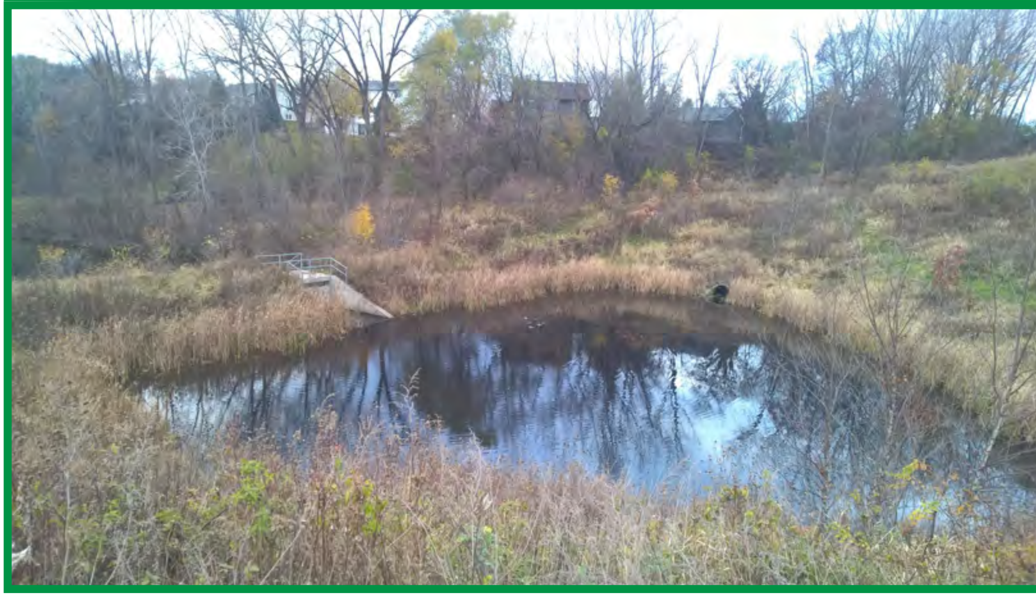
Alimagnet Lake Subwatershed Assessment Report



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List of Acronyms

BMP________ Best Management Practice
EPA ________ Environmental Protection Agency
GIS ________ Geographic Information System
LID ________ Low Impact Development
MIDS _______ Minimum Impact Design Standards
MPCA _______ Minnesota Pollution Control Agency
MS4 ________ Municipal Separate Storm Sewer Systems
NPDES ______ National Pollutant Discharge Elimination System
NRCS _______ National Resource Conservation Service
NURP _______ Nationwide Urban Runoff Program
ROW ________ Right of Way
SCM ________ Stormwater Control Measure
SCS ________ Soil Conservation Service
SSGI _______ Shared, Stacked-function Green Infrastructure
TMDL _______ Total Maximum Daily Load
TP __________ Total Phosphorus
TSS ________ Total Suspended Solids
VRWJPO_____ Vermillion River Watershed Joint Powers Organization

1.0 Summary

The Vermillion River Watershed Restoration and Protection Strategy (WRAPS) Report Plan calls for a best management practice (BMP) retrofit assessment study in the Alimganet Lake watershed to reduce phosphorus loading to the lake which is located in the northwest corner of the Vermillion River Watershed (MPCA, 2015a).

The Alimagnet Lake watershed covers portions of Burnsville and Apple Valley and contains a mixture of land uses with relatively high impervious area. The watershed developed with varying levels of stormwater controls and discharges to Alimagnet Lake which is impaired for nutrients. The purpose of this study is to help the Vermillion River Watershed Joint Powers Organization (VRWJPO) and the Cities of Apple Valley and Burnsville (Cities) reduce pollutant loads, mainly total phosphorus (TP), and runoff volumes discharging to Alimagnet Lake through implementation of stormwater BMPs.

The study focuses on providing the VRWJPO and Cities a variety of stormwater management options that can be used in the Alimagent Lake watershed to improve water quality. The study is meant to illustrate Shared, Stacked-Function Green Infrastructure (SSGI) in a highly impervious watershed. “Shared, stacked-function” refers to situations where the green infrastructure is intended to provide service for more than one parcel (public or private). The entire facility also functions to provide additional amenities beyond solely managing stormwater.

The proposed green infrastructure is designed to meet MPCA Minimum Impact Design Standards (MIDS). The first 1.1 inches of runoff will be retained on-site and infiltrated where practical. If all of the proposed practices were implemented, TP loading to Alimagent Lake would be reduced by about 112 pounds annually. In addition, the SSGI would infiltrate 185 acre-feet of runoff per year.

Section 3.0 of this report provides descriptions of specific types of green infrastructure, and Section 4.0 provides sample green infrastructure layouts to consider. Each page of Section 4.0 shows an approach to stormwater management in public and/or private settings. The green infrastructure identified in this report could be implemented as shown and also viewed as an assortment of stormwater management methods to be incorporated in reconstruction projects throughout the Alimagnet Lake watershed.

2.0 Background

2.1 PURPOSE

The purpose of this study is to help the VRWJPO and the Cities reduce stormwater runoff throughout the Alimagnet Lake watershed and nutrient loads discharging to the lake through implementation of Best Management Practices (BMPs). Alimagnet Lake is currently classified as 'Impaired' for excess nutrients by the Minnesota Pollution Control Agency (MPCA). Approximately 985 acres drains to Alimagnet Lake and the Alimagnet TMDL estimates phosphorus loads from the watershed needs to be reduced by 35%, or approximately 61 pounds per year (MPCA, 2015b).

The Alimagnet Lake watershed contains a mixture of land use with a moderately high impervious area that was developed under varying levels of stormwater management and BMPs. In this report, Wenck Associates will focus on areas with little or no stormwater BMPs and identify opportunities for implementing green infrastructure. Section 3.0 of this report provides descriptions of specific types of green infrastructure, and Section 4.0 provides sample green infrastructure layouts to consider. Each page of Section 4.0 plans an approach to stormwater management in public and private settings. The green infrastructure identified in this report could be implemented as shown and also viewed as an assortment of stormwater management methods that can be incorporated in reconstruction projects throughout each City.

2.2 STUDY AREA

The area identified for potential improvement is shown in Figure 1 of the attached figures. The Alimagent Lake watershed is roughly 985 acres of primarily single family, multifamily, commercial, industrial, and park land in the Cities of Burnsville and Apple Valley. The entire area is located in the North Creek subwatershed which is a major tributary to the Vermillion River.

Much of the watershed already incorporates some form of stormwater management. There are three major regional ponds (AL-P8, LA2-A and LA3-A) located near Alimagnet Lake that collectively drain approximately 73% of the watershed. There are also several other smaller ponds and wetlands located upstream of these ponds that capture and store runoff from the watershed. Historically, most of the aforementioned ponds were at one time small wetlands and low-lying areas that were incorporated into the City stormwsewer systems when the watershed began to develop in the 1970's. Thus, many of these systems are not capable of treating stormwater pollutant loads to today's standards. Furthermore, recent monitoring in the three major regional ponds suggests these systems are overloaded, may need maintenance and discharge high TP concentrations to Alimagnet Lake.

2.3 FRAMEWORK

Stormwater management in urban areas has evolved substantially over the past 20 years. Historically, the goal was to move water off the landscape quickly to reduce or eliminate flooding. Now, stormwater professionals focus on keeping a raindrop where it falls to mimic natural hydrology, recharge groundwater and minimize the amount of pollution reaching our lakes, rivers, and streams.

In 2009, the Minnesota Legislature allocated funds to "develop performance standards, design standards or other tools to enable and promote the implementation of low impact development and other stormwater management techniques." Minimum Impact Design Standards (MIDS) represent the next generation of stormwater management and is based on low impact development (LID). LID is an approach to land development (or re-development) that works with nature to manage stormwater as close to its source as possible. LID employs principles such as preserving and recreating natural landscape features, minimizing effective imperviousness to create functional and appealing site drainage that treats stormwater as a resource rather than a waste product. Using the LID approach, the MIDS study determined this region should seek to retain 1.1 inches of runoff on-site from all impervious surfaces.

Many practices have been used to adhere to these principles such as bioretention facilities, rain gardens, vegetated rooftops, rain barrels, and permeable pavements. By implementing LID principles and practices, water can be managed to reduce the impact of built areas and promote the natural movement of water within an ecosystem or watershed. Applied on a broad scale, LID can maintain or restore a watershed's hydrologic and ecological functions. LID has been characterized as a sustainable stormwater practice by the Water Environment Research Foundation and others.

The Cities of Apple Valley and Burnsville, along with Minnesota Department of Transporation (MNDOT) and Dakota County are bound to the Municipal Separate Storm Sewer System Permit (MS4) which was originally issued in 2006 to address the federal Phase II National Pollution Discharge Elimination System (NPDES) stormwater regulations for small MS4s. The MS4 permit has since been updated to further comply with and exceed the standards set forth in the NPDES. The municipal MS4 permit now requires no increase in runoff volume, total suspended solids (TSS), and total phosphorus (TP) for new development, and redevelopment must reduce runoff volume, TSS, and TP discharged from the site.

MIDS is more stringent than the NPDES requirements because it attempts to return stormwater hydrology to pre-settlement conditions rather than existing conditions under the NPDES permit.

2.4 METHODOLOGY

Wenck evaluated stormwater runoff in the Alimagnet Lake watershed by reviewing existing conditions using Geographic Information Systems (GIS) and data provided by the Cities and the Alimagnet Lake TMDL study. Wenck modeled the existing area hydrology and water quality using the computer program P8. Green infrastructure hydrology was modeled in HydroCAD. HydroCAD is capable of developing the hydraulic inputs (rating curves) to the P8 model with confidence and efficiency. It is also a sufficient model to evaluate baseline flooding concerns for design storm events. The rating curve hydraulics from the HydroCAD models were input to the P8 model devices to predict the potential for runoff volume and pollutant loading reductions in the study area.

P8 (Program for Predicting Polluting Particle Passage through Pits, Puddles and Ponds) is a computer model used for predicting the generation and transport of stormwater runoff pollutants in urban watersheds. P8 is a useful diagnostic tool for evaluating and designing watershed improvements like green infrastructure. The model requires a user to input watershed characteristics, green infrastructure dimensions, local precipitation and temperature, and water quality parameters.

P8 calculates runoff separately from pervious and impervious areas. Calculations for pervious areas use the Soil Conservation Service (SCS) Curve Number (CN) method. Runoff from impervious areas begins once the cumulative storm rainfall exceeds the specified depression storage, with the runoff rate equal to the rainfall intensity.

The P8 model uses an hourly precipitation record (rain and snowfall) and daily temperature record. Precipitation and temperature data were obtained from the Minneapolis-St. Paul International Airport. Records from 2005 to 2014 were used for this study.

Wenck selected the NURP50 particle file for this study. The component concentrations in the NURP50 file represent the 50th percentile (median) values compiled in the EPA's Nationwide Urban Runoff Program (NURP).

Wenck validated the P8 model using storm sewer flows through lift stations and pond water quality data, where available. Curve numbers were systematically adjusted within P8 to provide the best fit possible for runoff volumes at the Alimagnet Lake lift station operated by the City of Apple Valley. Model predicted TP runoff concentrations were also adjusted globally within the P8 model to provide the best possible fit for pond TP concentrations at three monitored stormwater ponds throughout the watershed (AL-P8, LA2-A and LA3-A).

2.5 LIMITATIONS AND ASSUMPTIONS

Due to limited information, potential SSGI locations shown in the following section require further investigation before they can be implemented. Topography, soil types, utilities, and future land use is needed to proceed with final design. The recommended SSGI designs were placed with the intention to fit the landscape and meet MIDS. The results of a final design may vary slightly from what is proposed in this report.

Impervious areas and runoff curve numbers were generated using NRCS Web Soil Survey data and county land use maps. The percent impervious and pervious area curve numbers were determined based on average literature values for different land uses and soil types. The use of literature values lends itself to inconsistencies with each individual site. However, curve numbers and impervious percentages were adjusted where needed to better reflect the current conditions.

Wenck assumed infiltration practices would occur in areas with soils conducive to infiltration and used an infiltration rate of 1.0 inches per hour for most proposed infiltration practices. This infiltration rate was used area-wide unless more detailed data was available that suggested otherwise. A detailed soil investigation to determine site specific soil type and groundwater elevations is needed before design of any of the proposed practices.

3.0 Shared, Stacked-Function, Green Infrastructure and Traditional BMP Options

Infiltration Trench

Pervious Pavers

Stormwater Reuse

Stormwater Planter

Tree Trench

Infiltration Basin

Infiltration Catchbasin

Alum Treatments

Iron-Enhanced Sand Filters

Street Sweeping

Communities can choose to maintain healthy waters, provide multiple environmental benefits and support sustainability using green infrastructure. Typically stormwater infrastructure serves only a single purpose: to dispose of runoff. Green infrastructure uses vegetation and soil to manage rainwater where it falls. Modern engineering practices can entwine natural processes with fabricated environments to provide stormwater management, flood mitigation, improved air quality, groundwater recharge, and improved downstream conditions.

A wide scale of options is available within the realm of green infrastructure. The Low Impact Development (LID) approach to stormwater management incorporates green infrastructure as well as traditional best management practices (BMPs). "Shared, stacked-function" refers to designs that intend to provide service to more than one parcel (public or private) and the entire facility may function to provide additional amenities including artwork, public interaction, and green space. Examples of green infrastructure and traditional BMP options are presented below. Specific uses for these technologies are summarized in Section 4.0.

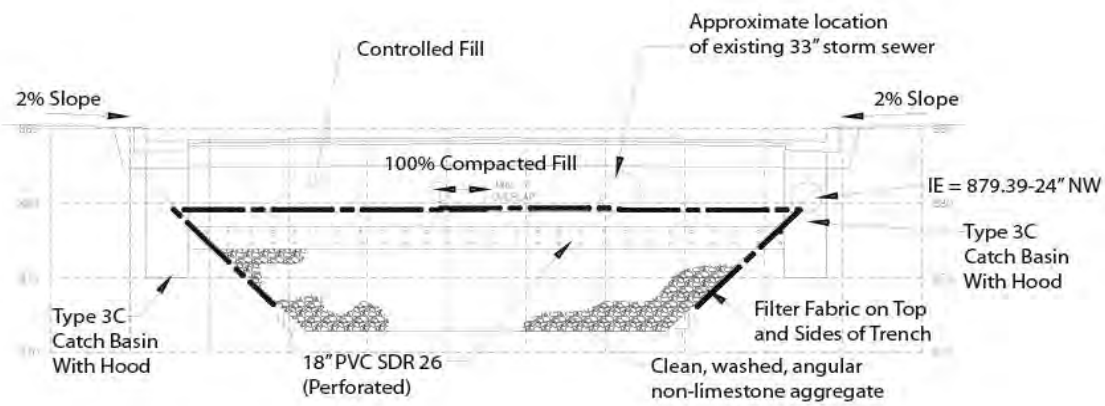
3.1 INFILTRATION TRENCH

Infiltration trenches are an adaptable stormwater management technique where space is limited, and is most suitable for highly urban areas or areas with large parking lots. Underground infiltration consists of perforated pipes or cisterns placed beneath a parking lot or open area. An example is shown to the right.

A cut view of an underground infiltration system. This system may be placed under a parking lot, park or other area to accommodate storage and infiltration of runoff.

Stormwater runoff is directed to this area via storm sewer for storage and infiltration. A manhole, filter, or hydrodynamic device provides pretreatment for runoff entering the storage area. In large storm events, the storage volume above the outlet reduces flow rates and discharge is directed into the storm sewer. Large angular rock (1-3 inches) surrounds the perforated pipes and provides additional storage capacity and structural stability for soils above. The design can be modified to include a filtration layer when infiltration is not practical.

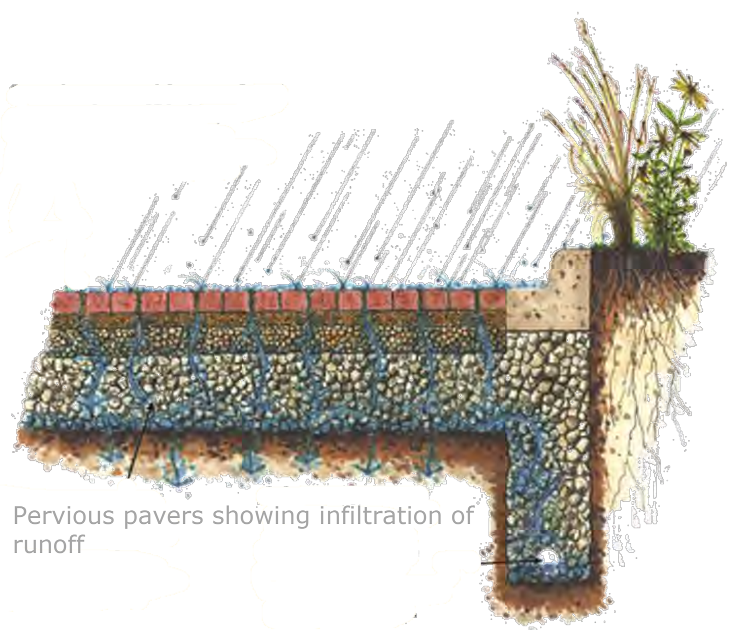
Street replacement also provides an opportunity for this type of shared, stacked-function green infrastructure. Infiltration trenches can be placed beneath roads where no utilities are present. During road reconstruction the infiltration trench can be added to the project to reduce downstream pollutant loads. Maintenance includes periodic removal of sediment accumulated in the pretreatment devices. To maintain system functionality, sediment deposition should not exceed 1 foot in depth. This assessment assumes that infiltration trenches have an annual maintenance cost of $2,000.



Cross section of an infiltration trench beneath the road.

3.2 PERVIOUS PAVERS

Pervious pavers have several different designs that follow the same general structure and result in reduced runoff volumes. Impervious pavement (concrete or asphalt) is replaced with pavers that allow water to pass through to the sub-base via gaps between the blocks. The subbase consists of an angular rock with large void spaces to temporarily store and infiltrate water that passes through the pervious pavement above. This method of pavement construction provides a means of infiltrating runoff from paved surfaces as well as any other contributing surface areas. The figure to the right is an illustration of pervious pavers and how water flows through.


Pervious pavers showing infiltration of runoff

While pervious pavers remain unproven for heavy traffic, trucks, and high speeds, it is well-suited to handle light traffic and occasional heavy vehicles. Potential areas for implementation are parking lots, residential roads, driveways, sidewalks, walkways; curb

Images of pervious pavement in a parking lot (A) and low traffic areas (B).

islands and other similar surfaces as shown in the photos above.

To ensure long performance of pervious pavers, it is important to maintain the pavement. This assessment assumes that porous pavement has an annual maintenance cost of $1,000. Periodic vacuuming is the key maintenance needed for pervious pavers and using little or no salt in the winter is recommended. Studies have shown that de-icing chemicals can be reduced or eliminated because snow-melt and ice infiltrates rather than refreezing. Maintenance of the surrounding landscaped areas will also ensure that the pavement does not become clogged with eroded sediment.

How snow accumulates on porous and traditional pavement in Robbinsdale, MN.

Pervious pavement has recently been shown to reduce the need for de-icing on roadways. In the images below, a section of porous asphalt is outlined in black. The image shows snow accumulating on the traditional pavement but not on the porous section. Snow and ice build-up is reduced substantially by pervious pavement, which allows municipalities to avoid applying salt as frequently. With recent increases in salt prices, pervious pavement in low traffic areas may be a valuable and a long-lasting alternative to salt application.

3.3 TREE TRENCH

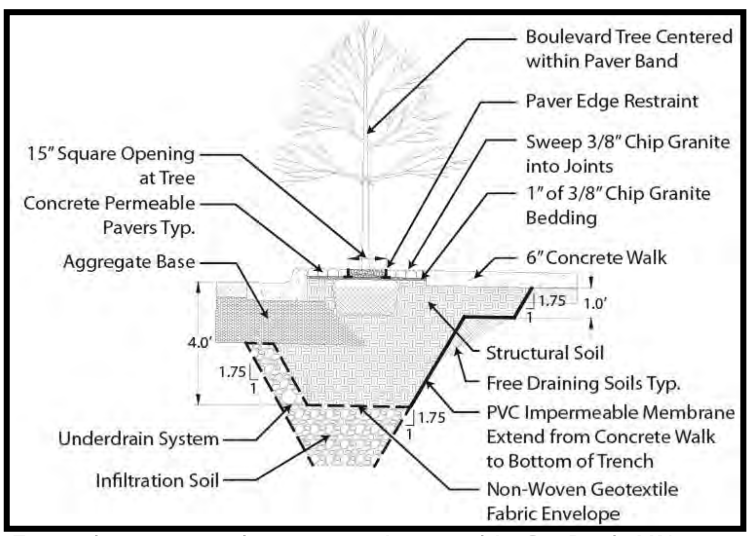
Tree trenches provide underground storage for runoff while increasing green space on the surface. These practices are aesthetically pleasing and great for largely paved areas like roads, parking lots, and sidewalks. Below is an example of a fully functioning tree trench system in the Maplewood Mall parking lot. The trees spring up from the pavement while stormwater is directed underground.

The Ramsey Washington Metro Watershed District (RWMWD) installed this tree trench system in the Maplewood Mall parking lot as part of a redevelopment effort. In this application, the tree trench extends between parking lot islands and below drive lanes and parking stalls. Trench drains connect parking lot islands and collect runoff from the parking lot to be stored and infiltrated in the engineered media below the parking lot surface.

Tree trenches installed in the Maplewood Mall parking lot in Maplewood, MN.

A common design in Europe is known as the Stockholm Tree Trench Method and was developed to provide suitable growing conditions for trees in highly urbanized environments. This method includes media with 2-4 inch angular rock layers that can support tree roots and provide storage for runoff.

To help sustain the growth of the trees in an urban environment, special measures are needed. The tree trenches installed by RWMWD used a patented structural soil developed by Cornell University. CU-Structural Soil™ (also known as CU-Soil™) was developed as a way to safely bear pavement loads after compaction and yet still allow root penetration and vigorous tree growth. The figures show healthy young trees in an entirely impervious landscape.

