Maple Grove, MN | HEI No. 5468-006
February 8, 2019

Photo: Minnesota Pollution Control Agency

TARGETED IMPLEMENTATION PLAN FOR THE ROSEAU WATERSHED

International Water Institute

RRWD ROSEAU RIVER WATERSHED DISTRICT

Agriculture and Agri-Food Canada

TABLE OF CONTENTS

EXECUTIVE SUMMARY 1

1 SCOPE AND PURPOSE 3

1.1 INTRODUCTION 3
1.2 PROJECT AREA 4

2 SUMMARY OF DATA SOURCES 5

3 METHODS 5

3.1 HYDROLOGIC CONDITIONING 5
3.2 TIME OF TRAVEL 5
3.3 PROCESSING DATA IN PTMAPP DESKTOP 5
3.4 TARGETING PRACTICES AND ESTIMATING IMPLEMENTATION COSTS 9
3.5 MANAGEMENT AREA IMPLEMENTATION PROFILES 11
3.6 USING THE MANAGEMENT AREA IMPLEMENTATION PROFILES 12

4 TARGETED IMPLEMENTATION PROFILES 12

TARGETED IMPLEMENTATION PROFILE: Roseau River Outlet (Management Area 8) 14
TARGETED IMPLEMENTATION PROFILE: Roseau Lake 15
TARGETED IMPLEMENTATION PROFILE: Management Area 1 16
TARGETED IMPLEMENTATION PROFILE: Management Area 2 17
TARGETED IMPLEMENTATION PROFILE: Management Area 3 18
TARGETED IMPLEMENTATION PROFILE: Management Area 4 19
TARGETED IMPLEMENTATION PROFILE: Management Area 5 20
TARGETED IMPLEMENTATION PROFILE: Management Area 6 21
TARGETED IMPLEMENTATION PROFILE: Management Area 7 20

5 REFERENCES 23

APPENDIX A: DATA REQUIREMENT TECHNICAL MEMORANDUM

APPENDIX B: PROGRESS TOWARD GOAL TABLE

List of Figures

FIGURE 1. MANAGEMENT AREAS USED IN DEVELOPING THE TARGETED IMPLEMENTATION PLAN FOR THE ROSEAU RIVER WATERSHED. 2
FIGURE 2. LAND USE WITHIN THE ROSEAU RIVER WATERSHED. 4
FIGURE 3. DIGITAL ELEVATION MODEL HYDROLOGIC CONDITIONING AND DATA PRODUCT SCALE. 8
FIGURE 4. PRIORITY RESOURCE POINT LOCATIONS WITHIN THE ROSEAU RIVER WATERSHED. 99

List of Tables

TABLE 1. CRITERIA USED FOR SCREENING PTMAPP-DESKTOP BMP DATA. 7
TABLE 2. ESTIMATED 2016 ANNUALIZED LIFE CYCLE COSTS USED TO ESTIMATE THE COST FOR A TREATMENT GROUP.. 10
TABLE 3. CRITERIA USED FOR TARGETING CONSERVATION PRACTICES IN DIFFERENT MANAGEMENT AREAS WITH THE ROSEAU RIVER WATERSHED. 11

EXECUTIVE SUMMARY

This Targeted Implementation Plan (Plan) identifies technically feasible locations for best management practices and conservation practices (collectively referred to as Practices) on agricultural land based on "best" (i.e., most cost-effective) value for improving resource conditions within the Roseau River Watershed. Estimates of water quality benefits from these Practices are also provided as a means of proactively managing surface water quality within the Roseau River Watershed, which spans the United States/Canadian border. Overland sources of sediment and nutrients from agricultural areas are the focus of the Plan, but in no way should this focus be construed as meaning agricultural overland sources are the only source of sediment and nutrients to surface waters. Runoff from urban areas and land adjacent to lakes and streams can also contribute sediment and nutrients to surface waters. However, the tools used here are focused on opportunities to treat sediment and nutrients from overland sources.

The information within the Plan:

- refines and adds detail to water quality improvement strategies already outlined within other plans;
- identifies the most cost-effective practices for restoring lakes and streams that are currently failing to meet water quality expectations; and
- guides the implementation needed to achieve water quality goals.

The Plan can be used to guide practice implementation decisions on both public and private lands and coordinate these efforts among local, state, and federal governments; non-profit governmental organizations; individual producers; and agribusiness. The information in this plan can also serve as part of the foundation for building a local watershed management plan or identify water quality benefits that might be associated with projects initially focused on other outcomes (e.g., flood reduction).

The Plan divides the Roseau River Watershed into management areas based primarily on United States Geological Survey (USGS) Hydrologic Unit Code (HUC) 10 boundaries as well as locally-defined priorities for the purpose of assessing whether the water quality goals can be achieved through reductions of sediment and nutrients in surface water runoff (**Figure 1**). The goals are expressed as the annual estimated reductions in sediment and total phosphorus (TP) at the most downstream location (i.e., the outlet) for each management area. The goals for this Plan were set through collaborative meetings between the project partners. The project partners include representatives from Agriculture and Agri-Food Canada, Manitoba Sustainable Development, the Red River Basin Commission, the Seine Rat River Conservation District, the Roseau River Watershed District, the International Water Institute, Minnesota Board of Water and Soil Resources (BWSR), and Houston Engineering, Inc. (HEI).

The water quality benefits of both non-structural (i.e., management) and structural Practices are evaluated within the Plan. Non-structural practices include the use of conservation tillage, cover crops, conservation reserve program (CRP), and permanent vegetative cover. Structural practices are constructed projects and include farm ponds, grassed waterways, nutrient reduction wetlands, bio-reactors, and other common agricultural practices. Management practices tend to be more cost-effective for reducing sediments and nutrient loads, but the decision to build them can be less certain because each year the producer decides whether to use them.

The intended outcome of this Plan is to provide practitioners within the Roseau River Watershed with a planning-level assessment of the targeted conservation actions that can be used to make progress towards local, regional, and international water quality goals. However, the data developed and utilized through this targeted implementation planning effort is designed to be delivered as a living source of information that can be used and improved upon for building effective and efficient conservation implementation programs.

Because of a lack of information, this plan excludes the water quality benefits of practices that currently exist within the watershed. No comprehensive database of existing practices is available resulting in an information gap that needs closing soon. Some information from recent years about constructed conservation practices is available from the BWSR e-link database. The e-link database contains 389 projects within the watershed. These Practices have likely led to some water quality improvements.

