EAGLE CREEK SUBWATERSHED ASSESSMENT

For:

CITY OF SAVAGE, MINNESOTA

JUNE 28, 2022

Prepared by:

CERTIFICATION

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly licensed professional engineer under the laws of the State of Minnesota.

William C. Alms, P.E.

Date: June 28, 2022 Lic. No. 54301

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1.0 Executive Summary

This subwatershed assessment analyzes the existing Eagle Creek subwatershed and details potential Best Management Practices (BMPs) to reduce external pollutant loading to the stream.

Eagle Creek is a DNR designated trout stream in Scott County that flows from Boiling Springs north through Shakopee, Savage and the Minnesota Valley National Wildlife Refuge before flowing into the Minnesota River. Flow is primarily driven by groundwater. The Eagle Creek subwatershed covers about 1,500 acres. The stream corridor from the headwaters to Trunk Highway 13 is nearly all part of the Eagle Creek Aquatic Management Area. The vast majority of the Subwatershed does not drain to Eagle Creek until the box culvert at Trunk Highway 13 or further downstream. This is due to the existing stormwater system, which includes a siphon structure, being routed to avoid outfalls in the trout-supporting reaches of Eagle Creek as shown in **Figure 1**.

WSB reviewed previous studies to identify additional characteristics of Eagle Creek to investigate and manage further (**Section 3.3**). The Lower Minnesota River WRAPS report calls for an 8% reduction in *E. coli* loading to the creek. As part of the Lower Minnesota River TMDL Report Part I, nearly 100 water samples from Eagle Creek were analyzed. This study found a geometric mean concentration of 79 organisms/100 milliliters. No samples exceeded the individual sample standard. Pinpointing the source of *E. coli* in the Creek has been difficult. Wildlife, particularly avian, are currently thought to be the primary source. Further monitoring is necessary to confirm this. Numerous organization collaborate to monitor long-term water quality in the creek. This has been focused on chloride levels. The City also monitors select stormwater ponds for phosphorus, suspended sediments, dissolved oxygen and chloride among other pollutants. DNR fish surveys have shown a decline in Eagle Creek's brown trout population. Geomorphic assessments have shown aggradation and excessive stream width to be an issue in the Creek.

An XPSWMM model was developed to further understand the subwatershed's hydrology and hydraulics. Potential BMPs and their locations identified by the City and WSB were based on BMPs already in place, feasible locations available, and upstream tributary areas. Proposed BMP sizes and locations were evaluated using P8 and the BWSR Soil Loss Spreadsheet. All models were used to determine water quality improvement potential. Top performing potential BMPs are described in further detail in **Section 4.1**.

2.0 Background

2.1 Purpose

The Eagle Creek Subwatershed Stormwater Study will be a valuable asset to the City of Savage to identify opportunities to reduce external loading to Eagle Creek and improve water quality and habitat in Eagle Creek.

Three goals were identified as part of the Eagle Creek Subwatershed Stormwater Study.

1. Provide detailed information on external loading, including hydrologic and hydraulic data and water quality modeling.
2. Summarize existing reports and water quality monitoring data.
3. Provide a detailed outline of future projects and improvements to address external loading.

2.2 Study Area

The Eagle Creek subwatershed is 1,524 acres. The west branch flows 1.3 miles north from Boiling Springs in Shakopee before its confluence with the east branch. The east branch begins west of CSAH 13 and north of 132nd Street in Savage, flowing 0.6 miles to the confluence. From this confluence Eagle Creek flows 0.9 miles north through Savage and the Minnesota Valley National Wildlife Refuge before draining into the Minnesota River. The Subwatershed is generally

Figure 1: Drainage Patterns

Eagle Creek Subwatershed Stormwater Study
City of Savage

N

0 1,600 Feet

1 inch = 1,600 feet

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bordered by McColl Drive in the south, County Roads 18 and 21 in the west, Trunk Highway 13 in the north and Wyoming Avenue in the east. This delineation differs from that found in the 2022 Trout Streams Gaps Analysis and Management Plan by expanding westward, primarily due to information on storm sewer in the City of Shakopee. In addition to the surface water which reaches the stream, the hydrology and hydraulics are influenced by groundwater. For this reason the stream flows year round, typically averaging 8.5 cubic feet per second. This area is unique in that there are no primary stormwater outlets draining to Eagle Creek until it meets 13th Avenue. A business park siphon structure allows drainage from 384 acres to flow west under Eagle Creek, where it is conveyed through the City of Savage stormwater system to its outlet north of Trunk Highway 13. An additional 469 acres from the City of Shakopee and the City of Savage also utilize this outlet. Approximately 193 acres drain directly to Eagle Creek. The vast majority of this land is within the Eagle Creek Aquatic Management Area.

Land use surrounding the creek was agricultural until the 1990s. As the area was developed, lawsuits led to the creation of the Eagle Creek Aquatic Management Area. Because of this, storm sewer systems are not designed to outlet into Eagle Creek until it reaches Trunk Highway 13. Today the area is approximately one-third residential and one-third open space or undeveloped. Remaining land is generally industrial, commercial or agricultural (**Figure 2**). Underlying soils are nearly all hydrologic soil group A or D (**Figure 3**). Although numerous stormwater ponds currently exist in both the City of Savage and the City of Shakopee, additional treatment opportunities are available.

2.3 Modeling Methodology

The Citywide XPSWMM model was built utilizing XPSWMM 2019.1.3 software. The model structure as well as catchment, node, and link data were configured using ArcGIS Pro. A seamless transfer from ArcGIS Pro to XPSWMM was completed to move all the data into the modeling software. Various hand edits and error adjustments were made in XPSWMM to obtain a clean and useful model. The XPSWMM model incorporates a runoff mode, hydraulics mode, boundary conditions, and rainfall data. The subwatershed XPSWMM model contains 98 catchments. The catchment delineation scale was determined by the location of storage areas. The area of each catchment was calculated in acres. The model utilizes the runoff routing method to generate a hydrograph and flow for each catchment. The runoff routing method requires area, impervious percent, slope, width, and infiltration parameters, all of which were calculated using ArcGIS Pro. Green-Ampt infiltration was calculated from existing land use (**Figure 2**) and soils (**Figure 3**). The hydraulics mode represents the network of nodes and links that route water throughout the study area. The network contains storm sewer structures, ponds, outfalls, storm sewer pipes, overland flows, and channels. A total of 143 nodes were included in the model and showed water leaving the model at one of five outfalls. The 2,10, and 100-year storms were also modeled. A model was also developed for back to back 100-year events. Depths for these events are shown in **Table 1**. A detailed schematic of the XPSWMM model is shown in **Figure 4**. Results can be seen in **Figure 5** as well as **Appendix C**.

Table 1: Scott County Atlas 14 Rainfall Depths

Storm Event	Rainfall Depth
2-year	2.84
10-year	4.22
100-year	7.43

Water quality modeling was performed using the P8 version 3.4 and the BWSR Soil Loss Spreadsheet. P8 was used to create an existing conditions model, evaluate green infrastructure BMPs such as filtration basins, and to calculate pollution concentrations to be used in water reuse evaluation. Stormwater BMPs within P8 were created using LiDAR and City as-builts to model existing stormwater routing and proposed BMPs. Particle sizes were input using P8 provided

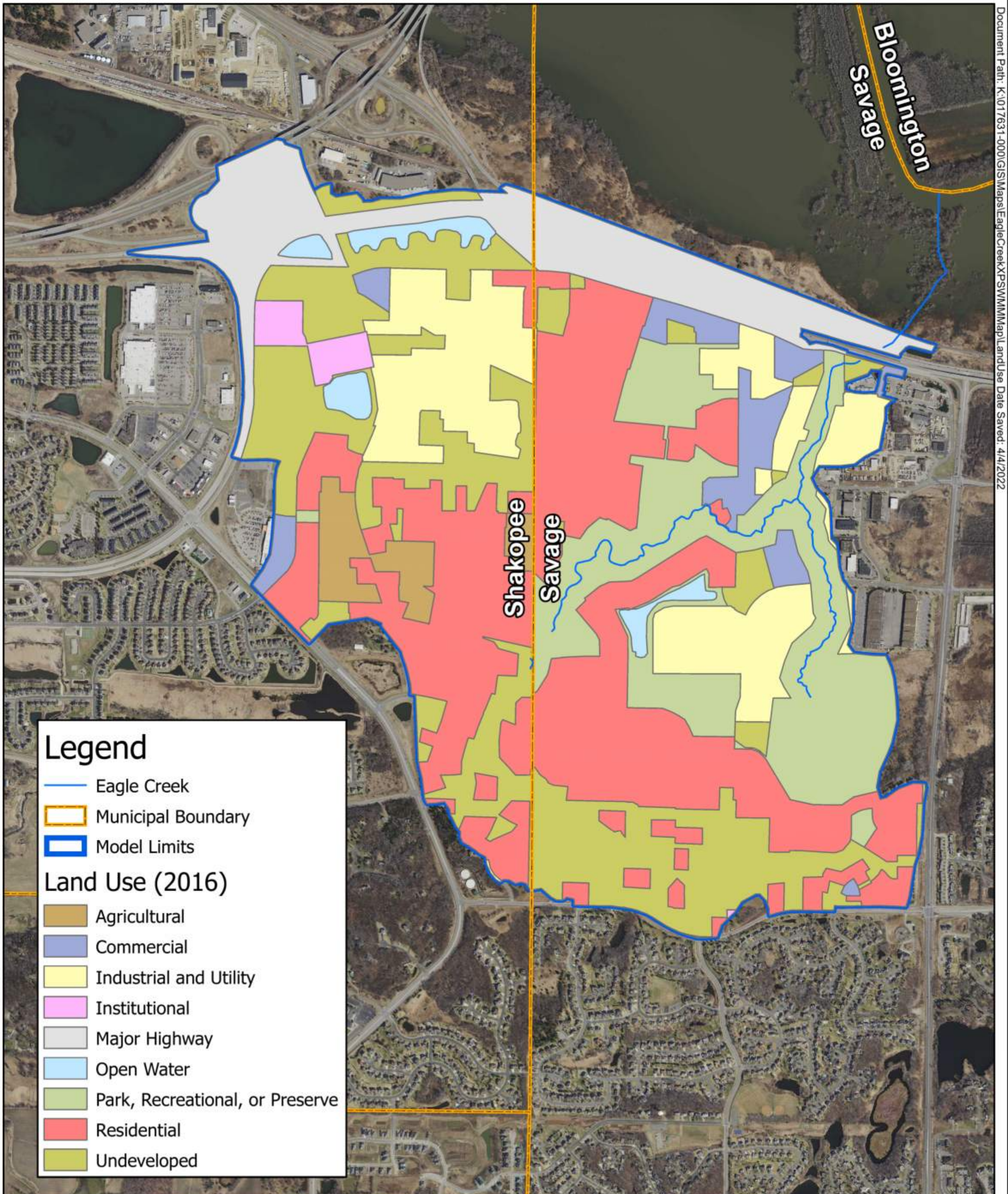

Figure 2: Land Use

Eagle Creek Subwatershed Stormwater Study
City of Savage

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0 1,600 Feet
1 inch = 1,600 feet

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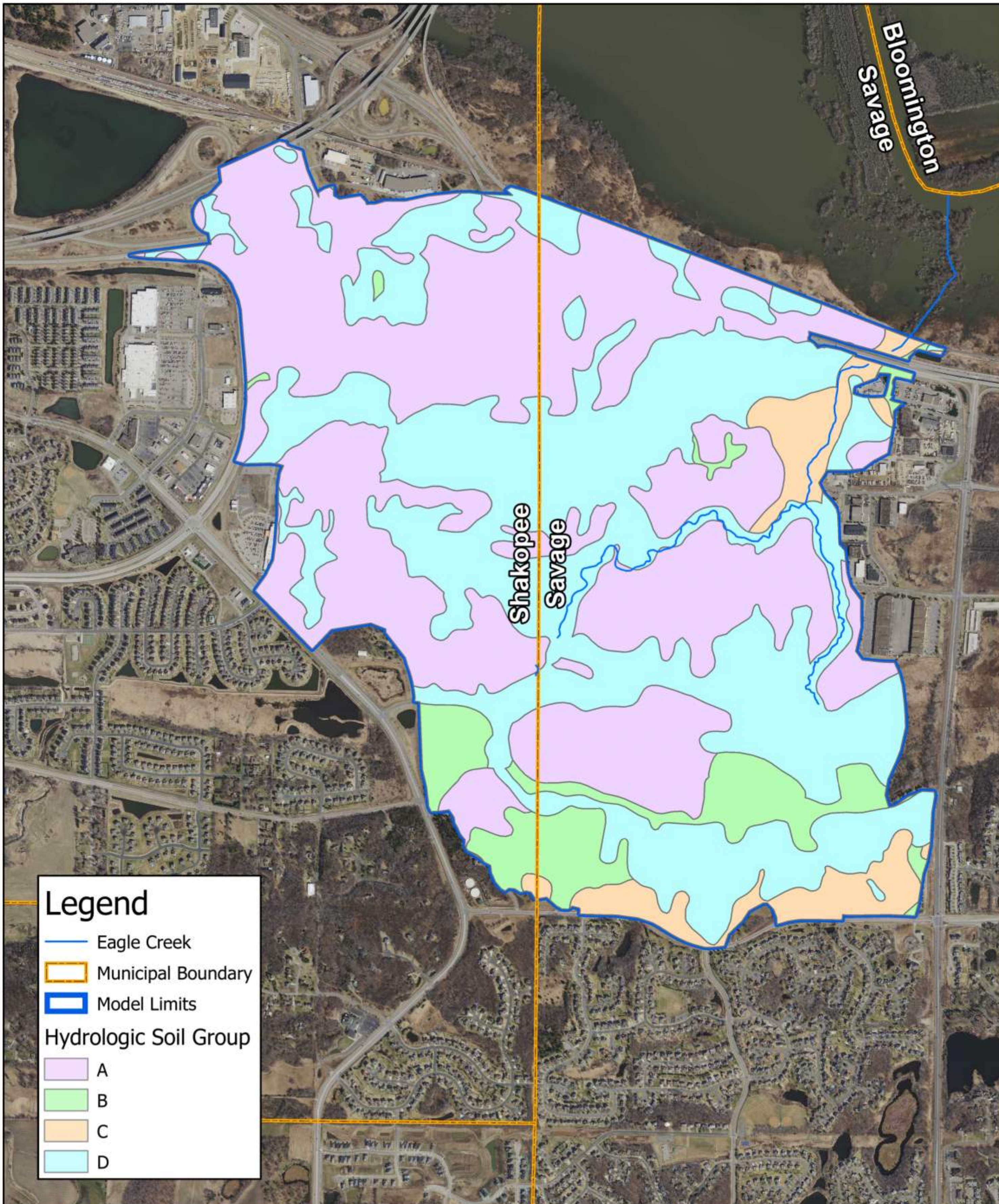

Figure 3: Soils

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City of Savage

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0 1,600 Feet
1 inch = 1,600 feet

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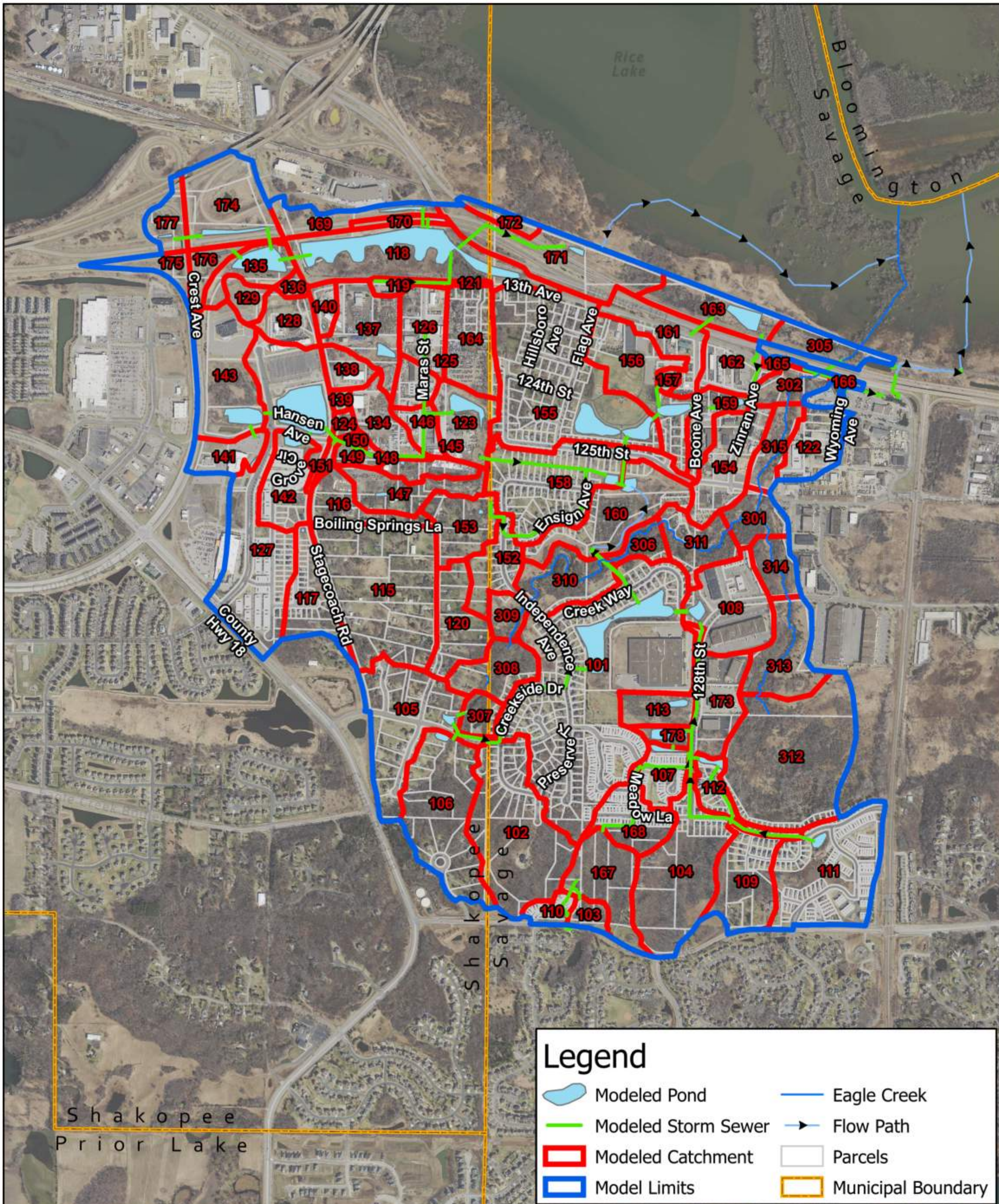

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Figure 4: XPSWMM Model Map

Eagle Creek Subwatershed Stormwater Study
City of Savage

N
0 1,600 Feet
1 inch = 1,600 feet

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Figure 5: Modeled 100-Year High Water Levels

Eagle Creek Subwatershed Stormwater Study
City of Savage

N

0 1,600 Feet

1 inch = 1,600 feet

NURP particle data, of which Total Suspended Solids (TSS) and Total Phosphorous (TP) were the primary pollutants of concern for this study. Eagle Creek subwatershed catchments within the City of Savage were studied in detail to determine priority areas for BMP improvements. Catchment attributes such as soil type, impervious area fraction, vegetation, and detailed drainage routings were also used to accurately model the study area. Priority locations were identified spatially using ArcGIS Pro, based on the BMPs tributary area, existing treatment and the available space. Potential BMP models were compared to the existing conditions model to evaluate overall pollutant load reduction, as well as pollutant removal at the potential BMP itself. Where an existing BMP is present, and the potential BMP is an improvement or expansion of the existing BMP, the potential BMP was evaluated on additional pollutants removed at the BMP, not total pollutants removed. **Figure 6** shows a detailed schematic of the P8 model. Results can be seen in **Figures 7A-F, Figures 8A-H,** and **Appendix D**.