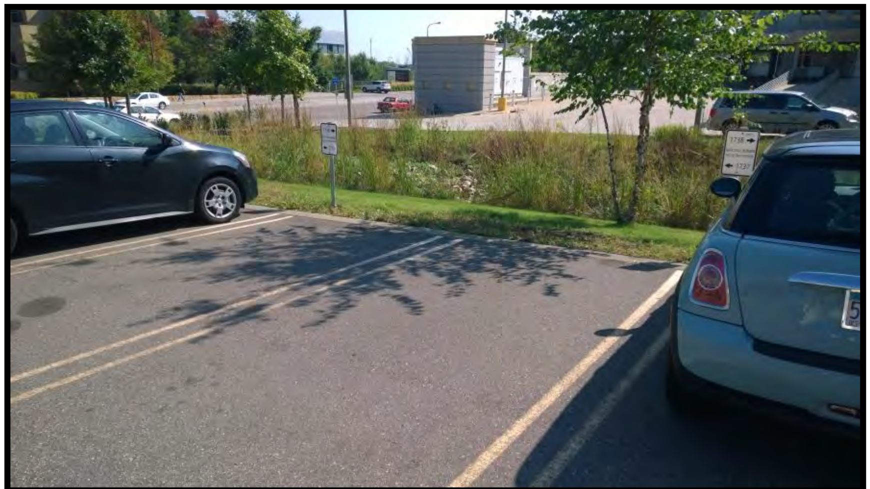


Example tree trench cross section used in St. Paul, MN.

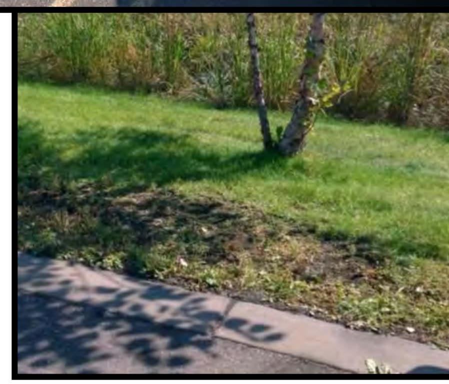
The Capitol Region Watershed District (CRWD), City of St. Paul and Metropolitan Council recently installed tree trenches on the Green Line in St. Paul. These trees are buried in a soil engineered to support the tree root system and collect runoff from the surrounding area. A cross-section of the design is shown below.

Maintenance of tree trenches is similar to other vegetated stormwater management. Newly planted trees need to be watered regularly. According to Johnson et al. 2008, trees need 1.5 gallons of water per inch of trunk diameter when the soil becomes dry. This watering should be sustained for the first three years after planting. Young trees should also be protected from rodents by installing plastic tubing or mesh that extends 1 to 2 feet above the snow line. Trees should be pruned once (1) in each year 2 and 3, every three (3) years up to 10 years, and every five (5) years after that. Periodic removal of sediment from pretreatment sumps and removal of trash and debris will improve the longevity of the trenches. Wenck assumed that infiltration trenches have an annual maintenance cost of $5,000.

3.4 INFILTRATION BASIN



Infiltration basins combine surface storage, infiltration, biological treatment, plant uptake, and evapotranspiration into a single green infrastructure. Stormwater is collected into the treatment area which consists of a grass buffer strip, sand bed, ponding area, organic or mulch layer, planting soil, and plants. The infiltration system incorporates the more natural means of managing stormwater than any other treatment type.



Infiltration basin along a parking lot in St. Paul, MN.

The adjacent pictures show an infiltration basin along the perimeter of a parking lot in downtown St. Paul. Note the ribbon curb that defines the edge of the pavement but also allows runoff to flow over the curb, through the vegetated buffer and into the bioretention basin.

Opportunities to include infiltration systems in the landscape include landscaping islands, cul-de-sacs, parking lot margins, commercial setbacks, open space, rooftop drainage and streetscapes (i.e., between the curb and sidewalk). Infiltration basins are extremely versatile because of their ability to be incorporated into landscaped areas. Maintenance activities typically include sediment removal and maintenance of the vegetation. Invasive species need to be managed, dead vegetation must be removed, and dead plants must be replaced.

“Stepped” infiltration basin in Oakdale, MN.

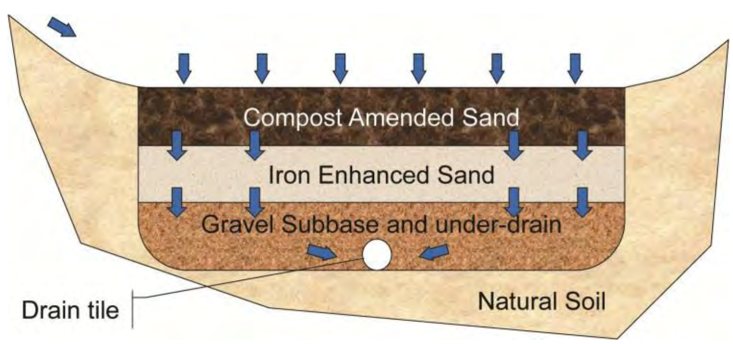
Similar to other green infrastructure, public art can be incorporated into infiltration basins. The picture below demonstrates how a basin in Oakdale, MN incorporated public art into the retaining walls and flow path. The decorative retaining walls create a “stepped” system that allows water to infiltrate or overflow to the next downstream step. The pictures above show the circular pretreatment sump at the upstream end of the steps and the decorative concrete spheres in the concrete flume that carries concentrated flow from the overflow of each step. This assessment assumes that infiltration basins have an annual maintenance cost of $2,500 for vegetative maintenance and removal of accumulated sediment.

3.5 ALUM TREATMENTS

Aluminum sulfate (alum) can be applied to stormwater pond sediments to reduce the amount of phosphorus released during periods of anoxia. The use of alum on stormwater ponds within the Alimagnet Lake watershed may be a cost effective method to reduce phosphorus since AL-P8, LA2-A, and LA3-A have exhibited signs of internal loading. Typically, sediment chemistry characteristics are used to assess the amount of alum needed to reduce sediment phosphorus release by 90%, however, sediment data for ponds within the Alimagnet Lake watershed are not available. An application rate of 100 mg/m^2 can be used for a guideline of how much aluminum should be applied to the surface sediments in each pond. Cost estimates will assume three alum applications over a 30 year period to the entire surface area of the pond. Cost estimates also assume that sediment cores will be collected prior to the alum applications at a cost of $2,000. This will ensure that alum doses are tailored to each pond, which will likely result in a cost reduction for pond alum applications.

3.6 IRON-ENHANCED SAND FILTERS

Iron-enhanced sand filters are filtration BMPs that incorporate filtration media mixed with iron. The iron removes several dissolved constituents, including phosphate, from stormwater. Iron-enhanced sand filters could potentially include a wide range of filtration BMPs with the addition of iron; however, iron is not appropriate for all filtration practices due to the potential for iron loss or plugging in low oxygen or persistently inundated filtration practices.



Example cross section schematic of an iron-enhanced sand filter

Iron-enhanced sand filters may be applied in the same manner as other filtration practices and are more suited to urban land use with high imperviousness and moderate solids loads. Because the primary treatment mechanisms are filtration and chemical binding and not volume reduction, vegetating the filter is not needed and may impair the filter function.

Iron-enhanced sand filters require underdrains that serve to convey filtered and treated stormwater and to aerate the filter bed between storms. The exit drain from the iron-enhanced sand filter should be exposed to the atmosphere and above downstream high water levels in order to keep the filter bed aerated. Iron-enhanced sand filters may be used in a treatment sequence, as a stand-alone BMP, or as a retrofit. If an iron-enhanced sand filter basin is used as a stand-alone BMP, an overflow diversion is recommended to control the volume of water, or more specifically, the inundation period in the BMP. As with all filters, it is important to have inflow be relatively free of solids or to have a pre-treatment practice in sequence.

Maintenance of the iron-enhanced sand filters consists of removing accumulated sediment and debris, pulling out all vegetation throughout the growing season, and tilling the soil to prevent clumping and preferential flow paths. This assessment assumes that iron-enhanced sand filters have an annual maintenance cost of $2,500.

3.7 STREET SWEEPING

Street sweeping can be a cost effective tool for nutrient reduction, especially for directly connected impervious areas near streams or lakes. Sediment and nutrient removal by street sweeping is influenced by the amount of canopy cover, sweeping frequency, and month of sweeping. Typically, nutrient loads recovered by street sweepers are higher in routes with higher canopy cover, and in the fall and spring. Spring (March and April) is the best time for cleaning up solids, including road salt, sand, and fines left behind from soil and debris entrained in snow after the snow melts. Fall sweeping, after fall leaf drop, is also a very important time for nutrient recovery.

Street sweeping in the directly connected impervious areas of the Alimagnet Lake watershed were evaluated using the University of Minnesota's Planning Calculator for Estimating Nutrient Removal through Street Sweeping. This calculator is designed to provide a rough estimate of the solids and nutrients (phosphorus and nitrogen) loads that can be recovered through street sweeping based on the timing and frequency of sweeping operations and an estimate of the percent tree canopy cover over the streets to be swept. The calculator was calibrated to conditions in Prior Lake, MN and is recommended for use in the greater Twin Cities metropolitan Region or geographic areas with comparable climate and vegetation.

3.8 SSGI IN COLD CLIMATES

In Minnesota, stormwater management is defined by managing rainfall runoff as well as snowmelt, whose characteristics are different. Design criteria focusing on rainfall runoff alone may not work well during cold periods resulting in increased maintenance costs. In years when snowfall is high, this becomes a major concern because a substantial percentage of annual runoff volume and loading can result from snowmelt.

A thorough description of the science of snowmelt and recommended management approaches can be found in the Minnesota Stormwater Manual. LID is effective because it relies on the natural interaction between runoff and soil biology. The manual discloses SSGI, such as permeable pavers, infiltration, and road drainage infiltration systems, are effective under cold climate conditions with proper maintenance.

Road salt application is an ever-increasing challenge for stormwater managers. High chloride concentrations damage and kill vegetation planted in infiltration basins, stormwater planters, and tree trench systems. Vegetation is a key ingredient to the performance of these systems and replacement can be costly. The following table from the Minnesota Stormwater Manual lists cold climate vegetation of the upper Midwest with known salt tolerance (sorted by growth form). These species should be considered for stormwater planters and tree trenches exposed to high chloride concentrations.

Table 1: Salt tolerant vegetation native to Minnesota.

Species	Soil Moisture	Salt Tolerance in Soil	Growth Form	Notes on Use
American Elm	Always Wet/Frequently Saturated	Medium/Low1	Tree	
Hackberry	Frequently Saturated/Mostly Drained	Medium	Tree	
Jack Pine	Mostly Drained	High1	Tree	
Poplars	Frequently Saturated/Mostly Drained	Medium1	Tree	Including aspen, cottonwood, black and silver-leaved poplar; fast growing; also provide good streambank stabilization; highly tolerant to salt spray
Cutleaf Sumac	Mostly Drained	High	Shrub	
Smooth Sumac	Mostly Drained	Medium	Shrub	Colonizes and spreads in high sun
Staghorn Sumac	Mostly Drained	High	Shrub	
Canada Wild Rye	Frequently Saturated	Medium	Herbaceous Grass	
Karl Foerster Reed Grass	Frequently Saturated/Mostly Drained	High	Herbaceous Grass	This is a cultivar for landscaping
Alkali Grass	Mostly Drained	High	Herbaceous Grass	
Blue Gramma Grass	Mostly Drained	High	Herbaceous Grass	Selections being made for strongly salt-tolerant varieties; see University of Minnesota for latest

Species	Soil Moisture	Salt Tolerance in Soil	Growth Form	Notes on Use
Little Bluestem	Mostly Drained	High	Herbaceous Grass	
Perennial Ryegrass	Mostly Drained	Medium	Herbaceous Grass	
Seed Mix: MN DOT Urban Prairie	Mostly Drained	High	Herbaceous Grass	
Seed Mix: MN DOT Western Tall Grass Prairie	Mostly Drained	Medium	Herbaceous Grass	
Tall Wheatgrass	Mostly Drained	High	Herbaceous Grass	

4.0 Assessment

Wenck reviewed existing conditions using Geographic Information Systems (GIS) and data provided by the Cities, and then modeled the area hydrology and water quality using the computer program P8. Wenck selected BMPs for the study that would achieve the goals of managing runoff rates, and reducing nutrient loads. These BMPs were tailored to fit each site and maximize the effects. A proposed model was constructed by incorporating the proposed BMPs into the existing conditions model.

4.1 EXISTING CONDITIONS

Wenck created the existing conditions model to mimic the watershed as it is today by routing runoff through the storm sewer, stormwater ponds, rain gardens, and infiltration basins. The majority of the watershed is collected in storm sewer and discharged to Alimagent Lake. The watershed is primarily residential and commercial property with intermittent City property including various city parks and easements (Table 2). Figure 1 shows the contributing areas of each MS4 in the watershed and Table 2 provides a breakdown of each MS4 and their TMDL required load reduction.

Table 2: MS4s in the Alimagnet Lake Watershed.

MS4	Area (acres)	Percent of Watershed	TMDL Required Load Reduction (lbs/year)
City of Burnsville	544.1	55%	25.6
City of Apple Valley	389.8	40%	30.8
Dakota County ROW	32.8	3%	1.8
MNDOT ROW	17.0	2%	2.6
Total	**983.7**	**100%**	**60.8**

The Alimagent Lake watershed is broken into 85 subwatersheds. During this study, it was determined that 10 of the subwatersheds within the watershed study are land-locked and do not outflow to Alimagnet Lake. A map of the subwatershed delineations is shown in Figure 2 (attached).

Under existing conditions the study area generates approximately 186 pounds of TP annually. This estimate includes the expected removals due to existing stormwater infrastructure in the study area: 32 stormwater ponds and 7 infiltration practices. Figure 2 shows the locations of the existing stormwater practices in the Alimagent Lake watershed.

Figure 3 (attached) gives a breakdown of existing pollutant loads by area. It is clear from this figure that the subwatersheds with the highest annual pollutant loads tend to be those that do not have existing green infrastructure in place and/or those with large amounts of impervious area.

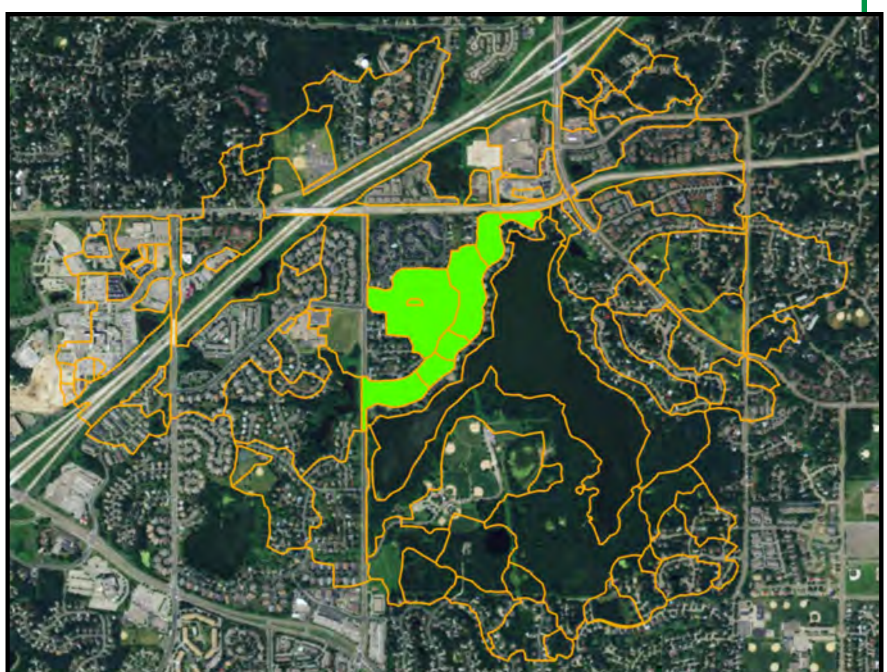
4.2 PROPOSED PRACTICES

The future possibilities model incorporates new green infrastructure into the existing conditions model to demonstrate what can be achieved in different applications. The new BMPs and stormwater infrastructure was designed to meet MIDS where practical. The BMPs and practices are placed strategically within the subwatersheds to capture the most runoff. These potential SSGI locations are described below. If all of the proposed practices were developed, Alimagnet Lake would see reduced TP loads of 112 pounds per year. In addition, the SSGI would infiltrate 185 acre-feet of runoff per year. Subwatersheds where MIDS was met achieved greater than 85% TP load reduction annually.

The following pages are dedicated to the proposed BMPs. Each page gives a breakdown of what the BMP achieves, how much it will cost, and what percentage of the watershed draining to each practice is publicly owned including streets. Since some of the proposed practices are located upstream of an existing stormwater pond/practice, phosphorus reduction estimates are presented both in terms of total load reduction from the site and load reduction to Alimagnet Lake. Please note that the estimated project costs only include construction and operation and maintenance costs and do not take into account easement and/or land acquisition costs. The practices are presented in order of cost effectiveness in terms total cost per pound of phosphorus removed (See Tables 3 and 4). All of the proposed practices located in Burnsville are presented first, followed by Apple Valley. Figure 4 (attached) show the net TP loads by subwatershed as a result of the proposed BMPs.

BURNSVILLE DIRECT STREET SWEPING

Subwatershed	Curb Miles	Canopy Coverage	Current Schedule		1X Per Month Schedule		2X Per Month Schedule	
			TP Reduction (lbs/yr)	Cost Benefit ($/lb)	TP Reduction (lbs/yr)	Cost Benefit ($/lb)	TP Reduction (lbs/yr)	Cost Benefit ($/lb)
Direct-PW1	0.10	32%	0.2	$29	0.4	$45	0.6	$56
Direct-PW2	0.16	32%	0.3	$28	0.6	$44	0.9	$57
Direct-PW3.1	0.52	29%	0.7	$32	1.7	$51	2.6	$64
Direct-PW3.2	0.34	41%	0.8	$19	1.8	$30	2.9	$38
Direct-PW3.3	0.04	15%	<0.1	$61	0.1	$92	0.1	$117
Direct-PW4	0.07	27%	0.1	$36	0.2	$56	0.3	$70
Direct-PW5	0.09	18%	0.1	$52	0.2	$81	0.3	$104
Direct-PW6	0.32	21%	0.3	$46	0.7	$73	1.1	$91
Total	1.64	29%	2.5	$30	5.6	$47	8.8	$60

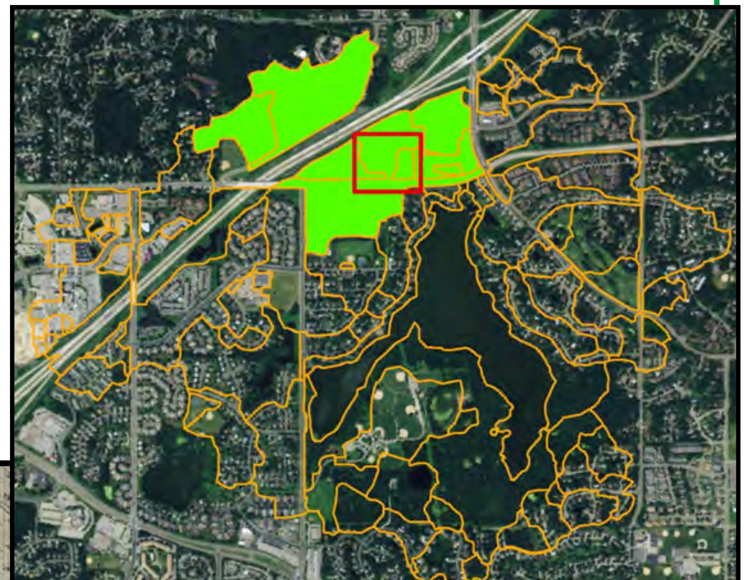


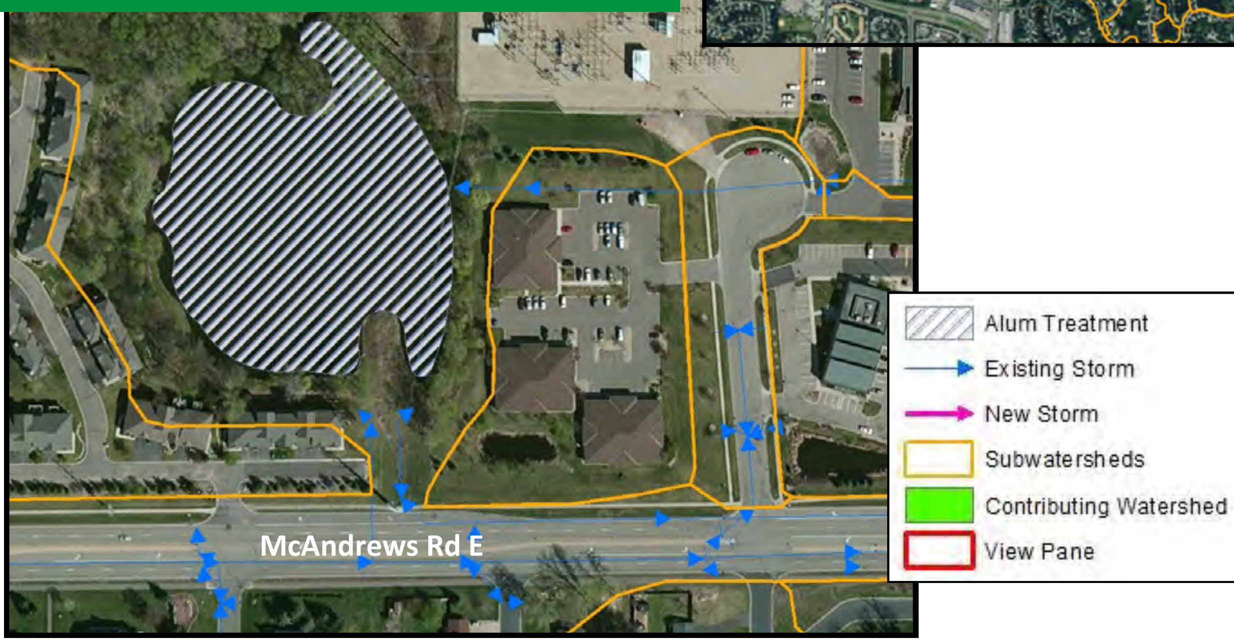
Burnsville Direct Sweeping
Street sweeping in the Burnsville subwatersheds that drain directly to the lake was evaluated using the University of Minnesota Street Sweeping Calculator. Currently, street sweeping in these subwatersheds is conducted approximately two times per year—one time in the spring and one time in the fall. Increasing sweeping frequency to 1-2 times per month would remove approximately 2-3 times more phosphorus than the current schedule. The enhanced street sweeping schedules are more cost efficient than the curb cut raingardens proposed in subwatersheds Direct-PW2, Direct-PW3.2, Direct-PW4, and Direct-PW5. However, the proposed raingardens offer slightly higher annual phosphorus load reductions and also provide volume reduction benefits. The University of Minnesota calculator default cost of $23/curb mile was used to represent sweeping costs.