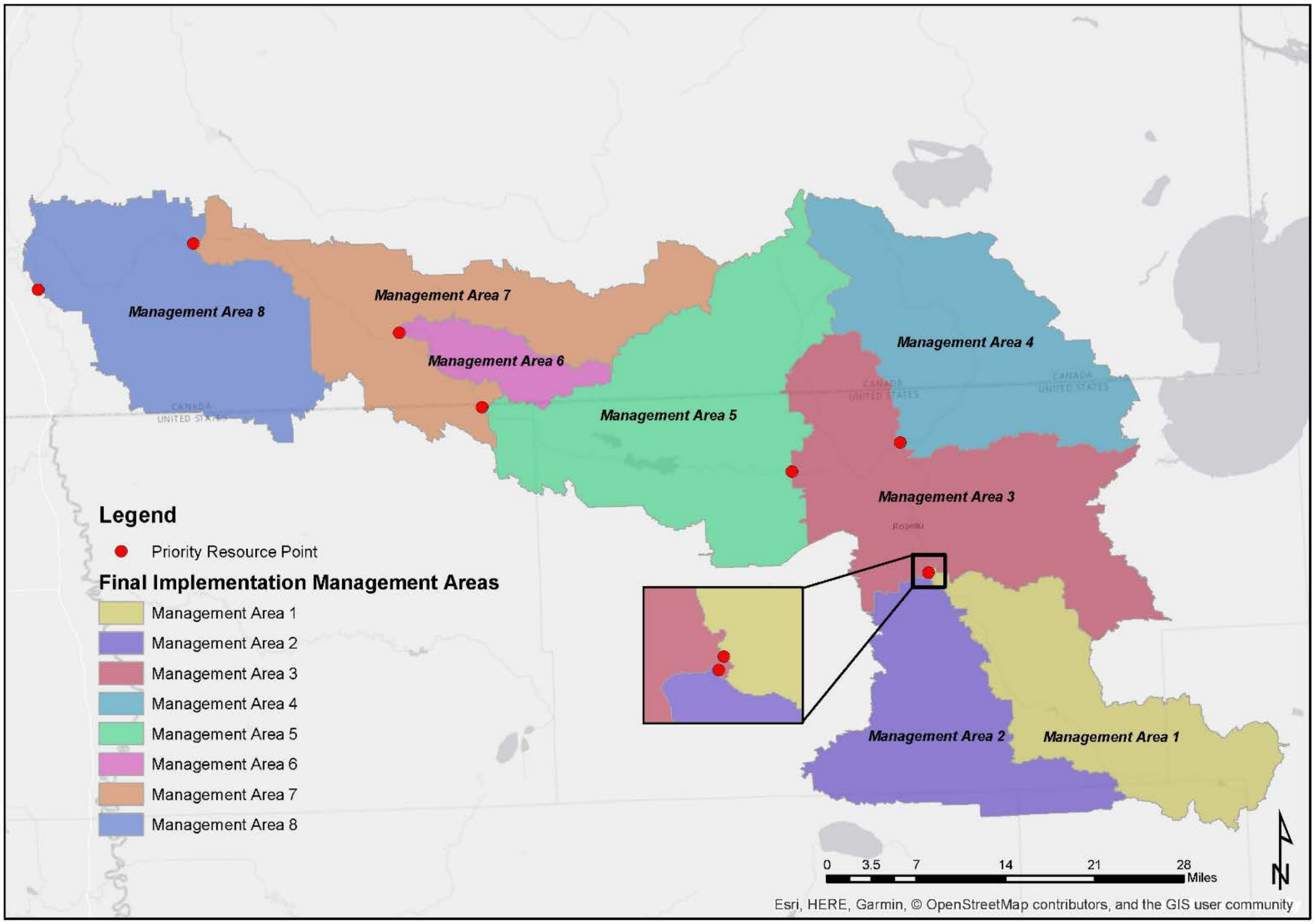
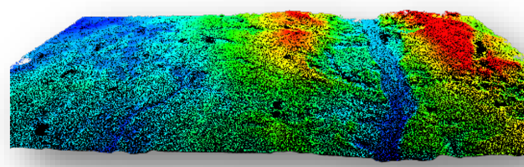


Figure 1. Management areas used in developing the Plan for the Roseau River Watershed.

1 SCOPE AND PURPOSE

1.1 INTRODUCTION

This project identifies technically feasible locations for best management practices and conservation practices (collectively referred to as Practices), based on "best" (most cost-effective) value and estimates of their water quality benefits, to proactively manage surface water quality within the Roseau River Watershed. Included within this Targeted Implementation Plan (Plan) are maps showing potential locations for implementing technically feasible Practices as well as estimates of the number and types of Practices needed to achieve regional sediment and TP reduction goals. The estimated cost of the Plan to make progress towards goals are included to guide funding requests for implementation.



This graphic shows the hydro-conditioned digital elevation model for a portion of the earth surface. High areas are in red and low areas in blue. The elevations are modified to account for water movement across the landscape. This information is used to help identify potential Practice locations.

This Plan divides the study area into eight management areas to assess whether the water quality goals can be achieved. The management areas for the study area are based largely on 10-digit HUC boundaries within the US and comparable watershed delineations that have been performed in Canada (**Figure 1**).

The Plan can be used to guide Practice implementation decisions on both public and private lands and to coordinate these efforts among local, state, and federal governments; international organizations; non-profit governmental organizations; individual producers; and agribusiness.

The Plan uses "smart" geo-spatial data created by using a computer application called the Prioritize, Target, and Measure Application (PTMApp) (https://ptmapp.bwsr.state.mn.us/). PTMApp can be used in watersheds to (1) identify the field-scale source locations and amounts of sediment, nitrogen, and phosphorus that leave the landscape and enter a downstream stream or lake; (2) target specific fields on the landscape (based on NRCS Field Office Technical Guide criteria, landscape characteristics, land productivity, and/or landowner preference) for the potential implementation of Practices; and (3) estimate the benefits one or many Practices to one or more streams, rivers, and lakes within a watershed where the benefits are expressed as the downstream load reduction and the estimated cost/unit load reduction. For a specific type of Practice (called "treatment groups" within PTMApp), a cost effectiveness curve showing the relationship between the estimated cost[1] and the reduction in annual load for a single watershed or multiple watersheds can be developed. These tools allow water quality practitioners to target solutions to the identified priorities and develop tailor-made implementation solutions. Products developed by using PTMApp are also useful in making day-to-day implementation decisions and communicating needs and benefits with landowners.