The BWSR Soil Loss Spreadsheet was used to estimate soil loss where Eagle Creek Parkway crosses the east branch of the Creek. The stream banks were modeled as primarily sand based, with a 60 ft^3/year erosion rate. These parameters were used to create a conservative model; however, in actuality, the erosion rate and mass loss per year may be much greater. Vegetating and armoring the stream would greatly reduce sediment transport, especially in high flow events. Bringing the banks in to allow for a deeper channel would improve fish passage through this section. Additionally, the stabilization protects infrastructure.

In total, 9 locations were identified as potential water quality improvement options. More information on these can be found in **4.1.1** through **4.1.9**.

3.0 Existing Conditions

The existing hydrologic and hydraulic data was used to create a P8 model, assess current water quality conditions, and evaluate potential BMP options. The existing conditions model consists of 30 subwatersheds routed through 31 stormwater devices. The results of this model are shown below (**Table 2**).

Table 2: Eagle Creek – Existing Pollutant Removals

Pollutant	Total Inflow (lbs./year)	Pollutants Removed (lbs./year)	Pollutant Removal Percent	Excess Pollutants Entering Eagle Creek (lbs./year)
TSS	274,415	225,701	82.2%	48,714
TP	877	482	55.0%	395

The watershed system generates 334,157 lbs./year of TSS, and 1,068 lbs./year of TP. Eagle Creek receives approximately 57,809 lbs./year of TSS (82.7% removal) and 588 lbs./year of TP (55.1% removal) each year. The vast majority of this enters the system downstream of Trunk Highway 13 near Eagle Creek's confluence with the Minnesota River.

3.1 Land Use

The Eagle Creek subwatershed is partially urbanized, consisting primarily of residential and undeveloped areas. Calculated impervious percentage by drainage area were highly variable, ranging from 0-88% (high impervious areas lead to more runoff and increased pollutant loading).

3.2 Subwatershed Summary

As shown in **Table 2**, the subwatershed does perform stormwater treatment; however, potential additional treatment locations exist. The amount of TP entering Eagle Creek from Savage is estimated to be over 310 lbs./year, with a majority of that coming from untreated drainage areas nearest to the stream. These results are based on BMP removal efficiencies in the existing

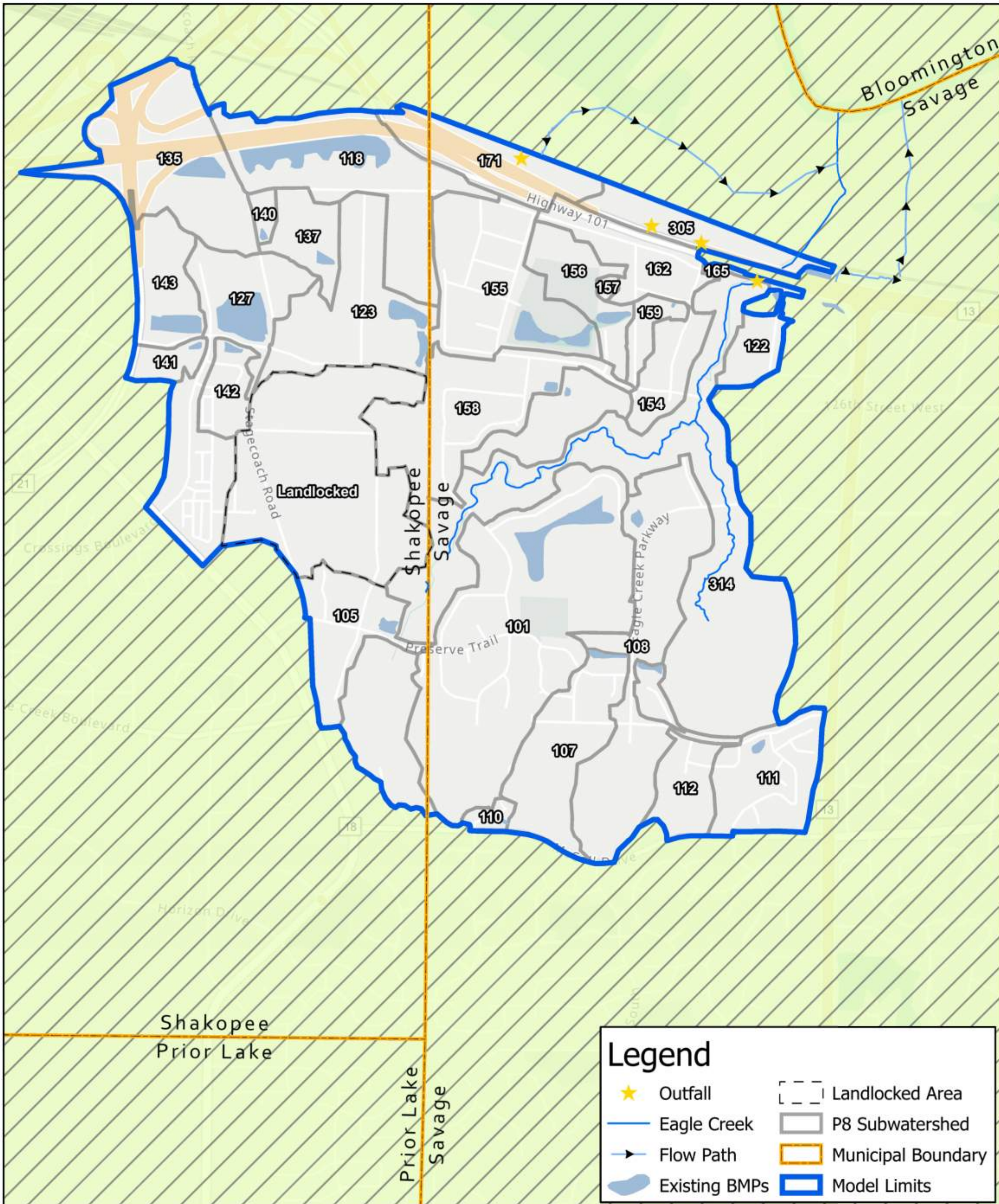

Figure 6: P8 Model Map

Eagle Creek Subwatershed Assessment
City of Savage

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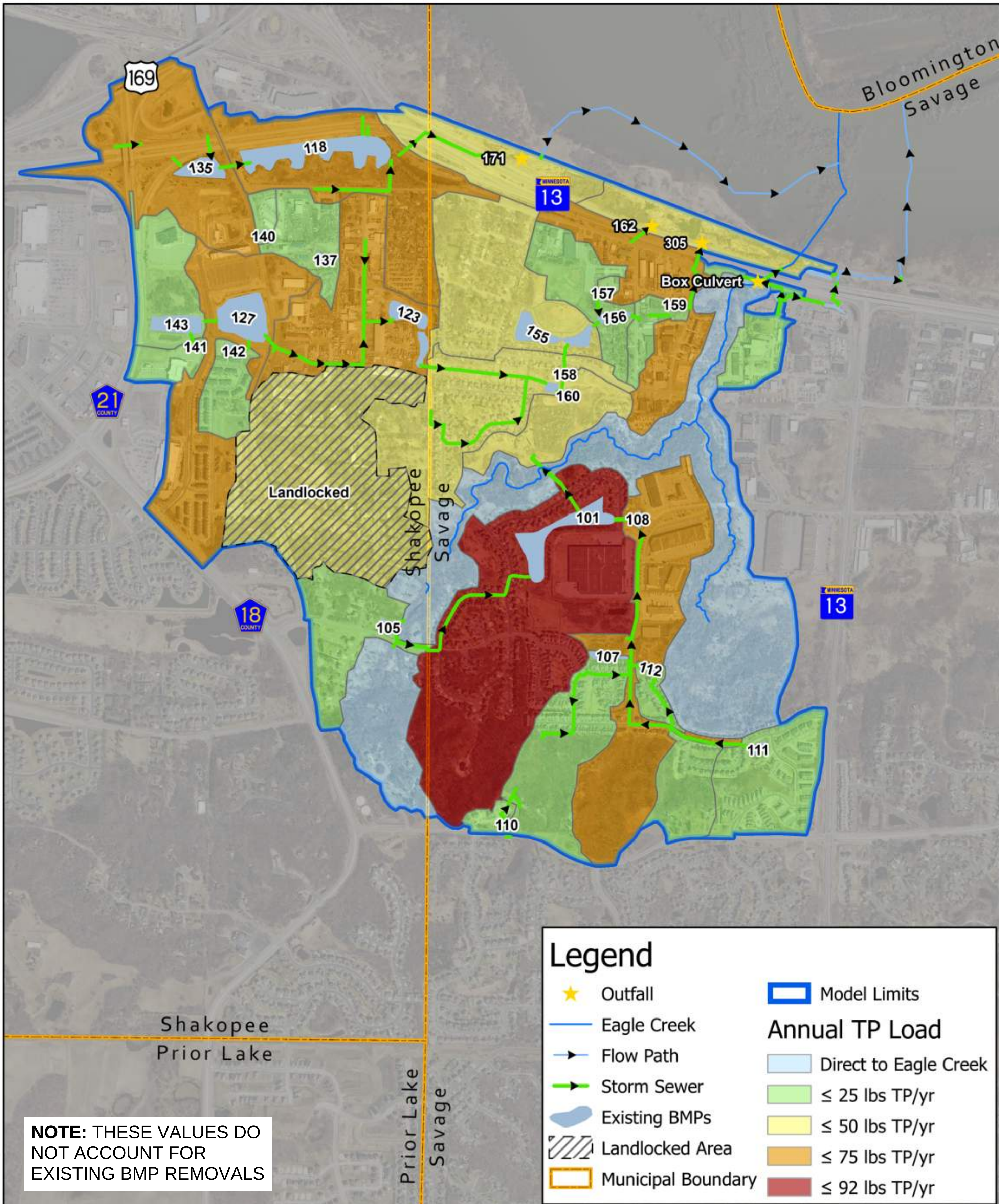

