Hastings Water Quality Improvement Planning

Prepared for
City of Hastings

May 2023

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Certification

I hereby certify that this 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.

Michael McKinney PE #: 54943	May 5, 2023 Date

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Abbreviations

BMP	Best management practice
CIP	Capital Improvement Plan
HDS	Hydrodyanmic separator
TSS	Total suspended solids
TP	Total phosphorus

Introduction

The purpose of this study was to identify locations for water quality improvement projects within the Vermillion River drainage area and complete planning-level evaluations for reductions in total suspended solids (TSS) and total phosphorus (TP). In order to accomplish this task Barr reviewed a wide range of data sets, discussed further in Section 2.1, to identify potential locations for best management practices (BMPs). The analysis resulted in identification of 34 potential BMP locations throughout the portion of the City of Hastings (City) that is tributary to the Vermillion River. Eight BMPs were selected for further evaluation based on coordination with City staff. Planning-level evaluations were completed for five filtration basins and three hydrodynamic separators (HDS). The following sections describe the methodology and results from the evaluation.

2 Identification of Potential Locations for Best Management Practices

2.1 Data Review

To evaluate potential BMP locations, a variety of data sources were compiled and reviewed. To help identify priority BMP implementation areas the following data sets were used and can be seen in Figure A-1:

- Future street projects (Caven 2023)
- Future capital projects (Caven 2023)
- Public parcels (Dakota County 2022)
- Trails (Caven 2023)
- Zoning (Caven 2023)
- Prior water quality projects (Caven 2023), (City of Hastings Watershed Management Plan 2009)

In addition, a qualitative screening for feasible locations was completed using the following criteria

- Treated and untreated areas, defined as discharging to an existing BMP
- Proximity and accessibility of storm sewer (Caven 2023)
- Adjacent to planned project in the City's CIP (Caven 2023)
- Publicly owned parcel (Dakota County 2022)
- Elevation and topography (Fugro Horizons Inc. 2011)
- Ease of construction access

One of the primary data sets used for the qualitative screen process was mapping of treated and untreated areas in the Vermillion River drainage area (Figure A-2). The treated and untreated dataset was developed by using subwatersheds from prior P8 and XPSWMM modeling (City of Hastings Watershed Management Plan 2009), locations of BMPs throughout the City (Caven 2023), (City of Hastings Watershed Management Plan 2009), and storm sewer network (Caven 2023). Subwatersheds were defined as treated if routed to a BMP modeled in P8 or a BMP installed throughout the City since 1998 (Caven 2023), (City of Hastings Watershed Management Plan 2009).

An important consideration for BMP implementation is potential soil constraints. Low soil permeability areas (National Cooperative Soil Survey 2019), karst areas (6), and wellhead protection zones (7) are shown on Figure A-3. A majority of soils within the study area are either unidentified or hydrologic group A or B. While hydrologic group A and B soils are suitable for infiltration practices, Figure A-3 shows that a majority of the Vermillion River study area is mapped within potential karst and/or wellhead protection areas. Due to the extents of potential karst, final selection of basin type (infiltration or filtration) would require a site investigation to determine if the proposed BMP is in a karst area and confirm soil permeability assumptions.

2.2 Identification of BMP Implementation Areas

To identify potential BMP implementation areas, a desktop analysis was completed. Potential BMPs were given qualitative rankings from low to very high. The qualitative ranking was based on potential treatment (size of drainage area), public parcel ownership, treated or untreated area, proximity to opportunity areas (planned road reconstruction areas, etc.), site factors such as tree loss, and constructability considerations. The desktop analysis resulted in 34 locations being identified throughout the City. In January, Barr met with the City to review the 34 BMP opportunity locations and determine which should be evaluated further. Figure A-4 shows the 34 BMPs reviewed with the City and one additional BMP opportunity identified by the Dakota County Soil and Water Conservation District. Figure A-4 also includes City review comments and highlights the eight BMPs selected for further evaluation.

3 Best Management Practice Planning-Level Evaluation

Planning-level evaluation for the eight BMP opportunities identified through coordination with the City (see opportunities highlighted in Figure A-4) was completed. Appendix B provides a planning level summary for each BMP evaluated, including summary of the following:

- BMP locations and description
- Approximate BMP drainage area
- BMP dimensions
- Pollutant loading summary
- Pollutant reduction summary
- Opinion of probable cost (OPC)
- Key design notes and considerations

The following subsections provide a summary of water quality modeling and cost estimating methodology.

3.1 Water Quality Modeling Methodology

The follow subsections provide an overview of water quality modeling methodology used to design and evaluate performance of the eight identified BMP opportunities. The 5 proposed filtration BMPs were evaluated using the water quality modeling program P8 Version 3.5 (P8), and the three HDS systems were evaluated using SHSAM Version 6.71.

3.1.1 Hydrology

Sizing and design of water quality BMPs is dependent on the drainage area and land use characteristics tributary to the BMP. The drainage area to each BMP was determined based on site topography, BMP siting, and assumed connections to City infrastructure (e.g., storm sewer connections, assumed curb cut locations, etc.). The City's XPSWMM model subwatersheds were referenced during this analysis. The assumed drainage area to each BMP is highlighted in Appendix B. Utilizing developed subwatershed divides, a GIS analysis was performed to generate hydrologic inputs required for water quality modeling (i.e., total area, average slope, tributary total and directly connected impervious area, and soil infiltration parameters).

3.1.2 BMP Sizing

Filtration BMPs (Figure B-1 through Figure B-5) were sized using design guidance outlined in the Minnesota Stormwater Manual (Design Criteria for Filtration n.d.). BMP water quality volume (live surface storage volume) was sized to treat 1.1 inches of runoff from tributary directly connected impervious surface area, and BMP depth was designed to allow for complete drawdown within 48-hours. Due to site constraints limiting the footprint size of the 15th Street Basin, two alternative sizing strategies were evaluated: (1) based on assumed bypass of 75% of the 15th St E storm sewer trunkline, and (2) based on assumed bypass of 50% of the 15th St E storm sewer trunkline (Figure B-4 and Figure B-5, respectively). Rather than explicitly modeling the bypass, the BMPs were sized to provide treatment of 50% and 25% of the tributary directly connected impervious surface area, respectively.

Sizing evaluation of proposed HDS systems (Figure B-6 through Figure B-8) was performed using iterative modeling in SHSAM Version 6.71. Specifically, the SHSAM program simulates performance of multiple models of the selected HDS technology simultaneously and presents results for each. The user then reviews results to select the model size which is most-appropriately sized for the input drainage areas (i.e., the system that optimizes performance considering parameters such as TSS removal, cleanouts required per year, and system dimensions). Based on the large tributary area to the proposed HDS system on Walnut Street (160.8 acres, Figure B-8), sizing and performance of this HDS assumes installation of a bypass system to bypass 75% of flow from the Walnut Street trunkline.

3.1.3 Model Results

Performance of the proposed filtration BMPs (Figure B-1 through Figure B-5) was evaluated using P8 Version 3.5. Performance of each filtration BMP was evaluated using both (a) standard filtration media and (b) iron-enhance sand filtration media. Iron-enhanced sand provides additional removal of dissolved pollutant constituents including phosphate but is more expensive than traditional filtration media. Filtration efficiency values for standard and iron-enhances sand media were assumed based on filtration efficiency values cited in the Minnesota Stormwater Manual (Design Criteria for Iron Enhanced Sand Filter n.d.). TSS and TP loading and reductions results determined through modeling in P8 are summarized in Appendix B.

Performance of the proposed HDS systems (Figure B-6 through Figure B-8) was evaluated using SHSAM Version 6.71. Several HDS technologies were evaluated in SHSAM, including CDS, Downstream Defender, SciClone, and SAFL. Rather than providing results for many HDS technologies and model sizes, based on review of composite results at each of the proposed HDS location, it was determined that an annual TSS load reduction value of 35% was attainable at each location. A TSS load reduction of 35% was selected as a representative, average removal efficiency for the multiple HDS technologies. As noted in Section 3.1.2, the planned bypass at the Walnut Street HDS location (Figure B-8) results in TSS reduction from the total drainage area of 8.8% (35% TSS reduction of the non-bypass load). Because SHSAM does not report TP loading and removal, a P8 modeling analysis was performed to determine equivalent TP loading and reduction at each HDS site. This analysis was used to estimate TP loading to each site and an assumed HDS TP annual reduction efficiency of 10.3%.

Each BMP opportunity, drainage area, pollutant loading, and pollutant removal is summarized in Appendix B. Table 1 summarizes annualized pollutant loading and pollutant reduction evaluated of the eight proposed BMP locations. The proposed BMP locations are hypothetical and exact siting of the BMP may be impacted by unique site constraints, land acquisition and coordination, and utility conflicts.

