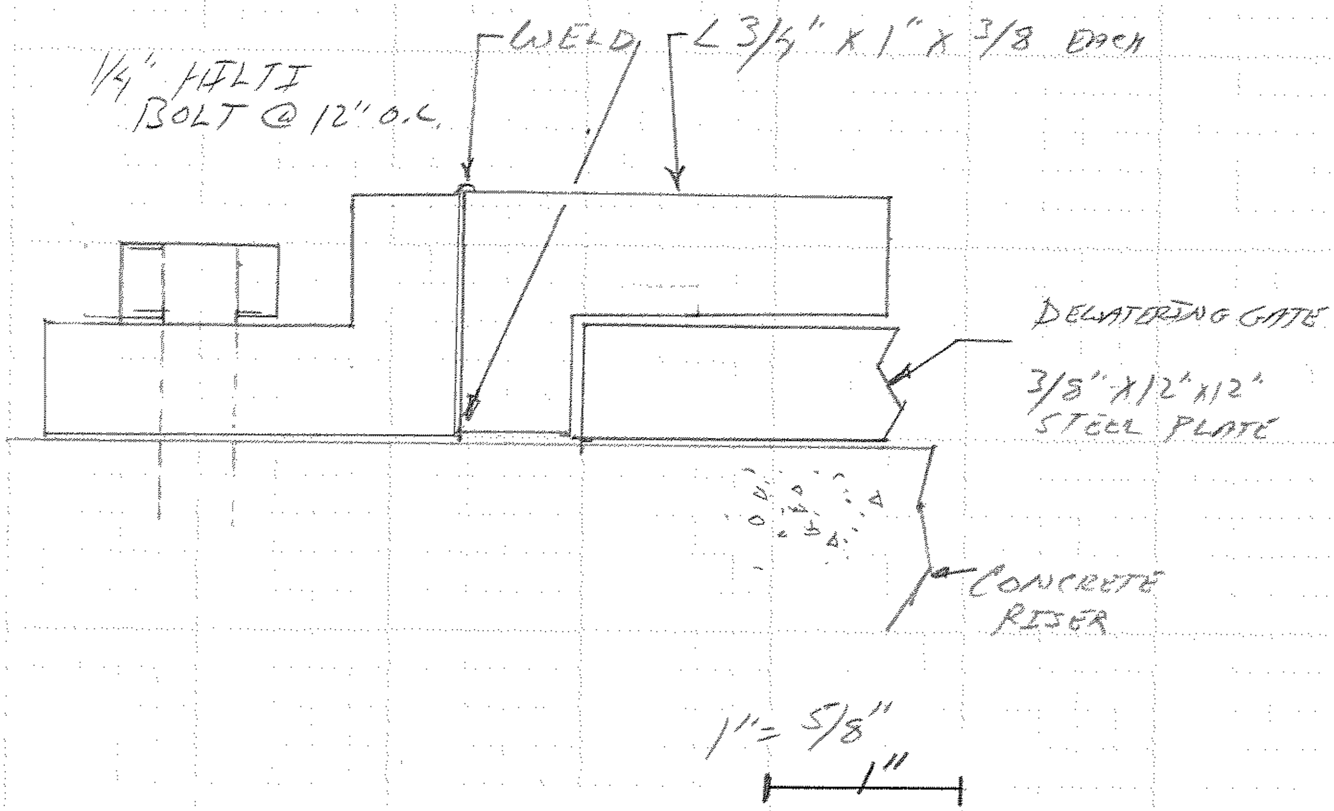
Maple Plain, MN 55359-0249

By EAM Date 9-1-09 Client CCWD Sheet 4 of 4

Chkd. By ______ Description NORTHDALE MIDDLE SCHOOL POND Job No. ______



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					EAM	9/2/2009
Northdale Pond Outlet Modification Phosphorus Removal Project						
				Extended		
Item	Unit	Quantity	Unit Cost	Amount		
Mobilization	Lump Sum	1	$1,000	$1,000		
24" RCP	LF	6	$70	$420		
84" Manhole	Each	1	$3,000	$3,000		
Frame & Cover	Each	1	$1,000	$1,000		
Site Restoration	Lump Sum	1	$500	$500		
Subtotal				$5,920		
Contingency @ 20%				$1,184		
Total Probable Project Cost				$7,104		

Magnolia Street Pond Analysis (SC-R7)

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E-mail: wenckmp@wenck.com

DRAFT
TECHNICAL MEMORANDUM

TO: Nate Zwonitzer, Anoka Conservation District
Tim Kelly, Coon Creek Watershed District

FROM: Todd Shoemaker, P.E.
Ed Matthiesen, P.E.