Figure 7A: Annual TP Loads

Eagle Creek Subwatershed Assessment
City of Savage

N
0 1,600 Feet
1 inch = 1,600 feet

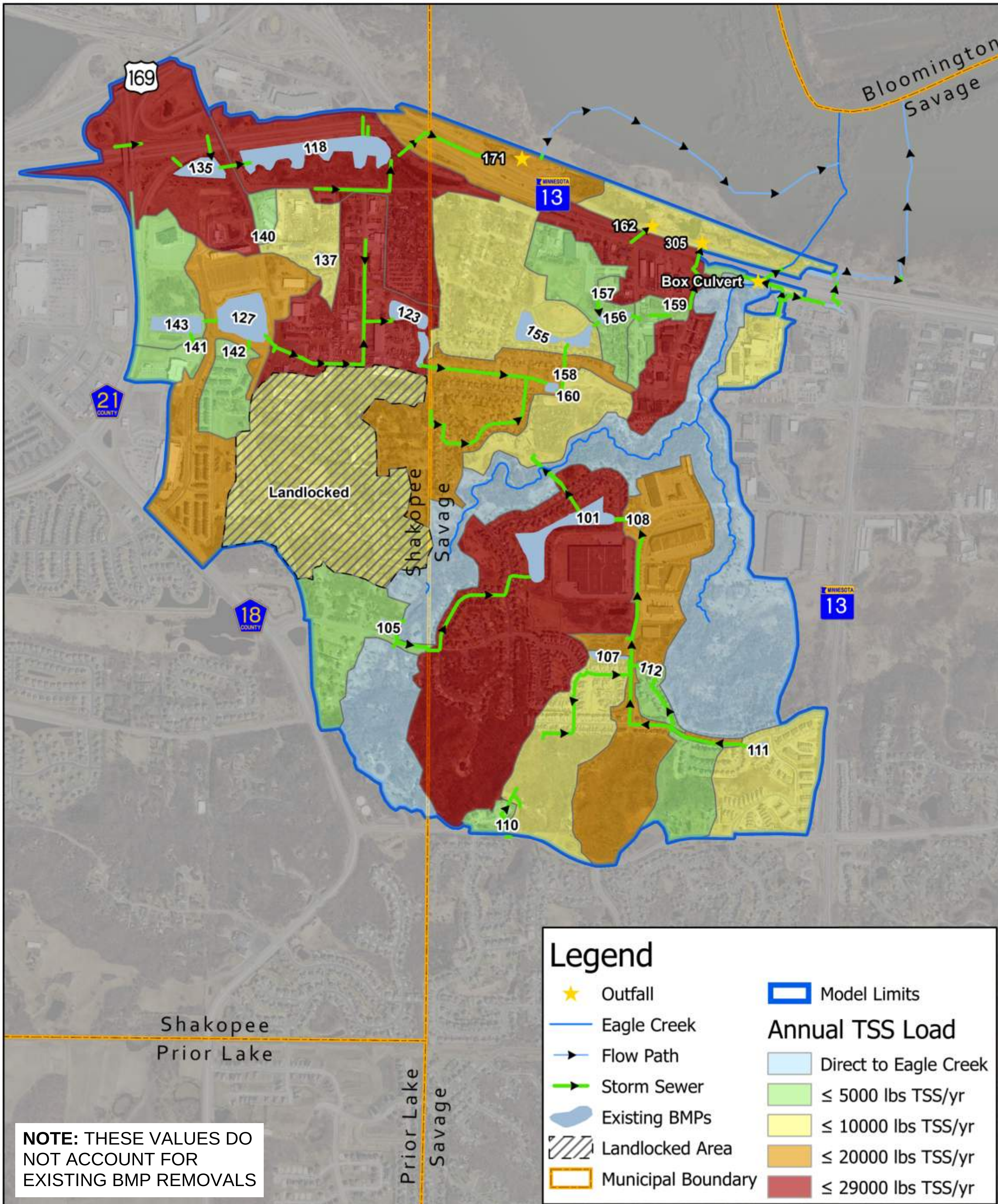

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Figure 7B: Annual TSS Loads

Eagle Creek Subwatershed Assessment

City of Savage

N

0 1,600 Feet

1 inch = 1,600 feet

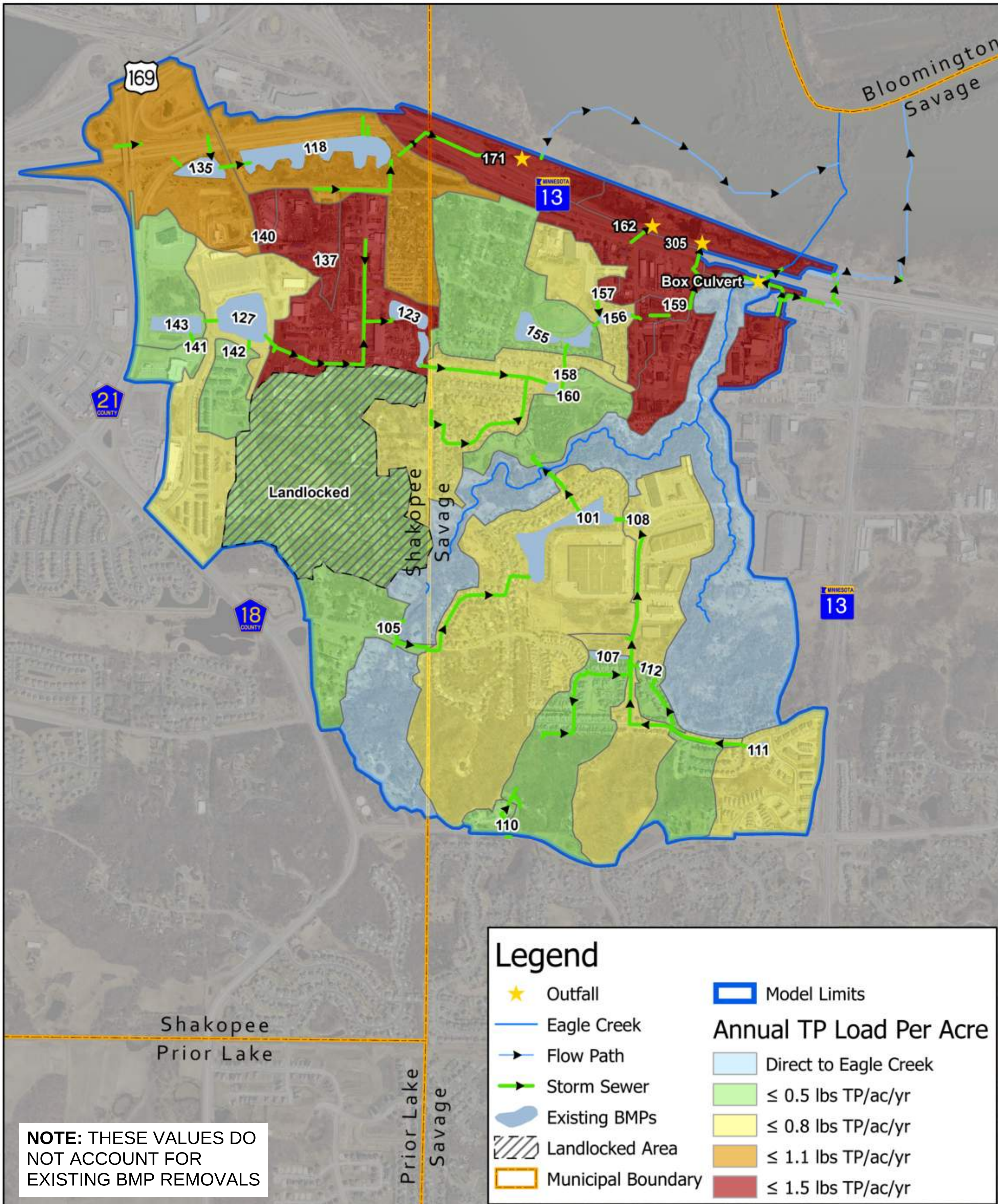

Figure 7C: Annual TP Loads Per Acre

Eagle Creek Subwatershed Assessment
City of Savage

N

0 1,600 Feet
1 inch = 1,600 feet

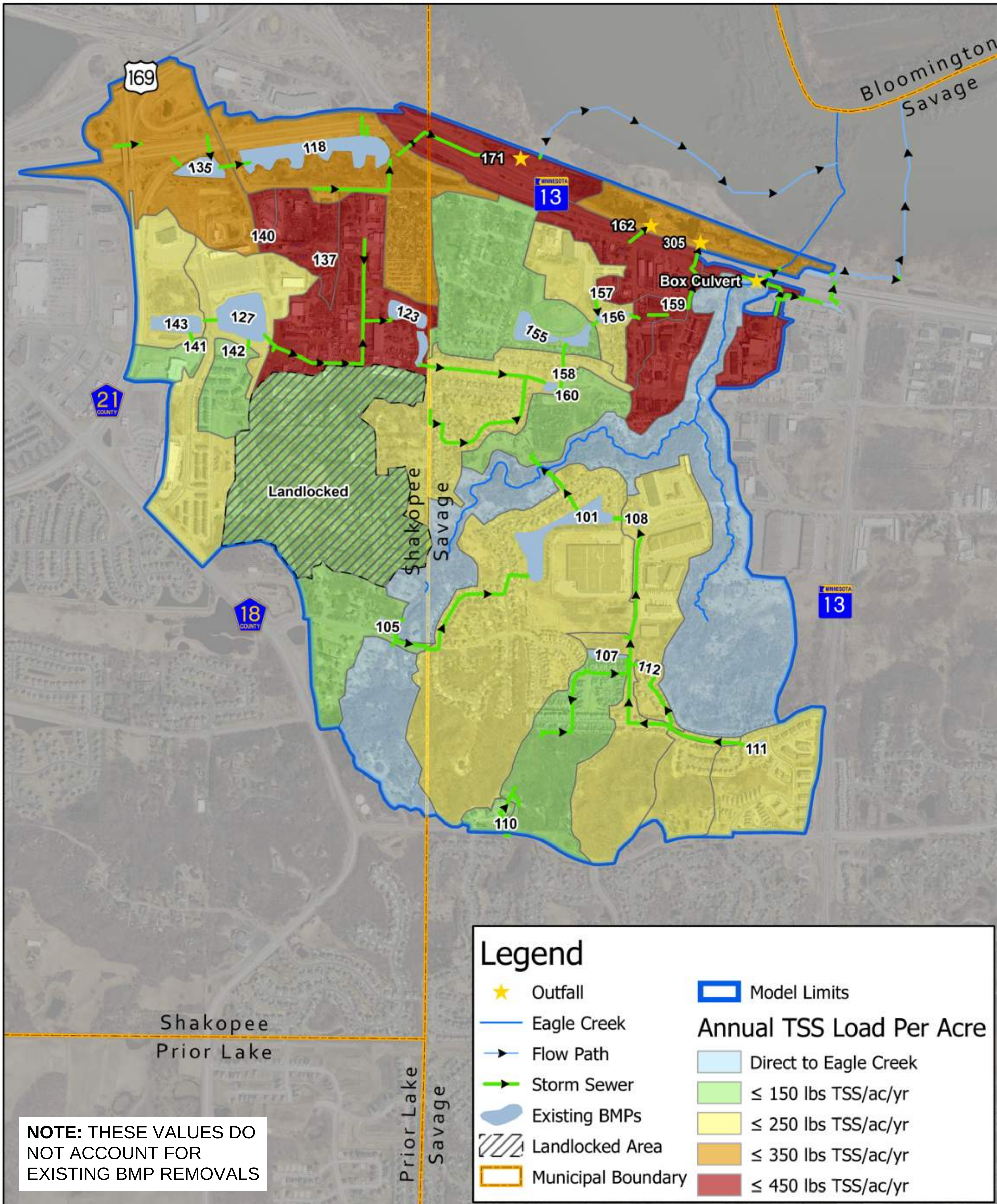

Figure 7D: Annual TSS Loads Per Acre

Eagle Creek Subwatershed Assessment

City of Savage

N

0 1,600 Feet

1 inch = 1,600 feet

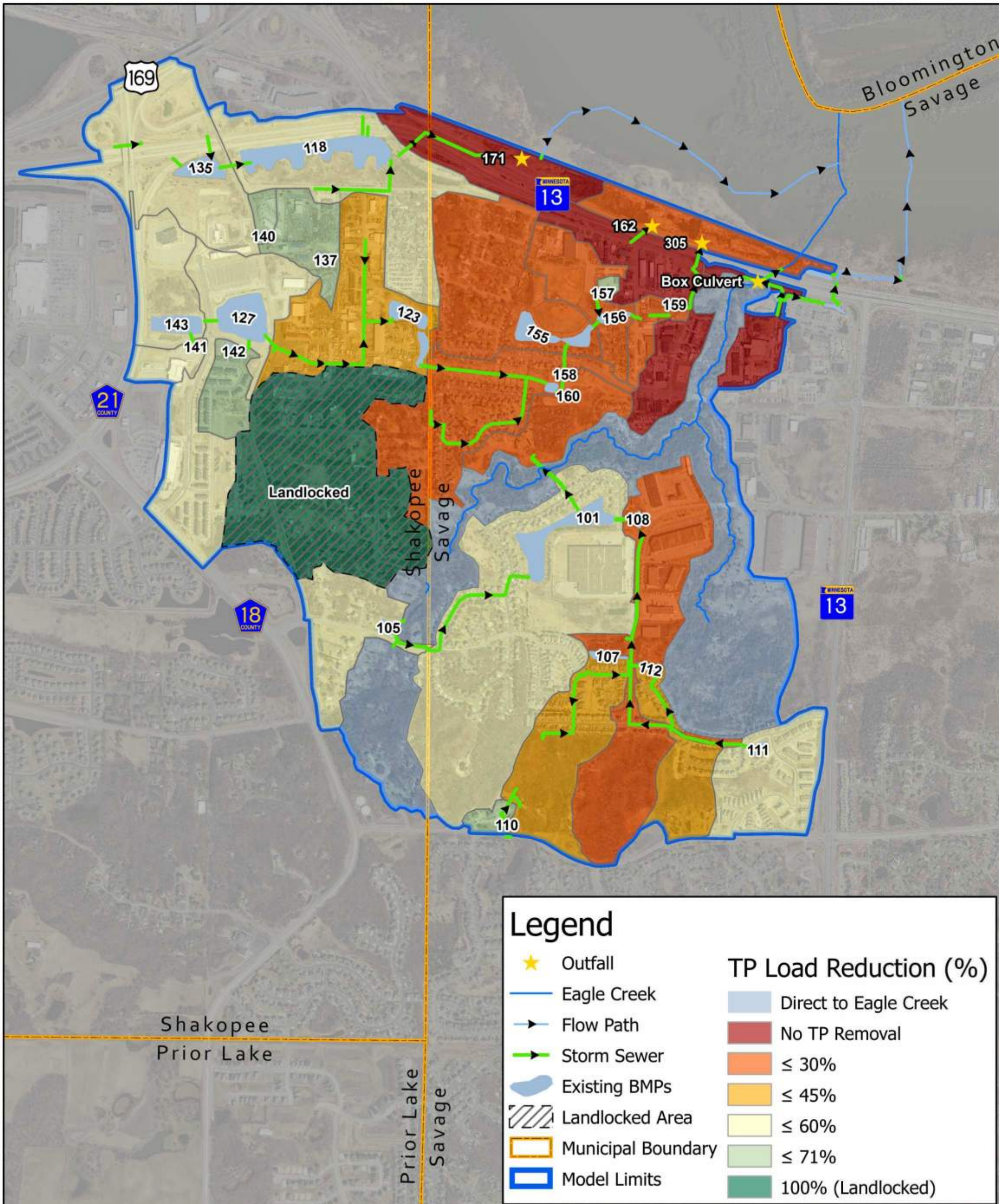

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Figure 7E: TP Reduction %

Eagle Creek Subwatershed Assessment
City of Savage

N

0 1,600 Feet

1 inch = 1,600 feet

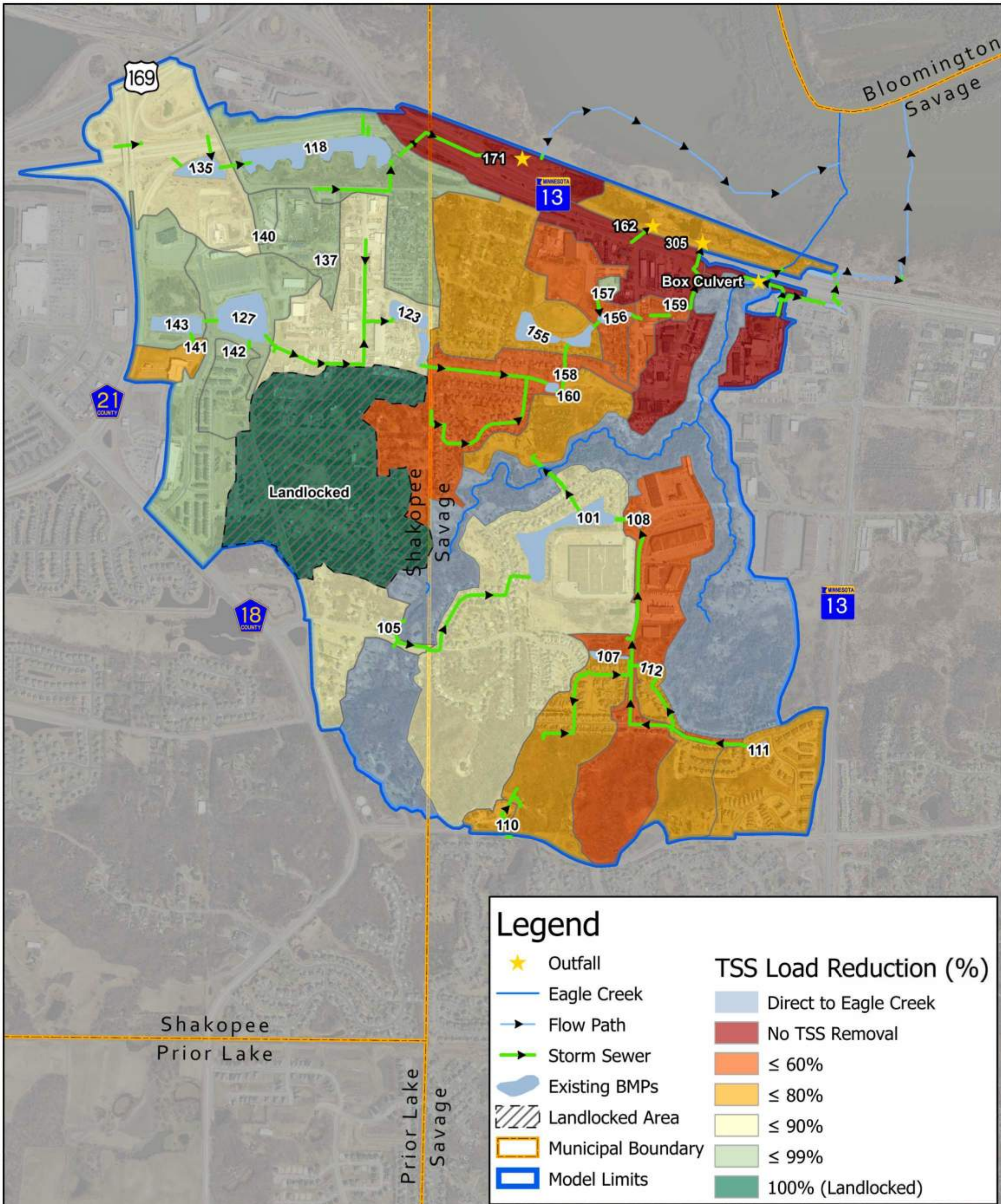

Figure 7F: TSS Reduction %

Eagle Creek Subwatershed Assessment
City of Savage

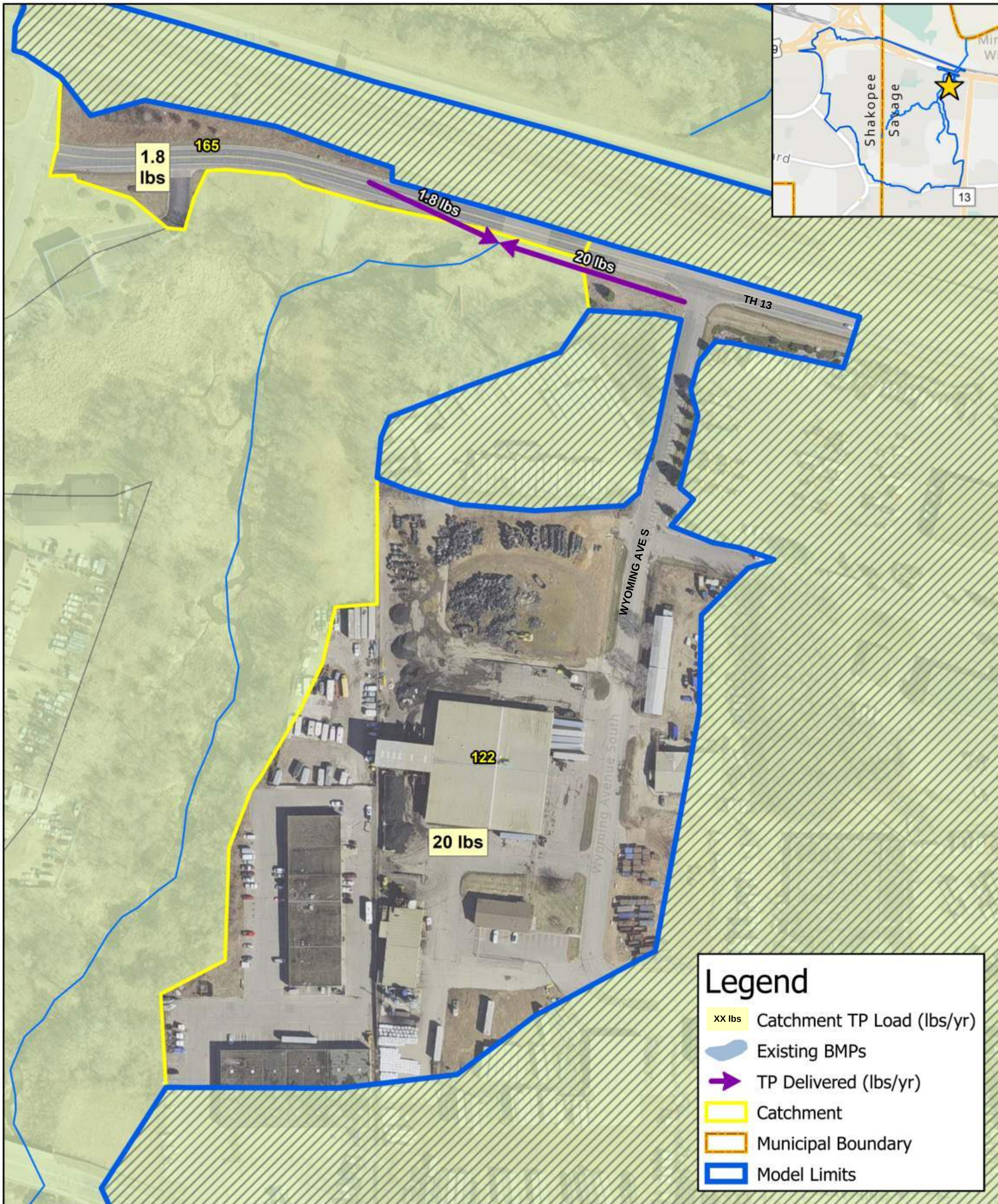

Figure 8A: Annual TP Loading: Savage - Box Culvert

Eagle Creek Subwatershed Stormwater Study
City of Savage

N
0 200 Feet
1 inch = 200 feet

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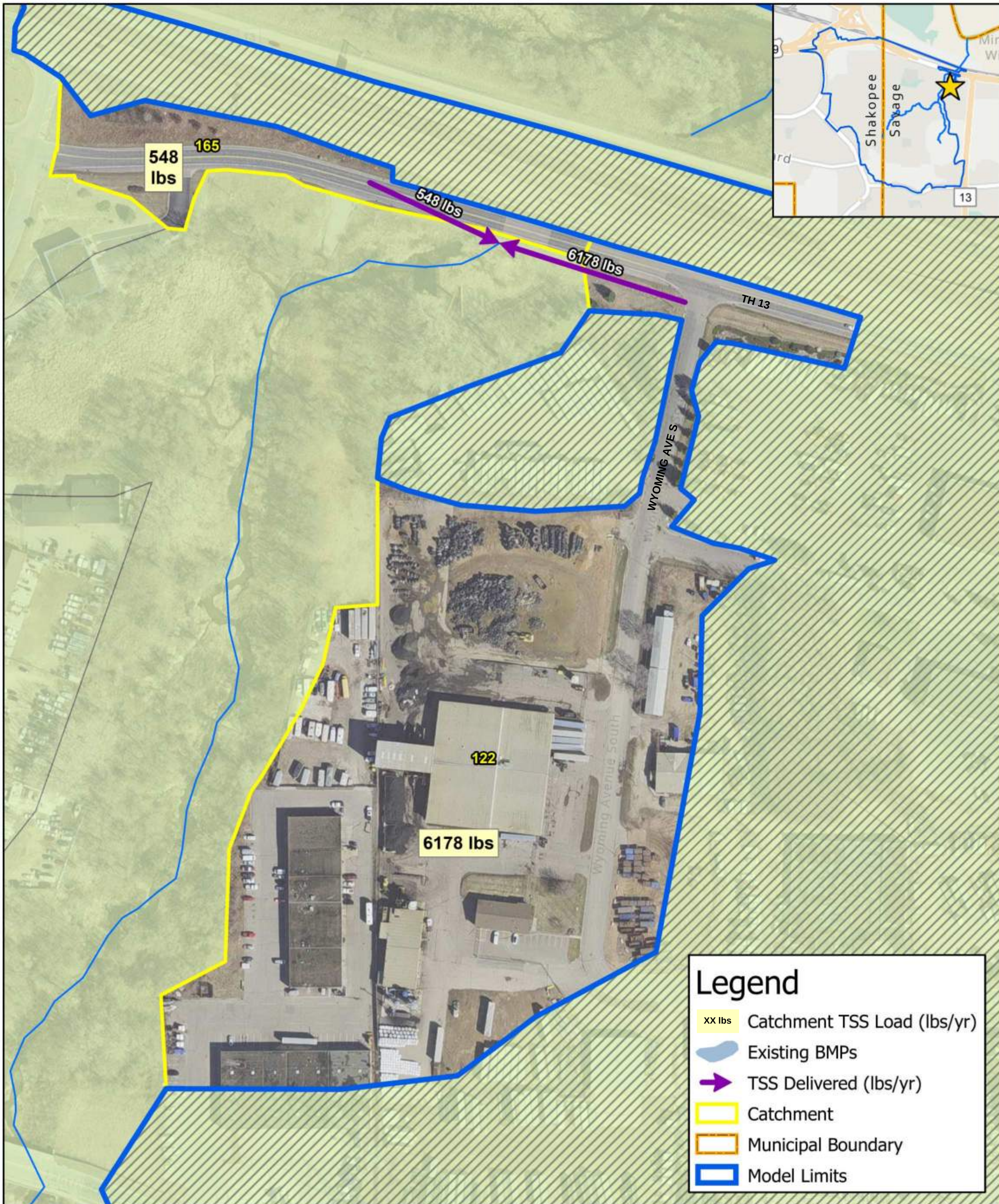