PTMApp has desktop (PTMApp-Desktop) and web (PTMApp-Web) components. PTMApp-Desktop consists of a toolbar to use within ESRI's ArcGIS technology. Once created, the geo-spatial data products from PTMApp-Desktop can be shared using PTMApp-Web. Local water quality practitioners can access and use the data to help make decisions daily via the web. The application was developed to meet the specific daily business needs of local water quality practitioners.

[1] Estimated 2016 annual life cycle costs are used in this report. These cost include planning, design, construction, land value, lost rent, lost yield, and maintenance. These cost are generally larger than one time incentive payments for establishing a Practice.

When implemented, the Practices identified by this Plan are intended to provide measurable progress towards the water quality goals for lakes and rivers (called "priority resources") within each of the eight management areas. The Practices with the greatest water quality benefit are identified and should be considered for future funding through various grants. The Practices identified are consistent with achieving the goals of the Minnesota Nonpoint Priority Funding Plan (BWSR, 2016), the Minnesota Nutrient Reduction Strategy (MPCA, 2014), and international efforts aimed at improving sediment and nutrient issues in Lake Winnipeg. The data and information from this plan are expected to be used by the project partners to implement "accountable" projects and Practices that improve water quality within the Roseau River Watershed.

Implementing Practices is voluntary and requires willing landowners. The specific locations where practices are eventually implemented will very likely differ from the locations identified within this plan. Nothing in this Plan should be construed as forcing landowner cooperation. This plan is intended to guide implementation efforts and should not be considered prescriptive.

1.2 PROJECT AREA

The Roseau River Watershed is 2,048 square miles (5,306 square kilometers) in size and contains are range of land use including regions that are primarily wetlands and open water, cultivated agriculture, or grazing and grasslands (**Figure 2**). The study area covers multiple jurisdictional boundaries across the United States and Canada and is a watershed that will receive focused conservation efforts for making progress towards sediment and nutrient reduction goals for Lake Winnipeg.

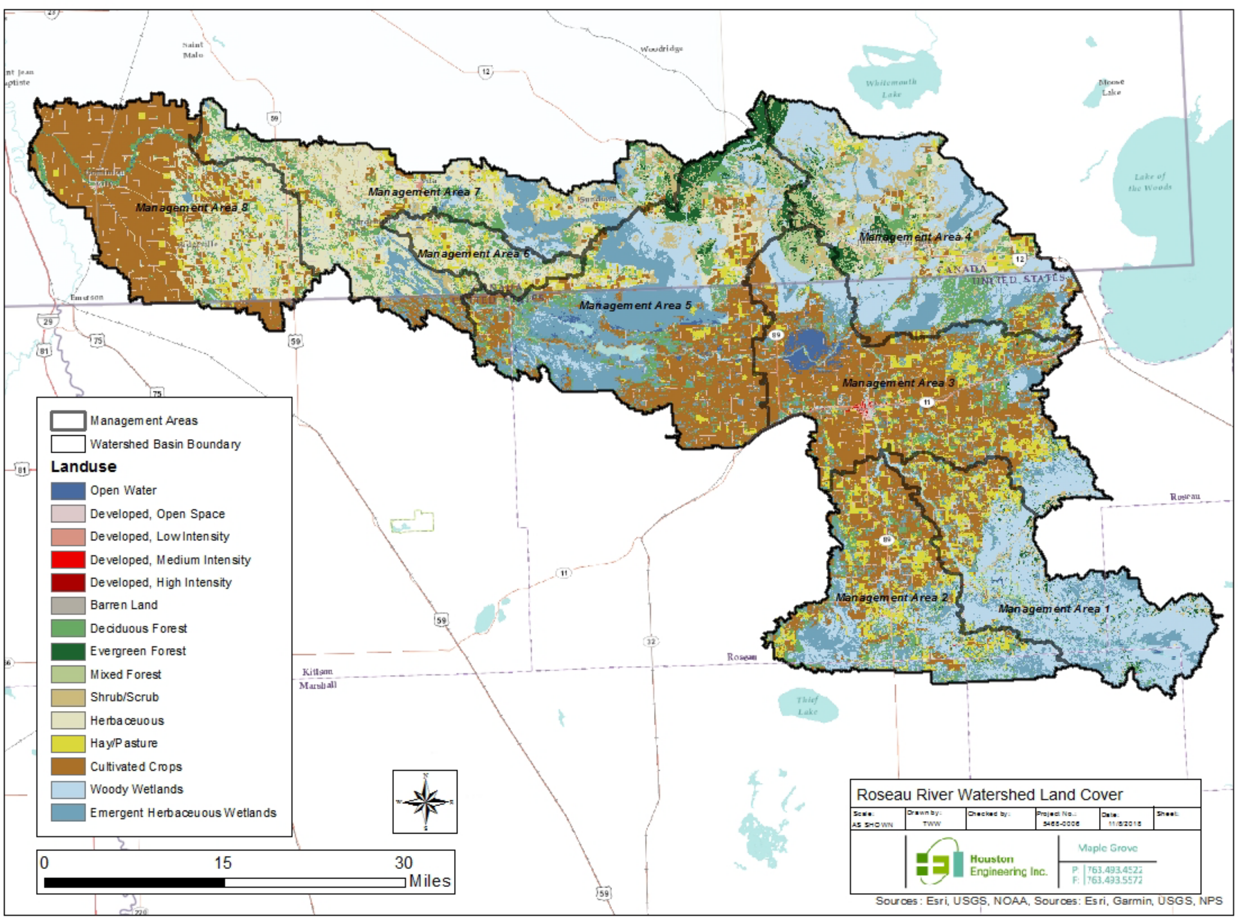


Figure 2. Land use within the Roseau River Watershed.

2 SUMMARY OF DATA SOURCES

Several data sources are required as inputs to run PTMApp-Desktop. **Section 3** summarizes the data sources that serve as or enable development of the required inputs for PTMApp-Desktop, which are documented in the PTMApp-Desktop User Guide (available online at https://ptmapp.bwsr.state.mn.us/User/Documentation). However, there are often subtle variations in the geospatial data available between the United States and Canada. As part of this project, a Data Requirement Technical Memorandum was developed to align data sources from the United States with data sources from Canada for use in PTMApp-Desktop (see **Appendix A**). This data requirements document should enable watersheds across Canada to more effectively develop the input data needed to utilize PTMApp-Desktop.