Table 1 Total Suspended Solids and Total Phosphorus Performance of Modeled Best Management Practices

BMP Description	Annual TSS Load to BMP (lb/year)	Annual TSS Removed (lb/year)	% TSS removed	TP Load to BMP (lb/year)	Annual TP Removed[1] (lb/year)	% TP removed[1]
18th Street Infiltration Basin	761	721	95%	2.5	2.2	91%
18th Street Filtration Basin (Iron Enhanced[2])	761	657	86%	2.5	1.4 (1.7)	56% (71%)
Westwood Park Infiltration Basin	852	792	93%	2.8	2.4	88%
Westwood Park Filtration Basin (Iron Enhanced[2])	852	723	85%	2.8	1.5 (1.9)	54% (69%)
10th Street Infiltration Basin	2,363	2,303	97%	7.7	7.2	94%
10th Street Filtration Basin (Iron Enhanced[2])	2,363	2,096	89%	7.7	4.4 (5.6)	58% (73%)
15th Street Infiltration Basin, treating 25% directly connected impervious	9,553	6,820	71%	31.1	16.6	53%
15th Street Filtration Basin, treating 25% directly connected impervious (Iron Enhanced[2])	9,553	6,411	67%	31.1	11.2 (13.5)	36% (43%)
15th Street Infiltration Basin, treating 50% directly connected impervious	9,553	8,270	87%	31.1	23.5	76%
15th Street Filtration Basin, treating 50% directly connected impervious (Iron Enhanced[2])	9,553	7,624	80%	31.1	15.2 (18.7)	49% (60%)
HDS on Pine Street[3]	5,080	1,778	35%	25.6	2.7	10.3%
HDS on Ashland Street[3]	2,824	988	35%	14.0	1.4	10.3%
HDS on Walnut Street (*includes 75% bypass)[3]	19,161	1,677	8.8%	98.8	2.6	2.6%

(1) Values are for standard filtration basin. Values in parentheses are for iron enhanced sand filtration

(2) Assumes media is 5-8% iron, in accordance with stormwater manual (Design Criteria for Iron Enhanced Sand Filter n.d.)

(3) HDS performance was evaluated for four systems (CDS, Downstream Defender, SciClone, and SAFL) in SHSAM. Using the results from SHSAM, a representative TSS reduction of 35% was selected and used to estimate HDS performance. Using results from P8, a representative TP reduction of 10.3% of selected.

3.2 Cost Estimate

Planning-level estimates of cost for each of the eight proposed BMPs evaluated is provided in Table 2 Following further definition of the scope of the water quality BMPs and completion of detailed design, the final cost may be lower or higher than the planning-level opinions of cost included in Table 2. These costs are intended to provide a planning-level estimate for the potential water quality BMPs described in previous sections.

These opinions of cost, project reserves, contingency, documentation, and discussion are intended to provide background information for planning-level budget planning. The cost of time escalation is not included in the opinions of probable cost. All costs are presented in 2022 US dollars.

Unit costs are based on recent bid prices, published construction cost-index resources, and similar projects. Costs associated with base planning engineering and design (PED), construction management (CM), permitting, and land acquisition are not included in the overall estimate for construction costs.

The opinions of cost also do not include engineering and design, permitting, land acquisition costs, and other tasks following construction, such as operations and maintenance or monitoring.

Contingency used in these opinions of probable cost is intended to help identify an estimated construction cost amount for items included in the current Project scope that have not yet been accurately quantified at the current level of design. Stated another way, contingency is the resultant of the pluses and minuses that cannot be estimated at the level of project definition that exists. The contingency also includes the cost of ancillary items not currently itemized in the quantity summaries but commonly identified in more detailed design and required for completeness of the work. A 30% contingency is applied to the estimated construction cost to account for the costs of these items.

Industry resources for cost estimating (10), (11) provide guidance on cost uncertainty, depending on the level of project design developed. The opinion of probable cost for the water quality BMPs evaluated generally corresponds to a Class 4 estimate characterized by completion of limited engineering. As the level of design detail increases, the level of uncertainty is reduced. Figure 1 provides a graphic representation of how uncertainty (or accuracy) of cost estimates can be expected to improve as more detailed design is developed.

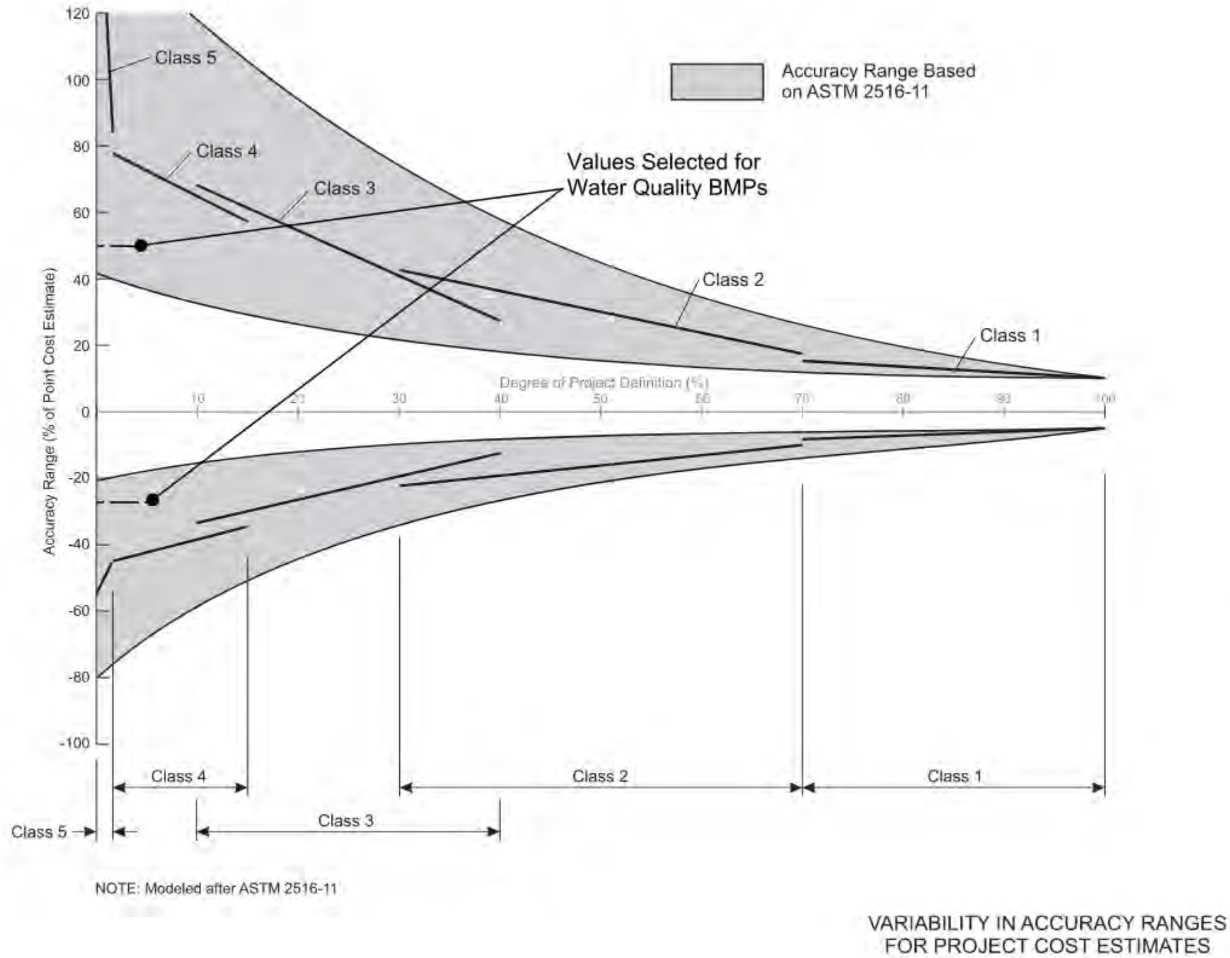

Figure 1 **Relationship between Cost Accuracy and Degree of Project Definition**

At this early stage of planning, the range of uncertainty of total project cost is high. Due to the early stage of the project, it is standard practice to place a broad accuracy range around the point cost estimate.

The accuracy range is based on professional judgment considering the level of design completed, the complexity of the project, and the uncertainties in the project scope; the accuracy range does not include costs for future scope changes that are not part of the project as currently defined or risk contingency. The estimated accuracy range for this point estimate is -25% to +50%.

The opinion of probable construction cost is made based on Barr's experience and qualifications and represents our best judgment as experienced and qualified professionals familiar with the project. It is acknowledged that additional investigations and additional site-specific information that becomes available in the next stage of design may result in changes to the proposed configuration, cost, and functioning of project features. This opinion is based on project-related information available to Barr at this time and includes a planning-level design of the project. In addition, because we have no control over the eventual cost of labor, materials, equipment, or services furnished by others, or over the contractor's methods of determining prices, or over competitive bidding or market conditions, Barr cannot and does not guarantee that proposals, bids, or actual costs will not vary from the opinion of probable cost presented.

Table 2 summarizes construction opinion of probable cost and cost based on annual TSS and TP removal. Appendix C contains the full opinion of probable cost and quantities for all BMPs.