POND LA2-A

County Parcel ID:
037-021985000020
Pond Size:
3.1 acres
TP Reduction to Lake:
10.4 lbs/yr
Volume Reduction:
NA
Per Treatment Cost:
$14,667
Life Cycle Cost:
$44,000
Cost / Pound TP:
$141 / lb

Percent Impervious:
34%
Drainage:
146.1 acres
<1% Apple Valley
90% Burnsville
5% Dakota Co.
4% MNDOT
Percent Public:
22%
Percent Private:
78%





Pond LA2-A - is located in Burnsville on the northwest corner of the lake. The pond is located on private property. Drainage area to pond LA2-A.1 is approximately 146 acres which is 15% of the Alimagnet watershed. Phosphorus loading from sediments is estimated to be 11.6 pounds per year and was calculated using surface water TP monitoring data, pond volume, and sediment surface area. To calculate load reductions from a potential alum treatment, LA2-A.1 internal P load was reduced by 90%, which is a standard load reduction estimate for alum application. It is estimated that a one-time alum application for LA2-A.1 would cost approximately $14,667 and result in an annual TP load reduction of 10.4 pounds. It is assumed the life expectancy of one alum treatment would be about 10 years, and therefore 3 treatments would be required over a 30-year period.

WENCK ASSOCIATES
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POND LA3-A

County Parcel ID:
Several (private)

Pond Size:
3.6 acres

TP Reduction to Lake:
9.6 lbs/yr

Volume Reduction:
NA

Per Treatment Cost:
$17,333

Life Cycle Cost:
$52,000

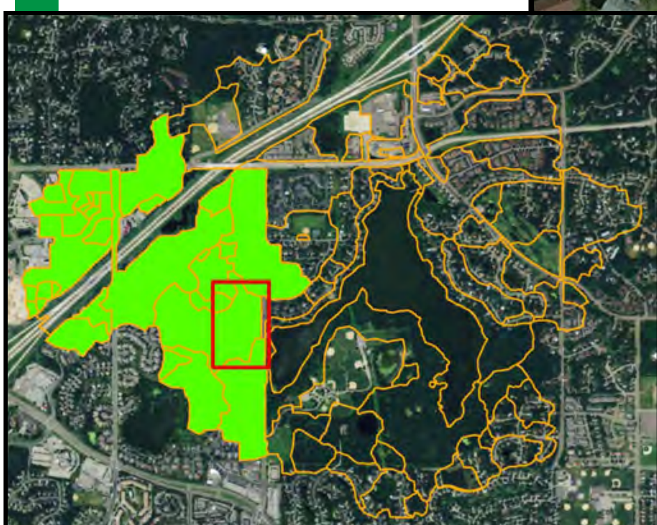
Life Cycle / Pound TP:
$181 / lb

Percent Impervious:
23%

Drainage:
308.1 acres
94% Burnsville
4% Dakota Co.
2% MNDOT

Percent Public:
40%

Percent Private:
60%



Pond LA3-A - is located in Burnsville on the southwest corner of the lake. The pond is located on private property. Drainage area to pond LA3-A is approximately 308 acres which is 31% of the Alimagnet watershed. Phosphorus loading from sediments was estimated to be 10.6 pounds per year and was calculated using surface water TP monitoring data, pond volume, and sediment surface area. To calculate load reductions from a potential alum treatment, LA3-A.1 internal P load was reduced by 90%, which is a standard load reduction estimate for alum application. It is estimated that a one-time alum application for LA3-A.1 would cost approximately $17,333 and result in an annual TP load reduction of 9.6 pounds. It is assumed the life expectancy of one alum treatment would be about 10 years, and therefore 3 treatments would be required over a 30-year period.

LA3-I.4

County Parcel ID:
037-022265001010

TP Reduction from Site:
51.4 lbs/yr

TP Reduction to Lake:
35.1 lbs/yr total
34.0 lbs/yr Burnsville
0.7 lbs/yr Dakota Co.
0.4 lbs/yr MNDOT

Volume Reduction:
57.6 ac-ft/yr

Construction Cost:
$187,245

Life Cycle Cost:
$262,245

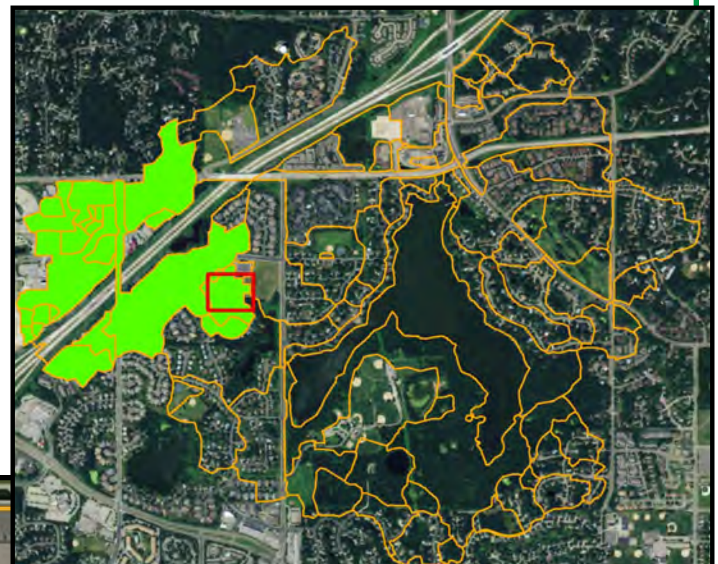
Life Cycle / Pound TP:
$249 / lb

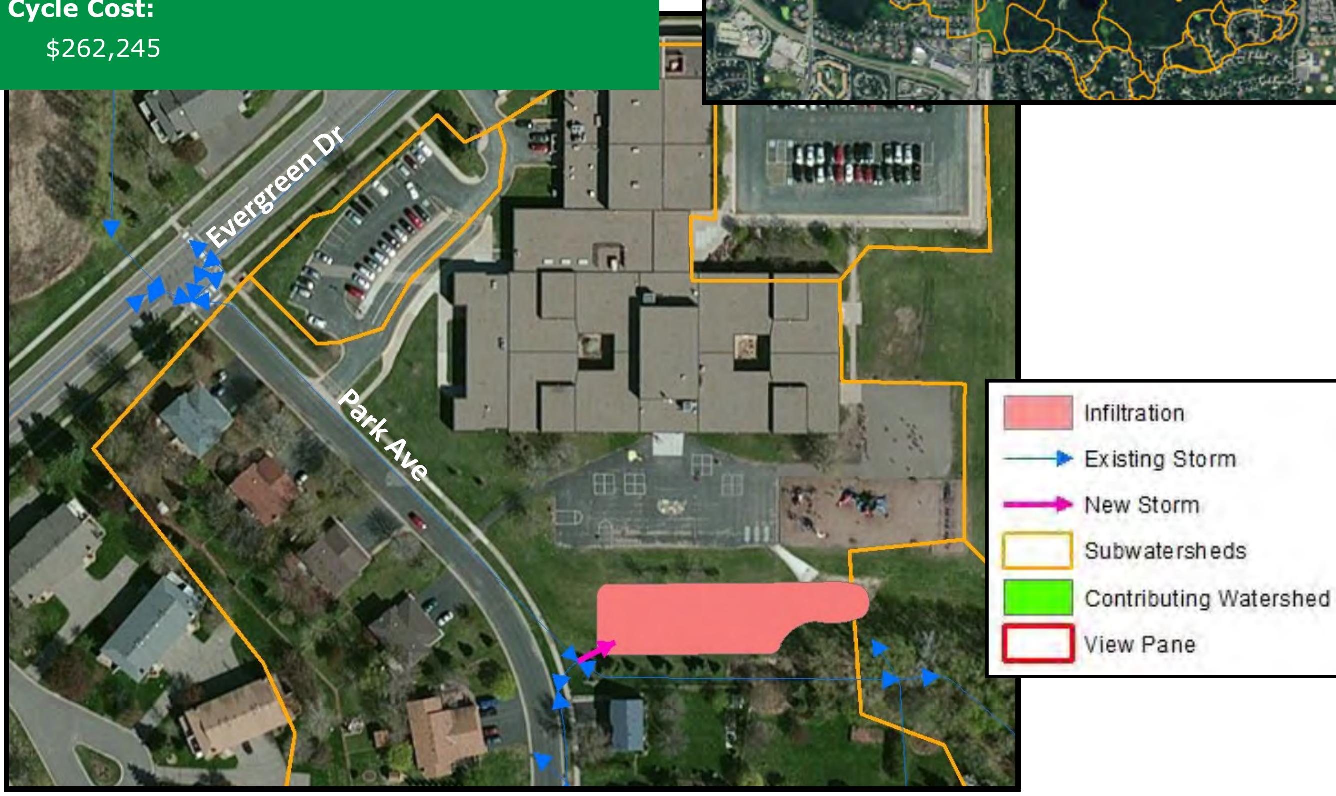
Percent Impervious:
28%

Drainage:
164.2 acres
97% Burnsville
2% Dakota Co.
1% MNDOT

Percent Public:
51%

Percent Private:
49%





LA3-I.4 - is a cost effective option and takes a large step toward meeting the TMDL goal. This location is public property and has a 164 acre drainage area. The size of the watershed lends itself to infiltrating large volumes of runoff and the phosphorus loads therein. The available space is already partially in use for stormwater management so this project would simply expand the system and redirect the storm sewer into the basin. The storm sewer is deep, so the system would require significant excavation. In larger storm events, the existing storm sewer should remain operational to allow for bypass of high flows.

LA3-I.1

County Parcel ID:
037-020190075016

TP Reduction from Site:
18.1 bs/yr

TP Reduction to Lake:
11.8 lbs/yr total
0.9 lbs/yr Dakota Co.
0.1 lbs/yr MNDOT

Volume Reduction:
22.2 ac-ft/yr

Construction Cost:
$19,580

Life Cycle Cost:
$94,580

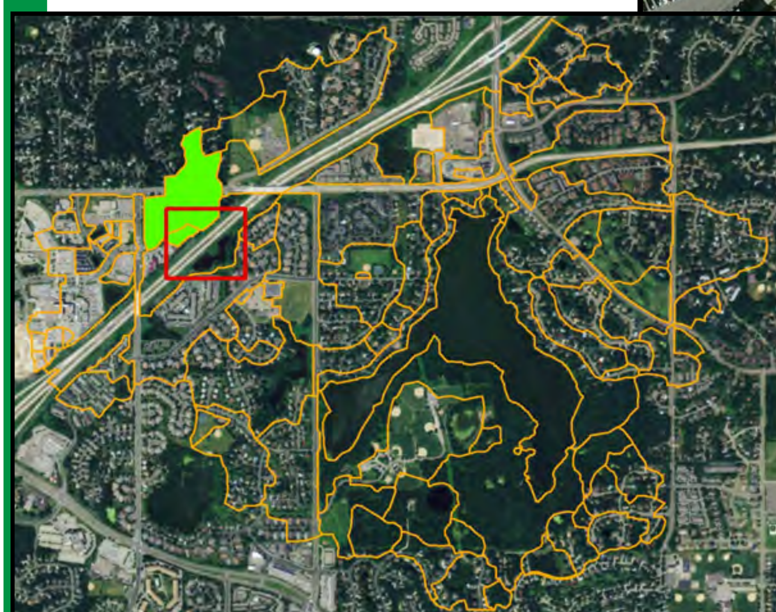
Life Cycle / Pound TP:
$267

Percent Impervious:
28%

Drainage:
26.7 acres
91% Burnsville
8% Dakota Co.
1% MNDOT

Percent Public:
28%

Percent Private:
72%



LA3-I.1 - is located within the public property surrounding a MnDOT pond along I35E. An infiltration practice is proposed to treat runoff form the adjacent neighborhood and drainage area on the north side of the highway. This infiltration practice is a cost effective option for treating a moderately large watershed. The total pollutant removal is nearly 20% of the TMDL goal and is the fifth most cost effective option presented.

POND LA3-A

County Parcel ID:
Practice would encompass 3 private parcels

Pond Size:
3.6 acres

TP Reduction to Lake:
12.7 lbs/yr

Volume Reduction:
N/A

Construction Cost:
$76,280

Life Cycle Cost:
$151,280

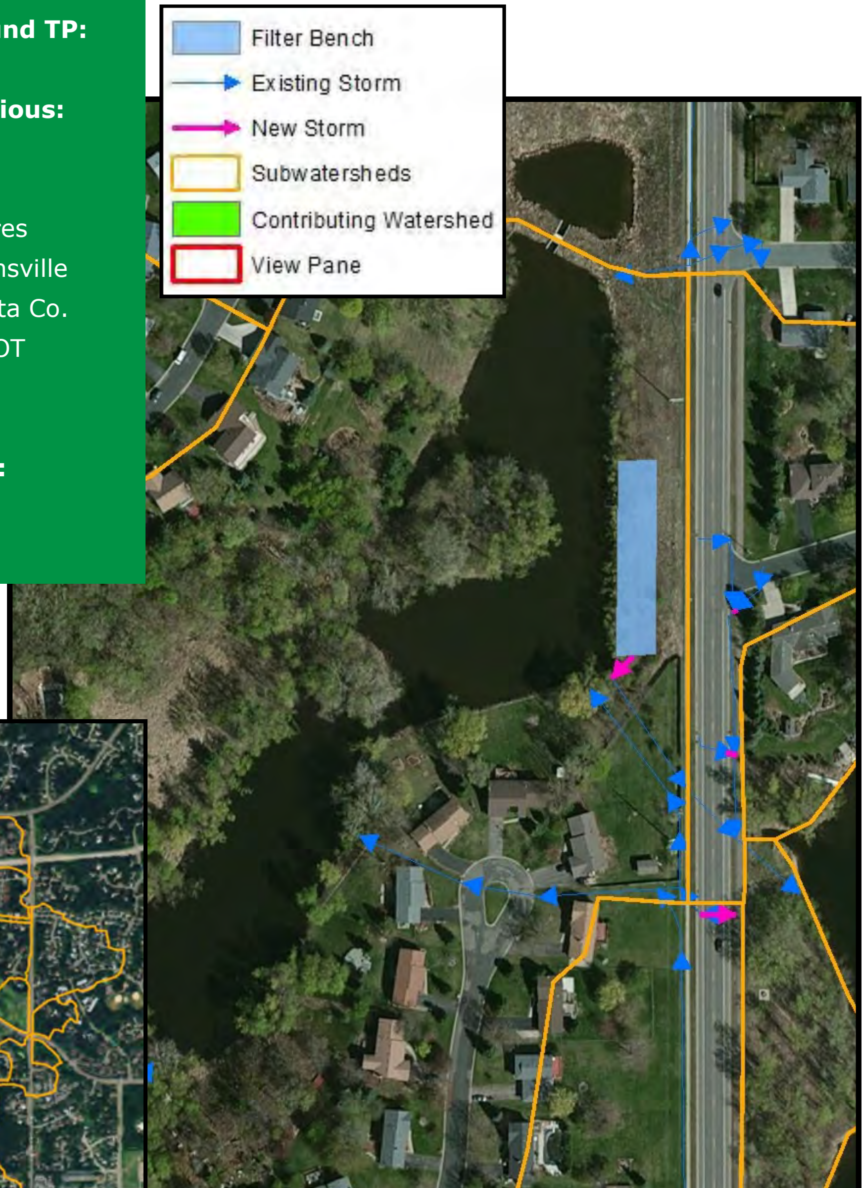
Life Cycle / Pound TP:
$397

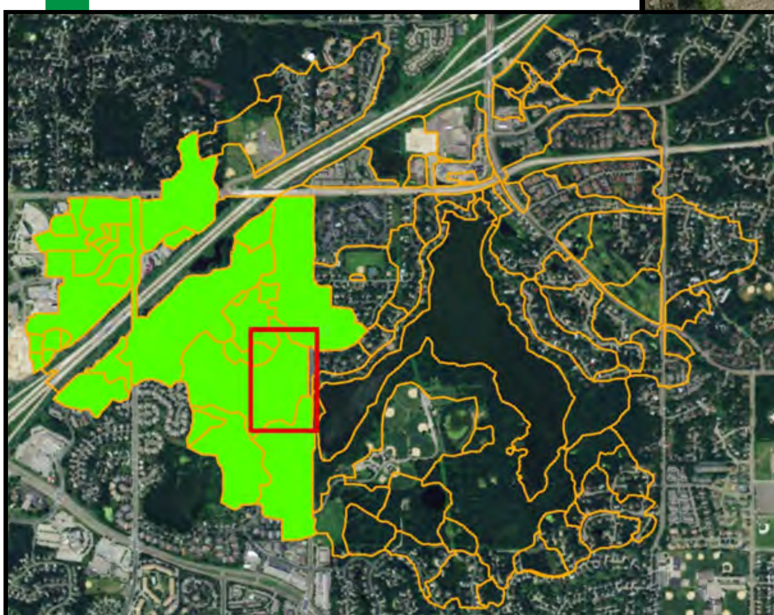
Percent Impervious:
23%

Drainage:
308.1 acres
94% Burnsville
4% Dakota Co.
2% MNDOT

Percent Public:
40%

Percent Private:
60%





Pond LA3-A - is a regional pond for a 308 acre watershed. A filtration bench on this pond is capable of making significant headway toward meeting the Alimagnet Lake TMDL goals. The filter bench is also a very cost effective option. Due to steep slopes and private property, space is limited for installing the filter bench. While the proposed filter bench size is not capable of filtering runoff from the entire contributing watershed, it still provides a significant sink for phosphorus.

POND LA2-A

County Parcel ID:
037-021985000020

TP Reduction to Lake:
16.1 lbs/yr

Volume Reduction:
N/A

Construction Cost:
$246,730

Life Cycle Cost:
$321,730

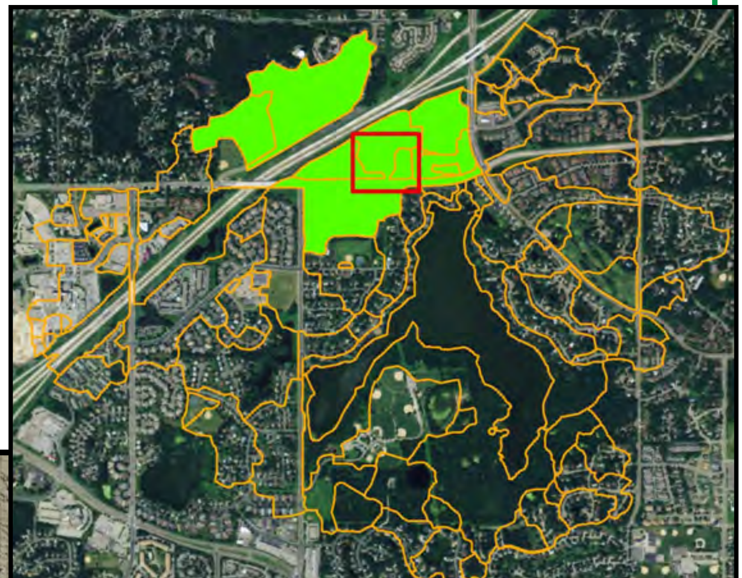
Life Cycle / Pound TP:
$666

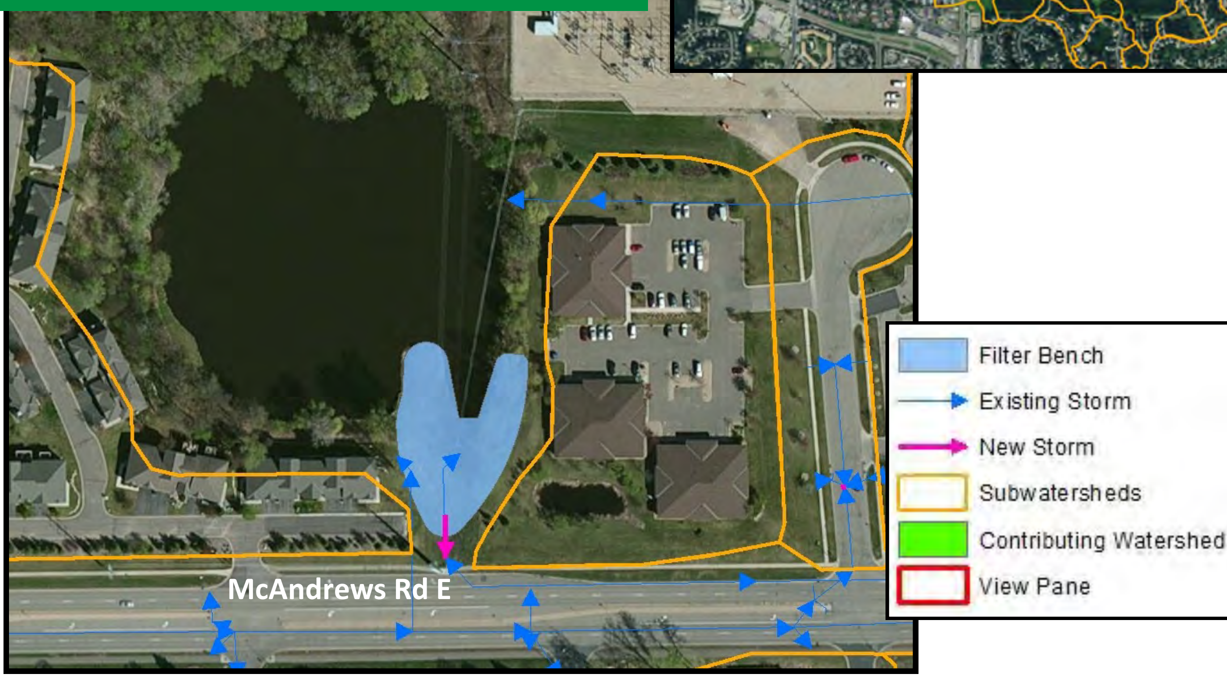
Percent Impervious:
34%

Drainage:
146.1 acres
<1% Apple Valley
90% Burnsville
5% Dakota Co.
4% MNDOT

Percent Public:
22%

Percent Private:
78%





Pond LA2-A - presents an opportunity to install an iron-enhanced filter bench to filter runoff from a large portion of the Alimagnet Lake watershed. The regional pond LA2-A receives runoff from 146 acres. The proposed filter bench is one of the more cost effective options because it filters runoff from that large watershed. Because it is located near the downstream end of the watershed, the filter bench will vary in effectiveness with the number of BMPs installed upstream.