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Savage

Figure 8B: Annual TSS Loading: Savage - Box Culvert

Eagle Creek Subwatershed Stormwater Study
City of Savage

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0 200 Feet

1 inch = 200 feet

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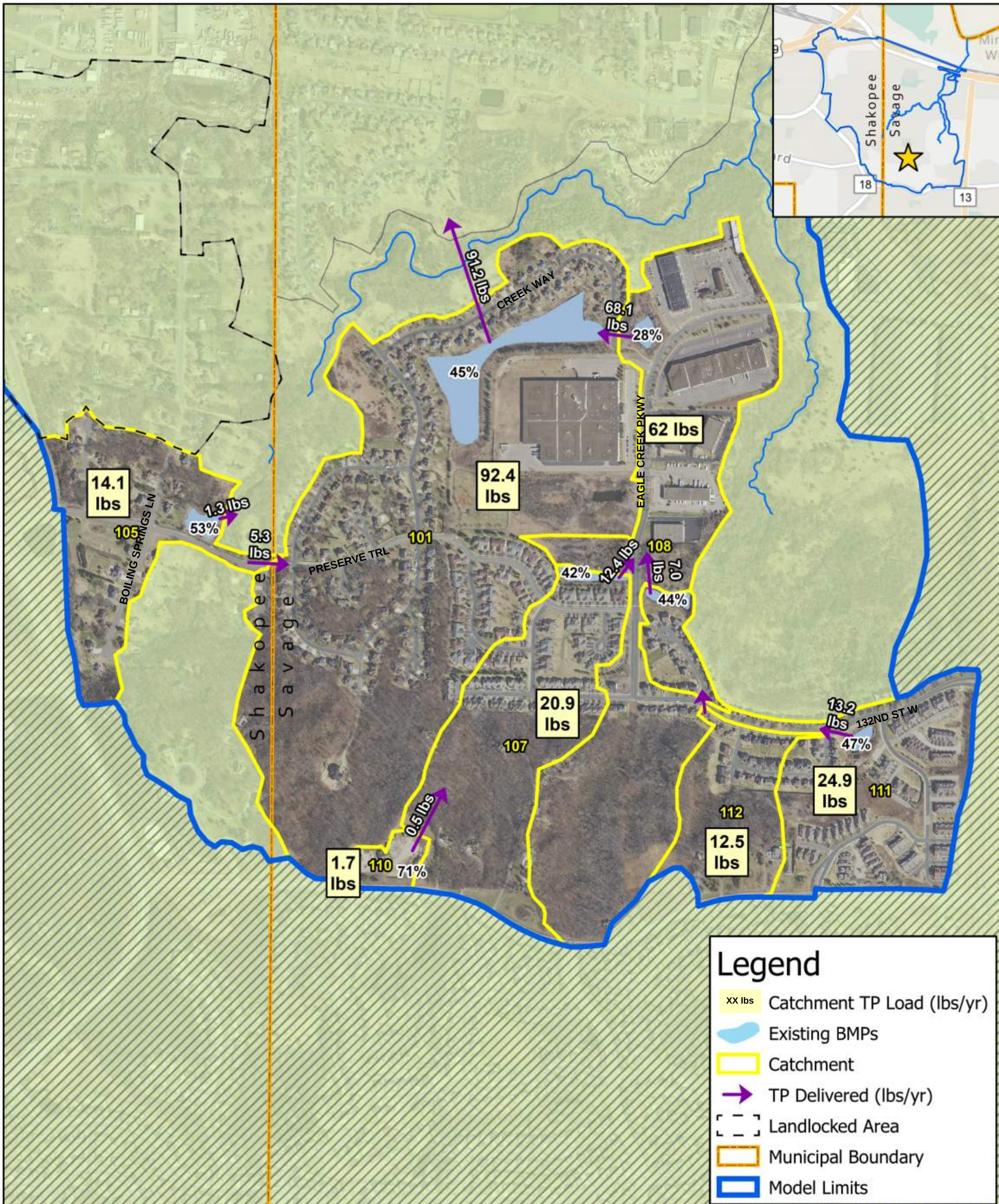

Figure 8C: Annual TP Loading: Savage - Business Park

Eagle Creek Subwatershed Stormwater Study
City of Savage

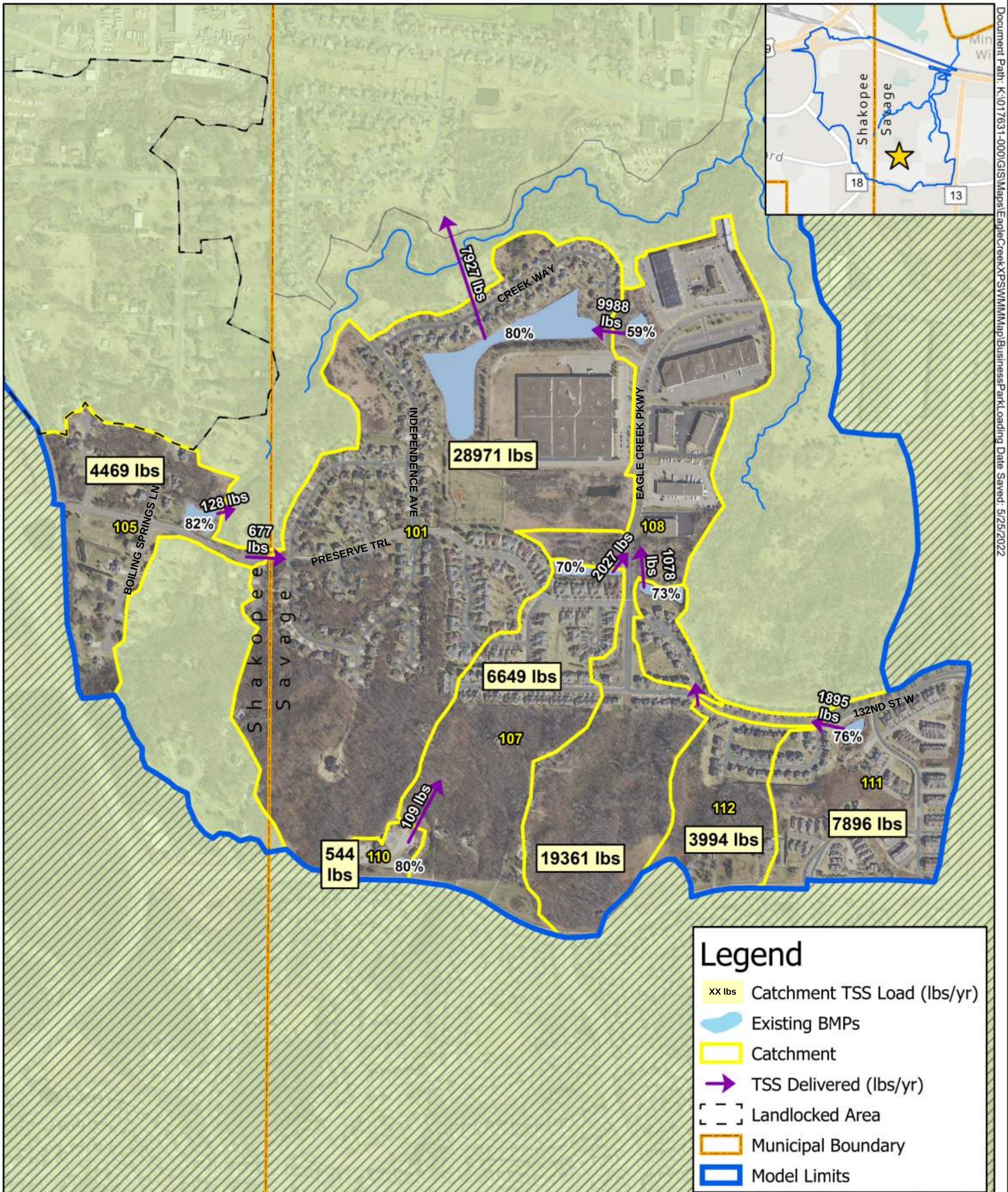

Figure 8D: Annual TSS Loading:
Savage - Business Park

Eagle Creek Subwatershed Stormwater Study
City of Savage

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0 900 Feet
1 inch = 900 feet

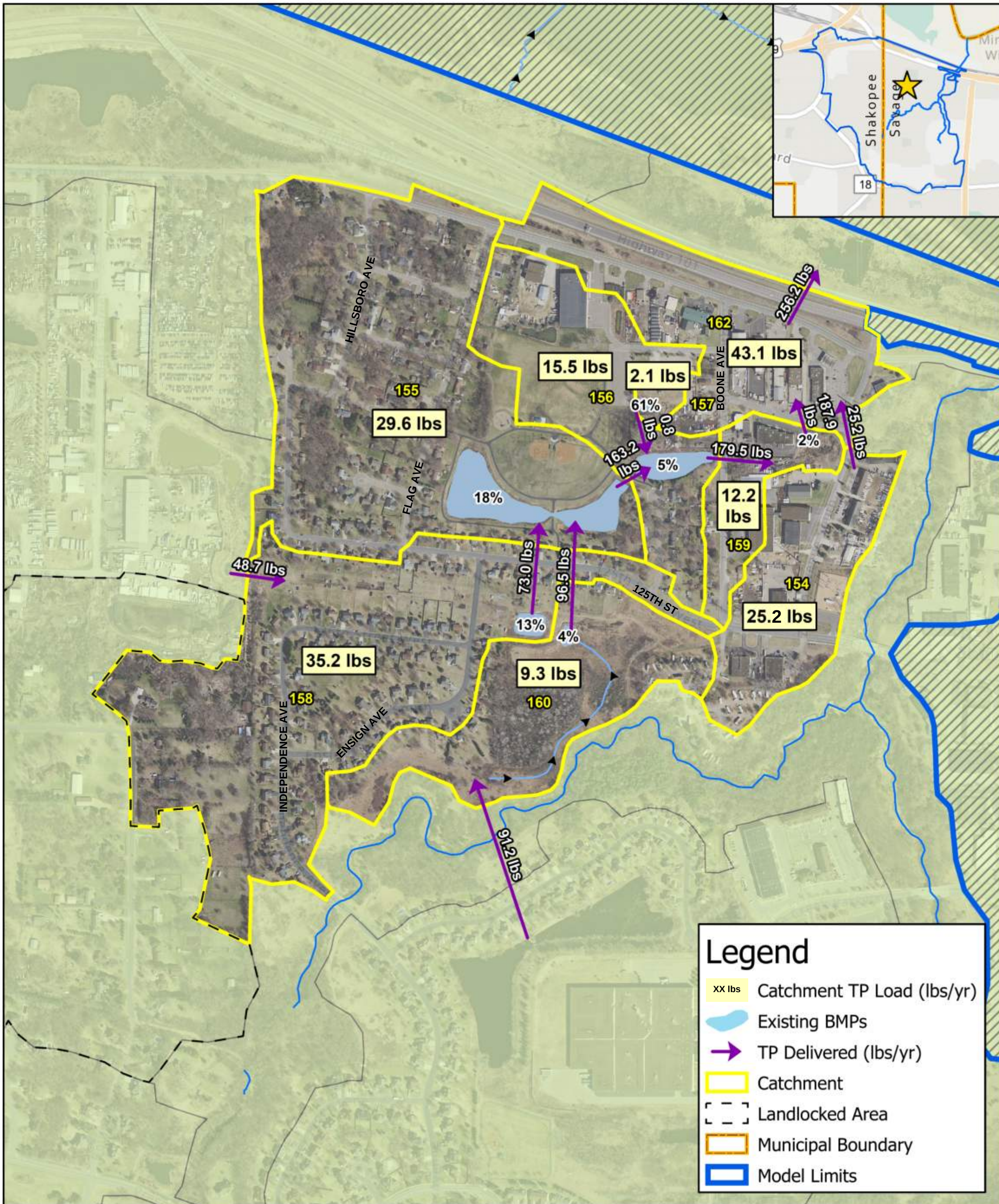

Figure 8E: Annual TP Loading: Savage - Northwest

Eagle Creek Subwatershed Stormwater Study
City of Savage

N
0 700 Feet
1 inch = 700 feet

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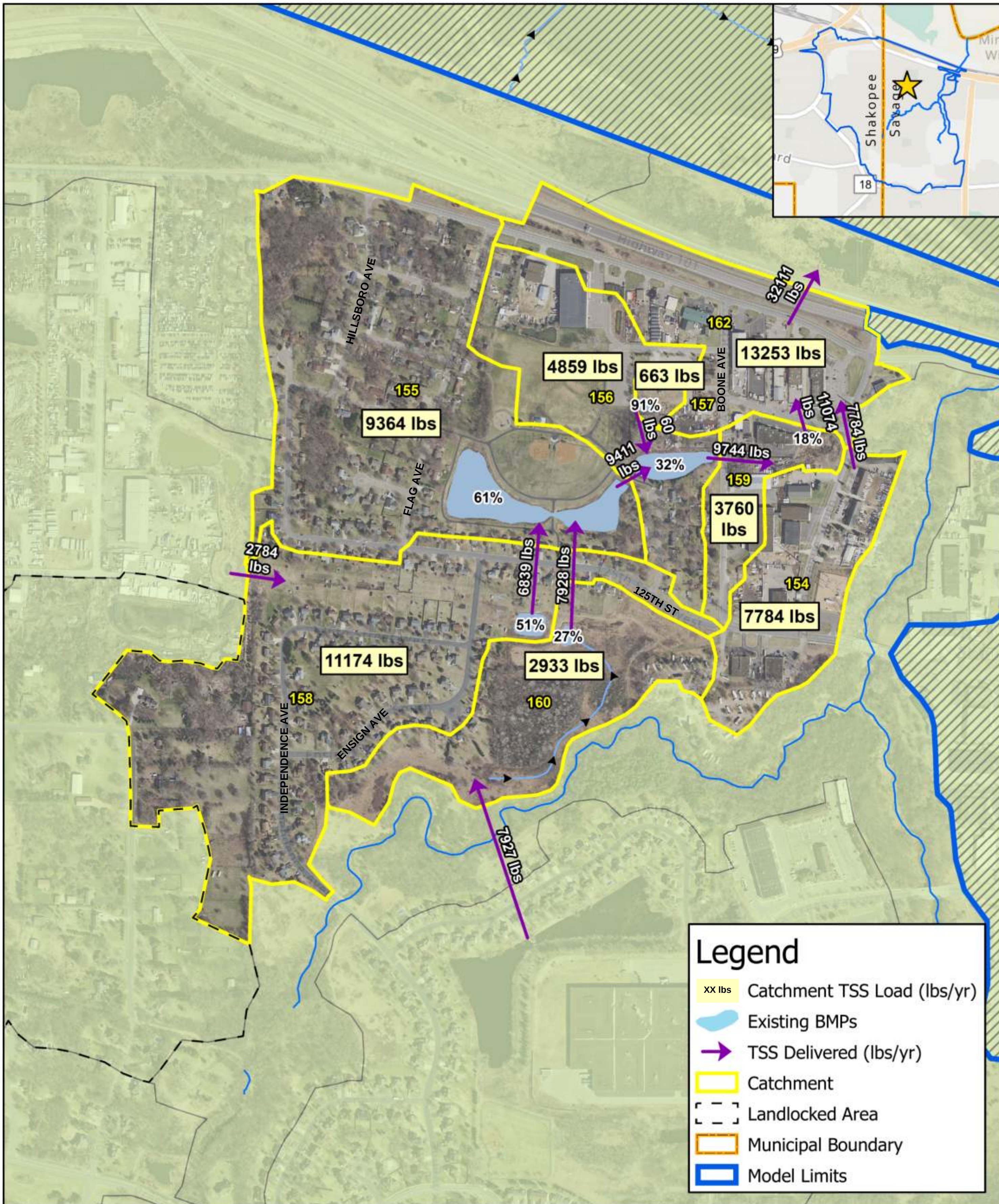