Table 2 Opinion of Probable Construction Cost for Best Management Practices

BMP Description	BMP Type	Opinion of Probable Cost [1,2]	Cost Per Pound of TSS Removed Annually [1,2]	Cost Per Pound of TP Removed Annually [1,2]
18th Street Infiltration Basin	Infiltration Basin	$54,800 - $109,500	$80 - $150	$24,000 - $49,000
18th Street Filtration Basin	Filtration Basin	$77,300 - $154,500	$120 - $240	$55,000 - $110,000
18th Street Iron Enhanced Filtration Basin	Iron Enhanced Filtration Basin	$91,500 - $183,000	$140 - $280	$54,000 - $108,000
Westwood Park Infiltration Basin	Infiltration Basin	$39,800 – $79,500	$50 - $100	$16,000 - $32,000
Westwood Park Filtration Basin	Filtration Basin	$63,000 - $126,000	$90 - $170	$42,000 - $84,000
Westwood Park Iron Enhanced Filtration Basin	Iron Enhanced Filtration Basin	$78,000 - $156,000	$110 - $220	$41,000 - $82,000
10th Street Infiltration Basin	Infiltration Basin	$97,500 - $195,000	$40 - $80	$14,000 - $27,000
10th Street Filtration Basin	Filtration Basin	$134,300 - $268,500	$60 - $130	$31,000 - $61,000
10th Street Iron Enhanced Filtration Basin	Iron Enhanced Filtration Basin	$180,000 - $360,000	$90 - $170	$40,000 - $80,000
15th Street Infiltration Basin, treating 25% directly connected impervious	Infiltration Basin	$90,000 - $180,000	$10 - $30	$5,000 - $11,000
15th Street Filtration Basin, treating 25% directly connected impervious	Filtration Basin	$126,800 - $252,000	$20 - $40	$11,000 - $23,000
15th Street Iron Enhanced Filtration Basin, treating 25% directly connected impervious	Iron Enhanced Filtration Basin	$170,300 - $340,500	$30 - $50	$13,000 - $25,000
15th Street Infiltration Basin, treating 50% directly connected impervious	Infiltration Basin	$135,000 - $270,000	$20 to $30	$6,000 - $11,000
15th Street Filtration Basin, treating 50% directly connected impervious	Filtration Basin	$205,500 - $411,000	$30 - $50	$14,000 - $27,000
15th Street Iron Enhanced Filtration Basin, treating 50% directly connected impervious	Iron Enhanced Filtration Basin	$294,800 - $589,500	$40 - $80	$16,000 - $32,000
HDS on Pine Street	HDS	$78,000 - $156,000	$40 - $90	$29,000 - $58,000
HDS on Ashland Street	HDS	$78,000 - $156,000	$80 - $160	$56,000 - $111,000
HDS on Walnut Street (*includes 75% bypass)	HDS	$105,500 - $270,000	$60 - $120	$39,000 - $77,000

(1) Opinion of probable cost is only for construction and does not include acquisition, design, construction observation, maintenance, or other costs

(2) Represents -25% to +50% range of probable cost

4 Conclusions

Using available data sources, 34 locations were identified in the City that could improve water quality before stormwater is discharged to the Vermillion River. From the 34 locations, eight were selected for further evaluation of water quality BMPs. The performance of BMP was evaluated using water quality modeling as described in Section 3, and varied based on location, BMP dimension, and BMP type. Planning-level estimates of water quality performance and cost are summarized in Table 3.

Table 3 Summary of Best Management Practices Sorted by Cost Effectiveness (1)

BMP Description	BMP Type	Cost Per Pound of TSS Removed Annually (1,2)	Cost Per Pound of TP Removed Annually (1,2)	Annual TSS Removed (lb/year)	Annual TP Removed (lb/year)
15th Street Infiltration Basin, treating 25% directly connected impervious	Infiltration Basin	$10 - $30	$5,000 - $11,000	6,820	16.6
15th Street Filtration Basin, treating 25% directly connected impervious	Filtration Basin	$20 - $40	$11,000 - $23,000	6,411	11.2
15th Street Iron Enhanced Filtration Basin, treating 25% directly connected impervious	Iron Enhanced Filtration Basin	$30 - $50	$13,000 - $25,000	6,411	13.5
15th Street Infiltration Basin, treating 50% directly connected impervious	Infiltration Basin	$20 to $30	$6,000 - $11,000	8,270	23.5
15th Street Filtration Basin, treating 50% directly connected impervious	Filtration Basin	$30 - $50	$14,000 - $27,000	7,624	15.2
15th Street Iron Enhanced Filtration Basin, treating 50% directly connected impervious	Iron Enhanced Filtration Basin	$40 - $80	$16,000 - $32,000	7,624	18.7
10th Street Infiltration Basin	Infiltration Basin	$40 - $80	$14,000 - $27,000	2,303	7.2
10th Street Filtration Basin	Filtration Basin	$60 - $130	$31,000 - $61,000	2,096	4.4
10th Street Iron Enhanced Filtration Basin	Iron Enhanced Filtration Basin	$90 - $170	$40,000 - $80,000	2,096	4.5
HDS on Pine Street	HDS	$40 - $90	$29,000 - $58,000	1,778	2.7
Westwood Park Infiltration Basin	Infiltration Basin	$50 - $100	$16,000 - $32,000	792	2.4
Westwood Park Filtration Basin	Filtration Basin	$90 - $170	$42,000 - $84,000	723	1.5
Westwood Park Iron Enhanced Filtration Basin	Iron Enhanced Filtration Basin	$110 - $220	$41,000 - $82,000	723	1.9
HDS on Walnut Street (*includes 75% bypass)	HDS	$60 - $120	$39,000 - $77,000	1,677	2.6
18th Street Infiltration Basin	Infiltration Basin	$80 - $150	$24,000 - $49,000	721	2.2
18th Street Filtration Basin	Filtration Basin	$120 - $240	$55,000 - $110,000	657	1.4
18th Street Iron Enhanced Filtration Basin	Iron Enhanced Filtration Basin	$140 - $280	$54,000 - $108,000	657	1.7
HDS on Ashland Street	HDS	$80 - $160	$56,000 - $111,000	988	1.4

(1) Table is sorted by annual TSS removal
(2) Represents -25% to +50% range of probable cost

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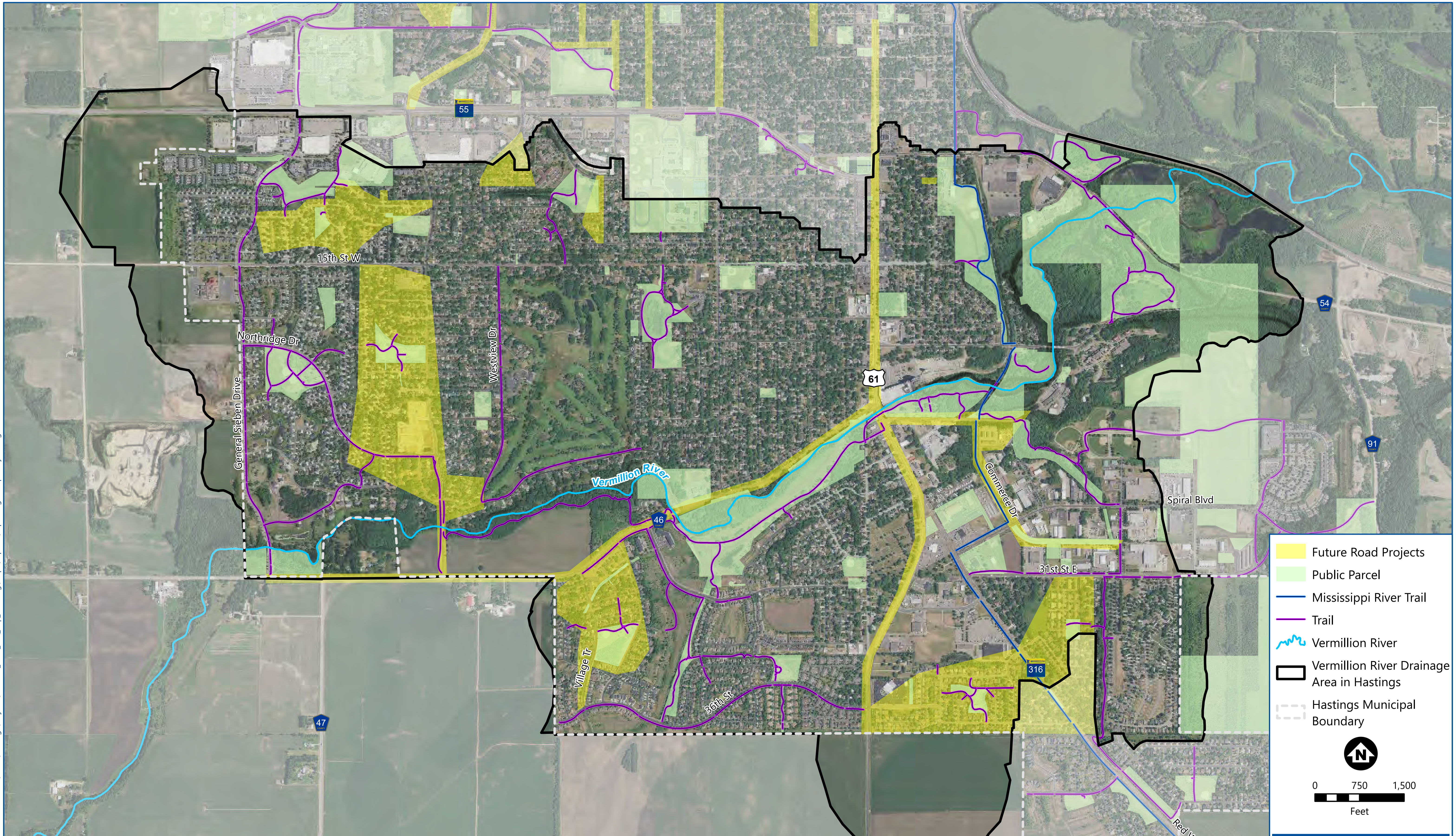
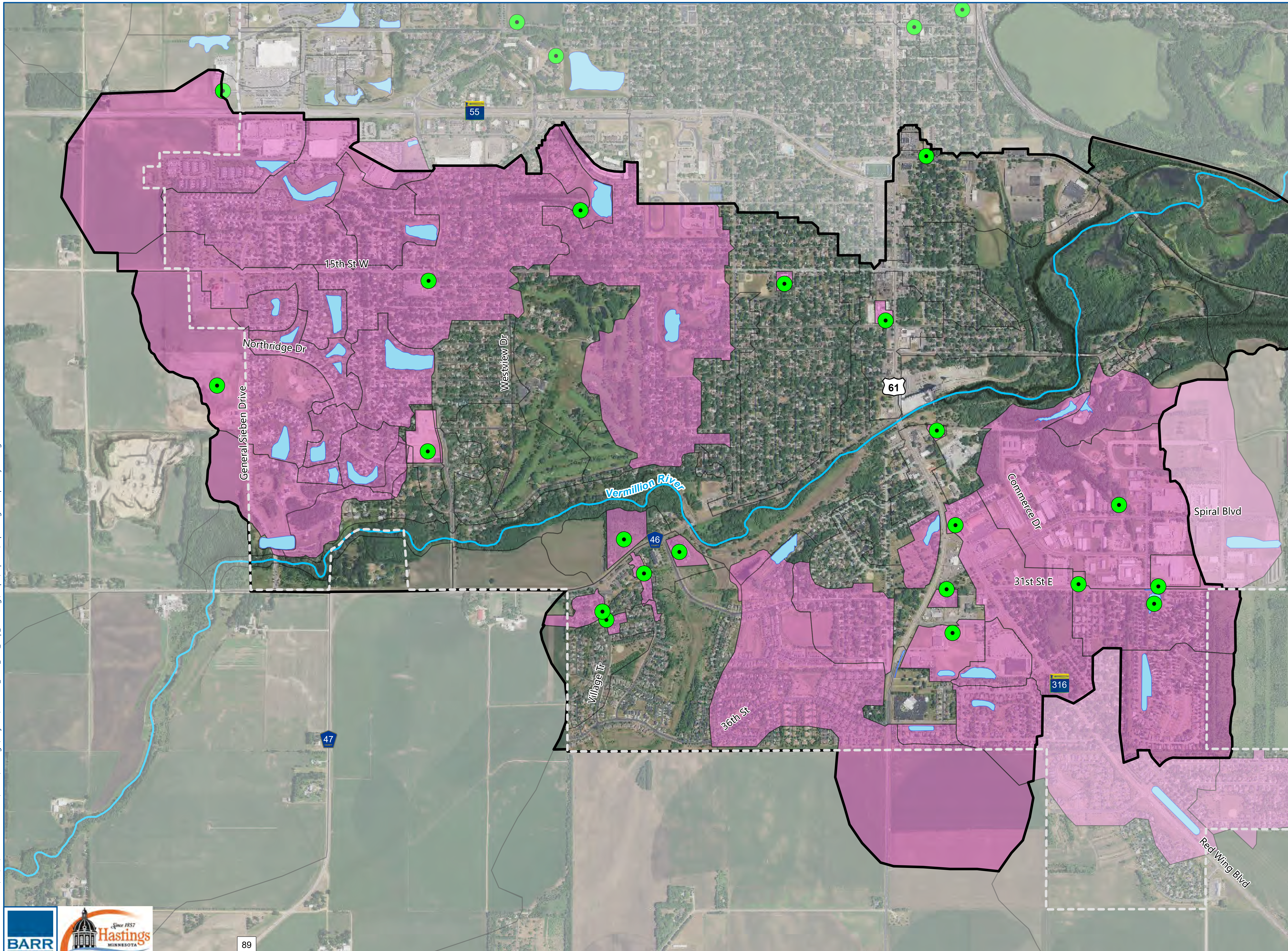
Appendix A