3 METHODS

3.1 HYDROLOGIC CONDITIONING

Hydrologic conditioning is the process of modifying the topographic data represented as the raw, or "bare earth," digital elevation model (DEM) through a series of geographic information systems (GIS) processing steps to more accurately represent the movement of water on the landscape. Upon completion of the hydrologic conditioning process, the DEM is modified to reflect the movement of water not only based on topography, but the presence of other factors affecting water movement such as the locations of culverts, drains, or other structures. The level of detail in the conditioning process can vary significantly depending on the purpose and need of the conditioned DEM's uses. **Figure 3** displays a conditioning scale and some basic explanation of their differences. The DEM conditioning for this project was performed to the H3DEM Plus standard to provide a large range of functionality in the output data products. "Plus" means the DEM has been modified to ensure proper representation of how water flows into and out of storage areas, including large wetlands, lakes, and reservoirs. PTMApp routes loads through these storage areas and the results reflect their influence on the movement of sediment, TP, and total nitrogen (TN) through a watershed. Lake mass balances can be derived using the PTMApp data, provided hydro-conditioning is completed to the "plus" (either H2DEME or H3DEM) level.

3.2 TIME OF TRAVEL

A time of travel raster is needed to estimate the amount of time needed for water to move across the landscape. We used a proprietary HEI tool to create the travel time raster (a similar free tool is available from the Minnesota DNR). The travel time tool uses Manning's equation to estimate flow velocity across a cell and then uses cell-to-cell flow lengths to determine the travel time across the cell. Once individual flow times across each cell have been estimated, travel times are accumulated in the downstream direction throughout the raster. Several pieces of input data must be created to run the travel time tool and are generated as outputs during the hydrologic conditioning process.

3.3 PROCESSING DATA IN PTMAPP DESKTOP

The science and theory used to process data in PTMApp-Desktop are well documented through a series of Technical Memoranda (HEI, 2014a, b, and c; HEI, 2015). These documents describe the technical aspects of the processing performed to generate the output products and are available at https://ptmapp.bwsr.state.mn.us/User/Documentation. The processing methods have been described in a webinar that can be viewed at https://ptmapp.bwsr.state.mn.us/User/Documentation.

PTMApp-Desktop generates estimates of annual loads (TP, TN, and sediment) leaving the landscape based on empirical methods and yield coefficients (HEI, 2014c). The loads are routed to downstream locations through concentrated flow paths and priority resource points using a sediment delivery ratio for sediment and first order decay equations for TP and TN as a function of travel time. **Figure 4** contains locations of priority resource points within each management area used for this Plan.

During development of the geospatial products and prior to developing the Plan, criteria were used to further screen Practices considered technically feasible for implementation (**Table 1**). The screening process is intended to remove practices that may be technically feasible, but not practicable to implement. Potential Practice locations are identified based on NRCS design standards (HEI, 2014a).

Table 1. Criteria used for screening PTMApp-Desktop BMP data.

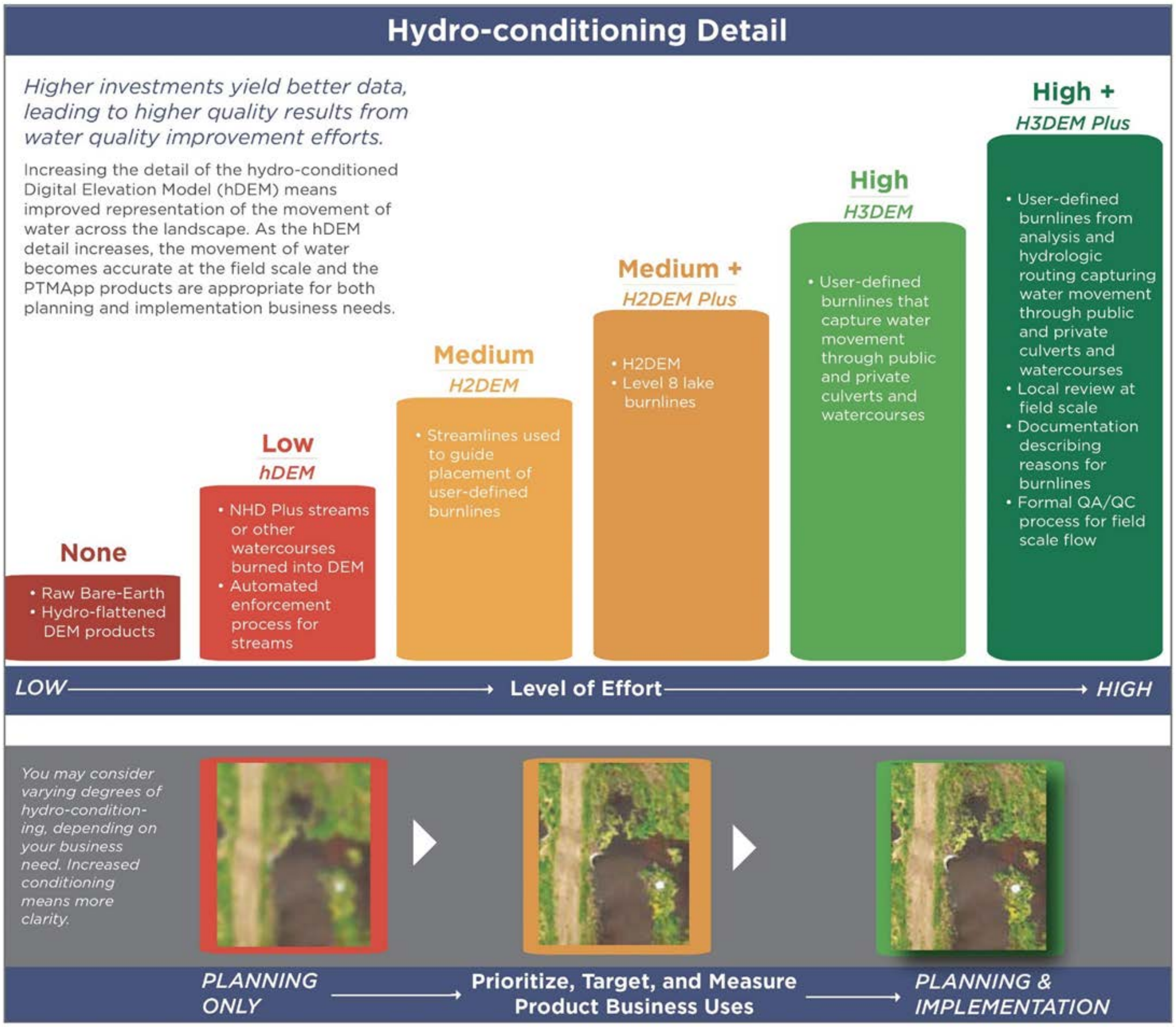
Group Code	Treatment Group	Total BMPs Generated	***Remove BMPs with little runoff volume delivery or constituent removal efficiency***							***Remove BMPs with low removal magnitudes at the edge-of-field***					
			Delivery and Efficiency Selection Criteria (value must be greater than) *				**BMPs Not Meeting Criteria**	**BMPs Remaining After Criteria Applied**	**% of Original BMPs Remaining**	**Reduction Magnitude Selection Criteria (value must be greater than) ****			**BMPs Not Meeting Criteria†**	**BMPs Remaining After Criteria Applied**	**% of Original BMPs Remaining**
			Excess Runoff Depth, 2-Year, 24-hour	**Sediment Reduction, %**	**TP Reduction, %**	**TN Reduction, %**				**Sediment Reduction @ Catchment Outlet, tons/year**	**TP Reduction @ Catchment Outlet, tons/year**	**TN Reduction @ Catchment Outlet, tons/year**			
1	Storage	8,862	0	5.0%	5.0%	5.0%	550	8,312	93.8%	0.25	0.25	0.5	6,458	1,854	20.9%
2	Filtration	11,593	0	20.0%	5.0%	5.0%	0	11,593	100.0%	0.25	0.25	0.5	5,746	5,847	50.4%
3	Biofiltration	3,371	0	20.0%	20.0%	20.0%	0	3,371	100.0%	0.25	0.25	0.5	837	2,534	75.2%
4	Infiltration	1,475	0	20.0%	5.0%	5.0%	73	1,402	95.1%	0.25	0.25	0.5	831	571	38.7%
5	Protection	16,082					0	16,082	100.0%	0.25	0.25	0.5	9,474	6,608	41.1%
6	Source reduction	11,989					0	11,989	100.0%	0.25	0.25	1	3,519	8,470	70.6%