Figure 8F: Annual TSS Loading: Savage - Northwest

Eagle Creek Subwatershed Stormwater Study
City of Savage

N
0 700 Feet
1 inch = 700 feet

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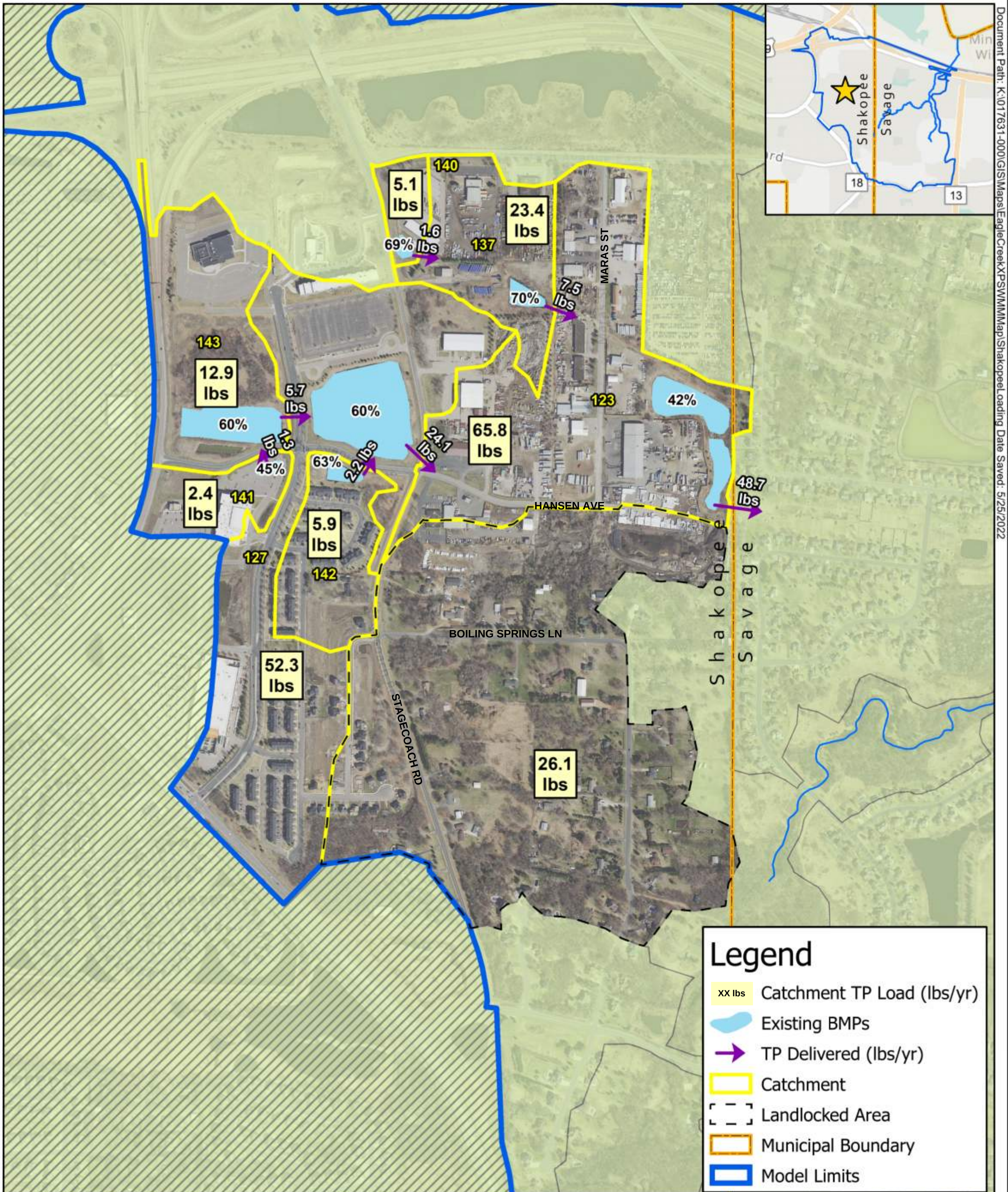

Figure 8G: Annual TP Loading: Shakopee

Eagle Creek Subwatershed Stormwater Study

City of Savage

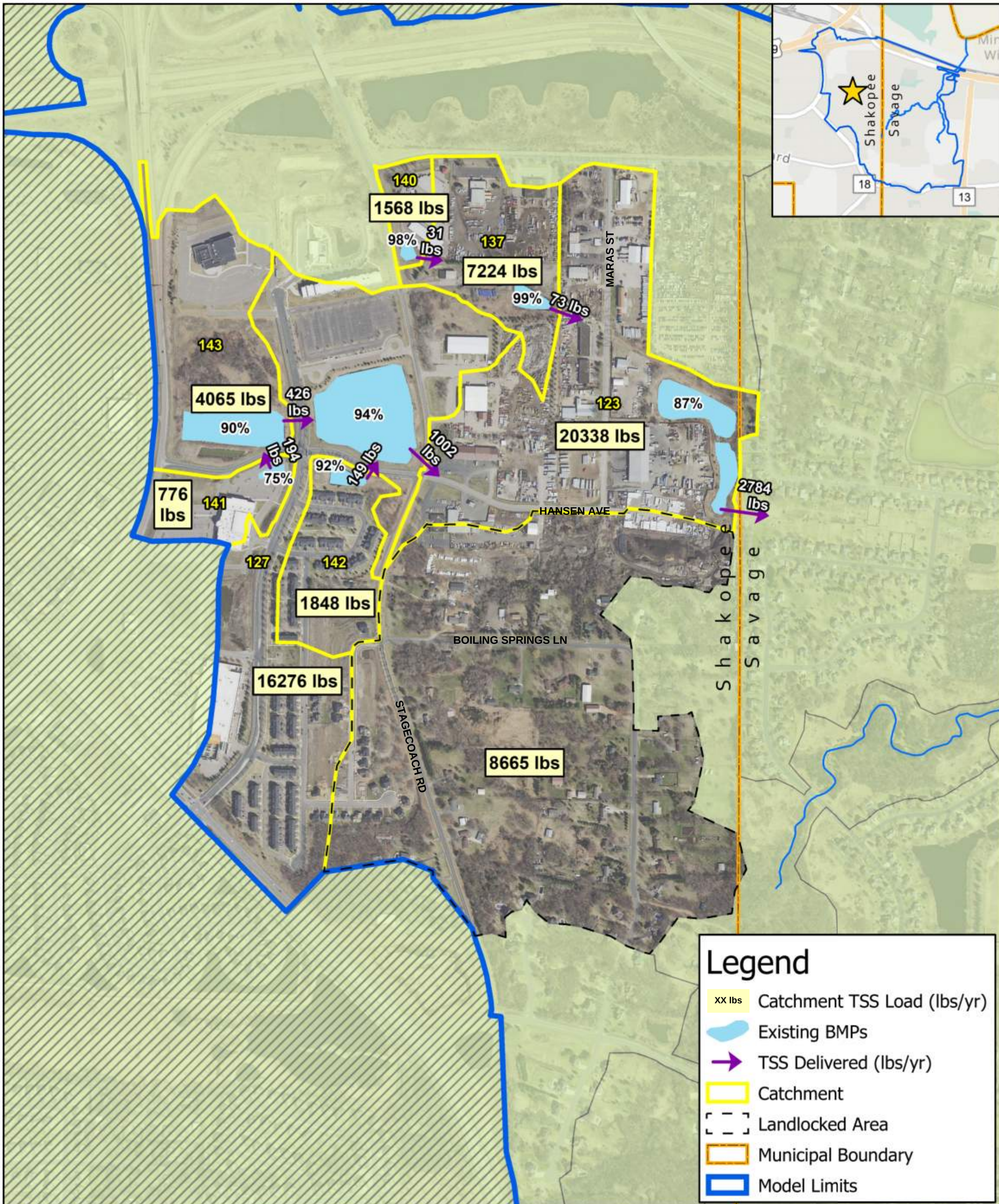

Figure 8H: Annual TSS Loading: Shakopee

Eagle Creek Subwatershed Stormwater Study
City of Savage

conditions P8 model for all drainage areas in the subwatershed. Refer to **Figures 7E-F** for the existing pollutant removal efficiencies by subwatershed.

Water drains through Eagle Creek to the Minnesota River, which is also a designated impaired waterbody by the state of Minnesota for nutrients, dissolved oxygen (DO), aquatic life, and recreation. Any improvement in the study area will benefit the Minnesota River.

3.3 Existing Studies/Plans

Numerous previous studies have analyzed Eagle Creek and its subwatershed. They are summarized below. Additional information and strategies come from the Lower Minnesota Restoration and Protection Strategies (WRAPS) document from 2020. The WRAPS Water Quality Report and Lower Minnesota TMDL report are included in **Appendices A and B**, respectively.

3.3.1 Lower Minnesota WRAPS Report

The Lower Minnesota River Watershed WRAPS document included discussion of current conditions, and measures to maintain and improve water quality in the Minnesota River. The full document is included as **Appendix A**. For Eagle Creek, it is specifically mentioned that *E. coli* be reduced by 8%. This is to be achieved through stormwater practices. Scott County has identified wildlife as a potential contributor to *E. coli* loading in Eagle Creek. A map of parcels within the Subwatershed which currently operate septic systems can be seen in **Figure 9**. Discussions during LMRWD board meetings on the timing of *E. coli* level spikes indicate a primary source may be avian wildlife.

WRAPS documents are completed every 10-years, with TMDL reviews completed every five years, and waterbodies reassessed every two years. These three tools are used to review progress, establish future goals, and are critical to subwatershed assessment and implementation efforts. It is the goal of the City that this subwatershed assessment reflects options to improve stormwater entering Eagle Creek, namely by assessing and recommending BMP installation and improvement options throughout the Eagle Creek subwatershed.

3.3.2 Lower Minnesota River TMDL Report

Eagle Creek is discussed in Part I of the Lower Minnesota River Watershed TMDL Report published in February 2020, which is included in **Appendix B**. Its designated use is aquatic recreation, which it is impaired for *E. coli* levels. There are no upstream impaired reaches. Out of 99 samples taken between 2006 and 2015, none produced an individual standard exceedance. The maximum value was 687 organisms/100 milliliters. The geometric mean was 79 organisms/100 milliliters. The baseline year for this impairment is 2010. An *E. coli* reduction of 8% is called for.

3.3.3 Water Quality Monitoring Data

A number of organizations conduct water quality monitoring in the Eagle Creek Subwatershed. MCES, the Lower Minnesota River Watershed District and Scott County Soil and Water Conservation District partnered to collect over 400 chloride samples from 2001 to 2019. Chloride concentrations increased sharply in the first 15 years of the study. They have continued to increase since 2016, but at a much smaller rate. The MCES study suggests an increase in road salt application may be a cause for the increased concentrations. The report also notes the majority of stormwater entering Eagle Creek does so north of Trunk Highway 13. This is downstream of the sampling station, thus a significant amount of loading may be missed. Chloride has not been named as an impairment in Eagle Creek, but the stream is vulnerable to chloride pollution.

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Figure 9: Parcels with Septic Systems

Eagle Creek Subwatershed Stormwater Study
City of Savage

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0 1,600 Feet
1 inch = 1,600 feet

The City of Savage does additional monitoring on its stormwater ponds. This includes one within the Eagle Creek Subwatershed – Schroeder's Acres pond. Dissolved oxygen, total phosphorus, orthophosphate, chloride, conductivity, pH and total suspended solids samples were taken at both the surface and bottom of the pond throughout the summers of 2019 and 2020. Samples were taken in both the east and west basins. Dissolved oxygen was routinely below the standard required to sustain trout populations. This drainage does not enter Eagle Creek until north of Trunk Highway 13, where the creek meets Minnesota River floodplain. Chloride levels were generally below the recommended maximum.

3.3.4 Geomorphic and Habitat Assessments

MCES began macroinvertebrate sampling in Eagle Creek in 2001. Family biotic index measures show good to excellent water quality in the Creek. Periods of drawn out high flows are correlated with less desirable sampling results. Generally, Eagle Creek has high community diversity. This is reduced following high flow events.

Minnesota DNR Fisheries Management surveyed Eagle Creek in 2020 with an electrofishing backpack. Only one reach contained brown trout with 11 being sampled. The sizes of the sample ranged between 12 and 17 inches with the largest brown trout weighing 2.3 pounds. Based on these sizes, the results indicate none of the fish sampled were age zero. This was the lowest amount of trout found since surveys on Eagle Creek began in 2005. Twelve (12) other species were found in the stream, with the greatest diversity closest to the Minnesota River. Only central mudminnows were found in the east branch of Eagle Creek. The next stream survey is scheduled for 2023.

In 2019 the Lower Minnesota River Watershed District and its partners published a geomorphic and habitat assessment which included Eagle Creek. While the study found Eagle Creek exhibited qualities that are critical to maintaining a trout population, it also observed aggradation to be an issue in the stream. Additionally, excessive stream width creates areas of shallow, warmer waters which stress trout populations seasonally.

4.0 Stormwater Improvement Options

Stormwater improvement options were identified based on strategic locations for potential BMPs. The locations of the potential BMPs are shown in **Figures 10A-H**. Water quality improvement BMPs with the lowest cost benefit ratio (dollars per pound removed) were selected for further study. Cost-benefit ratio was calculated using the ratio of estimated construction and 25-year maintenance costs to annual pollutant removal for 25 years and are described in the following sections.

The estimated construction and maintenance cost, cost-benefit ratio, and the best performing BMPs are also shown in **Table 3**.

Figure 10A: BMP Overview

Eagle Creek Subwatershed Stormwater Study
City of Savage

Table 3: Potential BMP Cost Benefit Analysis Table

BMP	Estimated Construction Costs	Estimated Annual Maintenance Costs	25-Year Cost Benefit ($/ton TSS Removed)	25-Year Cost Benefit ($/lb. TP Removed)
Wyoming Ave Stormwater Structure	$668,600	$2,500	$10,230	$1,660
Trunk Highway 13 Stormwater Structure	$240,100	$1,000	$5,090	$1,120
Zinran Ave Stormwater Structure	$168,800	$1,500	$5,250	$1,760
Eagle Creek Pkwy Bank Stabilization	$106,300	$1,000	$1,590	$1,880
Covington Ponds Filtration Bench	$315,200	$2,500	$27,390	$870
Preserve Trail Stormwater Structure	$558,300	$2,000	$463,500	$4,350

4.1 Project Summaries

The best performing potential BMP options were investigated by WSB to further evaluate viability. Descriptions, maps, pollutant removal tables, and estimated costs for each option are described in **Sections 4.1.1** through **4.1.9** below.

4.1.1 Schroeder's Acres Water Reuse

Water reuse at Schroeder's Acres Park was evaluated in this study. Irrigation of three baseball diamonds and adjacent areas would be supplied by the storm pond in the park.

To determine the volumes and water quality benefits associated with irrigation, the *Stormwater Reuse Calculator, Version 2.0* developed by *Emmons & Olivier Resources* was used. Below is a sample of the required inputs:

Table 4: Water Reuse Calculator

INPUTS					
IRRIGATION	**$A_{irrigation}$**	448,907			ft^2
	$D_{irrigation}$	0.17			*in/day (3 days/week)*
	Begin/End	6	**to**	10	*month*
WATERSHED	**$A_{watershed}$**	65.06			*acres*
	$\%_{Imp, connected}$	16%			%
	$\%_{Imp, disconnected}$	11%			%
	$CN_{Imp, disconnected}$	98			
	$CN_{pervious}$	58			
	C_{W-TP}	410			*ppb*
	$C_{W-orthoP}$	100			*ppb*
STORAGE	**V_{basin}**	179,031			ft^3
	$V_{storage}$	117,108			ft^3
	L_{basin}/W_{basin}	950	**by**	275	*ft*
	Begin/End	1	**to**	12	*month*
	D_{basin}	4			*ft*
	Side slope	3			*ratio*
	Evaporation	1			*1=on; 0=off*
	$V_{basin, initial}$	179,031			ft^3

- $A_{irrigation}$ = The surface area to be irrigated (Also receives direct rainfall)
- $D_{irrigation}$ = The irrigation depth per day (includes direct rainfall). The model assumes a maximum of 3 days of irrigation per week. The value entered here is total weekly irrigation depth divided by 3 days.
- $A_{watershed}$ = The direct watershed area draining to the basin.
- $\%_{imp}$ = The percentage of the watershed that is impervious area
- V_{basin} = The basins permanent pool in normal conditions
- $V_{storage}$ = The minimum required dead storage. The value shown assumes 1,800 cf/acre drained for NPDES designed ponds or runoff created by a 2.5" rain event for a NURP designed pond.
- L_{basin}/W_{basin} = The length and width, in feet, of the NWL of the basin.
- D_{basin} = The depth of the permanent pool in normal conditions
- V_{basin}, initial = The starting volume in the basin. The value shown assumes the basin starts the analysis under normal conditions.

For most cool-weather grasses in Minnesota a depth of water of 0.5-1.0 in/week is recommended which includes direct rainfall. The calculator used for determining irrigation volumes models real-world scenarios and factors in direct rainfall and evapotranspiration effects on the irrigated area. For this reason, irrigation depths of 0.5 and 1.0 in/week were analyzed.

Also note, the irrigation depth input value in the calculator is inches per day. The calculator assumes irrigation occurs no more than 3 days per week. Therefore, the depth shown is one-third the weekly irrigation depth. For 0.50 in/week irrigation, a value of 0.17 in/day will be used. For 1.0 in/week irrigation, a value of 0.33 in/day will be used.

Table 5 below summarizes the benefits of water reuse for irrigation of the three baseball fields at Schroeder's Acres Park.