Identification of Potential Best Management Practices Figures



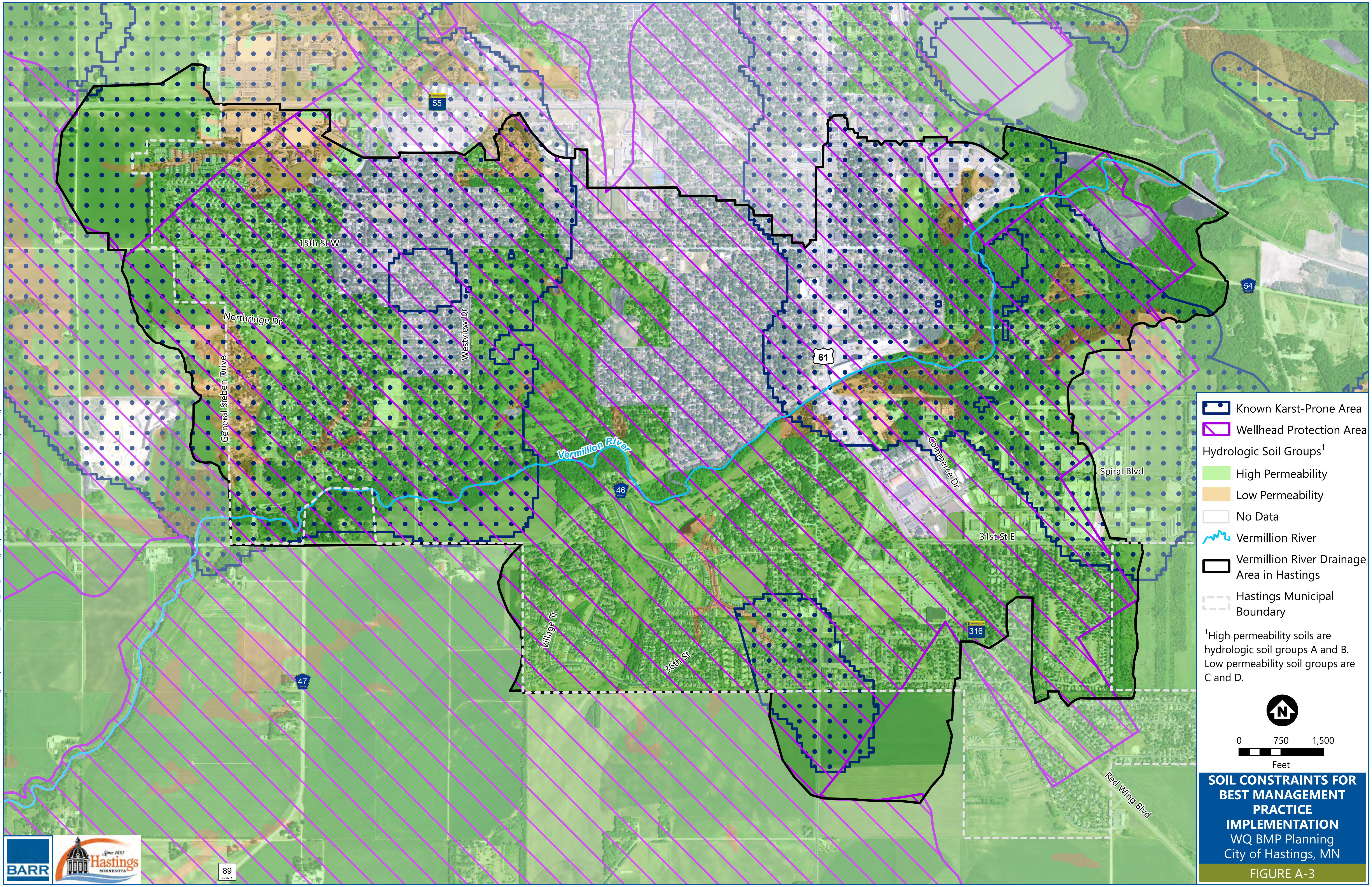
PRIORITY AREAS FOR BEST MANAGEMENT PRACTICE IMPLEMENTATION
WQ BMP Planning
City of Hastings, MN
FIGURE A-1



EXISTING BEST MANAGEMENT PRACTICES & TREATED DRAINAGE AREAS

WQ BMP Planning
City of Hastings, MN

FIGURE A-2



SOIL CONSTRAINTS FOR BEST MANAGEMENT PRACTICE IMPLEMENTATION
WQ BMP Planning
City of Hastings, MN

FIGURE A-3

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BEST MANAGEMENT PRACTICE OPPORTUNITIES
WQM BMP Planning
City of Hastings, MN
FIGURE 4

Appendix B

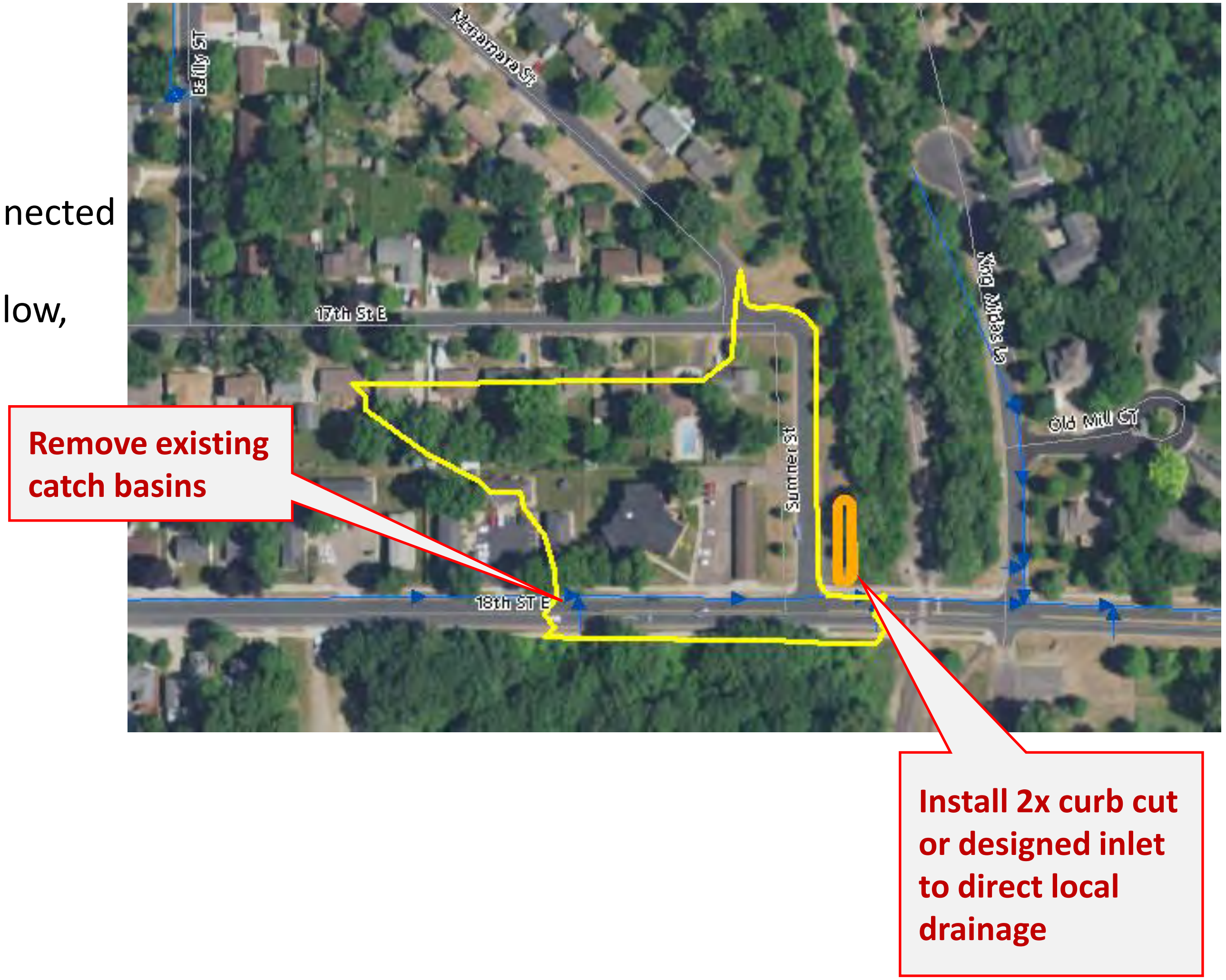
Best Management Practice Description and Evaluation Summaries