DATE: November 20, 2009

SUBJECT: Evaluation of Existing Magnolia Street-Sand Creek Pond

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The purpose of this evaluation is to evaluate the cost and benefit of improving the pollutant removal efficiency of the existing dry pond between Magnolia Street and Sand Creek in Coon Rapids (See Location Map on Figure 1). Dry ponds provide little water quality treatment because there is no means to retain settled pollutants. Although pollutants may settle at the bottom of a dry pond, they are likely resuspended and discharged during the next storm event.

For a design and construction cost of $14,400, the pond can be modified to increase infiltration of runoff, total phosphorus (TP) removal, and total suspended solids (TSS) removal. Figure 2 shows the proposed pond modifications to achieve these results.

ANALYSIS

A drainage area of approximately 53 acres was determined from City of Coon Rapids storm sewer maps. Lot sizes in the drainage area are approximately ¼-acre, so curve number 75 was chosen for computer modeling discussed below.

The city maps indicate runoff enters the pond through two storm sewer pipes – one at the west and the other at the northeast end of the pond. The west inlet pipe is approximately 50 feet and located directly across from the outlet pipe. Runoff exits from the pond through a concrete outlet structure and 12” reinforced concrete pipe at the southwest corner of the pond.

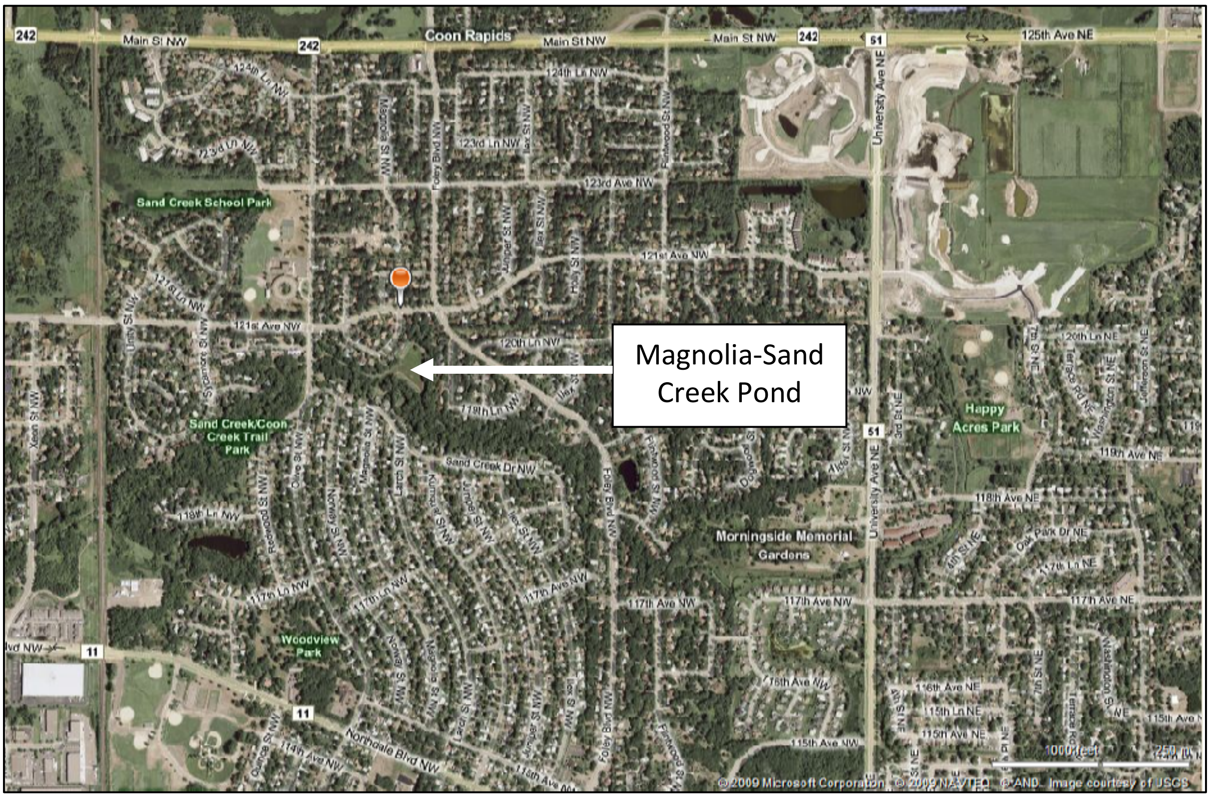

Figure 1. Location map of the Magnolia-Sand Creek Pond.

The bottom of the pond is approximately 874.0, and the water elevation in Sand Creek (groundwater elevation) is approximately 870-871. This separation satisfies guidance in the *Minnesota Stormwater Manual* that infiltration practices be at least three feet above the groundwater.

The concept shown in Figure 2 includes four phases to increase pollutant removal in the pond:

1) Conduct infiltration tests to ensure that infiltration is feasible.
2) Relocate outlet structure.
3) Create forebays to serve as pretreatment.
4) Increase outlet pipe elevation to retain and infiltrate runoff.

The Anoka County Soil Survey indicates alluvial and Sartell soils in the vicinity of the pond. Following the *Minnesota Stormwater Manual*, Wenck assumed an infiltration rate of 0.8 inches per hour for the proposed pond. We recommend that this rate be confirmed before proceeding with design or construction.

If infiltration is feasible, Wenck recommends increasing the outlet elevation of the pond from 874.0 (bottom of pond) to 875.0. This provides sufficient storage volume to infiltrate all runoff from a 2-inch rainfall.