Table 5: Water Reuse Benefits

Option	TP (lbs/yr)		TSS (tons/yr)		Volume (ac-ft/yr)	
	Inflow	Reduction	Inflow	Reduction	Inflow	Reduction
0.5 in/week	192.5	2.4	10.8	0.05	471.4	2.3
1.0 in/week		4.1		0.10		4.3

Installation of a water reuse system is estimated to cost \$245,000 to \$370,000. This cost is largely dependent on whether the City uses a suction pump head or a wet well. In addition to the installation of a water reuse system, improvements to the pond at Schroeder's Acres Park are shown on **Figure 10B**. Currently the pond is quite shallow – SWAMP data estimates the current depth as 1.08 feet. Pond excavation and strategic seeding would improve habitat, temperature and performance of the pond. This is a desirable location for improvements because of the large portion of the Eagle Creek Subwatershed routed through the pond.

4.1.2 Schroeder's Acres Pond Alum Treatment

Alum dosing can be used to control anoxic release of TP from sediments at the bottom of ponds. These treatments are a safe way to reduce internal TP loading, as well as algal blooms. Pond bottom sediment sampling can improve efficiency of alum treatment. **Table 6** shows the estimated dosing range and annual TP reduction for the Schroeder's Acres Pond. Because this pond is relatively shallow, the recommended dose is 25 g Al/m^2.

Table 6: Schroeder's Acres Pond Alum Treatment

Pond Surface Area (ac)	Estimated Dead Pool Storage Volume (ac-ft)	Recommended Dose of Alum (g Al/m^2)	TP Load Reduction Range (lbs/yr)	25-Year Cost Benefit (\$/lb. TP Removed)
3.77	**4.0**	**25**	**12 to 24**	**\$396**

Alum treatment at Schroeder's Acres is expected to bring average annual concentrations down from the existing level, 0.23 mg/L to 0.17 mg/L. This would prevent 12 to 24 pounds of TP from entering Eagle Creek each year. Each dose is expected to cost \$35,600. Doses need to be applied every five years. Alum treatment here has a total cost of \$178,000 over 25 years.

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Figure 10B: Schroeder's Acres Park Proposed Water Reuse

Eagle Creek Subwatershed Assessment

City of Savage

N

0 300 Feet

1 inch = 300 feet

4.1.3 BF Nelson Pond Alum Treatment

Alum dosing can be used to control anoxic release of TP from sediments at the bottom of ponds. These treatments are a safe way to reduce internal TP loading, as well as algal blooms. Pond bottom sediment sampling can improve efficiency of alum treatment. **Table 7** shows the estimated dosing range and annual TP reduction for the BF Nelson Pond. The recommended dose is 25 g Al/m^2. This site was originally a two-cell system, however, over time the center berm has disappeared.

Table 7: BF Nelson Pond Alum Treatment

Pond Surface Area (ac)	Estimated Dead Pool Storage Volume (ac-ft)	Recommended Dose of Alum (g Al/m^2)	TP Load Reduction Range (lbs/yr)	25-Year Cost Benefit ($/lb. TP Removed)
6.78	**25.3**	**25**	**22 to 44**	**$242**

Alum treatment at Schroeder’s Acres would prevent 22 to 44 lbs. of TP from entering Eagle Creek each year. Each dose is expected to cost $39,900. Doses need to be applied every five years. Alum treatment here has a total cost of $199,500 over 25 years.

4.1.4 Wyoming Avenue Stormwater Structure

This proposed option consists of installing an underground stormwater treatment structure in the area along Wyoming Avenue South see **Figure 10C**. The structure would work in conjunction with the Trunk Highway 13 stormwater structure to provide treatment to over 13 acres of industrial runoff currently flowing directly into Eagle Creek. Private land owner coordination would be required to make this project successful, due to its location. The results from P8 are outlined in **Table 8** below.

Table 8: Wyoming Ave Stormwater Structure Pollutant Removals

BMP	Total Suspended Solids Removal (lbs./year)	Total Phosphorus Removal (lbs./year)	25-Year Cost Benefit ($/ton TSS Removed)	25-Year Cost Benefit ($/lb. TP Removed)
Wyoming Ave Stormwater Structure	**5,720**	**17.6**	**$10,230**	**$1,660**

The Wyoming Avenue stormwater structure would remove 17.6 lbs. of TP from entering Eagle Creek each year. The proposed improvements are estimated to cost approximately **$668,600** with an annual cost of **$2,500** to complete operations and maintenance. The 25-year cost benefit of this option would be **$1,660** per pound of TP removed.

4.1.5 Trunk Highway 13 Stormwater Structure

This proposed option consists of installing an underground stormwater treatment structure in the right of way south of Trunk Highway 13. See **Figure 10C**. The structure would work in conjunction with the previously mentioned structure along Wyoming Avenue South to provide treatment to over 13 acres of residential runoff currently flowing directly into Eagle Creek. The results from P8 are outlined in **Table 9** below.

Table 9: Trunk Highway 13 Stormwater Structure Pollutant Removals

BMP	Total Suspended Solids Removal (lbs./year)	Total Phosphorus Removal (lbs./year)	25-Year Cost Benefit ($/ton TSS Removed)	25-Year Cost Benefit ($/lb. TP Removed)
Trunk Highway 13 Stormwater Structure	**4,170**	**9.5**	**$5,090**	**$1,120**

The Trunk Highway 13 stormwater structure would remove 9.5 lbs. of TP from entering Eagle Creek each year. The proposed improvements are estimated to cost approximately **$240,100** with an annual cost of **$1,000** to complete operations and maintenance. The 25-year cost benefit of this option would be **$1,120** per pound of TP removed.

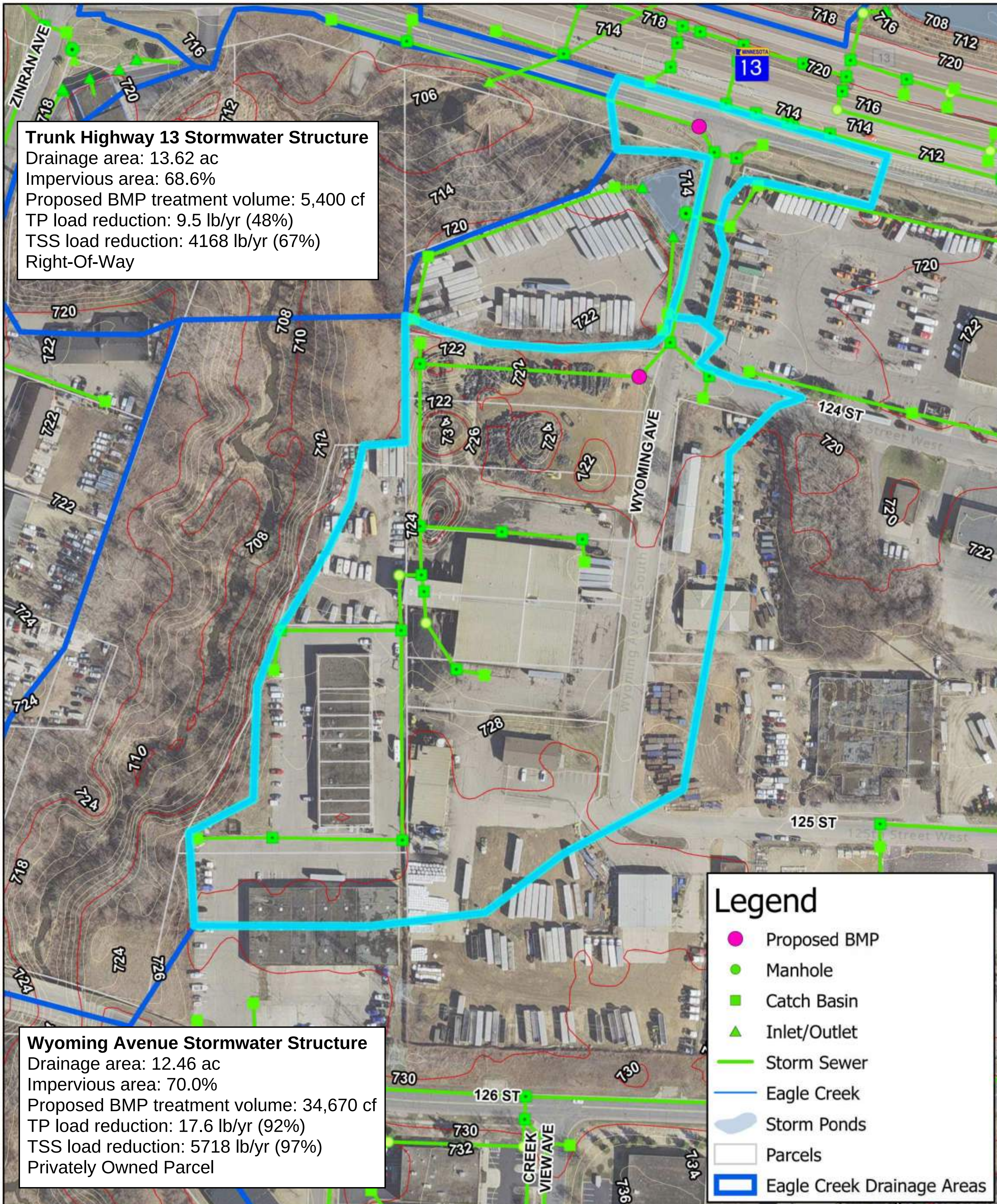

Figure 10C: Wyoming Avenue and Trunk Highway 13 Stormwater Structures

Eagle Creek Subwatershed Assessment
City of Savage

N
0 200 Feet
1 inch = 200 feet

wsb

4.1.6 Zinran Avenue Stormwater Structure

This proposed option consists of installing an underground stormwater treatment structure along Zinran Ave see **Figure 10D**. The structure would provide treatment to over 18 acres of commercial runoff currently not being treated by the City. If this BMP is to be located in the right-of-way, navigating existing utility conflicts will be critical to project success. The results from P8 are outlined in **Table 10** below.

Table 10: Zinran Ave Stormwater Structure Pollutant Removals

BMP	Total Suspended Solids Removal (lbs./year)	Total Phosphorus Removal (lbs./year)	25-Year Cost Benefit ($/ton TSS Removed)	25-Year Cost Benefit ($/lb. TP Removed)
Zinran Ave Stormwater Structure	**3,142**	**4.7**	**$5,250**	**$1,760**

The Zinran Avenue stormwater structure would remove 4.7 lbs. of TP from entering Eagle Creek each year. The proposed improvements are estimated to cost approximately **$168,800** with an annual cost of **$1,500** to complete operations and maintenance. The 25-year cost benefit of this option would be **$1,760** per pound of TP removed.

Figure 10D: Zinran Avenue Stormwater Structure

Eagle Creek Subwatershed Assessment
City of Savage

N
0 200 Feet
1 inch = 200 feet

4.1.7 Eagle Creek Parkway Bank Stabilization

This proposed option consists of stabilizing banks underneath the Eagle Creek Parkway bridge crossing the East Branch of Eagle Creek. See **Figure 10E**. The ravine is currently estimated to be eroding an average of 2 inches per year, which could deposit approximately 8,600 lbs. of sediment into the Lake annually. The results from the BWSR Soil Loss Spreadsheet are outlined in **Table 11** below. Additionally, **Figure 10F** shows how stone toe stabilization would deepen the channel, providing better habitat for aquatic species such as trout. It is also recommended that gravel be added to the stream bottom to provide substrate suitable to benthic macroinvertebrate populations which trout rely on.

Table 11: Eagle Creek Parkway Bank Stabilization Pollutant Removals

BMP	Total Suspended Solids Removal (lbs./year)	Total Phosphorus Removal (lbs./year)	25-Year Cost Benefit ($/ton TSS Removed)	25-Year Cost Benefit ($/lb. TP Removed)
Eagle Creek Parkway Bank Stabilization	**6,600**	**2.8**	**$1,590**	**$1,880**

The Eagle Creek Parkway bank stabilization would remove 2.8 lbs. of TP from entering Eagle Creek each year. Not only this, but the restoration could save over four tons of soil from being deposited in the Lake each year. The proposed improvements are estimated to cost approximately **$106,000** with an annual cost of **$1,000** to complete operations and maintenance. The 25-year cost benefit of this option would be **$1,880** per pound of TP removed.