LA2-A.5

County Parcel ID:
037-020190001015

TP Reduction from site:
11.9 lbs/yr

TP Reduction to lake:
6.5 lbs/yr

Volume Reduction:
13.9 ac-ft/yr

Construction Cost:
$77,910

Life Cycle Cost:
$152,910

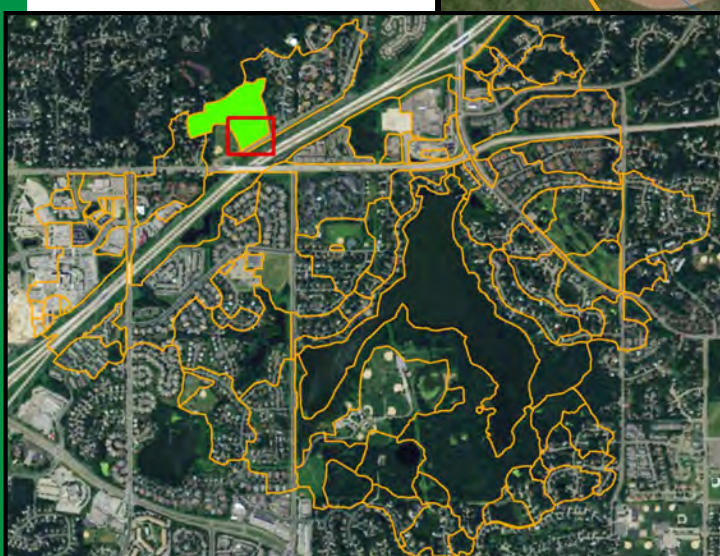
Life Cycle / Pound TP:
$784

Percent Impervious:
34%

Drainage:
17.8 acres
100% Apple Valley

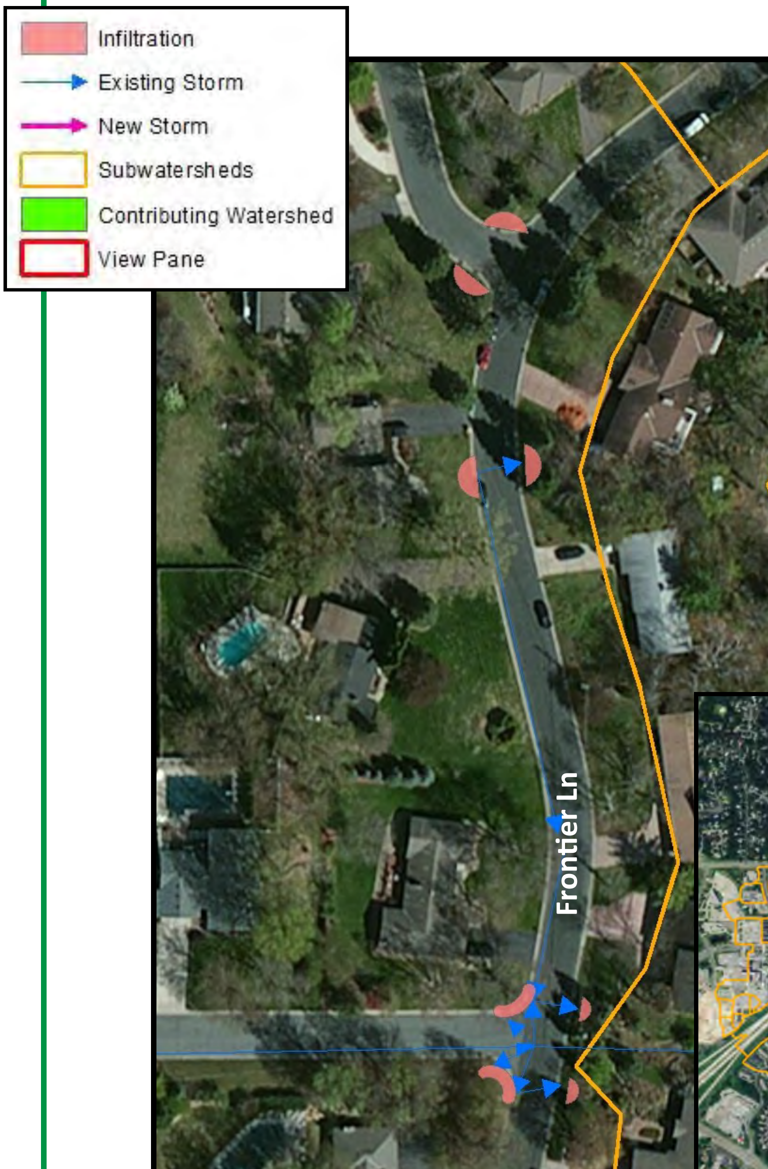
Percent Public:
87%

Percent Private:
13%



LA2-A.5 - is located at the South Metro Vinyard Church. The location of the prposed infiltration venue has a slight slope which may reduce some of the volume that can be retained. By intersecting the storm sewer and installing curb cuts along the parking lot, this system becomes a very cost effective option for stormwater management. While the property is not publicly owned, churches are often easier to work with than other non-public entities.

DIRECT-PW3.2



County Parcel ID:
N/A—City ROW

TP Reduction to Lake:
3.2 lbs/yr

Volume Reduction:
3.5 ac-ft/yr

Construction Cost:
$63,500

Life Cycle Cost:
$123,500

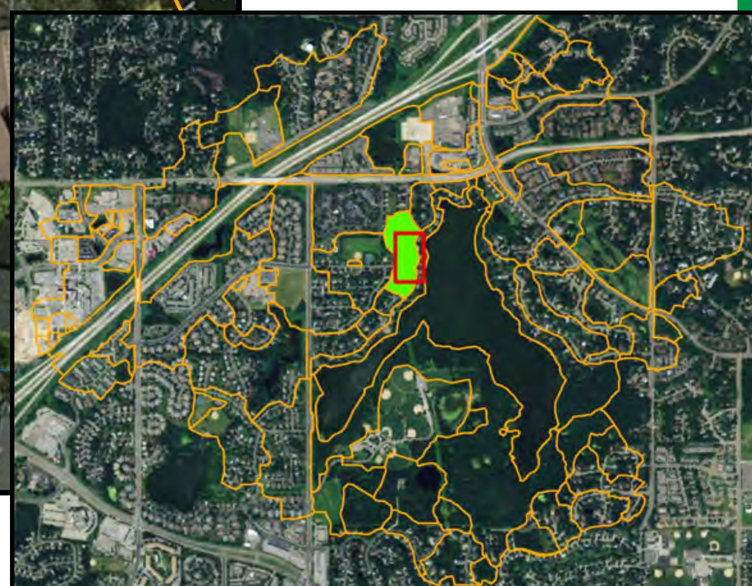
Life Cycle / Pound TP:
$1,287

Percent Impervious:
20%

Drainage:
11.6 acres
100% Burnsville

Percent Public:
28%

Percent Private:
72%



Direct-PW3.2 - discharges runoff directly to Alimagnet lake. With little space for treatment downstream, this watershed along Frontier Lane is another example of how rain gardens can be incorporated into the streetscape to manage runoff. By placing the curb cuts near storm sewer inlets, runoff will enter the rain gardens first. When the rain gardens are full, runoff simply continues along the curb to the storm sewer. This design minimizes flooding and maximizes the stormwater volume treated by the rain garden.

DIRECT-PW6

County Parcel ID:
N/A—County ROW

TP Reduction to Lake:
3.6 lbs/yr total
3.0 lbs/yr Burnsville
0.6 lbs/yr Dakota Co.

Volume Reduction:
N/A

Construction Cost:
$84,800

Life Cycle Cost:
$159,800

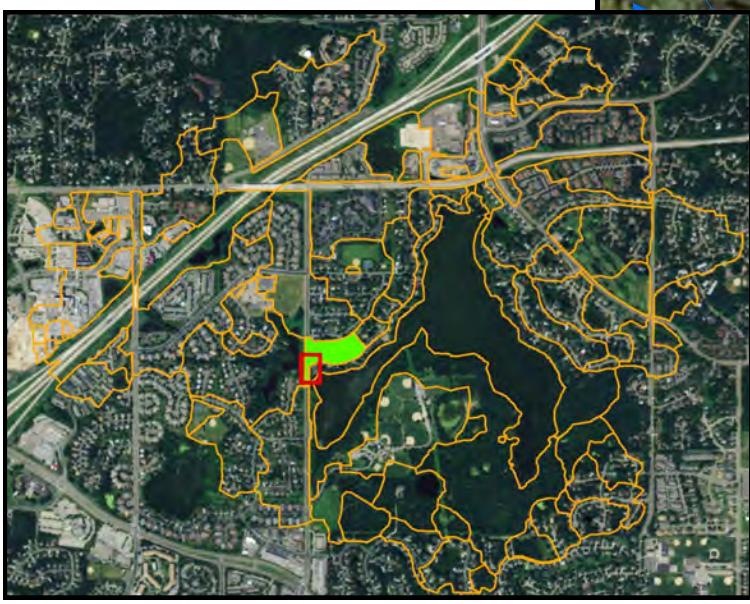
Life Cycle / Pound TP:
$1,480

Percent Impervious:
23%

Drainage:
7.7 acres
82% Burnsville
18% Dakota Co.

Percent Public:
33%

Percent Private:
67%



Direct-PW6 - drains to the west where it is collected by the storm sewer. The majority of the watershed is part of the neighborhood along Frontier Lane and also includes a portion of County Road 11. The county road offers more space for a regional treatment system. An underground system in-line with the storm sewer is proposed to treat runoff before discharging to the lake. Due to the proximity to the lake, a filtration practice is proposed. A typical infiltration trench can be modified to include a layer or filtration media with an underdrain for collection of filtered runoff. This is a moderately cost effective BMP and is in an ideal location for easy maintenance access.

DIRECT-PW3.1

County Parcel ID:
037-020200050012

TP Reduction to Lake:
4.6 lbs/yr total
4.6 lbs/yr Burnsville
<0.1 lbs/yr Dakota Co.

Volume Reduction:
9.8 ac-ft/yr

Construction Cost:
$158,830

Life Cycle Cost:
$233,830

Life Cycle / Pound TP:
$1,694

Percent Impervious:
18%

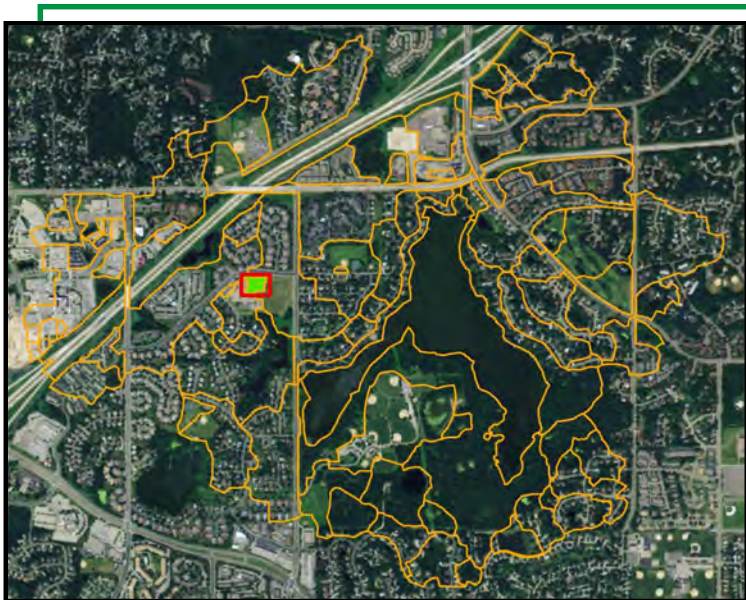
Drainage:
22.3 acres
99% Burnsville
1% Dakota Co.

Percent Public:
49%

Percent Private:
11%

Direct-PW3.1 - proposes an infiltration gallery in Echo Park. Due to steep slopes in the park and the proximity of adjacent homes, the system will most likely need to be an underground infiltration system and require significant excavation. The additional excavation and storm sewer reconstruction makes the practice slightly more expensive. This practice ranks moderately in terms of cost effectiveness but is capable of taking a significant stride toward meeting water quality goals.

LA3-I.3



County Parcel ID:
037-022265001010

TP Reduction from Site:
2.0 bs/yr

TP Reduction to Lake:
1.6 lbs/yr

Volume Reduction:
2.1 ac-ft/yr

Construction Cost:
$6,435

Life Cycle Cost:
$81,435

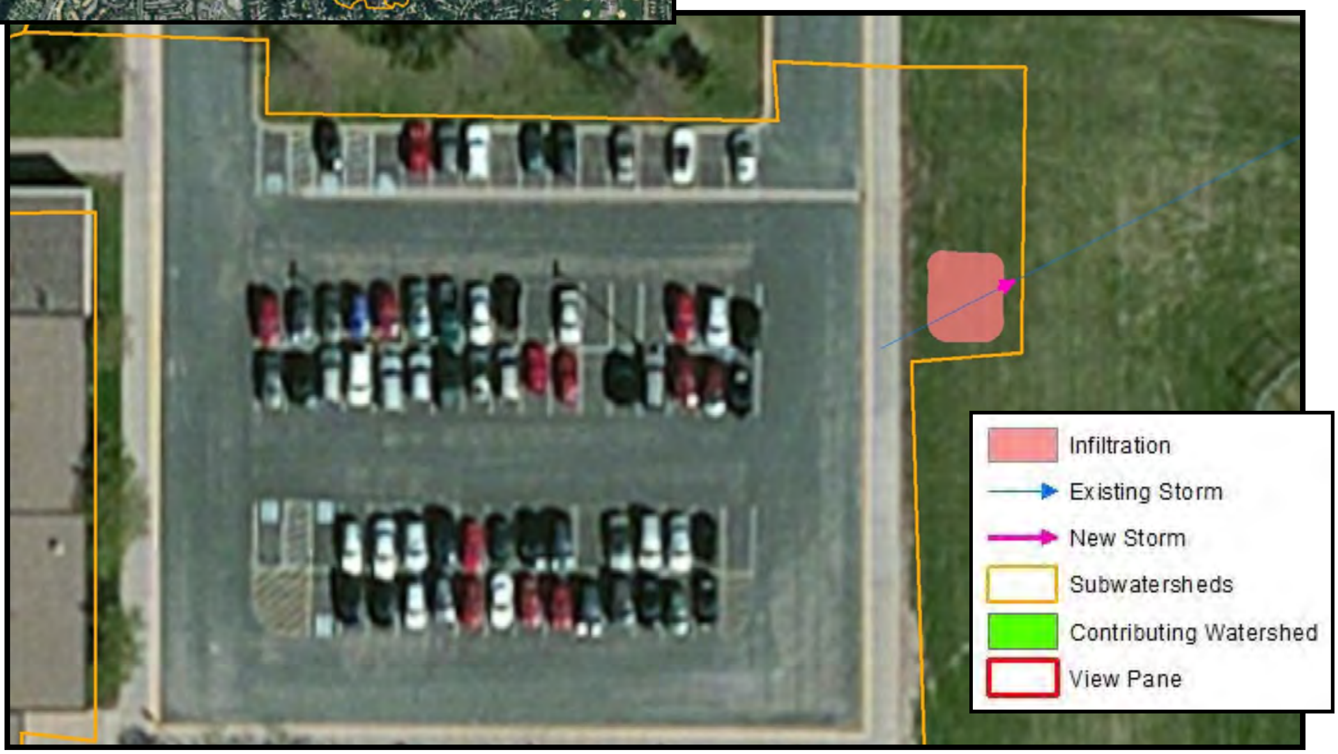
Life Cycle / Pound TP:
$1,697

Percent Impervious:
32%

Drainage:
1.6 acres
100% Burnsville

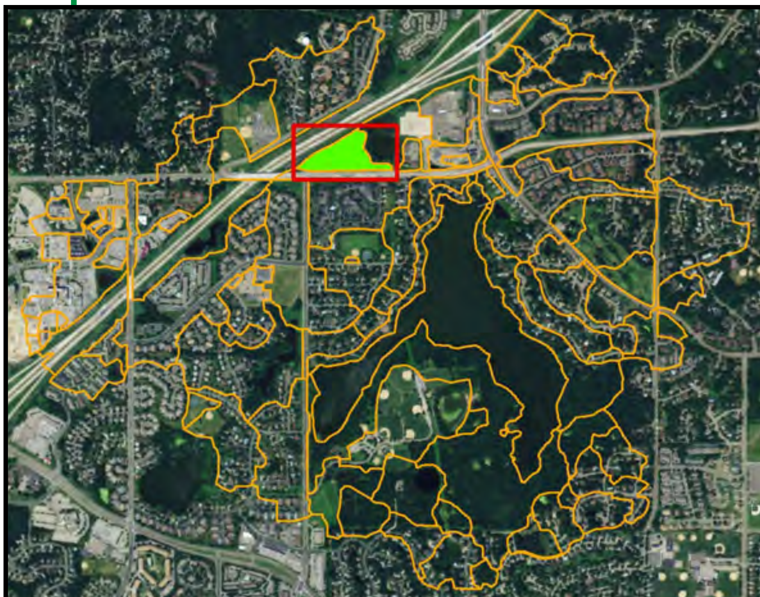
Percent Public:
100%

Percent Private:
0%



LA3-I.3 - is the northeast parking lot for Echo Park Elementary School. This large untreated parking lot is a good opportunity for an infiltration practice. Runoff could be directed to the infiltration basin by installing a curb cut along the east side of the parking lot where runoff would normally discharge to the storm sewer. This location is ideal because space is available, it does not require regrading the pavement, and the existing storm sewer can be used to collect overflow from the infiltration practice.

LA2-A.2



County Parcel ID:
037-028560001010

TP Reduction from site:
11.2 lbs/yr

TP Reduction to Lake:
5.9 lbs/yr total
5.7 lbs/yr Burnsville
0.2 lbs/yr MNDOT

Volume Reduction:
12.6 ac-ft/yr

Construction Cost:
$238,220

Life Cycle Cost:
$313,220

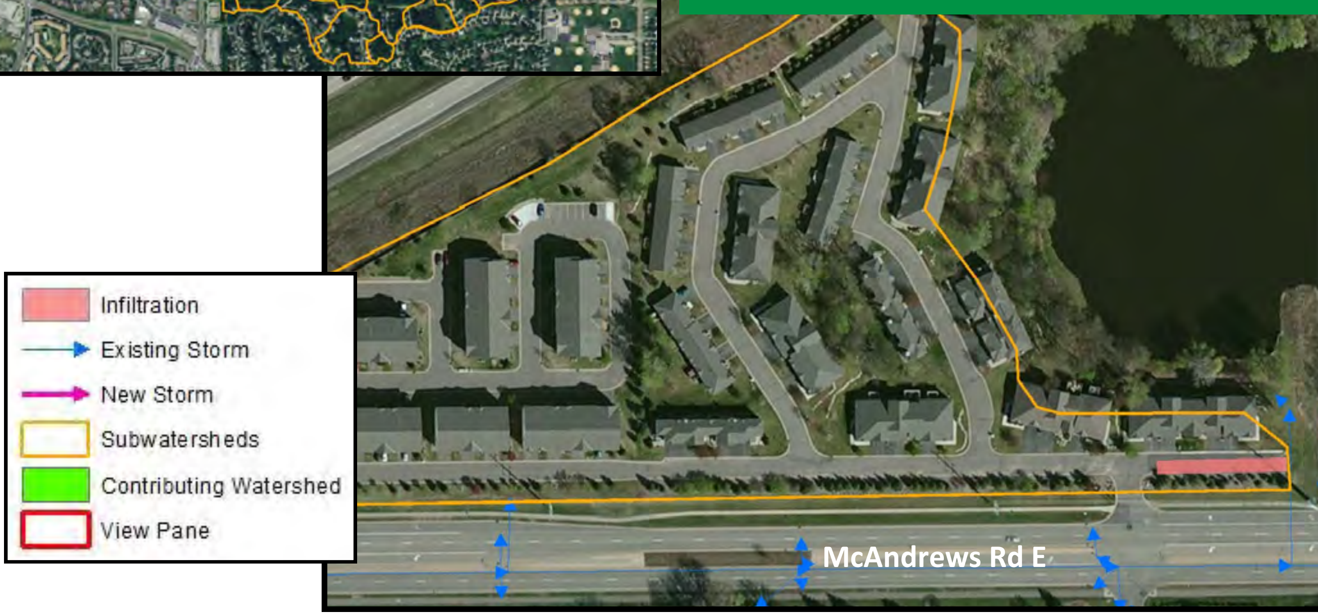
Life Cycle / Pound TP:
$1,770

Percent Impervious:
42%

Drainage:
9.9 acres
96% Burnsville
4% MNDOT

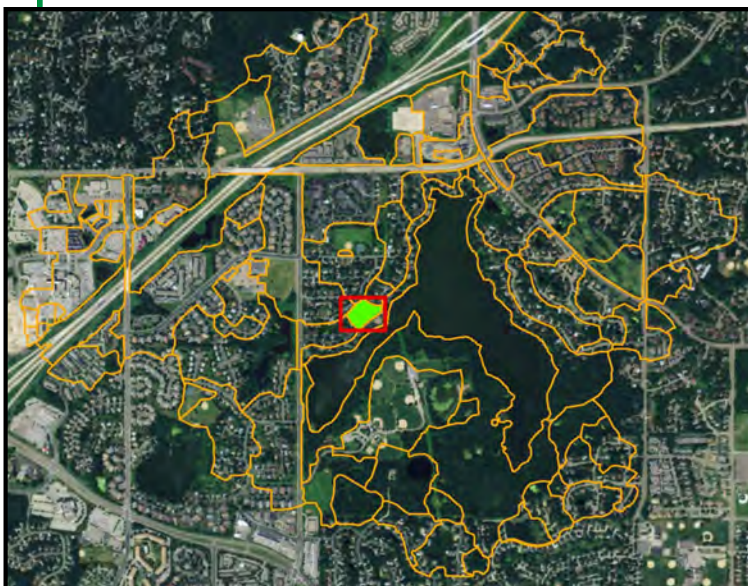
Percent Public:
3%

Percent Private:
97%



LA2-A.2 - is the watershed for Wyngate Townhomes. The townhome's property slopes toward the regional ponds shown at the right of the image above. A storm sewer collects runoff along the private drive and discharges to the east. The proposed infiltration practice is located within the private drive at the farthest downstream point in the watershed. It may be difficult to reach an agreement with the townhomes to get this practice installed. However, this is a more cost effective stormwater management practice and when the private drives need to be reconstructed there may be some room to incorporate this project.