Figure B-1

18th Street Basin

BMP opportunity description:

Basin was sized to treat 1.1 inches of runoff from the directly connected impervious. Filtration basin could be iron enhanced to increase phosphorus removal. An infiltration basin could be used if soils allow, would increase total suspended solids and phosphorus removal.



Water quality modeling results:

Dimensions

- 2.4 feet deep, 2,600 square feet
- 4,300 cubic feet storage

Drainage Area

- Total drainage area: 3.4 acres
- Total impervious area: 1.5 acres
- TSS loading: 761 lb/year
- TP Loading: 2.5 lb/year

Pollutant Reduction

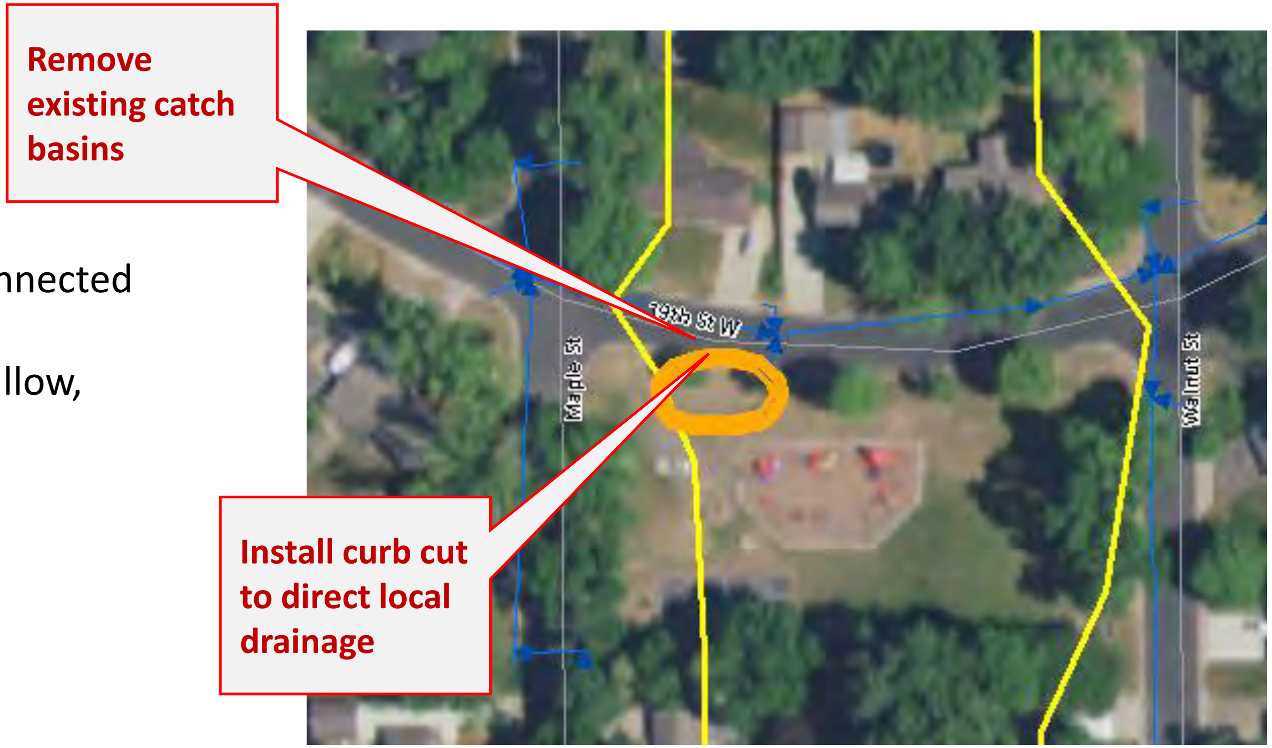
- Infiltration basin: 721 lb/year TSS (95%), 2.2 lb/year TP (91%)
- Filtration basin: 657 lb/year TSS (86%), 1.4 lb/year TP (56%)
- Iron enhanced basin: 657 lb/year TSS (86%), 1.7 lb/year TP (71%)

Opinion of Probable Cost:

Infiltration: $54,800 to $109,500
Filtration: $77,300 to $154,500
Iron Enhanced: $91,500 to $183,000

Figure B-2

Westwood Park Basin



BMP opportunity description:

Basin was sized to treat 1.1 inches of runoff from the directly connected impervious. Filtration basin could be iron enhanced to increase phosphorus removal. An infiltration basin could be used if soils allow, would increase total suspended solids and phosphorus removal.

Water quality modeling results:

Dimensions

- 2.4 feet deep, 2,500 square feet
- 4,600 cubic feet storage

Drainage Area

- Total drainage area: 5.1 acres
- Total impervious area: 1.7 acres
- TSS loading: 852 lb/year
- TP Loading: 2.8 lb/year

Pollutant Reduction

- Infiltration basin: 792 lb/year TSS (93%), 2.4 lb/year TP (88%)
- Filtration basin: 723 lb/year TSS (85%), 1.5 lb/year TP (54%)
- Iron enhanced basin: 723 lb/year TSS (85%), 1.9 lb/year TP (69%)

Opinion of Probable Cost:

Infiltration: $39,800 to $79,500
Filtration: $63,000 to $126,000
Iron Enhanced: $78,000 to $156,000

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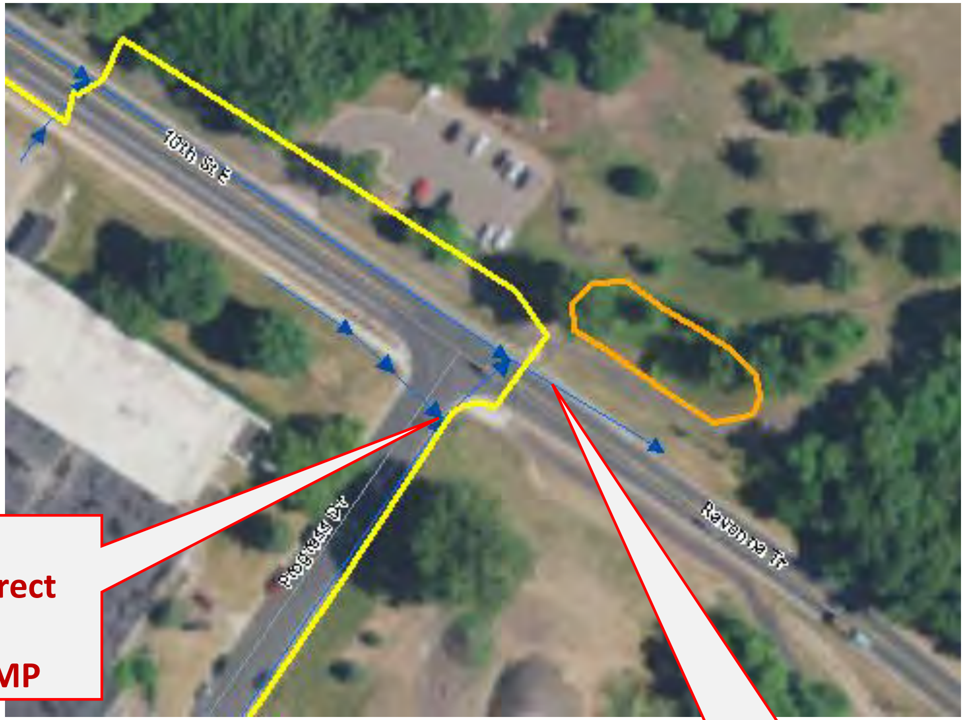
Figure B-3

10th Street Basin

BMP opportunity description:

Filtration basin was sized to treat 1.1 inches of runoff from the directly connected impervious. Filtration basin could be iron enhanced to increase phosphorus removal. An infiltration basin could be used if soils allow, would increase total suspended solids and phosphorus removal.