We also recommend creation of two forebays at each of the pond inlet pipes. The forebays will serve as pretreatment to retain coarse sediment that enters the pond rather than allow it to migrate into the rest of the pond and possibly decrease the soil infiltration capacity.

Finally, Wenck recommends relocating the outlet structure to prevent short-circuiting of the west storm sewer inlet. The outlet structure can be moved east to maximize the travel length from each of the inlet pipes. An 18-inch sanitary sewer exists near the relocated outlet, but it is deep enough that the relocated outlet pipe will not interfere.

Wenck used the computer models HydroCAD and P8 to determine the effectiveness of the proposed pond for treating storm water. Table 1 lists pollutants amounts and high water levels for the existing and proposed pond. The model indicates that the proposed pond removes an additional 16 pounds per year of TP and does not impact adjacent private property by increasing high water levels. The TP and TSS removal amounts are conservative because the P8 computer model does not account for resuspension. Therefore, the actual removal amount for existing conditions is less than that reported by the model, thereby making the difference between the existing and proposed greater than that listed in Table 1.

Table 1. Comparison of existing and proposed pollutant and high water levels of the Magnolia-Sand Creek Pond.

Condition	Infiltrated Volume (ac-ft/yr)	TSS Removal (lb/yr)	TP Removal (lb/yr)	100-year High Water Level (ft)
Existing Dry Pond	0	11,937	24	878.2
Proposed Infiltration Basin	42	13,345	40	878.0

COST ESTIMATE

The estimated design and construction cost (including a 20 percent contingency) is $14,400 as shown in Table 2. With an additional 16 pounds per year total phosphorus removal, this project results in a removal cost of $90/lb of phosphorus over a 10-year period.

Table 2. Estimated costs for the recommended modifications to the Magnolia-Sand Creek Pond.

Item	Estimated Cost
Infiltration Tests	$500
Design	$1,500
Relocate Outlet Structure	$5,000
Create Forebays	$4,000
Increase Pipe Outlet Elevation	Included in “Relocate Outlet Structure” Cost
Mobilization	$1,000
20% Contingency	$2,400
Total	**$14,400**

RECOMMENDATION

Wenck recommends modification of the Magnolia-Sand Creek Pond to increase pollutant removal. The recommended work is relatively simple to implement, and the cost per pound of phosphorus removed is very economical.