DIRECT-PW5



County Parcel ID:
NA—City ROW

TP Reduction to Lake:
1.3 lbs/yr

Volume Reduction:
1.5 ac-ft/yr

Construction Cost:
$17,985

Life Cycle Cost:
$77,985

Life Cycle / Pound TP:
$2,000

Percent Impervious:
20%

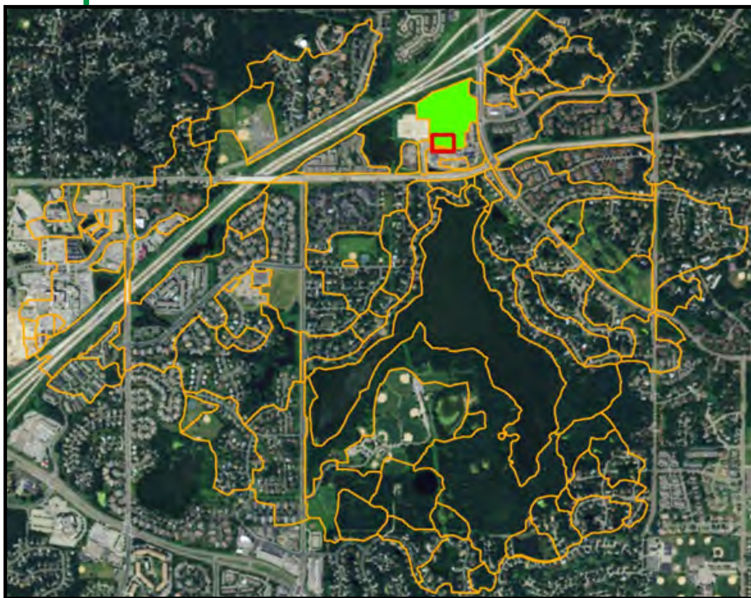
Drainage:
3.2 acres
100% Burnsville

Percent Public:
20%

Percent Private:
80%

Direct-PW5 - also implements the curb-cut rain garden as a means of managing runoff along Frontier Lane. It is optimistic to assume that six homeowners would agree to install rain gardens on their property. However, the potential of improving Alimagnet Lake water quality may greatly improve their desirability. In addition, the rain gardens add to the streetscape through native vegetation and flowers.

LA2-A.4



County Parcel ID:
037-022092001020

TP Reduction from site:
16.7 lbs/yr

TP Reduction to Lake:
3.0 lbs/yr total
3.0 lbs/yr Burnsville
0.0 lbs/yr Dakota Co.
0.0 lbs/yr MNDOT

Volume Reduction:
19.0 ac-ft/yr

Construction Cost:
$111,590

Life Cycle Cost:
$186,590

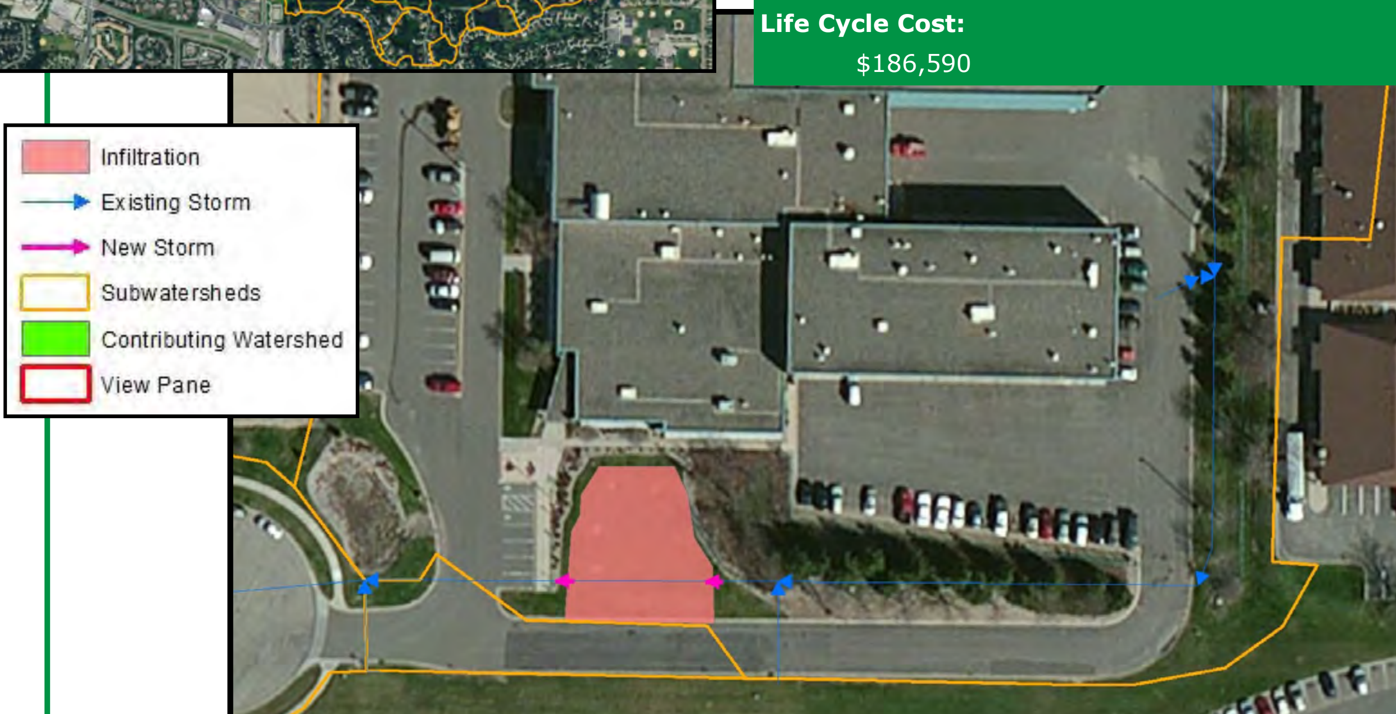
Life Cycle / Pound TP:
$2,073

Percent Impervious:
50%

Drainage:
14.3 acres
99% Burnsville
<1% Dakota Co.
1% MNDOT

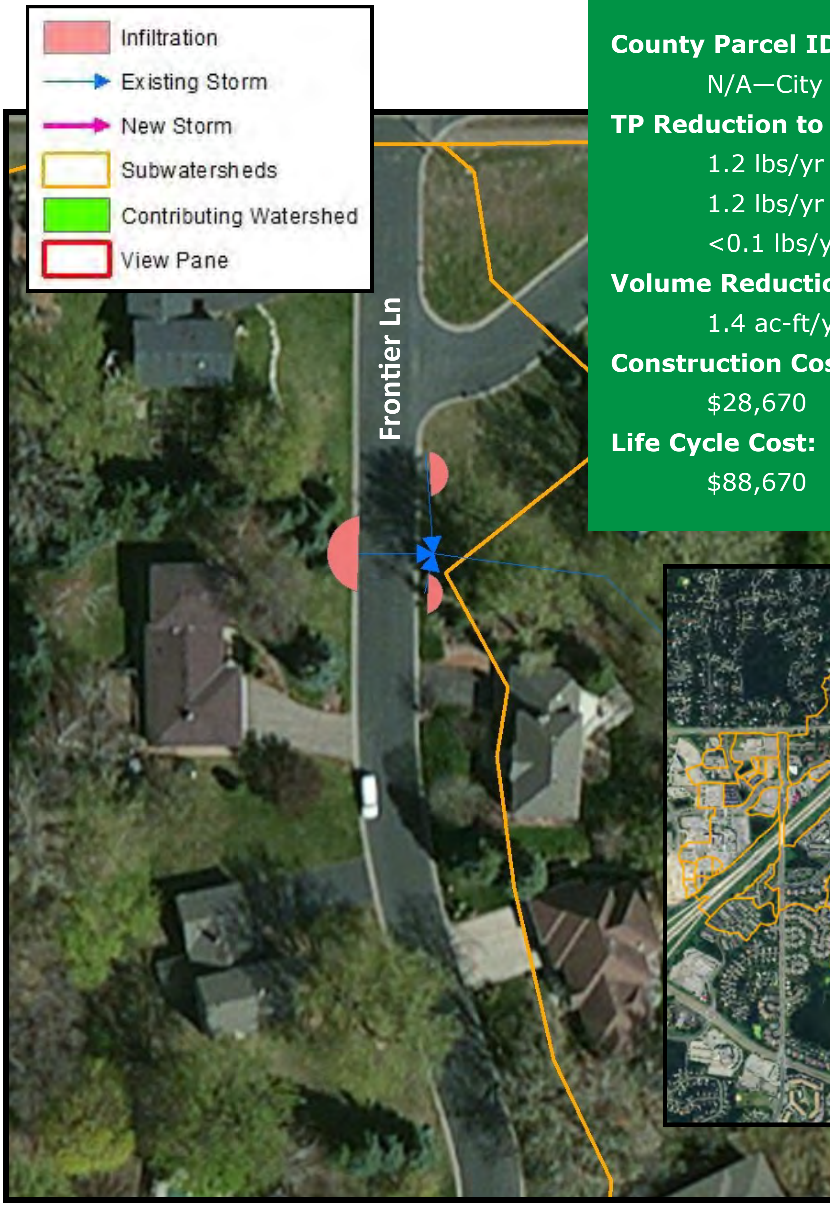
Percent Public:
86%

Percent Private:
14%



LA2-A.4 - This cost effective option utilizes some green space at the Burnsville Maintenance Facility to treat runoff from the building and parking lot. This watershed is an ideal size to maximize the cost effectiveness of stormwater management. This watershed is also largely impervious, so an infiltration practice will infiltrate a large amount of runoff. This location is also ideal because it is located on public property, making design and construction much easier.

DIRECT-PW2



County Parcel ID:
N/A—City ROW

TP Reduction to Lake:
1.2 lbs/yr total
1.2 lbs/yr Burnsville
<0.1 lbs/yr Dakota Co.

Volume Reduction:
1.4 ac-ft/yr

Construction Cost:
$28,670

Life Cycle Cost:
$88,670

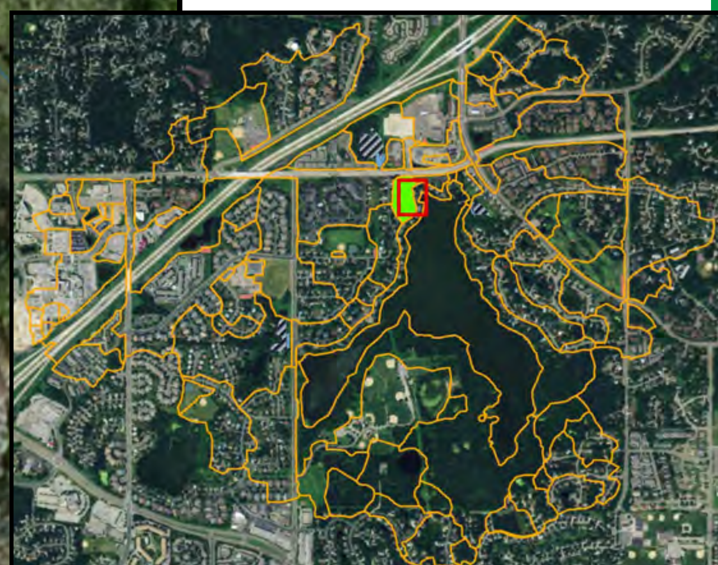
Life Cycle / Pound TP:
$2,463

Percent Impervious:
20%

Drainage:
5.1 acres
99% Burnsville
1% Dakota Co.

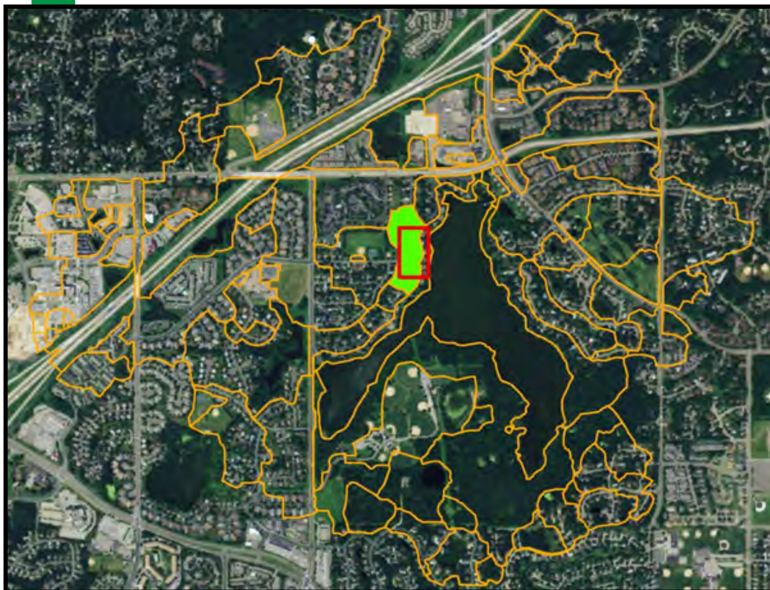
Percent Public:
24%

Percent Private:
76%



Direct-PW2 - is another example of using curb-cut rain gardens along a residential street where space is limited. The rain gardens are not the most cost effective stormwater management technique but may be the only option. The City could consider starting a rain garden program where the City will offer funding to install curb-cut rain gardens for homeowners that show interest. When a street is scheduled for reconstruction the City may also consider approaching homeowners to find interested parties and include the rain garden projects as part of the street reconstruction. These rain gardens may vary in size from 100 square feet to 400 square feet depending on what is arranged with the homeowners.

DIRECT-PW4



County Parcel ID:
N/A—City ROW
TP Reduction to Lake:
1.0 lbs/yr
Volume Reduction:
1.2 ac-ft/yr
Construction Cost:
$15,100
Life Cycle Cost:
$75,100
Life Cycle / Pound TP:
$2,500

Percent Impervious:
20%
Drainage:
2.7 acres
100% Burnsville
Percent Public:
19%
Percent Private:
81%

Direct-PW4 - continues with the trend for stormwater management using curb-cut rain gardens. This small watershed contributes only a small amount of runoff to Alimagnet Lake. However, the curb-cut rain gardens are able to treat runoff from the adjacent properties and street before discharging to the storm sewer. This can be very effective when considering the amount of fertilizer used to manage lawns, the grass clipping and leaves that may wash downstream, and salt used on sidewalks and driveways. The curb-cut rain gardens act as a barrier between the commonplace neighborhood pollutants and the downstream Alimagnet Lake.

LA3-Q

County Parcel ID:
037-026400801021

TP Reduction from Site:
5.9 lbs/yr

TP Reduction to Lake:
5.3 lbs/yr total
5.2 lbs/yr Burnsville
0.1 lbs/yr Dakota Co.

Volume Reduction:
8.2

Construction Cost:
$272,570

Life Cycle Cost:
$422,570

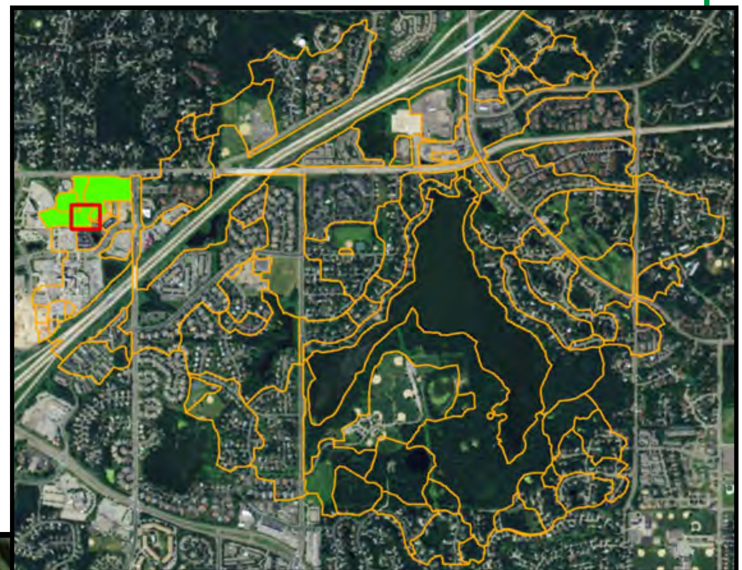
Life Cycle / Pound TP:
$2,658

Percent Impervious:
42%

Drainage:
16.5 acres
98% Burnsville
2% Dakota Co.

Percent Public:
93%

Percent Private:
7%



LA3-Q - is a small watershed in the middle of a highly urban and commercialized area. There are several existing ponds in the area but this small watershed does not have any treatment before discharging downstream. A small section of tree trenches is proposed along the road to intersect the storm sewer and infiltrate the contributing runoff. While the existing site does not currently receive treatment, some of the proposed practices downstream are more cost effective means of treating the runoff. However, if this area were to redevelop, tree trenches may be a good way to improve water quality and add some vegetative cover as well.

DIRECT-PW3.3

County Parcel ID:
037-020200055010

TP Reduction to Lake:
0.5 lbs/yr

Volume Reduction:
0.6 ac-ft/yr

Construction Cost:
$11,330

Life Cycle Cost:
$41,330

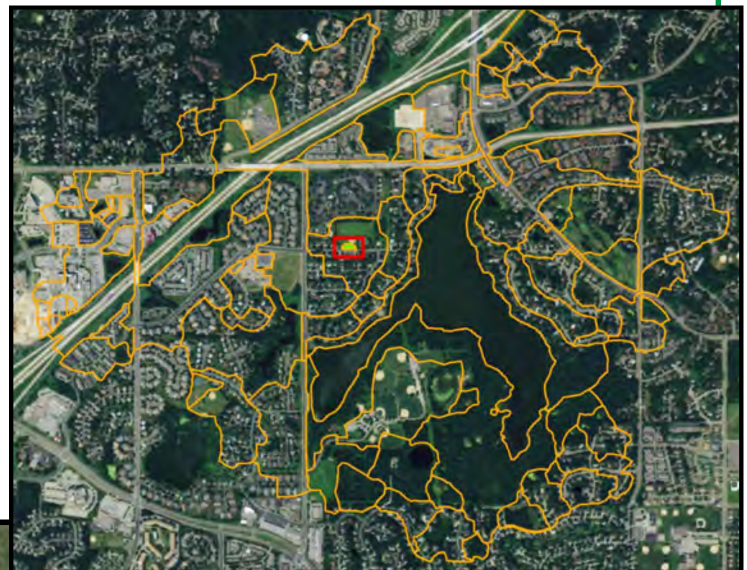
Life Cycle / Pound TP:
$2,756

Percent Impervious:
10%

Drainage:
0.4 acres
100% Burnsville

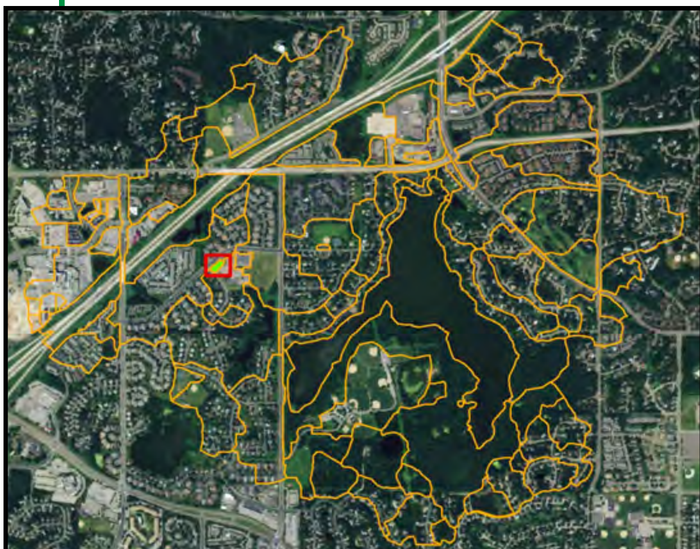
Percent Public:
100%

Percent Private:
0%



Direct-PW3.3 - is a small parking lot located in Echo Park in Burnsville. The existing parking lot drains to E. 140th Street where it is collected by the storm sewer. A patch of pervious pavement at the low end of the parking lot would cause runoff to infiltrate before discharging to the street. The pervious pavement is not a very cost effective option relative to other proposed BMPs, but the slope of the site makes it the most feasible for managing runoff from the parking lot. The adjacent green space is too steep for a surface basin.

LA3-I.5



County Parcel ID:
037-022265001010

TP Reduction from Site:
1.0 lbs/yr

TP Reduction to Lake:
0.8 lbs/yr

Volume Reduction:
0.9 ac-ft/yr

Construction Cost:
$2,220

Life Cycle Cost:
$77,220

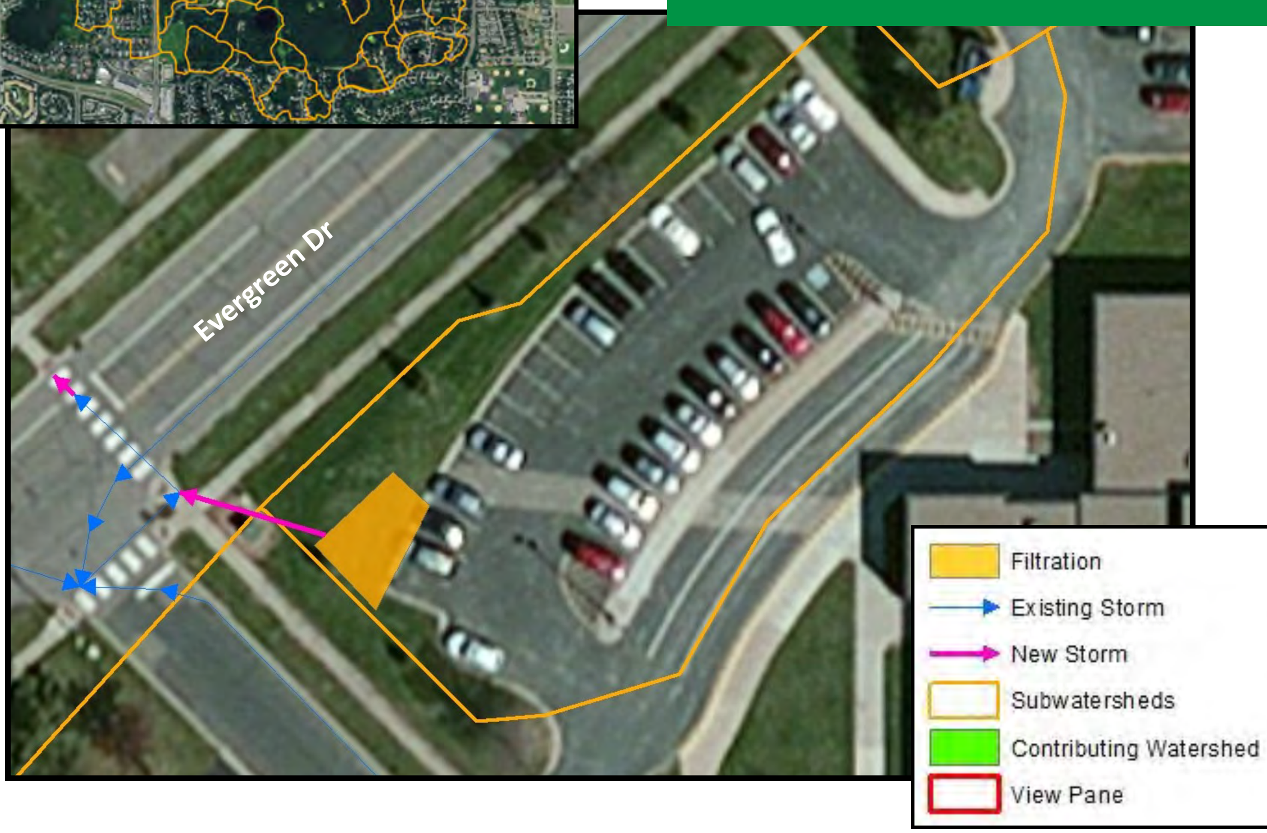
Life Cycle / Pound TP:
$3,218

Percent Impervious:
32%

Drainage:
0.5acres
100% Burnsville

Percent Public:
100%

Percent Private:
0%



LA3-I.5 - is a small parking lot on the north west side of Echo Park Elementary School. This parking lot currently discharges to the city storm sewer. Installing a curb cut and a small section of storm sewer would allow for runoff form the parking lot to be infiltrated. Due to the small watershed and phosphorus load reduction, this practice is not cost effective. Annual maintenance is too high to justify the benefit this practice may have.