Install bypass structure to direct Progress Dr trunkline to BMP

Install curb cut or designed inlet to direct local drainage

Water quality modeling results:

Dimensions

- 2.4 feet deep, 5,700 square feet
- 13,600 cubic feet storage

Drainage Area

- Total drainage area: 5.45 acres
- Total impervious area: 3.92 acres
- TSS loading: 2363 lb/year
- TP Loading: 7.7 lb/year

Pollutant Reduction

- Infiltration basin: 2,303 lb/year TSS (97%), 7.2 lb/year TP (94%)
- Filtration basin: 2,096 lb/year TSS (89%), 4.4 lb/year TP (58%)
- Iron enhanced basin: 2,096 lb/year TSS (89%), 5.6 lb/year TP (73%)

Opinion of Probable Cost:

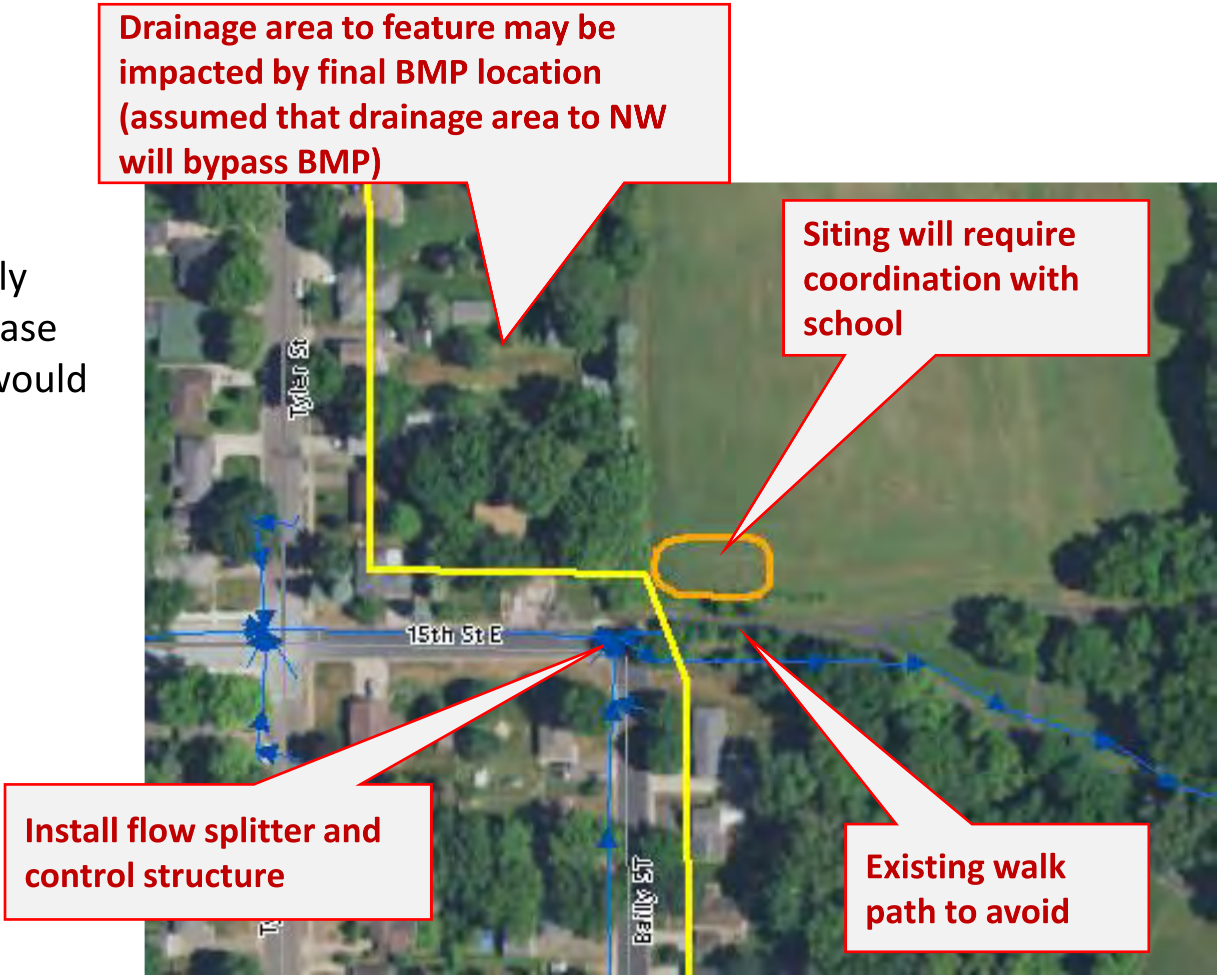
Infiltration: $97,500 to $195,000
Filtration: $134,300 to $268,500
Iron Enhanced: $180,000 to $360,000

Figure B-4

15th Street Basin, treating 25% directly connected impervious

BMP opportunity description:

Basin was sized to treat 1.1 inches of runoff from the 25% of the directly connected impervious. Filtration basin could be iron enhanced to increase phosphorus removal. An infiltration basin could be used if soils allow, would increase total suspended solids and phosphorus removal.



Water quality modeling results:

Dimensions

- 2.4 feet deep, 5,400 square feet
- 13,000 cubic feet storage

Drainage Area

- Total drainage area: 43.4 acres
- Total impervious area: 18.7 acres
- TSS loading: 9,553 lb/year
- TP Loading: 31.1 lb/year

Pollutant Reduction

- Infiltration basin: 6,820 lb/year TSS (71%), 16.6 lb/year TP (53%)
- Filtration basin: 6,411 lb/year TSS (67%), 11.2 lb/year TP (36%)
- Iron enhanced basin: 6,411 lb/year TSS (67%), 13.5 lb/year TP (43%)

Opinion of Probable Cost:

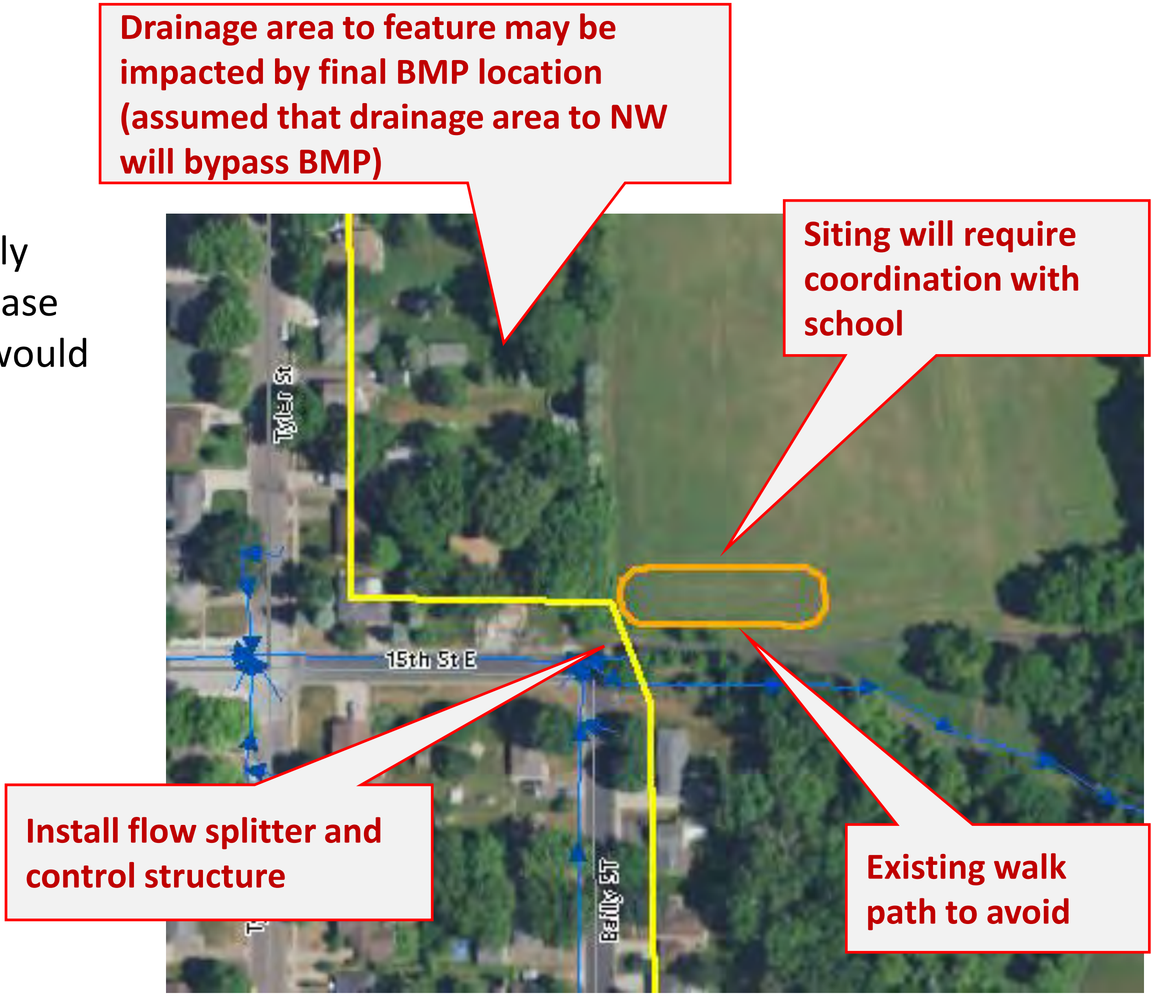
Infiltration: $90,000 to $180,000
Filtration: $126,000 to $252,000
Iron Enhanced: $170,300 to $340,500

Figure B-5

15th Street Basin, treating 50% directly connected impervious

BMP opportunity description:

Basin was sized to treat 1.1 inches of runoff from the 50% of the directly connected impervious. Filtration basin could be iron enhanced to increase phosphorus removal. An infiltration basin could be used if soils allow, would increase total suspended solids and phosphorus removal.