City staff and adjacent residents should be contacted early in the project planning process. Residents may object to the recommended work as it may interfere with their existing use of this “open space.”

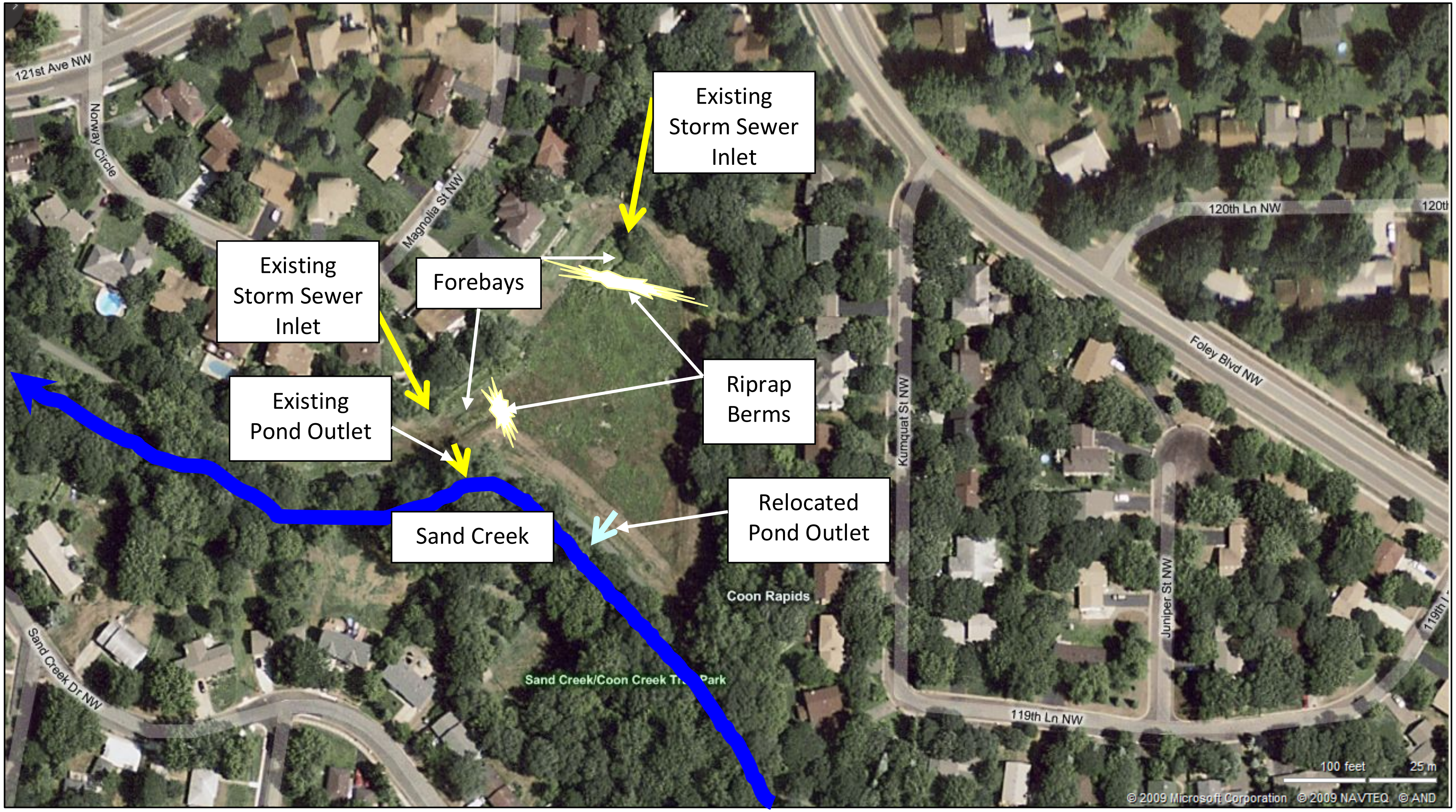

Figure 2. Proposed concept plan to increase pollutant removal in the existing Magnolia-Sand Creek Pond.