** Second quartile (Q2; 50th percentile) reduction efficiency was used for all treatment groups except filtration, where the third quartile (Q3; 75th percentile) reduction efficiency was used for TP and TN terms*

*** Second quartile (Q2; 50th percentile) catchment outlet reduction was used for all treatment groups except filtration, where the third quartile (Q3; 75th percentile) catchment reduction was used for TP and TN terms*

† Represents BMPs failing to meet Reduction Magnitude Selection Criteria after the BMPs failing to meet Delivery and Efficiency Selection Criteria were removed

Figure 3. Digital Elevation Model Hydrologic Conditioning and Data Product Scale. ‡



‡ The figure shows the relationship between the level of hydrologic conditioning and the appropriate use of the geo-spatial products created using PTMApp Desktop.

* 'Lake routing' is an analysis technique that adjusts sediment, TN, and TP loads based on lake dead storage in PTMApp-Desktop.

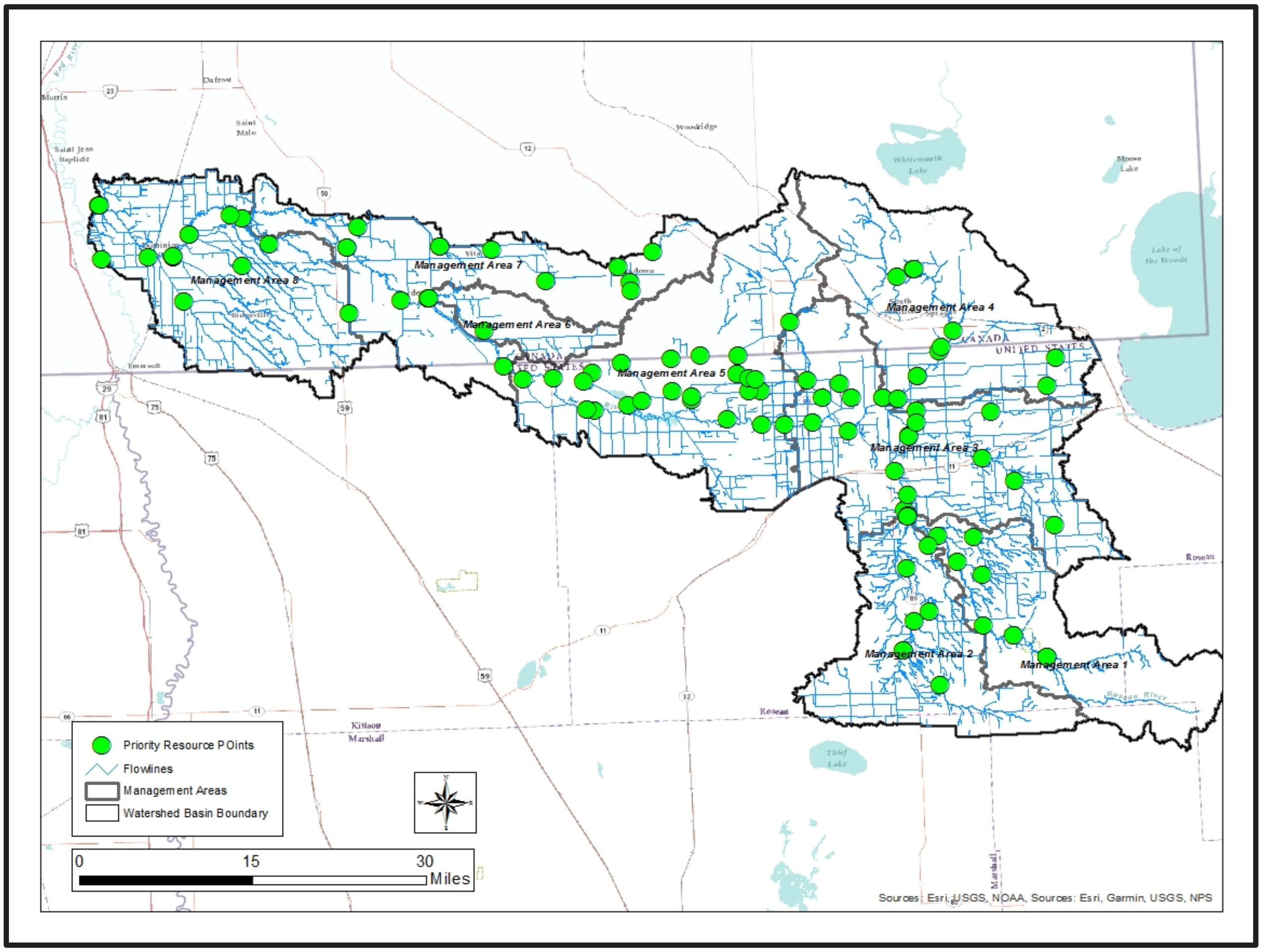


Figure 4. Priority resource point locations within the Roseau River Watershed.

3.4 TARGETING PRACTICES AND ESTIMATING IMPLEMENTATION COSTS

The annualized 2016 life cycle cost of potential Practices are estimated based on a representative Practice for each treatment group (**Table 3**) (see https://www.nrem.iastate.edu/bmpcosttools/). The costs for storage and infiltration were derived from alternative sources of information. It is important to note that there is a high degree of uncertainty in estimating costs at this scale of practice targeting. Practitioners who use the information from the Plan or from the data are encouraged to refine the cost estimates to fit local experience.

Table 2. Estimated 2016 Annualized Life Cycle Costs used to Estimate the Cost for a Treatment Group. Representative Practices Were Used for Each Treatment Group.

Treatment Group	Cost/Unit	Description
Storage	$0.10 per cubic foot of storage volume at practice	Based on costs for a pond: $0.10 per cubic foot = $4,356 per acre foot
Filtration	$233 per acre	Based on costs for Riparian Vegetative Filter Strip (NRCS Code PC 393)
Biofiltration	$40 per cubic yard of runoff volume delivered to practice from a 2-year rainfall event.	Based on costs for Denitrifying (Woodchip) Bioreactor (NRCS Code PC 747) *
Infiltration	$86,684 per acre	Based on costs for Infiltration BMP (e.g. Rain Garden)
Protection	$2133.35 per acre	Based on costs for critical plantings
Source Reduction	$65 per acre	Based on costs for cover crops-cereal rye (NRCS Code PC 340)

*Treated volume calculated as (1/8" runoff depth * watershed area delivering water to BMP)

The annualized life cycle cost includes the cost of planning, design, construction, annual maintenance, and the loss of land rent and/or crop yield. It is important to note that this is a desktop analysis to help target the locations for on-the-ground Practice implementation, assess their benefits, and provide information about the ability to achieve load reduction goals. Local knowledge is still critical for ensuring that the data generated from this desktop analysis identifies practical and feasible Practice locations. For example, land owner willingness and existing practices are two factors that cannot be accounted for in this Plan. Local knowledge can be used to incorporate and adjust for these factors.