Water quality modeling results:

Dimensions

- 2.4 feet deep, 11,000 square feet
- 26,000 cubic feet storage

Drainage Area

- Total drainage area: 43.4 acres
- Total impervious area: 18.7 acres
- TSS loading: 9,553 lb/year
- TP Loading: 31.1 lb/year

Pollutant Reduction

- Infiltration basin: 8,270 lb/year TSS (87%), 23.5 lb/year TP (76%)
- Filtration basin: 7,624 lb/year TSS (80%), 15.2 lb/year TP (49%)
- Iron enhanced basin: 7,624 lb/year TSS (80%), 18.7 lb/year TP (60%)

Opinion of Probable Cost:

Infiltration: $135,000 to $270,000
Filtration: $205,500 to $411,000
Iron Enhanced: $294,500 to $589,000

Figure B-6

HDS on Pine Street

BMP opportunity description:

HDS system can be installed during the next road construction project.

Water quality modeling results:

Dimensions

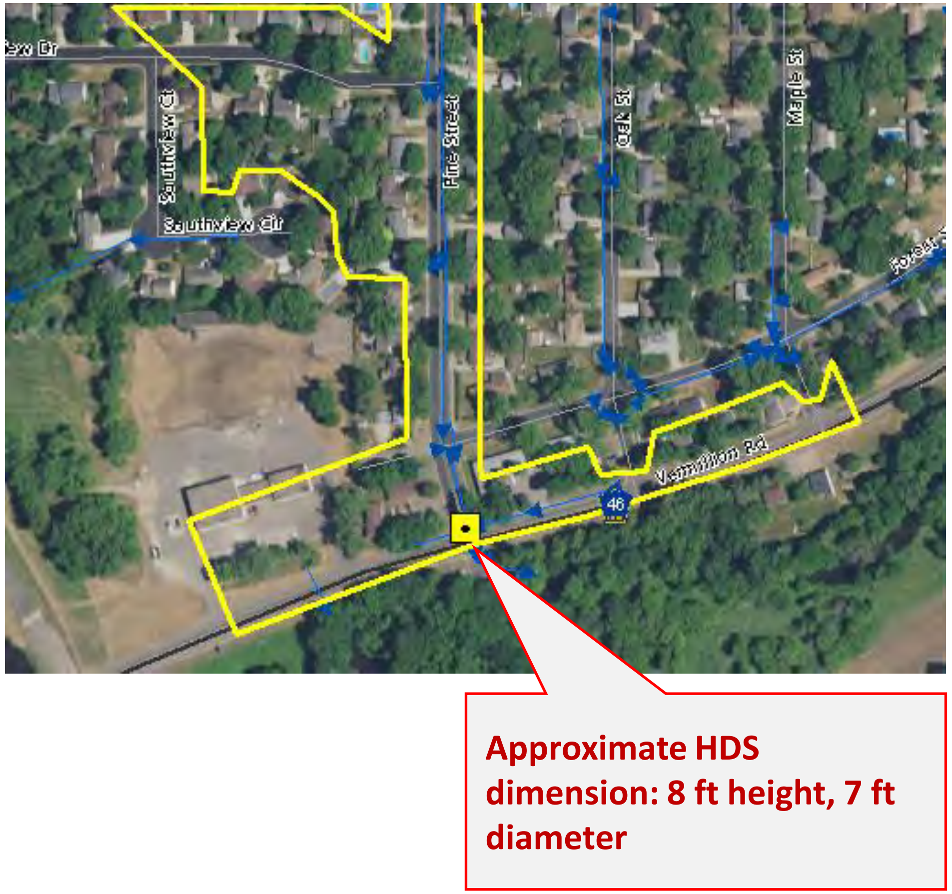
- Size is approximately 8 feet tall and 7 feet in diameter (SciClone)

Drainage Area

- Total drainage area: 36.5 acres
- Total impervious area: 15.8 acres
- TSS loading: 5,080 lb/year
- TP Loading: 25.6 lb/year

Pollutant Reduction

- 1,778 lb/year TSS (35%), assumed 35% based on ~average of four types of HDS (Downstream defender, CDS, SciClone, and SAFL)
- 2.7 lb/year TP (10.3%), modeled pond with equivalent % TSS removal to find % TP removal



Opinion of Probable Cost:

$78,000-$156,000

Figure B-7

HDS on Ashland Street

BMP opportunity description:

HDS system can be installed during the next road construction project.

Water quality modeling results:

Dimensions

- Size is approximately 8 feet tall and 7 feet in diameter (SciClone)

Drainage Area

- Total drainage area: 21 acres
- Total impervious area: 8.5 acres
- TSS loading: 2,284 lb/year
- TP Loading: 14 lb/year

Pollutant Reduction

- 988 lb/year TSS (35%), assumed 35% based on average of four types of HDS (Downstream defender, CDS, SciClone, and SAFL)
- 1.4 lb/year TP (10.3%)

Approximate HDS dimension: 8 ft height, 7 ft diameter

Opinion of Probable Cost:

$78,000-$156,000

Figure B-8

HDS on Walnut Street

BMP opportunity description:

HDS system can be installed during the next road construction project. HDS will include a bypass to only treat 25% of the drainage area

Water quality modeling results:

Dimensions

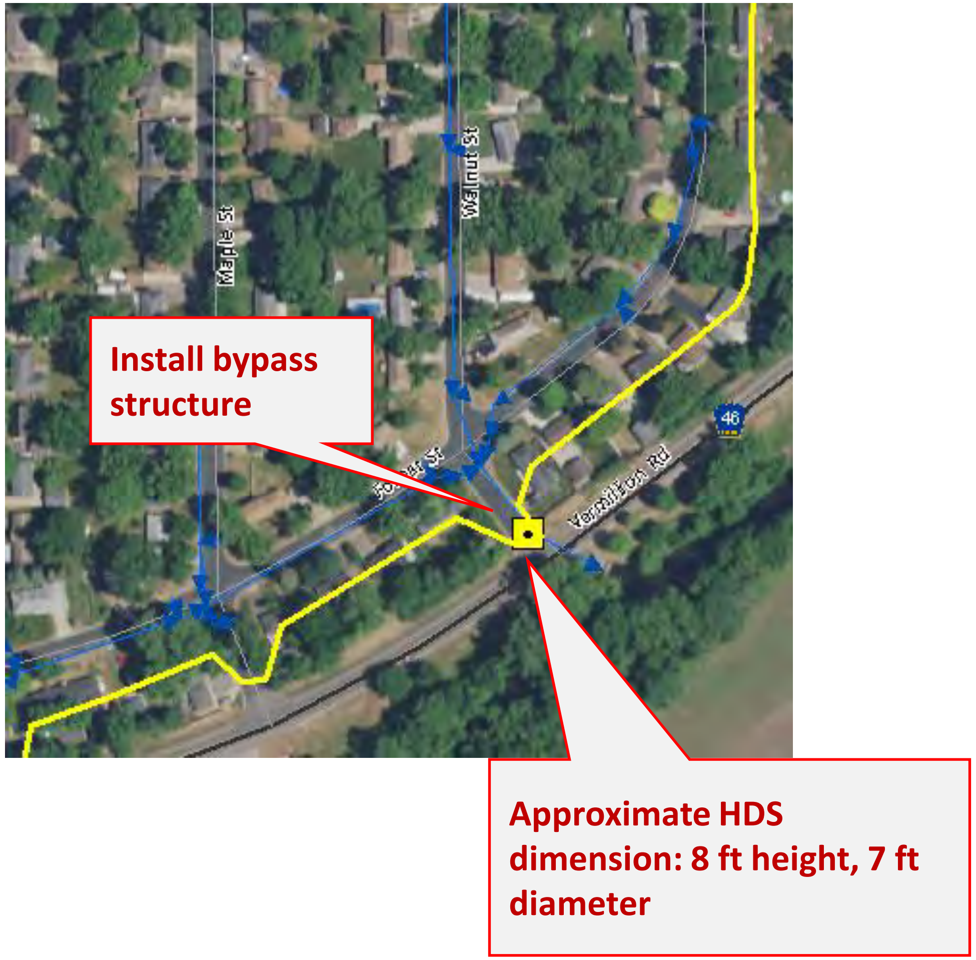
- Size is approximately 8 feet tall and 7 feet in diameter (SciClone)

Drainage Area

- Total drainage area: 160.8 acres
- Total impervious area: 62.7 acres
- TSS loading: 19,161 lb/year
- TP Loading: 98.8 lb/year

Pollutant Reduction

- 1,677 lb/year TSS (8.8%), assuming 75% is bypasses
- 2.6 lb/year TP (2.6%) , assuming 75% is bypasses



Opinion of Probable Cost:

$100,500-$201,000

Appendix C

Opinion of Probable Costs

Hastings Water Quality Improvement Planning Project
Best Management Practices Alternatives
Engineer's Opinion of Probable Cost (OPC)
Construction Cost Estimate (ASTM E2516-11, Class 4)
Barr Engineering #23-19-0703.00