LA2-A.3

County Parcel ID:
NA—City ROW

TP Reduction from site:
1.6 lbs/yr

TP Reduction to Lake:
0.9 lbs/yr total
0.9 lbs/yr Burnsville
0.0 lbs/yr Dakota Co.

Volume Reduction:
1.8 ac-ft/yr

Construction Cost:
$21,710

Life Cycle Cost:
$96,710

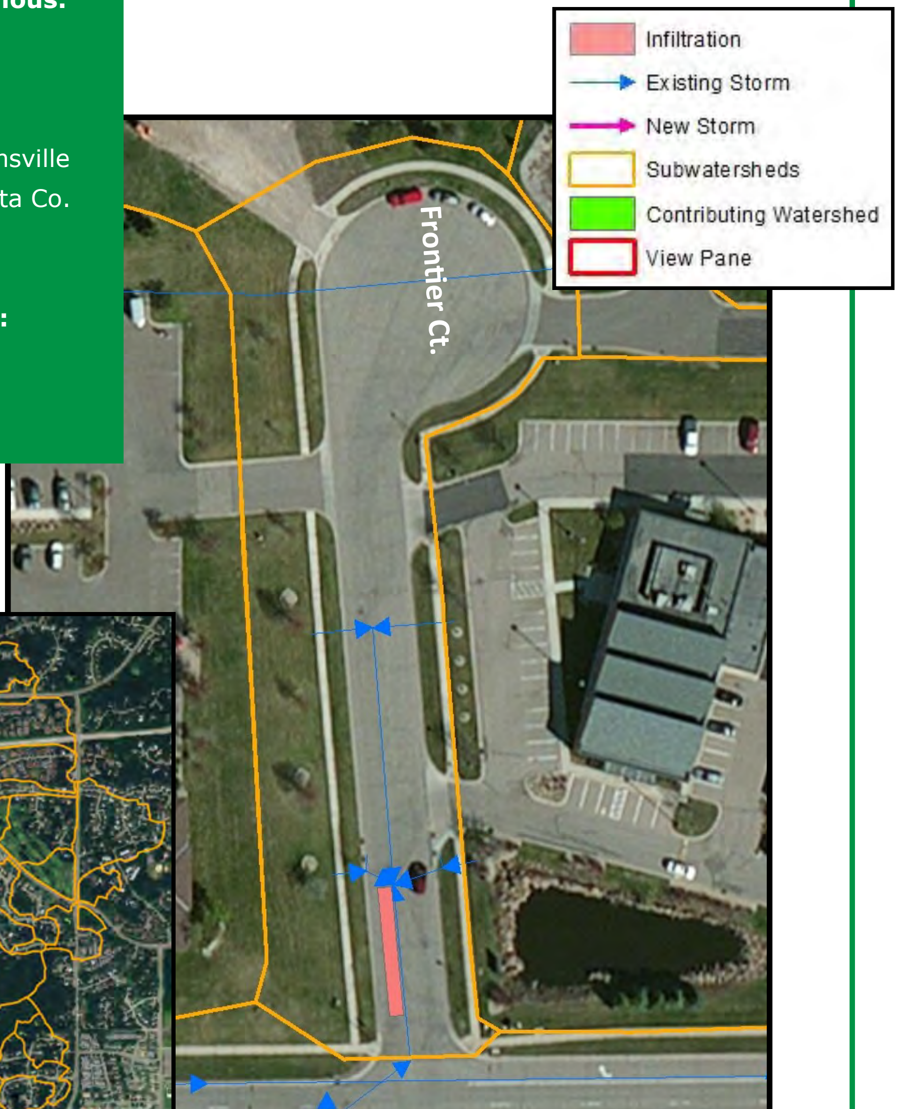
Life Cycle / Pound TP:
$3,582

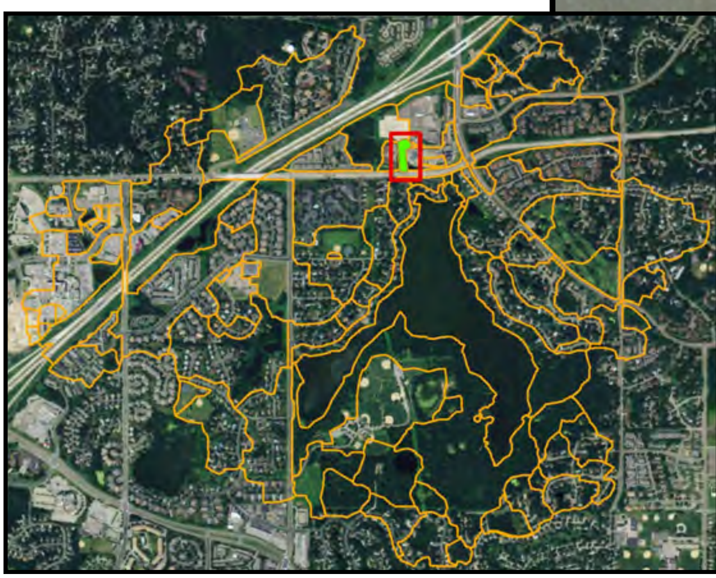
Percent Impervious:
37%

Drainage:
1.5 acres
99% Burnsville
1% Dakota Co.

Percent Public:
71%

Percent Private:
29%





LA2-A.3 - is a small cul-de-sac near the Burnsville Maintenance Facility. Runoff from this watershed currently flows to the storm sewer in McAndrews Road and west to the regional pond. The proposed practice is within the street right-of-way and would be ideally incorporated into a street reconstruction project when the time comes. Due to the small size of the watershed, this practice is not as cost effective as some other proposed BMPs.

LA3-A.4

County Parcel ID:
037-020290040011

TP Reduction from Site:
12.4 lbs/yr

TP Reduction to Lake:
6.0 lbs/yr total
5.0 lbs/yr Burnsville
1.0 lbs/yr Dakota Co.

Volume Reduction:
14.5

Construction Cost:
$622,360

Life Cycle Cost:
$772,360

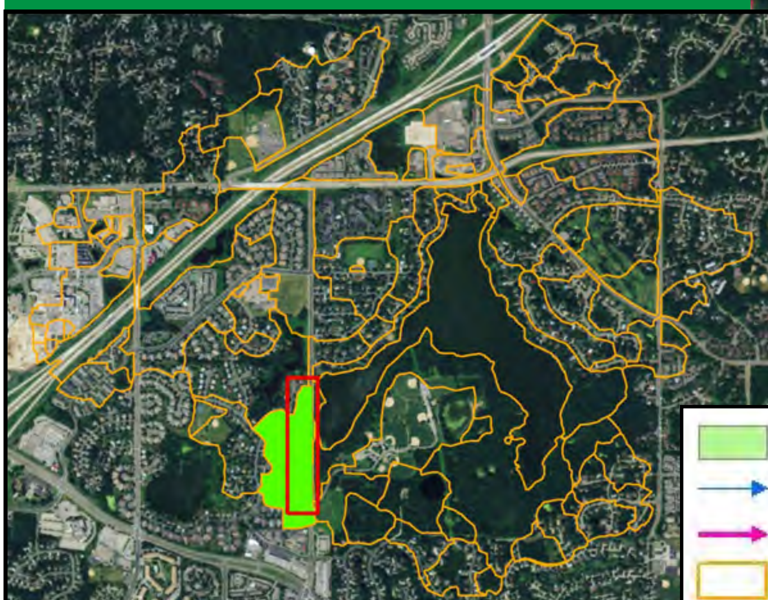
Life Cycle / Pound TP:
$4,291

Percent Impervious:
21%

Drainage:
30.1 acres
84% Burnsville
16% Dakota Co.

Percent Public:
33%

Percent Private:
67%



LA3-A.4 - has tree trenches proposed along County Road 11. Because the storm sewer for the watershed runs along the road, the sewer could be tied to the tree trenches for attenuation of flows and removal of phosphorus loads. Tree trenches are an expensive practice to implement and maintain. As a result, these tree trenches, though they remove a large amount of phosphorus, are not as cost effective as other BMPs.

LA3-A.3

County Parcel ID:
NA—City Rd

TP Reduction from Site:
7.8 lbs/yr

TP Reduction to Lake:
1.6 lbs/yr

Volume Reduction:
11.7 ac-ft/yr

Construction Cost:
$156,480

Life Cycle Cost:
$231,480

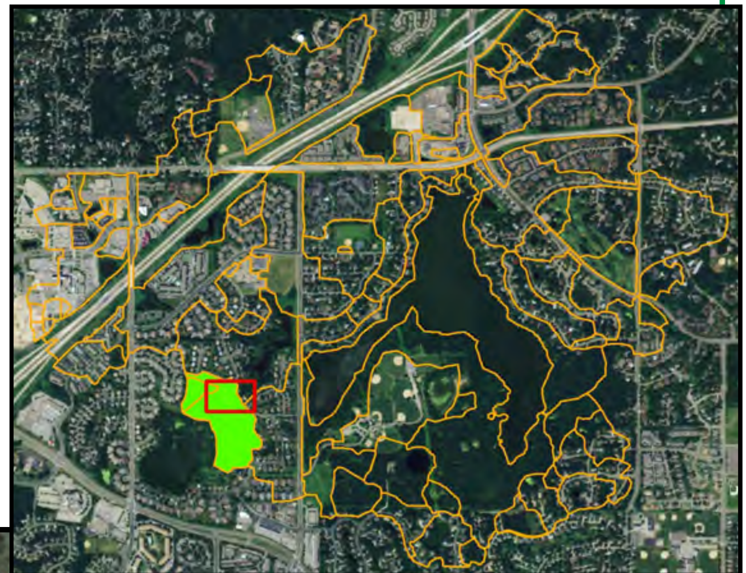
Life Cycle / Pound TP:
$4,823

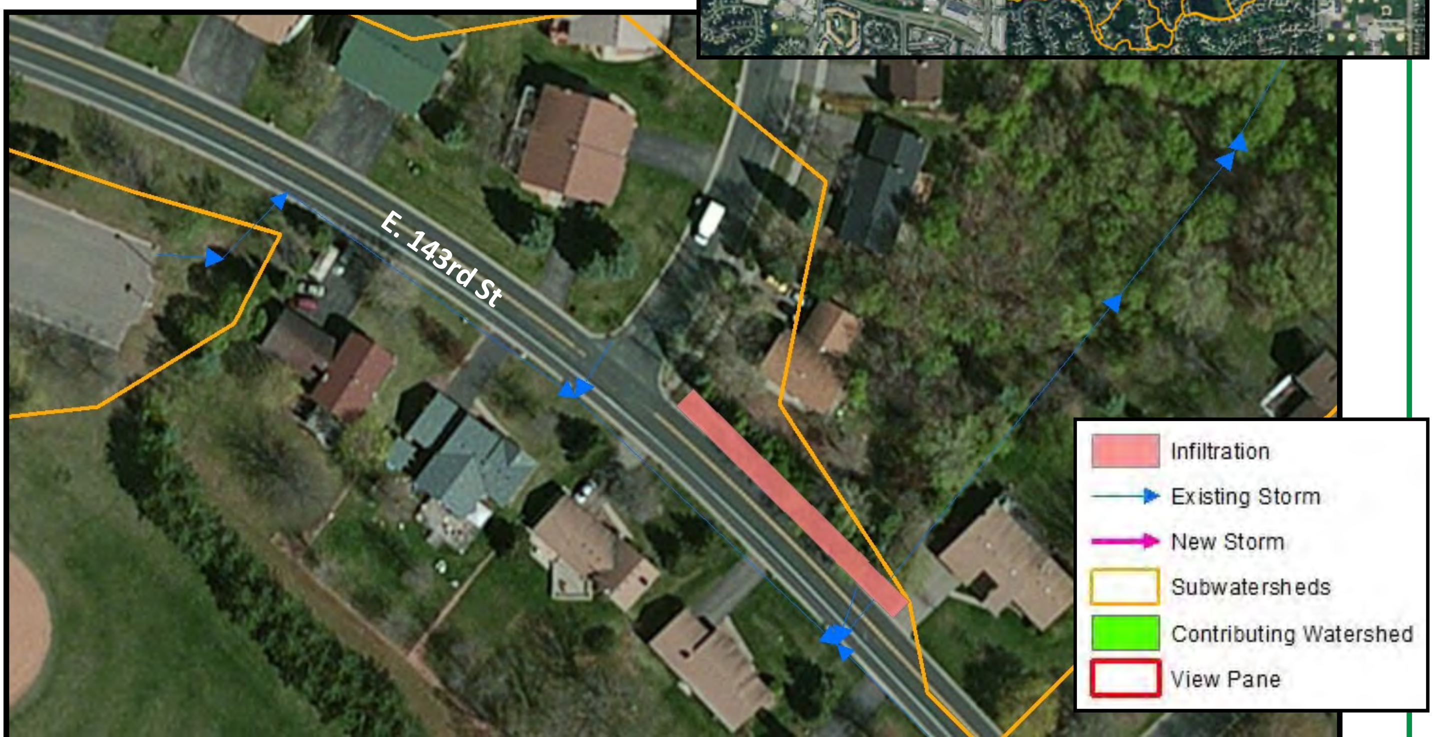
Percent Impervious:
18%

Drainage:
24.5 acres
100% Burnsville

Percent Public:
50%

Percent Private:
50%

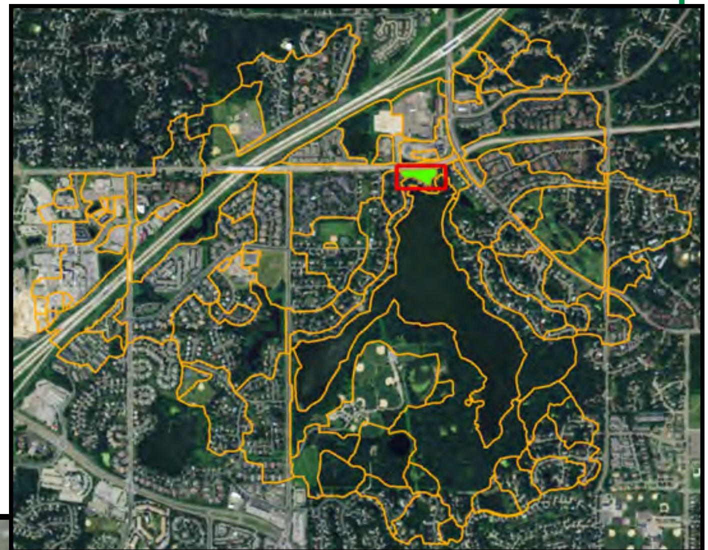




LA3-A.3 - is located along East 143rd Street where the storm sewer converges and discharges to Pond LA3-A. This project is meant to coincide with street reconstruction along East 143rd Street planned for the near future. The location is within the street right-of-way and maximizes the drainage area. It is not very cost effective in terms of reducing total load to the lake since it is located upstream of other stormwater practices. However, since the project aligns with future street reconstruction it could be considered for implementation.

DIRECT-PW1

County Parcel ID:	**Life Cycle / Pound TP:**
037-022270001071	$5,262
TP Reduction to Lake:	**Percent Impervious:**
0.8 lbs/yr total	20%
0.7 lbs/yr Burnsville	**Drainage:**
<0.1 lbs/yr Dakota Co.	2.0 acres
Volume Reduction:	95% Burnsville
N/A	5% Dakota Co.
Construction Cost:	**Percent Public:**
$6,270	58%
Life Cycle Cost:	**Percent Private:**
$126,270	42%



Direct-PW1 - is a small watershed that discharges directly to Alimagnet Lake. Some green space at the downstream end of the watershed is an ideal locations for surface stormwater management. Due to its proximity to the lake, this location would need to employ filtration as its means of treating runoff. The small filtration basin proposed in this watershed is less cost effective than other proposed BMPs because the watershed is small and media would need to be replaced about every 10 years.

LA3-I.7

County Parcel ID:
037-022265001010

TP Reduction from Site:
19.0 lbs/yr

TP Reduction to Lake:
12.1 lbs/yr

Volume Reduction:
41.3 ac-ft/yr

Construction Cost:
$2,203,900

Life Cycle Cost:
$2,353,900

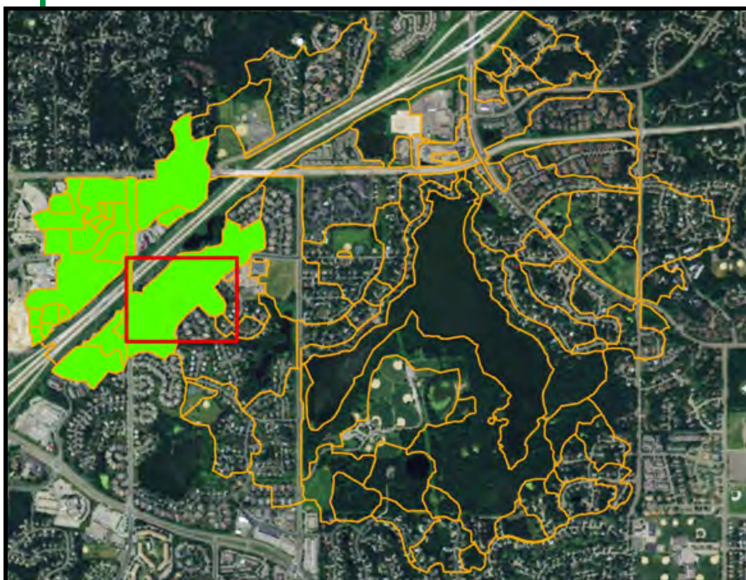
Life Cycle / Pound TP:
$6,485

Percent Impervious:
32%

Drainage:
0.5 acres
100% Burnsville

Percent Public:
100%

Percent Private:
0%



LA3-I.7 - is located along Evergreen Drive in Burnsville. The proposed tree trenches provide treatment for 140 acres and is located within the street right-of-way. The tree trenches would provide a nice visual barrier between the street and the apartment complexes to the north west. This would not only provide additional privacy to those apartments but improve the streetscape as well. The tree trenches also remove a large amount of phosphorus, but due to the high cost of installing and maintaining tree trenches, these practices are not as cost effective as other options.

LA3-A.2

County Parcel ID:
037-028480100010

TP Reduction from Site:
0.6 lbs/yr

TP Reduction to Lake:
0.2 lbs/yr

Volume Reduction:
0.7 ac-ft/yr

Construction Cost:
$4,035

Life Cycle Cost:
$79,035

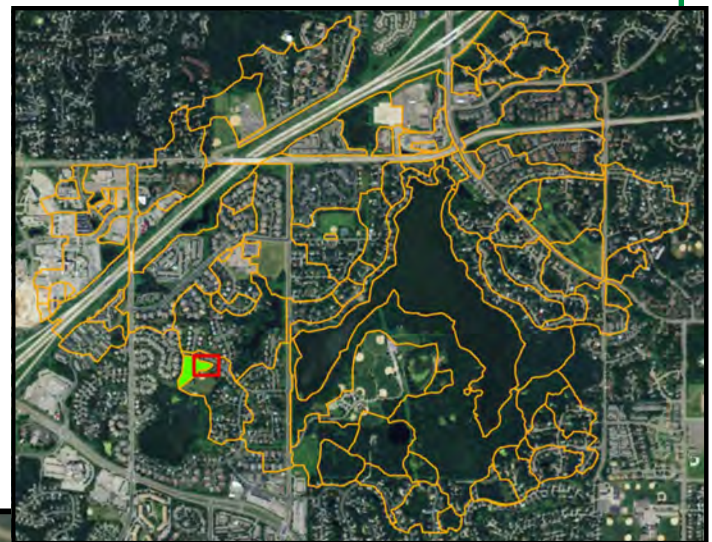
Life Cycle / Pound TP:
$13,172

Percent Impervious:
10%

Drainage:
3.1 acres
100% Burnsville

Percent Public:
100%

Percent Private:
0%



LA3-A.2 - is located in wood park along East 143rd Street. A small infiltration basin would collect runoff form the impervious parking lot before discharging to the storm sewer. While this practice is in a location that allows for easy implementation, the contributing watershed has very little impervious area and generates only a small amount of runoff and TP load. As a result, a practice in this location is not cost effective.