Several metrics were used to target conservation practices. Metrics were based on a combination of the cost-effectiveness of reducing sediment and nutrients as well as the total potential for a conservation practice to reduce sediment or nutrients at the outlet of the management area (**Table 3**). The criteria used were driven largely by the metrics that would achieve a 10% sediment and nutrient reduction goal for the outlets of both the Roseau River Watershed and Roseau Lake. It was assumed that the metrics developed for these two drainage areas would set reasonable metrics for management areas with larger drainage areas (i.e., management areas 5, 7, and 8) as opposed to the management areas with relatively smaller drainage areas (i.e., management areas 1, 2, 3, and 4). A different set of metrics was developed for the smaller management areas. The purpose of keeping the metrics similar for management areas with comparable drainage areas was to provide an "apples to apples" comparison of potential implementation strategies. In addition, the metrics were developed so that up to 75% of the load reduction goals could be met with field management practices with the remaining balance targeted with structural management practices.

Table 3. Criteria used for targeting source reduction conservation practices in different management areas with the Roseau River Watershed.

Management Areas	Targeting Criteria: Cost per Year	Targeting Criteria: Reduction
- Management Area 8 (Roseau River Watershed Outlet)	Management Practices: • < $1,500/ton/year of sediment reduction • <$2,500/lbs./year of TP reduction • <$2,500/lbs./year of TN reduction Structural Practices • < $8,000/ton/year of sediment reduction • <$10,000/lbs./year of TP reduction • <$8,000/lbs./year of TN reduction	Management Practices • > 1 ton/year of sediment reduction • > 1 lbs./year of TP reduction Structural Practices: • > 1 ton/year of sediment reduction • > 0.5 lbs./year of TP reduction
- Roseau Lake - Management Area 1 - Management Area 2 - Management Area 3 - Management Area 4	Management Practices: • < $600/ton/year of sediment reduction • <$1,000/lbs./year of TP reduction Structural Practices: • < $8,000/ton/year of sediment • <$8,500/lbs./year of TP reduction	Management Practices: • > 1 ton/year of sediment reduction • > 1 lbs./year of TP reduction Structural Practices: • > 1 ton/year of sediment reduction • > 0.5 lbs./year of TP reduction
- Management Area 5 - Management Area 7	Management Practices: • < $1,500/ton/year of sediment reduction • <$2,500/lbs./year of TP reduction • <$2,500/lbs./year of TN reduction Structural Practices: • < $8,000/ton/year of sediment reduction • <$10,000/lbs./year of TP reduction • <$8,000/lbs./year of TN reduction	Management Practices: • > 1 ton/year of sediment reduction • > 1 lbs./year of TP reduction Structural Practices: • > 1 ton/year of sediment reduction • > 0.5 lbs./year of TP reduction
- Management Area 6	Management Practices: • <$600/ton/year of sediment reduction • <$1,000/lbs./year of TP reduction Structural Practices: • <$8,000/ton/year of sediment reduction • <$8,500/lbs./year of TP reduction	Management Practices: • > 1 ton/year of sediment reduction • > 1 lbs./year of TP reduction Structural Practices: • > 1 ton/year of sediment reduction • > 1 lbs./year of TP reduction

3.5 MANAGEMENT AREA IMPLEMENTATION PROFILES

Implementation profiles were developed for each management area. Each implementation profile contains:

- A map of the management area along with current sediment and nutrient loads delivered to the outlet of the management area;
- the location of targeted management practices, associated anticipated sediment and nutrient load reductions, and cost-effectiveness curves; and
- the location of targeted structural practices, associated anticipated sediment and nutrient load reductions and cost-effectiveness curves.