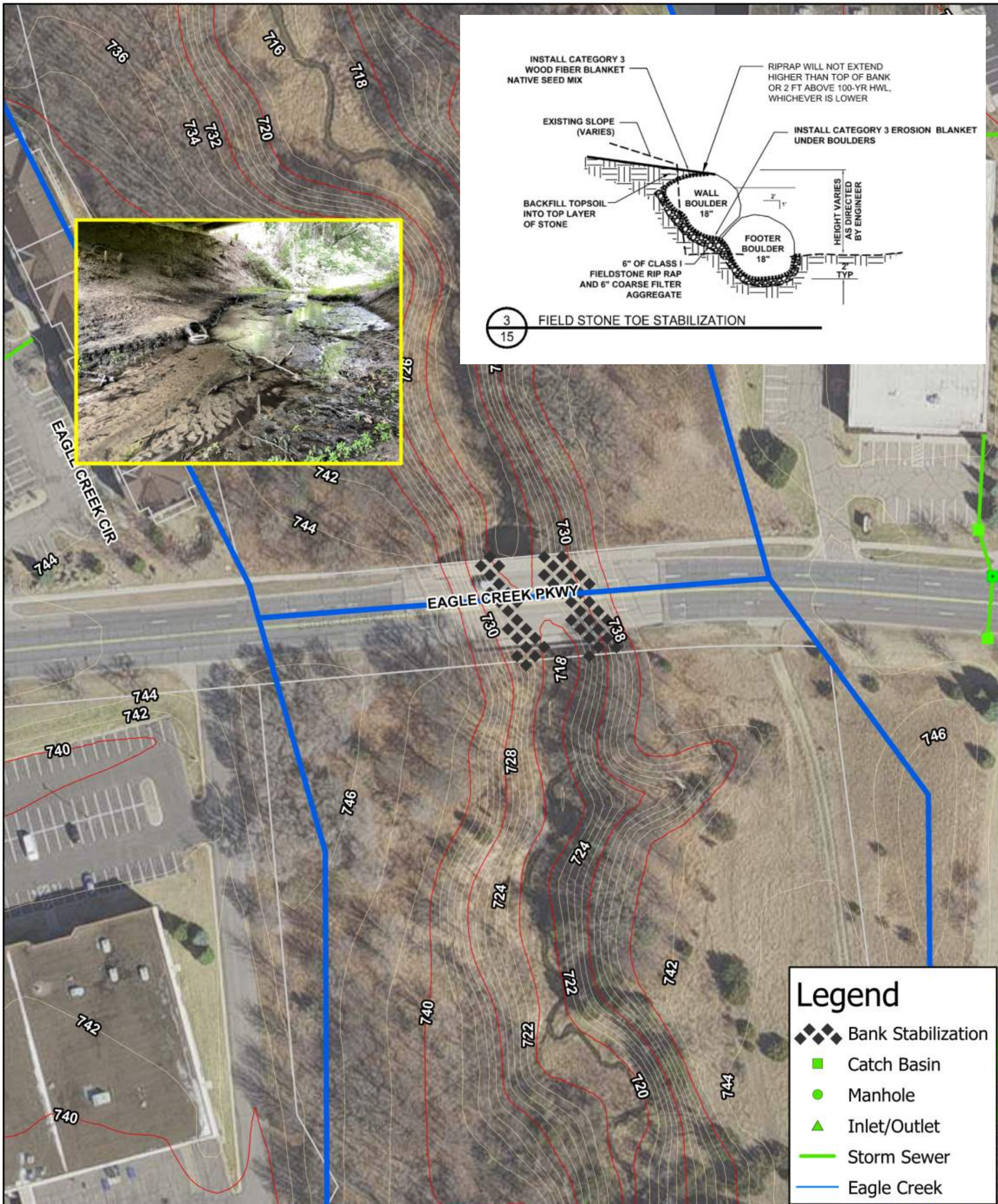

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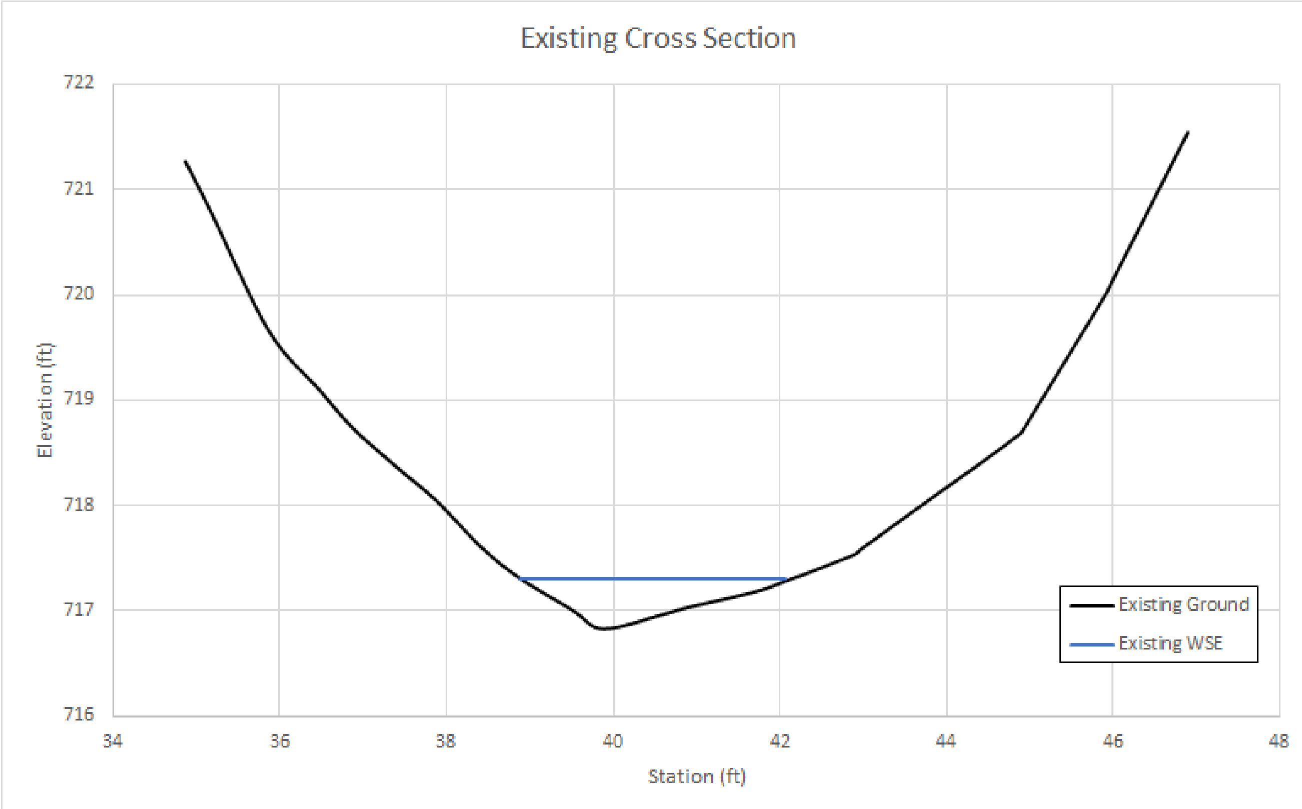
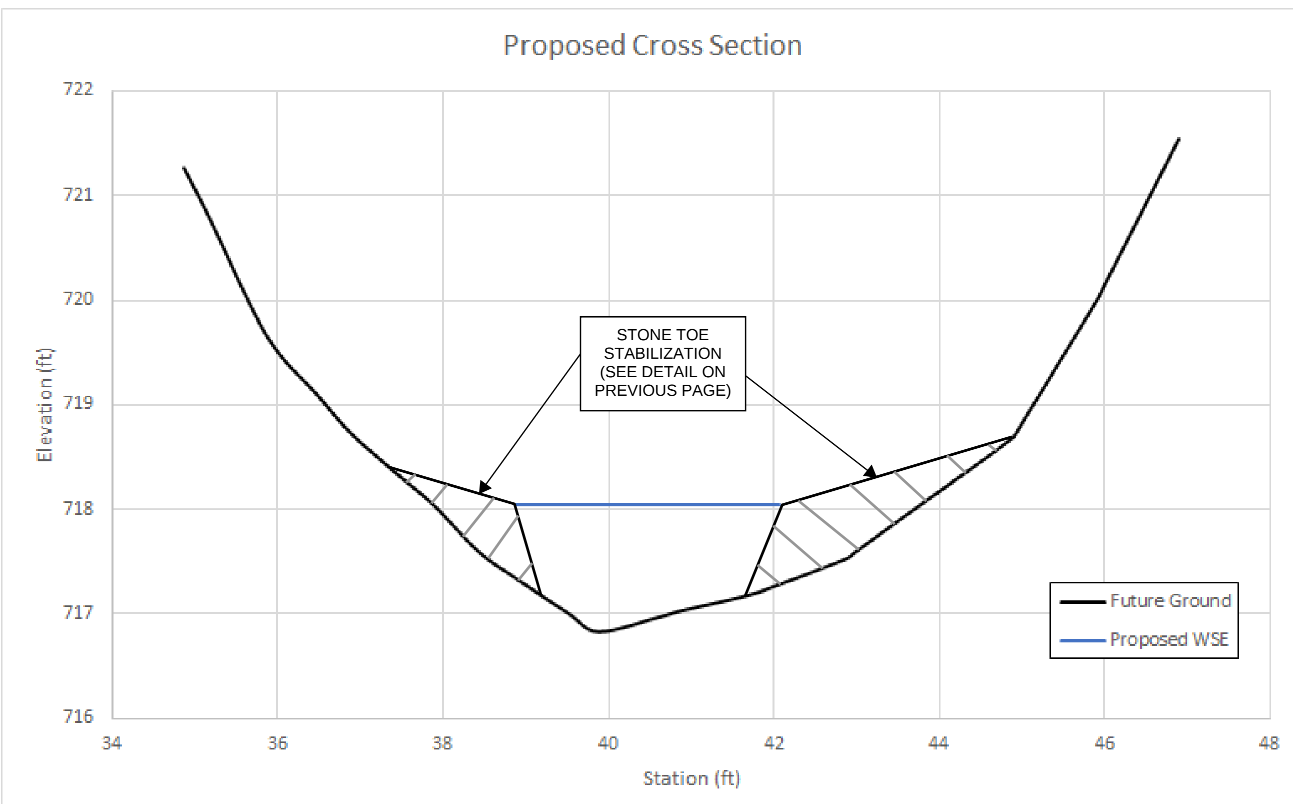
Figure 10E: Eagle Creek Parkway Bank Stabilization

Eagle Creek Subwatershed Assessment
City of Savage

N
0 100 Feet
1 inch = 100 feet

Figure 10F: Bank Stabilization Cross-Sections





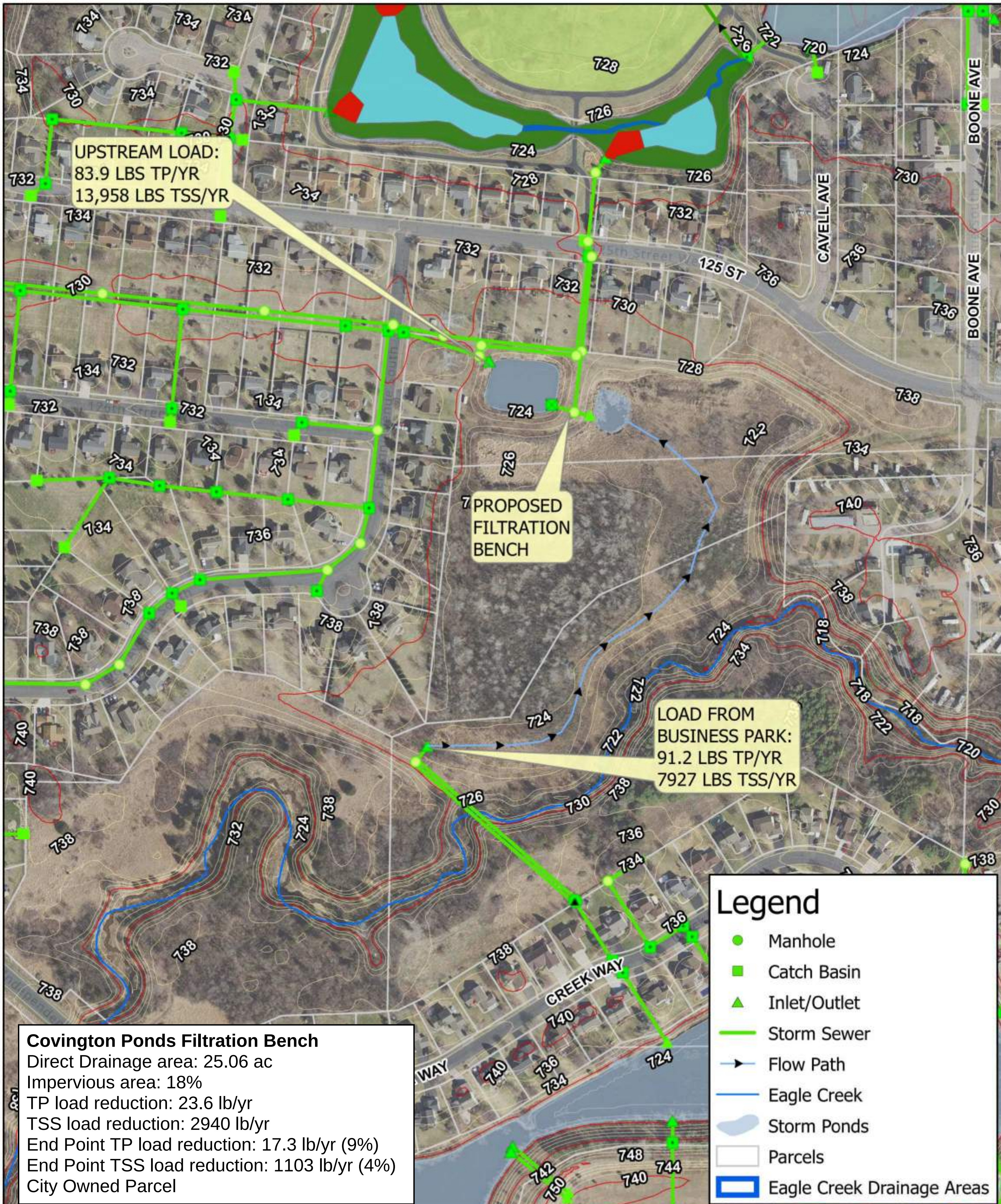
4.1.8 Covington Ponds Filtration Bench

This proposed option consists of an intensive pond restoration plan for the basins on the city owned parcel at Ensign Ave and 125th St W. See **Figure 10G**. A filtration bench would be place between the existing ponds to provide additional treatment to a large portion of residential area and upstream drainage areas. The location of the proposed BMP is on a city-owned parcel. In the future, the city of Shakopee may provide a hydraulic connection to a large landlocked area near Independence Ave. These two projects may work best if done in conjunction with one another. The results from P8 are outlined in **Table 12** below. Benefits to Eagle Creek are diminished by the multiple existing BMPs downstream of the Covington Ponds which also provide treatment. This is particularly notable when evaluating TSS reductions. Values reported are based on reductions at the outfall of the stormwater system.

Table 12: Covington Ponds Filtration Bench Pollutant Removals

BMP	Total Suspended Solids Removal (lbs./year)	Total Phosphorus Removal (lbs./year)	25-Year Cost Benefit ($/ton TSS Removed)	25-Year Cost Benefit ($/lb. TP Removed)
Covington Ponds Filtration Bench	**1103**	**17.3**	**$27,390**	**$870**

The Covington Ponds filtration bench would remove 17.3 lbs. of TP from entering Eagle Creek each year. The proposed improvements are estimated to cost approximately **$315,200** with an annual cost of **$2,500** to complete operations and maintenance. The 25-year cost benefit of this option would be **$870** per pound of TP removed.



Covington Ponds Filtration Bench
Direct Drainage area: 25.06 ac
Impervious area: 18%
TP load reduction: 23.6 lb/yr
TSS load reduction: 2940 lb/yr
End Point TP load reduction: 17.3 lb/yr (9%)
End Point TSS load reduction: 1103 lb/yr (4%)
City Owned Parcel

Figure 10G: Covington Ponds Filtration Bench

Eagle Creek Subwatershed Assessment
City of Savage

N
0 300 Feet
1 inch = 300 feet

4.1.9 Preserve Trail Stormwater Structure

This proposed option consists of installing an underground stormwater treatment structure on the western portion of a parcel owned by the Savage Economic Development Authority. See **Figure 10H**. The structure would provide treatment to over 17 acres of residential runoff prior to it entering the large storm basin in the business park. Because this runoff is routed through numerous stormwater ponds before outletting, the realized pollutant reduction is much smaller – particularly for TSS. Additionally, it is known that the water table in this area is extremely high. This will make development of this site difficult. The results from P8 are outlined in **Table 13** below. Benefits to Eagle Creek are greatly diminished by the numerous existing BMPs downstream of the proposed BMP which also provide treatment. This is particularly notable when evaluating TSS reductions. Values reported are based on reductions at the outfall of the stormwater system.

Table 13: Preserve Trail Stormwater Structure Pollutant Removals

BMP	Total Suspended Solids Removal (lbs./year)	Total Phosphorus Removal (lbs./year)	25-Year Cost Benefit ($/ton TSS Removed)	25-Year Cost Benefit ($/lb. TP Removed)
Preserve Trail Stormwater Structure	**105**	**5.6**	**$463,500**	**$4,350**

The Preserve Trail stormwater structure would remove 5.6 lbs. of TP from entering Eagle Creek each year. The proposed improvements are estimated to cost approximately **$558,300** with an annual cost of **$2,000** to complete operations and maintenance. The 25-year cost benefit of this option would be **$4,350** per pound of TP removed.

Preserve Trail Stormwater Structure
Drainage area: 17.24 ac
Impervious area: 40.9%
Proposed BMP treatment volume: 28,030 cf
TP load reduction: 21 lb/yr
TSS load reduction: 7004 lb/yr
End Point TP load reduction: 5.6 lb/yr (23%)
End Point TSS load reduction: 105 lb/yr (1%)
City Owned Parcel

Figure 10H: Preserve Trail Stormwater Structure

Eagle Creek Subwatershed Assessment
City of Savage

N
0 300 Feet
1 inch = 300 feet

5.0 Conclusion/Next Steps

Opportunities exist to maintain and improve the water quality of Eagle Creek. BMP improvements would provide water quality treatment, improved habitat for wildlife, an increase in biodiversity within the BMP area, and improved natural aesthetics of basin and BMP areas. Installing and/or upgrading multiple BMPs around Eagle Creek will decrease maintenance in downstream basins and loading to downstream water bodies such as the Minnesota River.

The proposed BMPs were given a score for each of four criteria. These scores were then totaled to provide a ranking of proposed BMPs, as seen in Table 14. A higher total indicates the project should be a higher priority. BMPs were given a score of one through five based on their total phosphorus removed annually from reaching Eagle Creek. Five points were given to the Eagle Creek Parkway Bank Stabilization project because it directly affects the trout-supporting reaches of Eagle Creek. Due to stormwater routing, other options primarily impact Eagle Creek downstream of areas which support trout. The Minnesota River would be the primary benefactor of these BMPs. This project, along with the proposed stormwater structures on Wyoming Avenue, Zinran Avenue and Trunk Highway 13 each received five points for being located in currently untreated drainage areas. Scores for constructability were determined by a variety of factors. The four projects which received fives are on city property and did not show obstacles to completion during this review. The Covington Ponds filtration bench received a four due to the need for more information on wetlands in the area. The Preserve Trail stormwater structure was also given three points. It is located on city property, however, the existing high water table is a notable design constraint. The Zinran Avenue stormwater structure was given two points. This project is proposed in a right-of-way and coordination with other utilities would be necessary. The Wyoming Avenue stormwater structure received a one because it requires a public-private partnership. The Trunk Highway 13 stormwater structure received a one because of its proximity to the Eagle Creek AMA and the known difficulty working around existing utilities.

WSB recommends pursuing the installation and construction of multiple BMPs in a variety of locations within the Eagle Creek subwatershed to maximize pollutant load treatment. It is recommended to prioritize the Eagle Creek Parkway Bank Stabilization. This is a cost-effective project that will directly impact water quality and trout habitat in Eagle Creek. Secondly, scheduled alum treatments of the Schroeder's Acres and BF Nelson ponds are recommended to make sizable reductions in TP passed downstream. Third, installing underground treatment structures at Wyoming Avenue and Zinran Avenue will provide stormwater treatment to currently untreated drainage areas and allow for routine maintenance.

Table 14: Ranking of Proposed BMPs

BMP Name	TP Reduction	Directly affects trout-supporting portion of Eagle Creek?	Untreated Drainage Area?	Constructability	Total
Eagle Creek Parkway Bank Stabilization	2	5	5	5	**17**
Schroeder's Acres Alum Treatment	5	0	0	5	**10**
Wyoming Ave Stormwater Structure	4	0	5	1	**10**
Zinran Ave Stormwater Structure	2	0	5	2	**9**
BF Nelson Alum Treatment	4	0	0	5	**9**
TH 13 Rd Stormwater Structure	3	0	5	1	**9**
Schroeder's Acres Water Reuse	1	0	0	5	**6**
Covington Ponds Filtration Bench	1	0	0	4	**5**
Preserve Trail Stormwater Structure	2	0	0	3	**5**

WSB also recommends inspecting stormwater outfalls consistent with the City's MS4 permit to determine if a sediment removal project should be completed at the outfalls. Water quality and sediment sampling should continue to be analyzed through annual monitoring activities. The City will support MCES, Scott County WMO and the LMRWD efforts to continue sample Eagle Creek for *E. coli*. Testing may aid in determining the primary source of *E. coli* in the Subwatershed. While it is assessed that primary sources of E. coli contamination within Eagle creek are non-MS4 related, it is suggested that all MS4s within the watershed continued enforcement of pet waste ordinances and other best practices. The City of Savage will also support their residents and the City of Shakopee in reduction of single residence septic systems.