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SP8-B

County Parcel ID:
037-022450000010

TP Reduction from Site:
0.6 lb/yr

TP Reduction to Lake:
0.2 lbs/yr

Volume Reduction:
N/A

Construction Cost:
$20,620

Life Cycle Cost:
$95,620

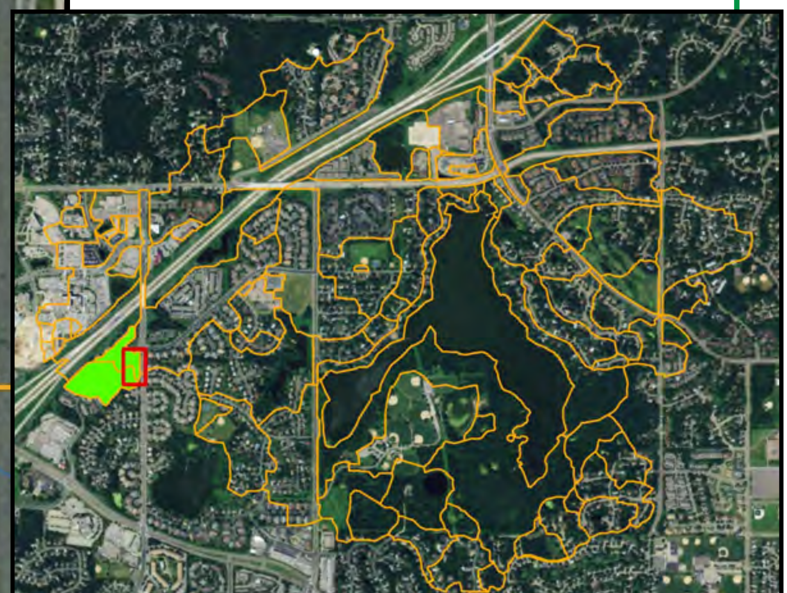
Life Cycle / Pound TP:
$15,936

Percent Impervious:
53%

Drainage:
15.0 acres
99% Burnsville
1% MNDOT

Percent Public:
19%

Percent Private:
81%



SP8-B - has an existing wetland basin at the intersection of Plymouth Avenue and Portland Avenue. The slope of the area and utilities limit available space for alternate practices. However, the existing basin is public property and there is space for a filter bench. The adjacent areas already discharge runoff to the existing basin so a filter bench is a likely candidate for stormwater management. Due to the existing treatment provided by the wetland basin, the filter bench does not show an added benefit. Because very little phosphorus is removed by the proposed filter bench, this practice is not a cost effective retrofit.

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APPLE VALLEY DIRECT STREET SWEPING

Subwatershed	Curb Miles	Canopy Coverage	Current Schedule		1X Per Month Schedule		2X Per Month Schedule	
			TP Reduction (lbs/yr)	Cost Benefit ($/lb)	TP Reduction (lbs/yr)	Cost Benefit ($/lb)	TP Reduction (lbs/yr)	Cost Benefit ($/lb)
Direct-PE1	0.34	25%	0.5	$44	0.9	$61	1.4	$77
Direct-PE2	0.10	30%	0.2	$35	0.3	$49	0.5	$62
Total	0.44	26%	0.7	$42	1.2	$58	1.9	$73

Apple Valley Direct Sweeping Street sweeping in the Apple Valley subwatersheds that drain directly to the lake was evaluated using the University of Minnesota Street Sweeping Calculator. Currently, street sweeping in these subwatersheds is conducted approximately three times per year—two times in the spring and one time in the fall. Increasing sweeping frequency to 1-2 times per month would remove approximately 2-3 times more phosphorus than the current schedule. The enhanced street sweeping schedules are more cost efficient than the curb cut raingardens proposed in subwatershed Direct-PE1. However, the proposed raingardens offer higher annual phosphorus load reductions and also provide volume reduction benefits. The University of Minnesota calculator default cost of $23/curb mile was used to represent sweeping costs.

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AL-P8

County Parcel ID: 011126001060

Pond Size: 0.88 acres

TP Reduction to Lake: 5.9 lbs/yr

Volume Reduction: N/A

Construction Cost: $66,340

Life Cycle Cost: $141,340

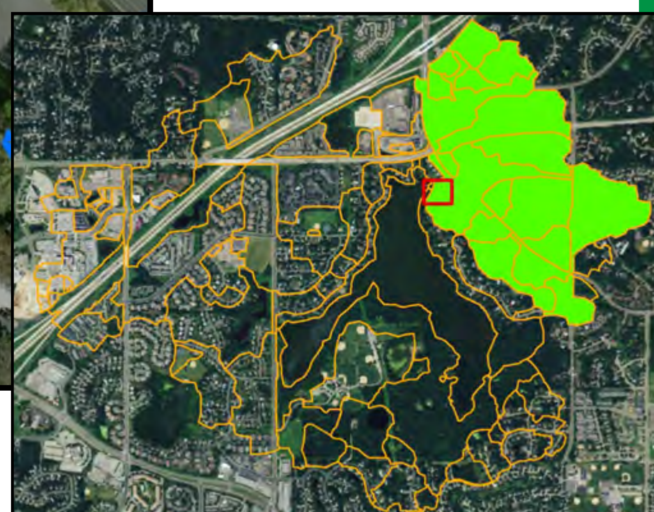
Life Cycle / Pound TP: $799/lb

Percent Impervious: 24%

Drainage: 258.3 acres
93% Apple Valley
<1% Burnsville
4% Dakota Co.
3% MNDOT

Percent Public: 25%

Percent Private: 75%



Pond AL-P8 - also has the space available for an iron-enhanced filter bench retrofit. Because this pond receives runoff from a very large portion of the Alimagnet watershed, the filter bench would serve a major role in phosphorus load reduction.

Access to the site would be possible along a City owned sidewalk to the south-east of the site. However, the most ideal location for the filter bench is within a wooded area. Construction of the system may require cutting down several mature trees and adjacent property owners would need to be convinced of the project’s value.

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AL-P8

County Parcel ID:
011126001060

Pond Size:
0.88 acres

TP Reduction to Lake:
1.7 lbs/yr

Volume Reduction:
N/A

Per Treatment Cost:
$11,733

Life Cycle Cost:
$35,200

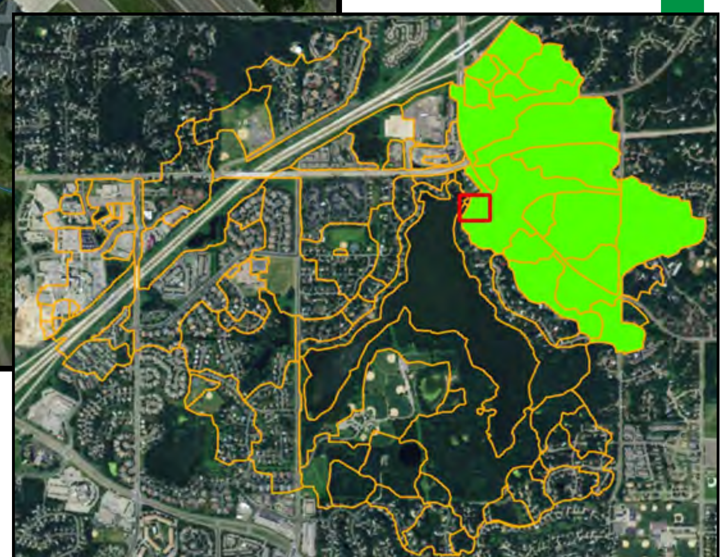
Life Cycle / Pound TP:
$690 / lb

Percent Impervious:
24%

Drainage:
258.3 acres
93% Apple Valley
<1% Burnsville
4% Dakota Co.
3% MNDOT

Percent Public:
25%

Percent Private:
75%



Pond AL-P8 - is located in Apple Valley on the northeast corner of the lake. Most of the pond is located on private property, however a City Park (Sunset Park) is located along the south edge of the pond. Drainage area to pond AL-P8 is approximately 258 acres which is 26% of the Alimagnet watershed. Phosphorus loading from sediments was estimated to be 2.0 pounds per year and was calculated using surface water TP monitoring data, pond volume, and sediment surface area. To calculate load reductions from a potential alum treatment, AL-P8 internal P load was reduced by 90%, which is a standard load reduction estimate for alum application. It is estimated that a one-time alum application for AL-P8 would cost approximately $11,733 and result in an annual TP load reduction of 1.7 pounds. It is assumed the life expectancy of one alum treatment would be about 10 years, and therefore 3 treatments would be required over a 30-year period.

DIRECT-PE1

County Parcel ID:
N/A—City Rd

TP Reduction to Lake:
4.0 lbs/yr

Volume Reduction:
4.5 ac-ft/yr

Construction Cost:
$85,280

Life Cycle Cost:
$145,280

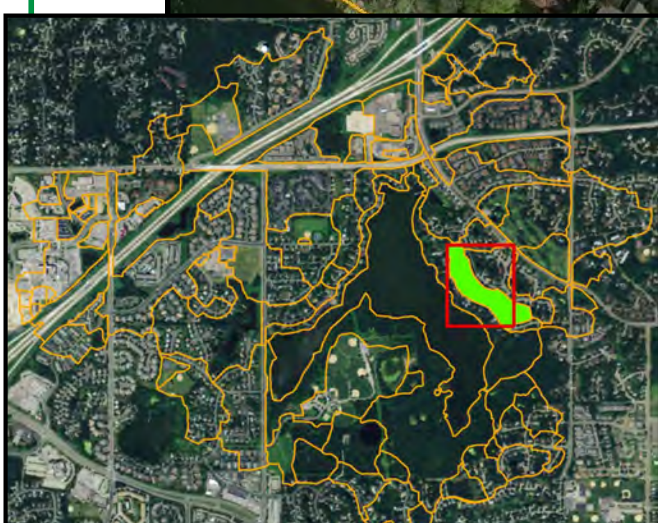
Life Cycle / Pound TP:
$1,211

Percent Impervious:
20%

Drainage:
15.3 acres
100% Apple Valley

Percent Public:
20%

Percent Private:
80%



Direct-PE - is a residential street that discharges directly to Alimagnet Lake. Space for stormwater management within the neighborhood is limited and with the input from adjacent homeowners, even the best stormwater management practices can be difficult to implement. In these scenarios, curb-cut rain gardens offer a means of managing runoff that may appeal to homeowners by spreading the BMPs throughout the watershed. However, the smaller practices also reduce the total volume of runoff managed. The rain gardens should be spaced evenly along the street and, where possible, immediately upstream of any catchbasins or storm inlets.

AL-P2.2

County Parcel ID:
NA—County Rd

TP Reduction from site:
18.2 lbs/yr

TP Reduction to Lake:
8.6 lbs/yr total
6.9 lbs/yr Apple Valley
1.7 lbs/yr Burnsville

Volume Reduction:
21.3 ac-ft

Construction Cost:
$365,670

Life Cycle Cost:
$440,670

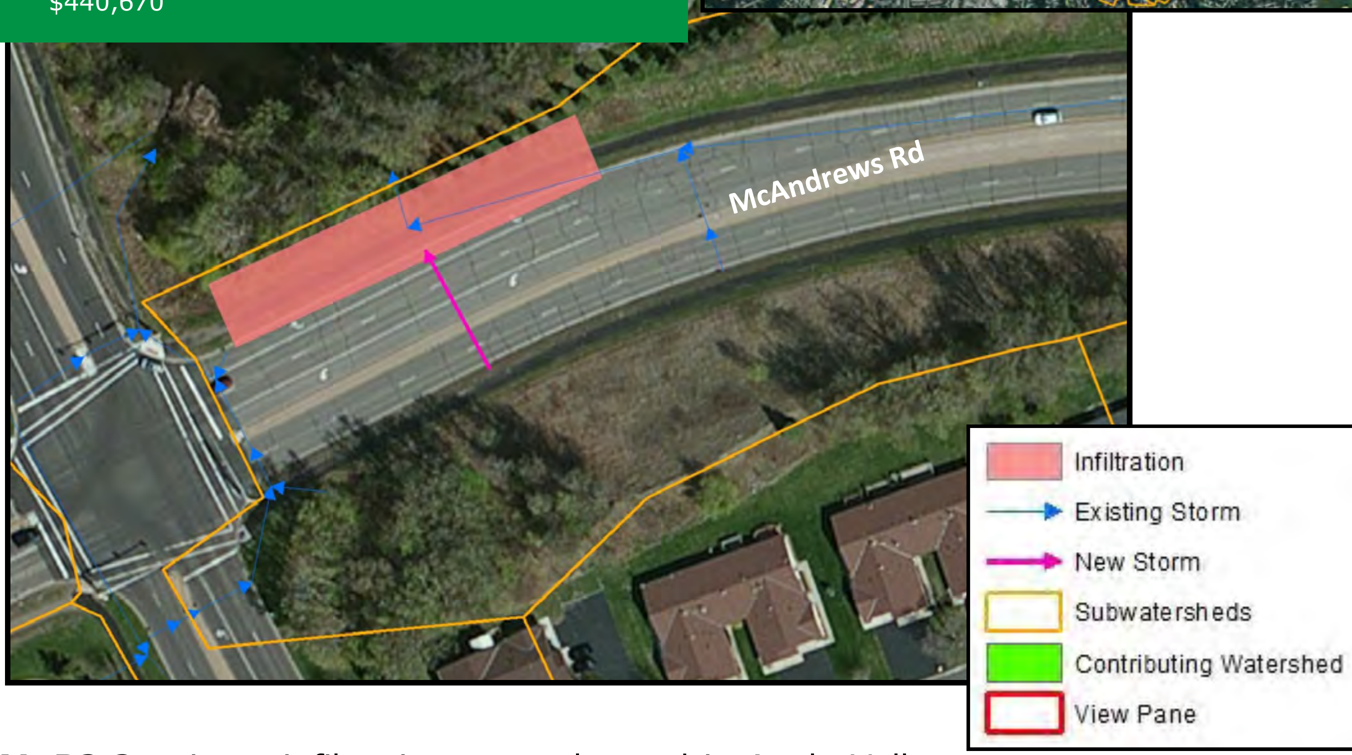
Life Cycle / Pound TP:
$1,700

Percent Impervious:
31%

Drainage:
29.5 acres
80% Apple Valley
20% Dakota Co.

Percent Public:
29%

Percent Private:
71%

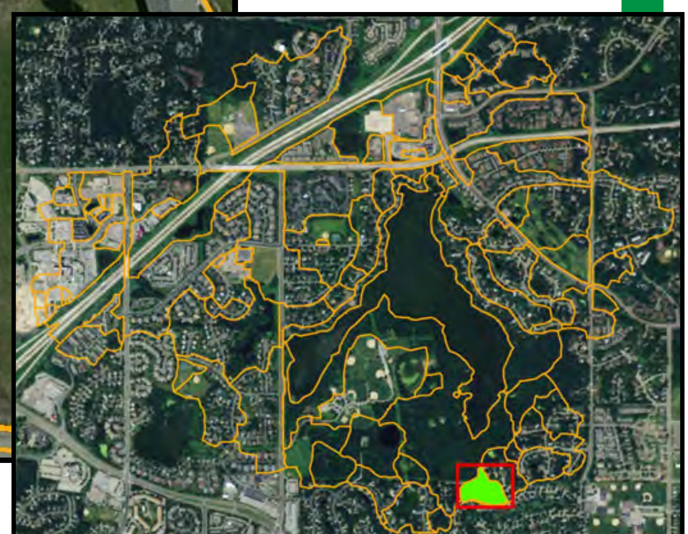


AL-P2.2 - is an infiltration venue located in Apple Valley on the north side of McAndrews Road. Because of the proximity to the road and the existing sidewalk, this practice would need to be an underground unit. The existing storm sewer drains directly though the proposed location allowing for retention of runoff from McAndrews Road and the neighborhood to the north. McAndrews is a high traffic road and accumulates greater amounts of sediment and phosphorus than local streets. Because of the higher pollutant load, this practice has the potential to trap large amounts of phosphorus. The practice is located entirely within public property and road right-of-way which allows for ease of design and construction.

DIRECT-S.2

County Parcel ID:
037-010290005010
TP Reduction to Lake:
1.6 lbs/yr
Volume Reduction:
1.9 ac-ft/yr
Construction Cost:
$10,360
Life Cycle Cost:
$85,360
Life Cycle / Pound TP:
$1,778

Percent Impervious:
12%
Drainage:
6.7 acres
100% Apple Valley
Percent Public:
85%
Percent Private:
15%



Direct-S.2 - is located at the top of a small ravine flowing through Alimagnet Lake Park. The basin would collect runoff from the adjacent parking lot and some of the street to the south. As the trend is toward larger rainfall events, ravines like this one begin to experience higher peak flows which cause erosion. The eroded nutrients and sediment can wash downstream to Alimagnet Lake. An infiltration practice at the head of the ravine will work to prevent some of the erosion and trap pollutant loads from the parking lot.

AL-P3

County Parcel ID:
NA

TP Reduction from Site:
3.2 lbs/yr

TP Reduction to Lake:
2.0 lbs/yr total
0.0 lbs/yr Apple Valley
2.0 lbs/yr Burnsville

Volume Reduction:
N/A

Construction Cost:
$45,260

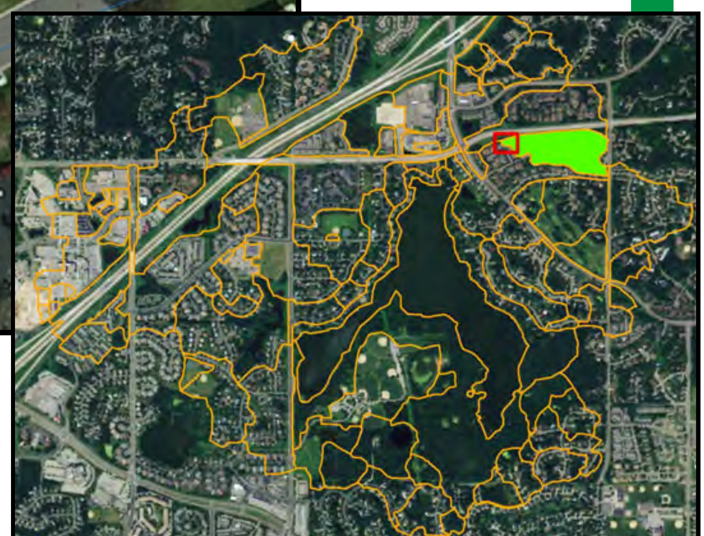
Life Cycle Cost:
$120,260

Life Cycle / Pound TP:
$1,984

Percent Impervious:
28%

Drainage:
19.9 acres
98% Apple Valley
2% Burnsville

Percent Public:
13%



AL-P3 - is an iron-enhanced filter bench proposed on an existing pond. Runoff from the adjacent community is collected in the existing pond. The community owns the pond and has expressed some interest in modifications in the past. Although this pond is on private property, a filter bench presents a good opportunity for a community willing to see improvement to the pond and the potential to reduce TP loading from a higher loading watershed.

The filter bench would be designed to maintain the existing pond functionality while filtering the first 1.1 inches of runoff through the iron-enhanced media. Runoff volumes that exceed 1.1 inches would overflow through the existing outlet structure at a slightly higher elevation.

AL-P5.2

County Parcel ID:
037-015665000040

TP Reduction from site:
14.1 lbs/yr

TP Reduction to Lake:
1.8 lbs/yr total

Volume Reduction:
16.5 ac-ft/yr

Construction Cost:
$283,400

Life Cycle Cost:
$358,400

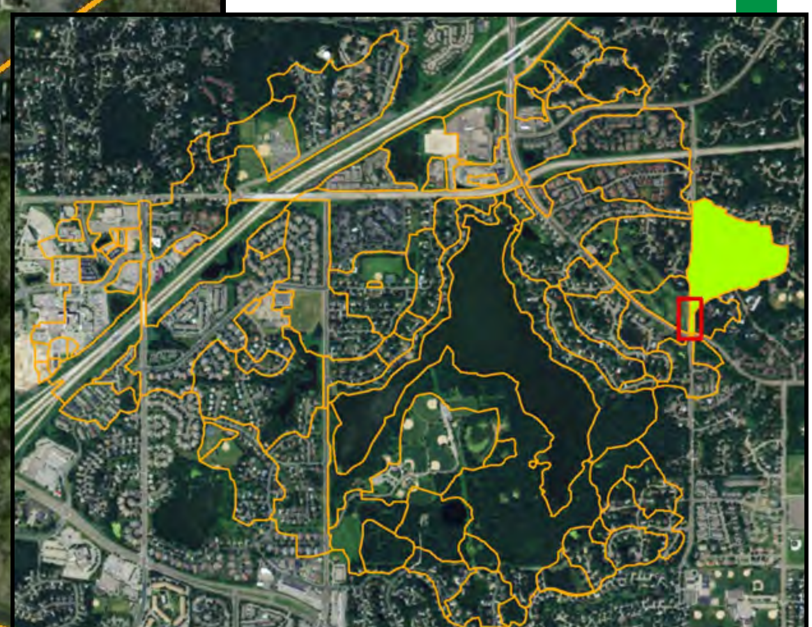
Life Cycle / Pound TP:
$6,637

Percent Impervious:
22%

Drainage:
32.6 acres
100% Apple Valley

Percent Public:
28%

Percent Private:
72%



AL-P5.2 - is an infiltration gallery situated between Garden View Drive and the Apple Valley Golf Course. The proposed layout would divert runoff from the storm sewer in Garden View Drive thus collecting runoff form the road and the neighborhood to the north-east. The slope of this location is not conducive to above ground infiltration so the cost was estimated for an underground unit. This regional treatment could effectively treat stormwater runoff in a centralized location and preserve the functionality of the golf course. However, since it is upstream of a series of stormwater ponds, the total phosphorus reduction benefit to the lake is low compared to some of the other proposed practices.

5.0 Recommendations

The proposed green infrastructure have been prioritized based on the 30 year life cycle cost per pound of TP removed. The most cost effective projects are given first priority and less effective projects have lower priorities. These practices have been partitioned into City of Burnsville (Table 3) and City of Apple Valley (Table 4) projects. The tables and one page summaries presented previously are presented in order of total life cycle cost per pound of TP removed. The tables should be used to gauge the value of each proposed practice and plan for future projects.

5.1 CITY OF BURNSVILLE PROJECTS

In citing and developing the list of proposed projects, Wenck focused on all potential project locations, but gave additional attention to tax exempt properties (parks, schools, churches), easements, and areas within city, county, and state right of way as they are usually easier to implement, maintain, and manage over the life of the practice. A breakdown of the percent of public and private property being treated by an individual practice is listed in Section 4.0. City of Burnsville projects are ranked in Table 3 based on life cycle cost per pound of TP removed. Wenck recommends the City focus its initial efforts on implementing an enhanced street sweeping schedule for the direct subwatersheds, alum treatments in ponds LA2-A and LA3-A, and the underground infiltration gallery proposed at Echo Park Elementary School (LA3-I.4). The Echo Park gallery is a relatively cost effective option and manages runoff from a large watershed. This project has a watershed larger than recommended for infiltration practices which may cause changes in groundwater elevations. It will be important for the City to review the potential impacts before moving forward.