3.6 USING THE MANAGEMENT AREA IMPLEMENTATION PROFILES

This section describes the information contained within the Targeted Implementation Profiles and is intended to serve as a guide for how the profiles can be used. Below is an explanation of the elements contained within each Targeted Implementation Profile and how each element is intended to be used:

- **Measurable Goal** – this section shows the existing load at the outlet of the management area, the targeted load reduction, and the cost of implementing the targeted Practices upstream of that management area's priority resource point based on annual life cycle costs. It is also important to note that the total cost of implementing Practices upstream of a management area may include Practices that were also targeted for implementation in other management areas. In other words, there is some redundancy in total cost estimates between management areas. In addition, all loads and load reductions were estimated using PTMApp-Desktop and are subject to the associated assumptions and limitations (see https://ptmapp.bwsr.state.mn.us/User/Documentation).
- **Targeting Approach** – this section describes the information that was used to select the targeted Practices from PTMApp-Desktop. As this is implemented, it is likely that adjustments will be made to these targeting criteria based on available funding and landowner willingness to implement conservation practices. The targeting criteria are intended to guide decision making processes regarding the selection of the most cost-effective conservation practices that make progress towards the measurable goals of the Roseau River Watershed targeted implementation plan.
- **Practice Summary** – this section provides statistics on the number, cost, and load reduction benefits of the individual treatment groups from PTMApp, along with examples of the types of Practices that could be implemented within each treatment group. The benefits shown are an aggregate of the individual Practices and are not reflective of the treatment trains results.
- **Tailoring Implementation** – this section provides suggestions as to how the data can be used to implement a conservation implementation program within the Management Area. It describes how critical sediment loss information might be used to tailor decisions on when and where to implement Practices and suggests optimal investment levels.
- **Cost-effectiveness** – this section serves two primary functions; (1) identifying if the load reduction goals for the Management Area can be achieved through the targeted Practices targeted; and (2) providing an estimate of a reasonable return in sediment or nutrient reduction for a given level of investment.
- **Management Area Map** – each targeted profile has a map of the Management Area and targeted Practices for the Management area.

4 TARGETED IMPLEMENTATION PROFILES

This section contains the results of the targeted implementation plan profiles. It is organized as follows:

- **Roseau River Outlet** – There is local, regional, and international interest in reducing the sediment and nutrients (i.e., TN and TP) delivered from the Roseau River to the Red River and eventually Lake Winnipeg. The broad partnership engaged in completing this Plan indicates that interest. The Roseau River Outlet Targeted Implementation Profile is focused specifically on sediment and nutrient delivery from the Roseau River Watershed to the Red River of the North.
- **Roseau Lake** – Roseau Lake is in Northwestern Minnesota between the town of Roseau and the border between the United States and Canada. In the early 1900s, the lake was drained for agricultural purposes. However, farming within the Roseau Lake bottom has been mostly abandoned due to frequent flooding. The Roseau River Watershed District and its partners are actively pursuing a project to rehabilitate Roseau Lake to reduce flood damage and improve habitat. A critical component of that project is planning and implementing Practices upstream of the lake to protect the quality of the water within the project area from excess sediment and TP as well as improve the quality of water delivered to downstream resources, such

as the Red River of the North and Lake Winnipeg. A special Targeted Implementation Profile is included for the delivery of sediment and phosphorus to the outlet of the Roseau Lake project area.

- **Management Areas** – A Targeted Implementation Profile is included for each management area within the Roseau River Watershed to support conservation decisions across the watershed aimed at reducing the delivery of sediment and TP to surface waters.

TARGETED IMPLEMENTATION PROFILE: ROSEAU RIVER OUTLET (MANAGEMENT AREA 8)

MEASURABLE GOAL

Existing Load at Management Area Outlet:

-Sediment 64,412 tons/year, TN 1,481,058 lbs/year, TP 72,781 lbs/year

Targeted Load Reduction at Outlet:

-Sediment 6,441 tons/year, TN 148,106 lbs/year, TP 7,278 lbs/year

Cost: $43,009,274

TARGETING APPROACH

Structural Practices

- Sediment cost-effectiveness < $8,000/ton/year
- Sediment Reduction > 1 ton/year
- TP cost-effectiveness < $10,000/lbs./year
- TP Reduction > 0.5 lbs./year

Field Management

- Sediment cost-effectiveness < $1,500/ton/year
- Sediment Reduction > 1 ton/year
- TP cost-effectiveness < $2,500/lbs./year
- TP Reduction > 1 lbs./year