The quantity and extent of Eagle Creek subwatershed improvement strategies will depend on further research, available funding, and updated water quality and sediment data. The following list contains management plans that will expire in the coming years and the suggested year in which to update management plans and conduct additional surveys:

- WRAPS documents (completed every 10 years) – Due for renewal in 2030.
- Fish Survey – Next scheduled for 2023
- Sediment Sampling
- Water Sampling

APPENDIX A

2020 Lower Minnesota River WRAPS Report

APPENDIX B
Lower Minnesota River TMDL Report Part I

APPENDIX C
Tabular XPSWMM Results

XPSWMM Results

Node	City Pond #	2-year HWL (ft)	10-year HWL (ft)	100-year HWL (ft)	Back to Back 100-year HWL (ft)
101	18-2	728.76	730.08	734.14	737.31
102	None (Savage)	764.67	765.86	773.63	773.64
103	None (Savage)	943.87	944.64	947.00	947.00
104	None (Savage)	775.75	777.77	781.82	781.97
105	27	752.47	753.22	754.72	754.74
106	None (Shakopee)	756.38	756.57	756.91	756.91
107	18-5	763.85	765.67	767.18	767.18
108	18-1	730.75	731.74	734.16	737.32
109	None (Savage)	805.97	807.19	814.29	814.29
110	18-8	966.05	966.49	967.27	967.89
111	18-7	813.54	814.32	816.66	816.69
112	18-6	767.71	768.62	772.35	772.46
113	None (Savage)	742.63	743.93	746.29	746.38
114	None (Savage)	966.21	967.42	969.09	970.30
115	None (Shakopee)	736.05	736.21	736.72	737.31
116	None (Shakopee)	736.86	737.94	738.43	738.52
117	None (Shakopee)	742.63	743.00	743.38	743.49
118	265	732.66	732.90	733.56	734.50
119	None (Shakopee)	742.46	742.66	742.97	742.97
120	None (Shakopee)	736.50	737.28	737.95	738.10
121	None (Shakopee)	736.65	737.99	739.83	739.83
122	None (Savage)	714.70	716.80	717.18	717.18
123	26 & 286	730.84	732.17	734.08	734.72
124	None (Shakopee)	737.76	738.24	738.86	739.05
125	None (Shakopee)	734.58	735.58	735.92	736.35
126	None (Shakopee)	735.86	736.17	736.81	736.81
127	22	735.43	735.96	737.76	739.68
128	None (Shakopee)	736.10	736.61	738.03	739.86
129	None (Shakopee)	741.07	741.56	743.04	743.74
130	315	744.99	745.95	747.95	748.24
131	43	748.25	748.71	750.70	751.40
132	44	748.46	749.12	750.70	751.40
133	45	749.20	749.20	750.70	751.41
134	None (Shakopee)	734.87	735.12	735.97	736.36
135	262	732.66	732.90	733.56	734.50
136	None (Shakopee)	736.24	736.57	737.57	738.67
137	285	732.96	734.18	737.90	739.96
138	None (Shakopee)	740.75	741.00	741.77	742.16

XPSWMM Results continued

Node	City Pond #	2-year HWL (ft)	10-year HWL (ft)	100-year HWL (ft)	Back to Back 100-year HWL (ft)
139	None (Shakopee)	738.91	739.47	740.75	742.16
140	263	739.77	741.09	741.80	742.22
141	327	738.50	738.50	738.76	739.69
142	24	735.08	735.96	739.38	741.74
143	23	736.71	737.05	737.94	739.69
145	None (Shakopee)	734.77	735.13	735.98	736.36
146	None (Shakopee)	733.03	734.23	735.92	736.35
147	None (Shakopee)	734.13	735.03	736.22	736.73
148	None (Shakopee)	735.64	735.96	736.36	736.81
149	None (Shakopee)	735.74	736.37	737.38	737.51
150	None (Shakopee)	735.39	736.44	737.42	737.52
151	None (Shakopee)	737.00	737.38	738.91	739.65
152	None (Savage)	730.03	730.65	734.34	734.48
153	None (Shakopee)	732.04	735.07	735.31	735.39
154	None (Savage)	714.04	714.61	716.65	717.85
155	7-1	722.84	724.34	725.85	726.54
156	7-2	720.62	721.62	722.75	723.61
157	7-6	724.31	724.49	724.80	724.83
158	7-4	725.61	726.38	728.16	729.31
159	7-7	714.25	714.82	716.93	718.14
160	7-3	723.19	724.88	726.87	728.21
161	None (Savage)	715.38	716.22	718.84	718.84
162	None (Savage)	712.48	713.36	714.75	715.11
163	None (Savage)	712.37	712.61	713.32	713.59
164	None (Shakopee)	732.08	732.33	733.78	735.02
165	None (Savage)	710.81	711.68	712.87	715.10
166	None (Savage)	711.16	712.64	716.22	716.22
167	None (Savage)	833.56	837.25	837.92	837.94
168	None (Savage)	773.26	774.50	776.84	776.84
169	None (Shakopee)	732.66	732.90	733.56	734.50
170	None (Shakopee)	732.82	733.25	734.32	735.10
171	None (Savage)	714.63	714.92	715.74	715.96
172	None (Savage)	726.00	726.67	727.90	729.57
173	None (Savage)	740.29	743.96	746.44	746.47
174	264	733.02	733.27	733.83	734.51
175	None (Shakopee)	739.05	739.84	741.82	743.51
176	None (Shakopee)	735.00	735.03	735.82	735.82
177	None (Shakopee)	737.83	738.87	740.89	742.58
178	None (Savage)	753.62	754.69	756.27	756.27

XPSWMM Results continued

Node	City Pond #	2-year HWL (ft)	10-year HWL (ft)	100-year HWL (ft)	Back to Back 100-year HWL (ft)
179	28	759.08	759.96	761.36	761.73
180	29	751.00	751.22	752.23	753.37
181	31	948.57	949.99	953.07	953.15
182	19-24 & 19-26 & 19-27	959.71	961.39	964.19	968.03
183	None (Savage)	969.10	969.43	970.13	970.13
184	19-25	963.84	963.88	963.93	963.93
185	19-11	971.00	971.00	971.35	971.35
186	19-10	950.24	951.16	954.43	954.43
201	None (Junction Node)	735.08	735.96	738.34	740.65
202	None (Junction Node)	735.52	735.96	737.85	739.92
203	None (Junction Node)	735.25	735.96	737.79	739.79
204	None (Junction Node)	915.58	915.66	915.76	915.81
205	None (Junction Node)	734.00	734.00	734.00	734.00
206	None (Junction Node)	949.33	949.68	949.93	949.93
207	None (Junction Node)	814.90	814.90	814.90	814.90
208	None (Junction Node)	749.96	750.06	750.63	751.06
211	None (Junction Node)	719.88	720.18	721.38	723.15
212	None (Junction Node)	719.52	719.97	721.33	723.06
214	None (Junction Node)	764.44	767.08	771.35	771.43
219	None (Junction Node)	939.85	941.08	942.55	943.63
220	None (Junction Node)	726.45	727.93	730.78	733.30
221	None (Junction Node)	725.81	727.28	729.99	732.34
222	None (Junction Node)	723.85	725.33	727.46	729.12
223	None (Junction Node)	724.37	726.55	729.73	732.02
224	None (Junction Node)	724.20	725.37	727.71	729.45
225	None (Junction Node)	723.20	724.96	727.01	728.44
226	None (Junction Node)	813.48	814.08	815.79	815.82
227	None (Junction Node)	811.45	812.05	814.32	814.35
228	None (Junction Node)	805.59	806.40	807.15	807.16
229	None (Junction Node)	797.93	798.07	798.26	798.26
230	None (Junction Node)	815.13	817.10	824.17	824.18
231	None (Junction Node)	800.63	802.60	809.01	809.24
232	None (Junction Node)	796.69	798.90	801.84	801.94
233	None (Junction Node)	770.11	771.09	775.36	775.39
234	None (Junction Node)	723.53	723.63	723.82	724.10
235	None (Junction Node)	768.55	769.53	773.15	773.44
236	None (Junction Node)	836.80	836.80	836.80	836.90
237	None (Junction Node)	720.57	721.57	722.71	723.59
238	None (Junction Node)	725.62	726.42	728.38	730.30

XPSWMM Results continued

Node	City Pond #	2-year HWL (ft)	10-year HWL (ft)	100-year HWL (ft)	Back to Back 100-year HWL (ft)
239	None (Junction Node)	723.11	724.76	726.55	728.35
240	None (Junction Node)	736.02	736.56	737.63	738.80
241	None (Junction Node)	735.06	735.46	736.36	736.81
242	None (Junction Node)	735.42	735.80	737.25	738.84
243	None (Junction Node)	748.21	748.64	750.49	751.14
244	None (Junction Node)	747.37	747.81	748.22	748.55
245	None (Junction Node)	748.80	750.97	751.94	751.97
246	None (Junction Node)	752.46	753.22	754.72	754.74
247	None (Junction Node)	766.37	766.37	773.79	774.00
248	None (Junction Node)	965.45	965.45	965.58	965.75
249	None (Junction Node)	710.10	710.10	710.10	710.10
255	None (Junction Node)	742.60	742.95	743.76	743.95
256	None (Junction Node)	743.68	744.07	745.01	745.28
301	None (Eagle Creek)	712.78	713.92	715.48	715.55
302	None (Eagle Creek)	710.25	710.25	710.78	711.08
303	None (Eagle Creek)	711.18	711.45	711.00	711.04
304	None (Eagle Creek)	710.79	710.79	710.79	710.79
305	None (Eagle Creek)	710.10	710.10	710.10	710.10
306	None (Eagle Creek)	719.19	720.05	721.20	721.24
307	None (Eagle Creek)	748.33	748.83	749.45	749.46
308	None (Eagle Creek)	728.52	729.50	730.62	730.65
309	None (Eagle Creek)	727.41	728.24	729.34	729.38
310	None (Eagle Creek)	722.22	723.07	724.20	724.24
311	None (Eagle Creek)	714.78	715.71	717.01	717.09
312	None (Eagle Creek)	730.17	730.51	731.10	731.10
313	None (Eagle Creek)	717.57	718.26	719.27	719.27
314	None (Eagle Creek)	715.15	715.77	716.78	716.79
315	None (Eagle Creek)	710.32	710.32	710.97	711.23
316	None (Eagle Creek)	756.38	756.57	756.96	756.96

APPENDIX D
Tabular P8 Results

P8 Results: Total Phosphorus					
Name	City Pond #	Watershed Inflows (lbs TP/yr)	Load Reduction (% TP removed)	Area (ac)	Loading (lbs TP/ac/yr)
101	18-2	92.4	45	159.35	0.58
105	27	14.1	53	32.11	0.44
107	18-5	20.9	42	44.73	0.47
108	18-1	62	28	81.76	0.76
110	18-8	1.7	71	4.12	0.41
111	18-7	24.9	47	37.51	0.66
112	18-6	12.5	44	25.28	0.49
118	265	72.5	56	73.36	0.99
122	None (Savage)	20	0	13.64	1.47
123	26 & 286	65.8	42	57.33	1.15
127	22	52.3	60	67.55	0.77
135	262	67.3	52	70.37	0.96
137	285	23.4	70	18.36	1.27
140	263	5.1	69	4.03	1.27
141	327	2.4	45	8.58	0.28
142	24	5.9	63	14.28	0.41
143	23	12.9	60	27.02	0.48
155	7-1	29.6	18	65.06	0.45
156	7-2	15.5	5	24.59	0.63
157	7-6	2.1	61	1.51	1.39
158	7-4	35.2	13	62.34	0.56
159	7-7	12.2	2	8.69	1.40
160	7-3	9.3	4	25.06	0.37
162	None (Savage)	68.3	0	47.01	1.45
165	None (Savage)	1.8	0	1.51	1.19
171	None (Savage)	42.2	0	33.01	1.28
302	Eagle Creek	9.6	41	23.6	0.41
305	Eagle Creek	26.4	19	23.6	1.12
311	Eagle Creek	43.9	43	95.35	0.46
314	Eagle Creek	24.9	28	84.24	0.30
Landlocked	None (Shakopee)	26.1	0	112.7	0.23

P8 Results: Total Suspended Solids					
Name	City Pond #	Watershed Inflows (lbs TSS/yr)	Load Reduction (% TSS Removed)	Area (ac)	Loading (lbs TSS/ac/yr)
101	18-2	28970.7	80	159.4	182
105	27	4469.3	82	32.11	139
107	18-5	6649.2	70	44.73	149
108	18-1	19360.9	59	81.76	237
110	18-8	543.9	80	4.12	132
111	18-7	7895.6	76	37.51	210
112	18-6	3993.8	73	25.28	158
118	265	22508.6	94	73.36	307
122	None (Savage)	6177.6	0	13.64	453
123	26 & 286	20338.2	87	57.33	355
127	22	16276	94	67.55	241
135	262	20945.8	82	70.37	298
137	285	7223.6	99	18.36	393
140	263	1567.9	98	4.03	389
141	327	776.1	75	8.58	90
142	24	1847.8	92	14.28	129
143	23	4064.9	90	27.02	150
155	7-1	9364.4	61	65.06	144
156	7-2	4858.7	32	24.59	198
157	7-6	663.3	91	1.51	439
158	7-4	11173.5	51	62.34	179
159	7-7	3760.1	18	8.69	433
160	7-3	2933.1	27	25.06	117
162	None (Savage)	21037.4	0	47.01	448
165	None (Savage)	547.6	0	1.51	363
171	None (Savage)	13160.6	0	33.01	399
302	Eagle Creek	3072.3	72	23.6	130
305	Eagle Creek	8176.6	64	23.6	346
311	Eagle Creek	13932.5	74	95.35	146
314	Eagle Creek	8124.5	58	84.24	96
Landlocked	None (Shakopee)	8665.4	0	112.7	77

APPENDIX E

List of Parcels with Septic Systems

List of Parcels with Septic System

Address	City	Parcel ID
8260 MCCOLL DR	Savage	260640010
12630 BOONE AVE	Savage	260960040
13320 HILLSBORO AVE	Savage	261850010
8538 MCCOLL DR	Savage	269180020
9100 MCCOLL DR	Savage	269180110
8900 MCCOLL DR	Savage	269180112
8800 MCCOLL DR	Savage	269180114
8850 MCCOLL DR	Savage	269180115
9090 MCCOLL DR	Savage	269180116
8359 MCCOLL DR	Savage	269190020
8992 13 AVE E	Shakopee	270430020
9016 13 AVE E	Shakopee	270430030
9040 13 AVE E	Shakopee	270430040
9064 13 AVE E	Shakopee	270430050
9081 13 AVE E	Shakopee	270430070
9085 13 AVE E	Shakopee	270430081
9095 13 AVE E	Shakopee	270430100
9097 13 AVE E	Shakopee	270430110
1350 MARAS ST	Shakopee	270570020
1386 MARAS ST	Shakopee	270570030
1415 MARAS ST	Shakopee	270570050
1395 MARAS ST	Shakopee	270570060
1315 MARAS ST	Shakopee	270570070
1425 STAGECOACH RD	Shakopee	270700010
1475 STAGECOACH RD	Shakopee	270700020
1416 MARAS ST	Shakopee	270990020
1393 STAGECOACH RD	Shakopee	271070010
1444 MARAS ST	Shakopee	271510040
2183 KELLY CIR	Shakopee	272210010
2163 KELLY CIR	Shakopee	272210020
2143 KELLY CIR	Shakopee	272210030
2123 KELLY CIR	Shakopee	272210040
2103 KELLY CIR	Shakopee	272210050
2108 KELLY CIR	Shakopee	272210060
2128 KELLY CIR	Shakopee	272210070
2148 KELLY CIR	Shakopee	272210080
1894 PRESERVE CT	Shakopee	272510010
1864 PRESERVE CT	Shakopee	272510020
1834 PRESERVE CT	Shakopee	272510030
1821 PRESERVE CT	Shakopee	272510040

Address	City	Parcel ID
1841 PRESERVE CT	Shakopee	272510050
1861 PRESERVE CT	Shakopee	272510060
1881 PRESERVE CT	Shakopee	272510070
9430 BOILING SPRINGS LN	Shakopee	272510080
9450 BOILING SPRINGS LN	Shakopee	272510090
9470 BOILING SPRINGS LN	Shakopee	272510100
9490 BOILING SPRINGS LN	Shakopee	272510110
9427 BOILING SPRINGS LN	Shakopee	272510120
9447 BOILING SPRINGS LN	Shakopee	272510130
9467 BOILING SPRINGS LN	Shakopee	272510140
9487 BOILING SPRINGS LN	Shakopee	272510150
9105 PRESERVE TRL	Shakopee	272510160
1922 BOILING SPRINGS CIR	Shakopee	272510170
1942 BOILING SPRINGS CIR	Shakopee	272510180
1962 BOILING SPRINGS CIR	Shakopee	272510190
1982 BOILING SPRINGS CIR	Shakopee	272510200
2012 BOILING SPRINGS CIR	Shakopee	272510210
2032 BOILING SPRINGS CIR	Shakopee	272510220
2043 BOILING SPRINGS CIR	Shakopee	272510230
2023 BOILING SPRINGS CIR	Shakopee	272510240
2003 BOILING SPRINGS CIR	Shakopee	272510250
1983 BOILING SPRINGS CIR	Shakopee	272510260
1963 BOILING SPRINGS CIR	Shakopee	272510270
1943 BOILING SPRINGS CIR	Shakopee	272510280

List of Parcels with Septic System

Address	City	Parcel ID
1923 BOILING SPRINGS CIR	Shakopee	272510290
1936 CREEK RIDGE CT	Shakopee	272510300
1966 CREEK RIDGE CT	Shakopee	272510310
2006 CREEK RIDGE CT	Shakopee	272510320
1431 MARAS ST	Shakopee	274150010
8600 HANSEN AVE	Shakopee	279120220
8800 13 AVE E	Shakopee	279120221
8607 HANSEN AVE	Shakopee	279120222
8700 13 AVE E	Shakopee	279120223
8620 13 AVE E	Shakopee	279120224
1465 MARAS ST	Shakopee	279120240
1500 MARAS ST	Shakopee	279120250
1488 MARAS ST	Shakopee	279120260
9050 BOILING SPRINGS LN	Shakopee	279130010
9130 BOILING SPRINGS LN	Shakopee	279130011
8678 BOILING SPRINGS LN	Shakopee	279130012
9382 BOILING SPRINGS LN	Shakopee	279130020
9290 BOILING SPRINGS LN	Shakopee	279130030
9407 BOILING SPRINGS LN	Shakopee	279130070
1789 STAGECOACH RD	Shakopee	279130080
1762 STAGECOACH RD	Shakopee	279130110
1794 STAGECOACH RD	Shakopee	279130120
1808 STAGECOACH RD	Shakopee	279130130
1818 STAGECOACH RD	Shakopee	279130140
1753 STAGECOACH RD	Shakopee	279130150
1586 STAGECOACH RD	Shakopee	279130180
1723 STAGECOACH RD	Shakopee	279130211
1579 STAGECOACH RD	Shakopee	279130220
8615 BOILING SPRINGS LN	Shakopee	279130230
8785 BOILING SPRINGS LN	Shakopee	279130250
1685 STAGECOACH RD	Shakopee	279130260
8917 BOILING SPRINGS LN	Shakopee	279130270

Address	City	Parcel ID
9129 BOILING SPRINGS LN	Shakopee	279130280
9401 BOILING SPRINGS LN	Shakopee	279130290
9186 BOILING SPRINGS LN	Shakopee	279130300
9230 BOILING SPRINGS LN	Shakopee	279130310
8708 BOILING SPRINGS LN	Shakopee	279130320
8707 BOILING SPRINGS LN	Shakopee	279130330
1655 STAGECOACH RD	Shakopee	279130340
9365 BOILING SPRINGS LN	Shakopee	279130350
9315 BOILING SPRINGS LN	Shakopee	279130360
8786 BOILING SPRINGS LN	Shakopee	279130370
9075 BOILING SPRINGS LN	Shakopee	279130380
9225 BOILING SPRINGS LN	Shakopee	279130390
9177 BOILING SPRINGS LN	Shakopee	279130400
9035 BOILING SPRINGS LN	Shakopee	279130410
8963 BOILING SPRINGS LN	Shakopee	279130420
9011 BOILING SPRINGS LN	Shakopee	279130430
9269 BOILING SPRINGS LN	Shakopee	279130440
9326 BOILING SPRINGS LN	Shakopee	279130450
8911 EAGLE CREEK BLVD	Shakopee	279130730