Table 3: Priority list of Burnsville projects by life cycle cost per pound of TP removed.

Priority	Project	TP removed from site (lbs/yr)	TP load reduction to lake (lbs/yr)	Volume reduction (ac-ft/yr)	Construction cost	Construction cost per pound of TP to lake	Life cycle cost (30 yrs)	Life cycle cost per pound of TP to lake
1	Enhanced Sweeping [1X/Month]	5.6	5.6	N/A	$264/yr	$47	$7,920	$47
	Enhanced Sweeping [2X/Month]	8.8	8.8	N/A	$528/yr	$60	$15,840	$60
2	LA2-A Alum	10.4	10.4	N/A	$14,667	$141	$44,000	$141
3	LA3-A Alum	9.6	9.6	N/A	$17,333	$181	$52,000	$181
4	LA3-I.4	51.4	35.1	57.6	$187,245	$179	$262,245	$249
5	LA3-I.1	18.1	11.8	22.2	$19,580	$55	$94,580	$267
6	LA3-A Bench	12.7	12.7	Filtration	$76,280	$200	$151,280	$397
7	LA2-A Bench	16.1	16.1	Filtration	$246,730	$511	$321,730	$666
8	LA2-A.5	11.9	6.5	13.9	$77,910	$400	$152,910	$784
9	Direct-PW3.2 Raingardens	3.2	3.2	3.5	$63,500	$662	$123,500	$1,287
10	Direct-PW6	3.6	3.6	Filtration	$84,800	$785	$159,800	$1,480
11	Direct-PW3.1	4.6	4.6	9.8	$158,830	$540	$233,830	$1,694
12	LA3-I.3	2.0	1.6	2.1	$6,435	$134	$81,435	$1,697
13	LA2-A.2	11.2	5.9	12.6	$238,220	$1,346	$313,220	$1,770
14	Direct-PW5	1.3	1.3	1.5	$17,985	$461	$77,985	$2,000

Priority	Project	TP removed from site (lbs/yr)	TP load reduction to lake (lbs/yr)	Volume reduction (ac-ft/yr)	Construction cost	Construction cost per pound of TP to lake	Life cycle cost (30 yrs)	Life cycle cost per pound of TP to lake
	Raingardens							
15	LA2-A.4	16.7	3.0	19.0	$111,590	$129	$186,590	$2,073
16	Direct-PW2 Raingardens	1.2	1.2	1.4	$28,670	$796	$88,670	$2,463
17	Direct-PW4 Raingardens	1.0	1.0	1.2	$15,100	$504	$75,100	$2,500
18	LA3-Q	5.9	5.3	8.2	$272,570	$1,714	$422,569	$2,658
19	Direct-PW3.3	0.5	0.5	0.6	$11,330	756	$41,330	$2,756
20	LA3-I.5	1.0	0.8	0.9	$2,220	$93	$77,220	$3,218
21	LA2-A.3	1.6	0.9	1.8	$21,710	$804	$96,710	$3,582
22	LA3-A.4	12.4	6.0	14.5	$622,360	$3,458	$772,360	$4,291
23	LA3-A.3	7.8	1.6	11.7	$156,480	$3,260	$231,480	$4,823
24	Direct-PW1	0.8	0.8	Filtration	$6,270	$262	$126,270	$5,262
25	LA3-I.7	19.0	12.1	41.3	$2,203,900	$6,071	$2,353,900	$6,485
26	LA3-A.2	0.6	0.2	0.7	$4,035	$673	$79,035	$13,172
27	SP8-B Bench	0.6	0.2	Filtration	$20,620	$3,437	$95,620	$15,936

5.2 CITY OF APPLE VALLEY PROJECTS

In citing and developing the list of proposed projects, Wenck focused on all potential project locations, but gave additional attention to tax exempt properties (parks, schools, churches), easements, and areas within city, county, and state right of way as they are usually easier to implement, maintain, and manage over the life of the practice. A breakdown of the percent of public and private property being treated by an individual practice is listed in Section 4.0. City of Apple Valley projects are ranked in Table 4 based on life cycle cost per pound of TP removed. Wenck Recommends the City focus its initial efforts on an enhanced street sweeping schedule in the direct watershed and a filter bench in Pond AL-P8. These practices are the most cost effective options and will make progress toward reaching the TMDL goals. Access to the filter bench can be gained through Sunset Park and nearby homeowners should be engaged to share their input on the project. While the Alum treatment in Pond AL-P8 appears to be a cost effective options, it does not decrease phosphorus loads as much as the filter bench and some of the other proposed BMPs.

Table 4: Cost and pollutant removal summary for City of Apple Valley projects.

Priority	Project	TP removed from site (lbs/yr)	TP load reduction to lake (lbs/yr)	Volume reduction (ac-ft/yr)	Construction cost	Construction cost per pound of TP to lake	Life cycle cost (30 yrs)	Life cycle per pound of TP to lake
1	Enhanced Sweeping [1X/Month]	1.2	1.2	N/A	$70/yr	$58	$2,100	$58
	Enhanced Sweeping [2X/Month]	1.9	1.9	N/A	$139/yr	$73	$4,170	$73
2a	AL-P8 Bench	5.9	5.9	Filtration	$66,340	$375	$141,340	$799
2b	AL-P8 Alum	1.7	1.7	N/A	$11,733	$690	$35,200	$690
3	Direct-PE1 Raingardens	4.0	4.0	4.49	$85,280	$711	$145,280	$1,211
4	AL-P2.2	18.2	8.6	21.25	$365,670	$1,417	$440,670	$1,700
5	Direct-S.2	1.6	1.6	1.87	$10,360	$216	$85,360	$1,778
6	AL-P3 Bench	3.2	2.0	Filtration	$45,260	$754	$120,260	$1,984
7	AL-P5.2	14.1	1.8	16.52	$283,400	$5,248	$358,400	$6,637

5.3 NEXT STEPS

In order to accomplish improved water quality within the study area, the VRWJPO and Cities should take the following steps:

- **Select** projects that the Cities would like to construct within the foreseeable future.
- **Estimate** the total phosphorus reduction resulting from the projects to see if the TMDL goals will be met.
- **Form** relationships with private entities where coordinating may be required.
- **Apply** for grants. The Minnesota Clean Water Fund is receiving applications for funding on projects that improve water quality throughout the state.
- **Notify** property owners this report is available and request feedback from interested parties.
- **Contact** Dakota County to begin the planning process for practices along county roads.
- **Evaluate** any area impacts resulting from the selected projects.
- **Fully Design and Construct** projects that receive funding.

Wenck can assist the Cities with securing funding, if needed, and is available for questions from other interested parties.

6.0 References

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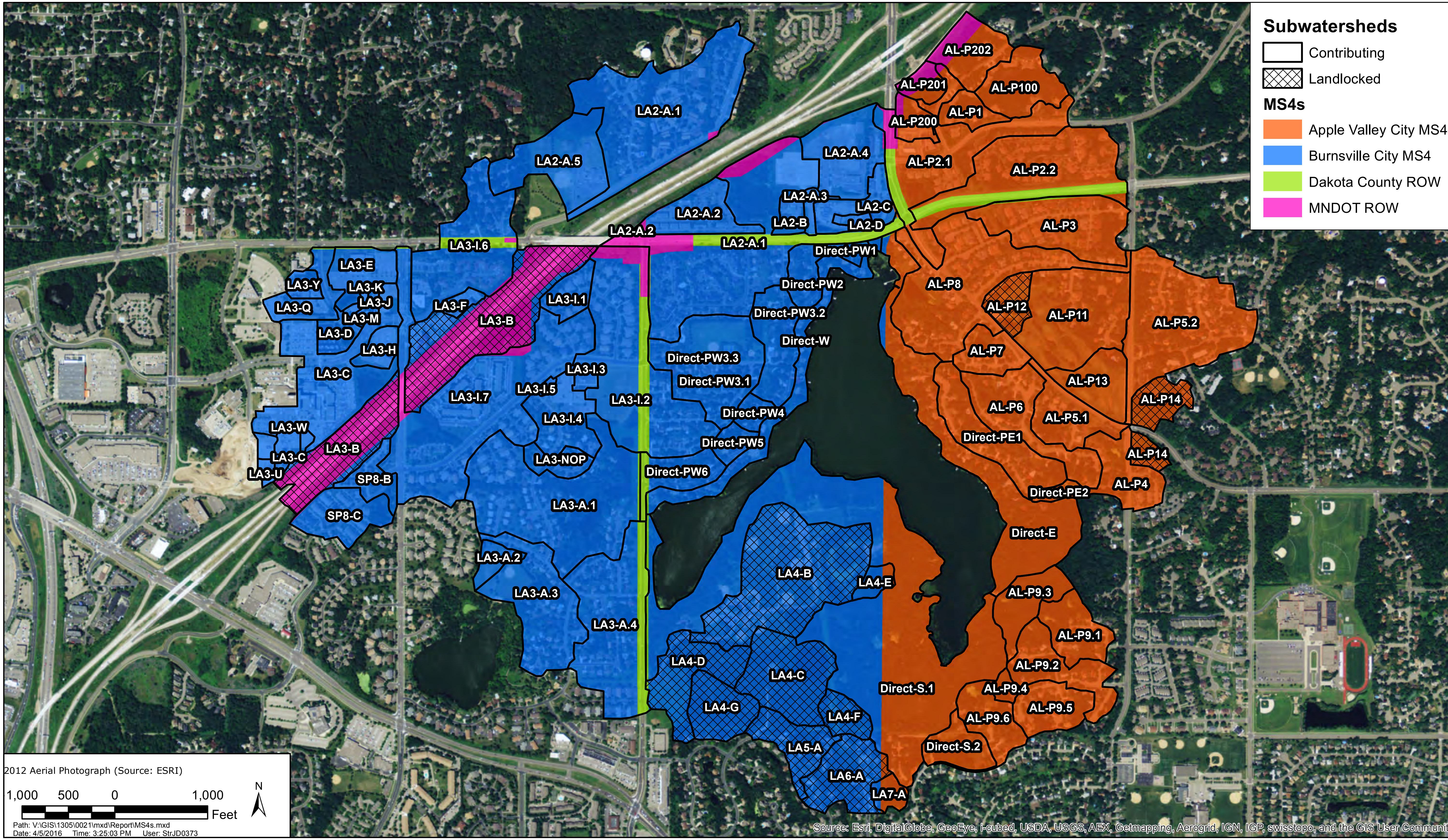
Figures



ALIMAGNET LAKE SUBWATERSHED ASSESSMENT

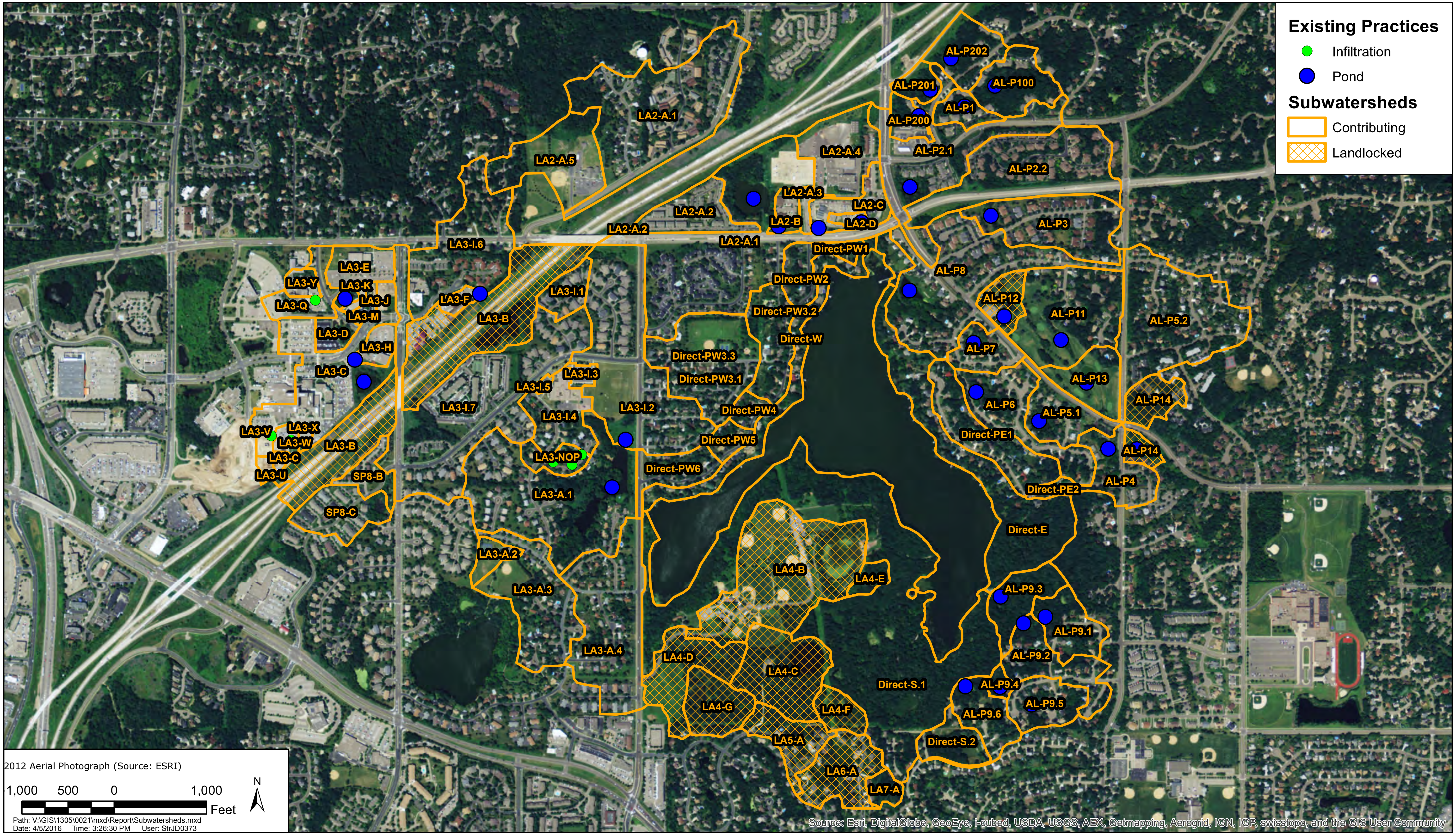
MS4 Coverage

WENCK ASSOCIATES

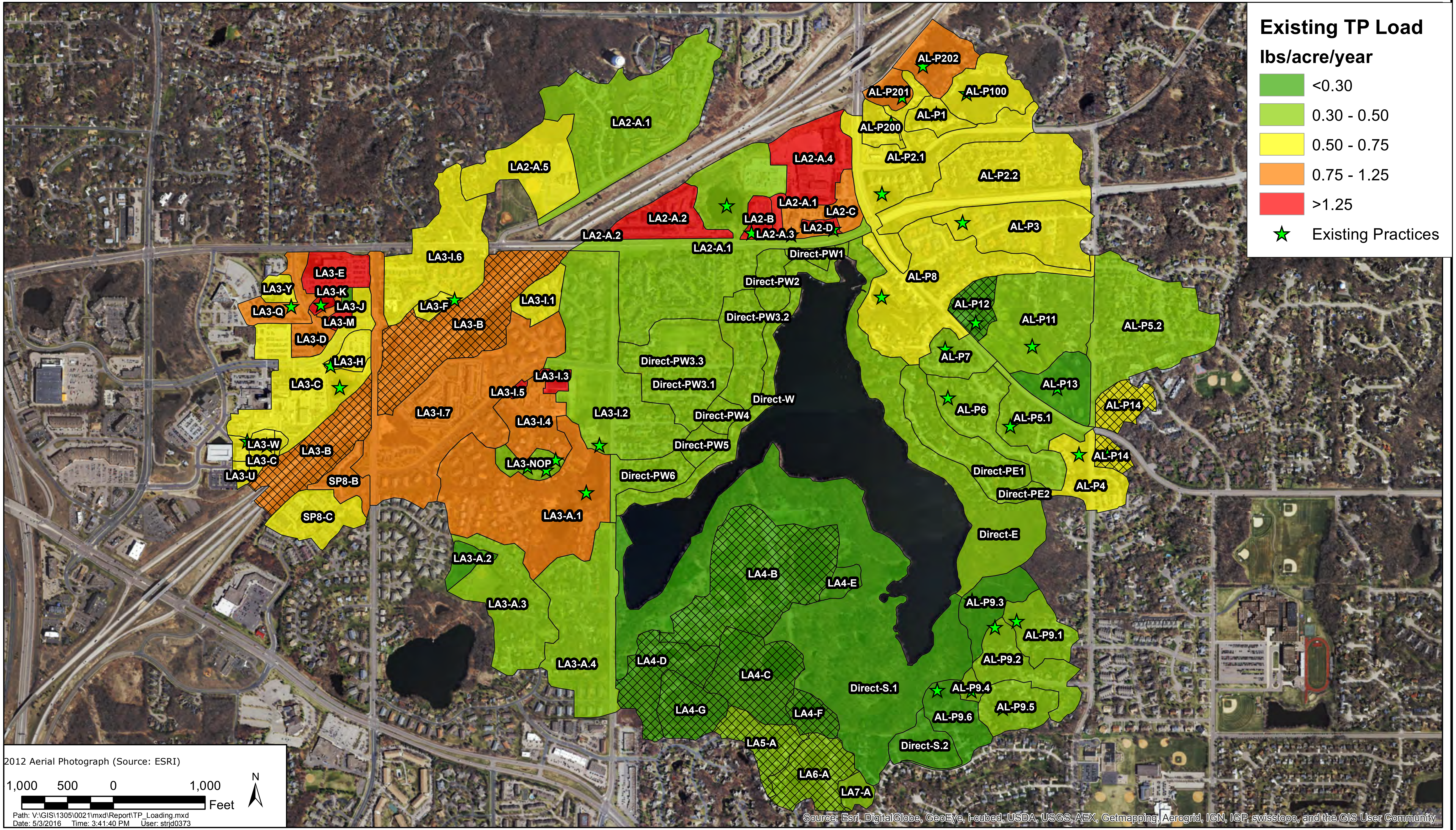
Responsive partner. Exceptional outcomes.

APRIL 2016

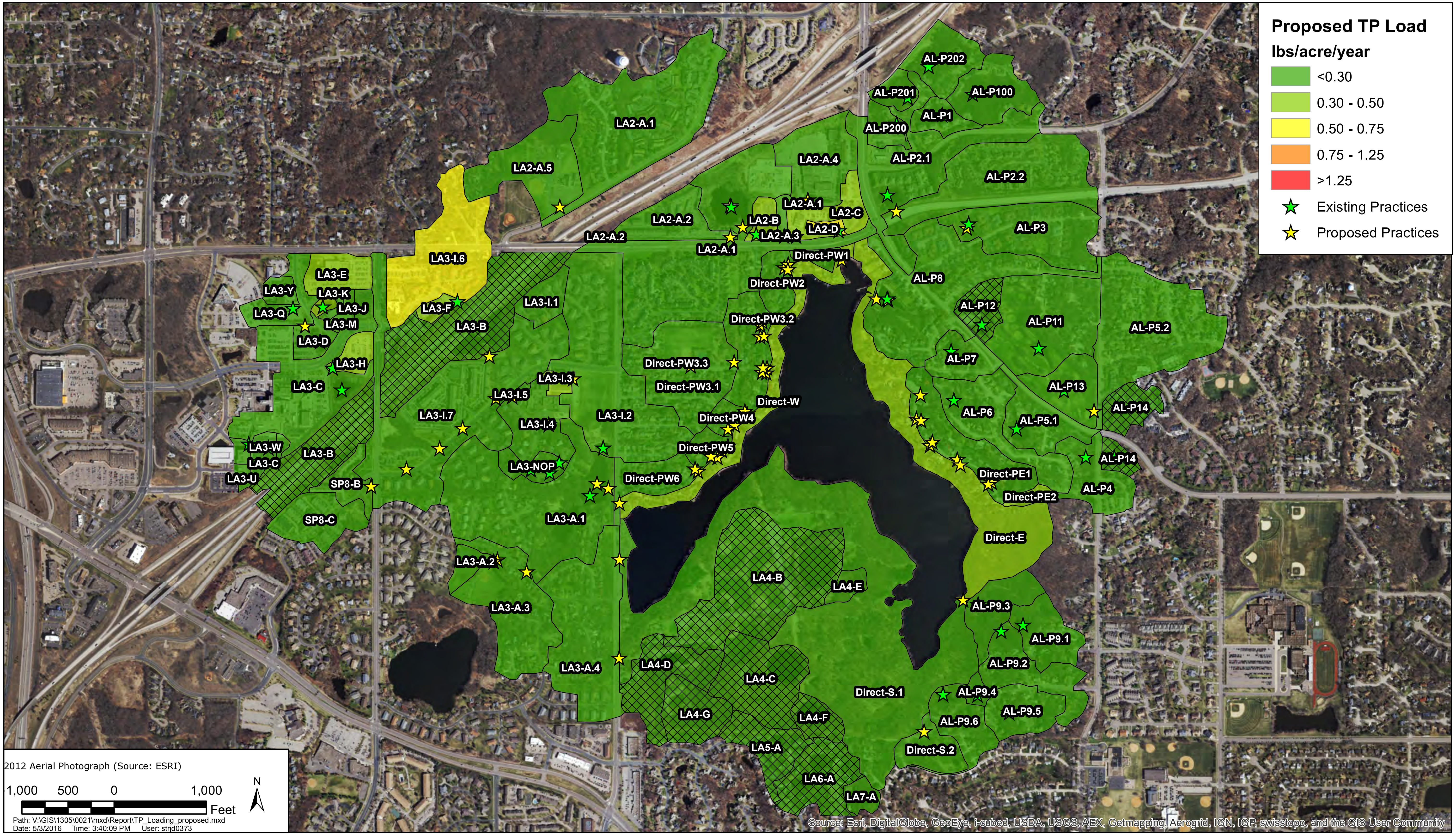
Figure 1



ALIMAGNET LAKE SUBWATERSHED ASSESSMENT	WENCK ASSOCIATES	APRIL 2016
Subwatersheds and Existing Stormwater Practices	Responsive partner. Exceptional outcomes.	Figure 2



ALIMAGNET LAKE SUBWATERSHED ASSESSMENT	WENCK ASSOCIATES Responsive partner. Exceptional outcomes.	APRIL 2016
Existing TP Loading		Figure 3



ALIMAGNET LAKE SUBWATERSHED ASSESSMENT

Proposed TP Loading

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Figure 4