Construction Costs				18th Street Filtration Basin		18th Street Filtration Basin, with iron		18th Street Infiltration Basin		Westwood Park Filtration Basin		Westwood Park Filtration Basin, with iron		Westwood Park Infiltration Basin	
Category	Item Description	Unit	Unit Price	Qty	Extension	Qty	Extension	Qty	Extension	Qty	Extension	Qty	Extension	Qty	Extension
General/Restoration	Mobilization/Demobilization	LS	10% Construction Cost	1	$ 7,200	1	$ 8,500	1	$ 5,100	1	$ 5,900	1	$ 7,300	1	$ 3,700
	Erosion Control	LS	2% Construction Cost	1	$ 1,500	1	$ 1,700	1	$ 1,100	1	$ 1,200	1	$ 1,500	1	$ 800
	Restoration	SY	$ 11.50	280	$ 3,300	280	$ 3,300	280	$ 3,300	310	$ 3,600	310	$ 3,600	310	$ 3,600
Best Management Practice Costs	Excavation	CY	$ 40	170	$ 6,800	170	$ 6,800	170	$ 6,800	190	$ 7,600	190	$ 7,600	190	$ 7,600
	Sand Filtration Media	TON	$ 40	130	$ 5,200	0	$ -	0	$ -	140	$ 5,600	0	$ -	0	$ -
	Iron Enhanced Sand Filtration Media	TON	$ 140	0	$ -	130	$ 18,200	0	$ -	0	$ -	140	$ 19,600	0	$ -
	Perforated Draintile	SF	$ 3	1700	$ 5,100	1700	$ 5,100	0	$ -	1900	$ 5,700	1900	$ 5,700	0	$ -
	Riser Outlet and Connection	LS	$ 10,000	1	$ 10,000	1	$ 10,000	0	$ -	1	$ 10,000	1	$ 10,000	0	$ -
	Complex outlet structure and connection	LS	$ 15,000	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -
	Removal / Disposal of Manhole	EA	$ 5,000	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -
	Catch Basin Removal	EA	$ 5,000	4	$ 20,000	4	$ 20,000	4	$ 20,000	4	$ 20,000	4	$ 20,000	4	$ 20,000
	Curb Cut / Designed Inlet	LS	$ 10,000	2	$ 20,000	2	$ 20,000	2	$ 20,000	0	$ -	0	$ -	0	$ -
	Curb Cut	LS	$ 5,000	0	$ -	0	$ -	$ -		1	$ 5,000	1	$ 5,000	1	$ 5,000
	HDS and Bypass Structures [2]	LS	$ 65,000	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -
	Bypass Structure	LS	$ 20,000	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -
	SUBTOTAL				$ 79,100		$ 93,600		$ 56,300		$ 64,600		$ 80,300		$ 40,700
CONTINGENCY	30%				$ 24,000		$ 28,000		$ 17,000		$ 19,000		$ 24,000		$ 12,000
SUBTOTAL W/CONTINGENCY					$ 103,000		$ 122,000		$ 73,000		$ 84,000		$ 104,000		$ 53,000
ESTIMATED TOTAL OPINION OF PROBABLE COST					$ 103,000		$ 122,000		$ 73,000		$ 84,000		$ 104,000		$ 53,000
TOTAL OPION OF COST					$ 103,000		$ 122,000		$ 73,000		$ 84,000		$ 104,000		$ 53,000
Anticipated Accuracy Range	High	50%			$ 154,500		$ 183,000		$ 109,500		$ 126,000		$ 156,000		$ 79,500
	Low	-25%			$ 77,300		$ 91,500		$ 54,800		$ 63,000		$ 78,000		$ 39,800

Construction Costs		15th Street Filtration Basin, 25% drainage area		15th Street Filtration Basin, 25% drainage area with iron		15th Street Infiltration Basin, 25% drainage area		15th Street Filtration Basin, 50% drainage area		15th Street Filtration Basin, 50% drainage area with iron		15th Street Infiltration Basin, 50% drainage area	
Category	Item Description	Qty	Extension	Qty	Extension	Qty	Extension	Qty	Extension	Qty	Extension	Qty	Extension
General/Restoration	Mobilization/Demobilization	1	$ 11,700	1	$ 15,900	1	$ 8,400	1	$ 19,200	1	$ 27,500	1	$ 12,600
	Erosion Control	1	$ 2,300	1	$ 3,200	1	$ 1,700	1	$ 3,800	1	$ 5,400	1	$ 2,500
	Restoration	1100	$ 12,700	1100	$ 12,700	1100	$ 12,700	2200	$ 25,300	2200	$ 25,300	2200	$ 25,300
Best Management Practice Costs	Excavation	730	$ 29,200	730	$ 29,200	730	$ 29,200	1450	$ 58,000	1450	$ 58,000	1450	$ 58,000
	Sand Filtration Media	410	$ 16,400	0	$ -	0	$ -	810	$ 32,400	0	$ -	0	$ -
	Iron Enhanced Sand Filtration Media	0	$ -	410	$ 57,400	0	$ -		$ -	810	$ 113,400	0	$ -
	Perforated Draintile	5400	$ 16,200	5400	$ 16,200	0	$ -	10800	$ 32,400	10800	$ 32,400	0	$ -
	Riser Outlet and Connection	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -
	Complex outlet structure and connection	1	$ 15,000	1	$ 15,000	1	$ 15,000	1	$ 15,000	1	$ 15,000	1	$ 15,000
	Removal / Disposal of Manhole	1	$ 5,000	1	$ 5,000	1	$ 5,000	1	$ 5,000	1	$ 5,000	1	$ 5,000
	Catch Basin Removal	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -
	Curb Cut / Designed Inlet	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -
	Curb Cut	0	$ -	0	$ -		$ -	0	$ -	0	$ -	0	$ -
	HDS and Bypass Structures [2]	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -
	Bypass Structure	1	$ 20,000	1	$ 20,000	1	$ 20,000	1	$ 20,000	1	$ 20,000	1	$ 20,000
	SUBTOTAL		$ 128,500		$ 174,600		$ 92,000		$ 211,100		$ 302,000		$ 138,400
CONTINGENCY	30%		$ 39,000		$ 52,000		$ 28,000		$ 63,000		$ 91,000		$ 42,000
SUBTOTAL W/CONTINGENCY			$ 168,000		$ 227,000		$ 120,000		$ 274,000		$ 393,000		$ 180,000
ESTIMATED TOTAL OPINION OF PROBABLE COST			$ 168,000		$ 227,000		$ 120,000		$ 274,000		$ 393,000		$ 180,000
TOTAL OPION OF COST			$ 168,000		$ 227,000		$ 120,000		$ 274,000		$ 393,000		$ 180,000
Anticipated Accuracy Range	High		$ 252,000		$ 340,500		$ 180,000		$ 411,000		$ 589,500		$ 270,000
	Low		$ 126,000		$ 170,300		$ 90,000		$ 205,500		$ 294,800		$ 135,000

Construction Costs		10th Street Filtration Basin		10th Street Filtration Basin, with iron		10th Street Infiltration Basin		HDS on Pine Street		HDS on Ashland Street		HDS on Walnut Street	
Category	Item Description	Qty	Extension	Qty	Extension	Qty	Extension	Qty	Extension	Qty	Extension	Qty	Extension
General/Restoration	Mobilization/Demobilization	1	$ 12,500	1	$ 16,800	1	$ 9,100	1	$ 7,300		$ 7,300	1	$ 9,400
	Erosion Control	1	$ 2,500	1	$ 3,300	1	$ 1,800	1	$ 1,500	1	$ 1,500	1	$ 1,900
	Restoration	1000	$ 11,500	1000	$ 11,500	1000	$ 11,500	-- [1]	$ 1,400	-- [1]	$ 1,400	-- [1]	$ 1,800
Best Management Practice Costs	Excavation	560	$ 22,400	560	$ 22,400	560	$ 22,400	0	$ -	0	$ -	0	$ -
	Sand Filtration Media	420	$ 16,800	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -
	Iron Enhanced Sand Filtration Media	0	$ -	420	$ 58,800	0	$ -	0	$ -	0	$ -	0	$ -
	Perforated Draintile	5700	$ 17,100	5700	$ 17,100	0	$ -	0	$ -	0	$ -	0	$ -
	Riser Outlet and Connection	1	$ 10,000	1	$ 10,000	1	$ 10,000	0	$ -	0	$ -	0	$ -
	Complex outlet structure and connection	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -
	Removal / Disposal of Manhole	1	$ 5,000	1	$ 5,000	1	$ 5,000	1	$ 5,000	1	$ 5,000	1	$ 5,000
	Catch Basin Removal	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -
	Curb Cut / Designed Inlet	2	$ 20,000	2	$ 20,000	2	$ 20,000		$ -		$ -		$ -
	Curb Cut		$ -		$ -		$ -		$ -		$ -		$ -
	HDS and Bypass Structures [2]	0	$ -	0	$ -	0	$ -	1	$ 65,000	1	$ 65,000	1	$ 65,000
	Bypass Structure	1	$ 20,000	1	$ 20,000	1	$ 20,000	0	$ -	0	$ -	1	$ 20,000
	SUBTOTAL		$ 137,800		$ 184,900		$ 99,800		$ 80,200		$ 80,200		$ 103,100
CONTINGENCY	30%		$ 41,000		$ 55,000		$ 30,000		$ 24,000		$ 24,000		$ 31,000
SUBTOTAL W/CONTINGENCY			$ 179,000		$ 240,000		$ 130,000		$ 104,000		$ 104,000		$ 134,000
ESTIMATED TOTAL OPINION OF PROBABLE COST			$ 179,000		$ 240,000		$ 130,000		$ 104,000		$ 104,000		$ 134,000
TOTAL OPION OF COST			$ 179,000		$ 240,000		$ 130,000		$ 104,000		$ 104,000		$ 134,000
Anticipated Accuracy Range	High		$ 268,500		$ 360,000		$ 195,000		$ 156,000		$ 156,000		$ 201,000
	Low		$ 134,300		$ 180,000		$ 97,500		$ 78,000		$ 78,000		$ 100,500

Notes:

[1] - Assumed restoration cost 1% of construction cost for HDS installation.

[1] - HDS structure assumed based on tributary drainage area. Cost may vary based on technology selected.