All Practices

- All values reported for reductions at the outlet of the Roseau River Watershed

PRACTICE SUMMARY

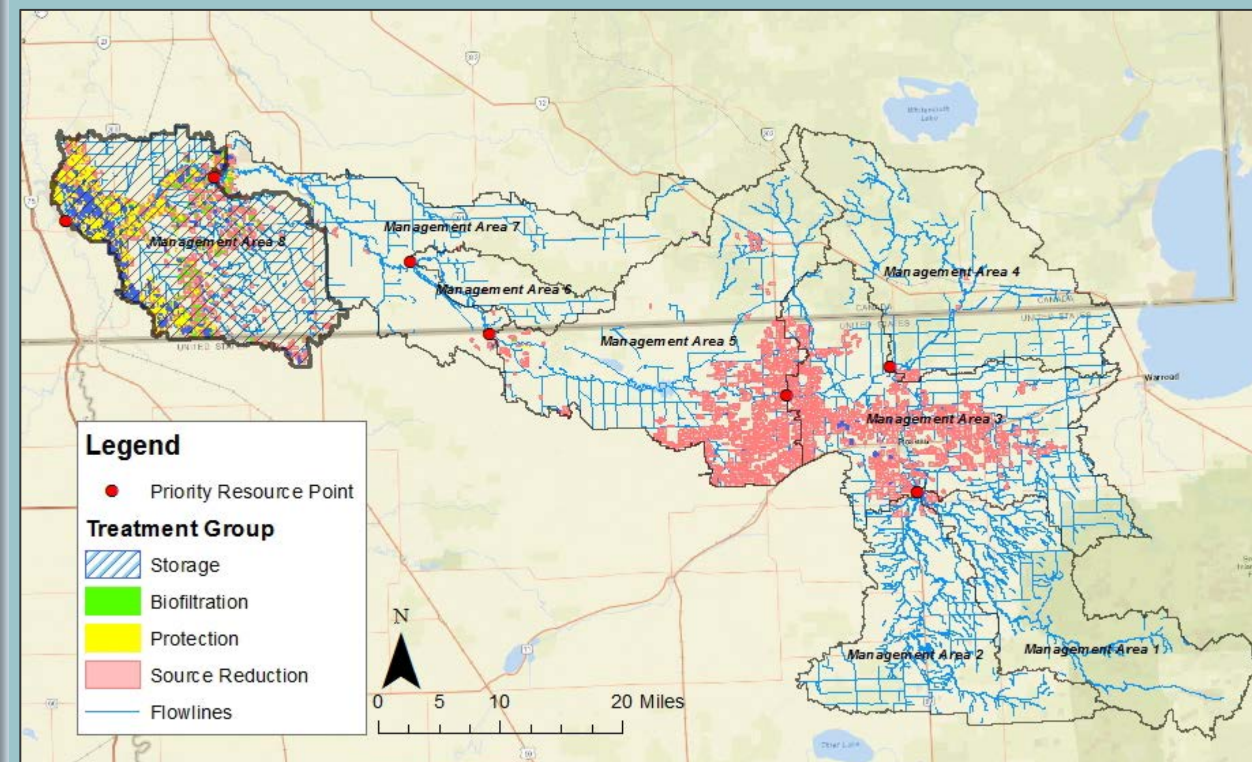
Below is a summary of targeted conservation practices based on aggregated individual benefits and costs and the specific types of Practices that will be targeted within treatment groups. All values are reported for reductions at the outlet of the area.

	Treatment Group				
	Storage	Biofiltration	Protection	Source Reduction	*Totals*
Count	287	844	540	2,268	***3,939***
Sediment Reduction, Tons/year (CE*)	1,787 ($3,528)	5,775 ($4,562)	2,462 ($3,917)	12,417 ($666)	***22,440 ($2,155)***
TP Reduction, lbs./year (CE*)	1,002 ($5,583)	4,401 ($5,232)	1,089 ($7,488)	7,065 ($1,167)	***13,558 ($3,226)***
TN Reduction, lbs./year (CE*)	24,538 ($203)	111,621 ($161)	21,1128 ($401)	56,618 ($146)	***213,906 ($146)***
Cost	$5,484,601	$22,377,053	$8,148,070	$6,999,550	***$43,009,274***

Treatment Types

Storage	Filtration	Biofiltration	Protection	Source Reduction
• Drainage Water Management • Wetland Restoration • Water Control Structures • Water and Sediment Control Basins • Diversion	• Conservation Cover • Cover Crop • Filter Strips • Grassed Waterway • Riparian Buffers	• Denitrifying Bioreactor • Saturated Buffer	• Critical Area Planting • Grad Stabilization Structure • Tree/Shrub Establishment • Well Sealing • Septic System Upgrades • Upland Wildlife Habitat Management • Restoration and Management of Rare/ Declining Habitat • Prescribed Burning • Gravel Pit Reclamation	• Residue and Tillage Management • Nutrient Management

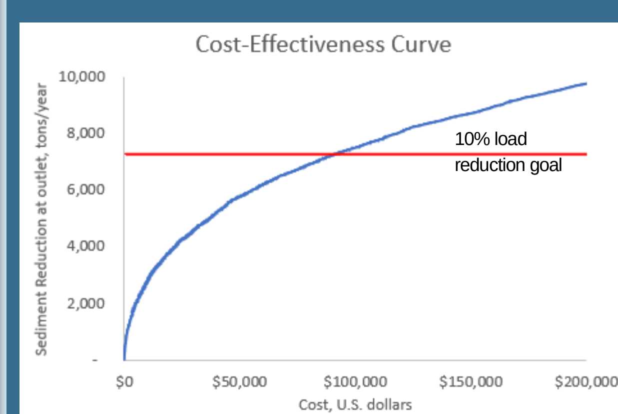
*(CE) – average cost-effectiveness in US $/mass removed/ year

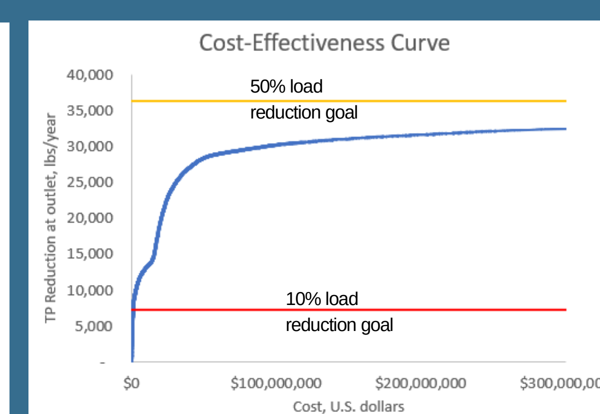


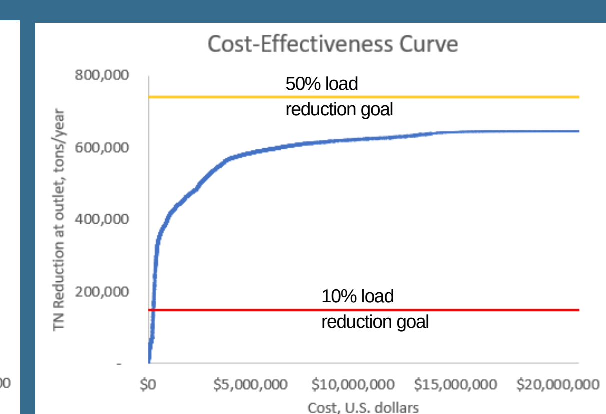
TAILORING IMPLEMENTATION

Ambitious, but necessary, goals have been set for reducing the amount of nutrient (TN and TP) delivered to Lake Winnipeg. The cost-effectiveness curves for the Roseau River Watershed show that overland treatment alone will not likely allow nutrient load reductions of 50% in the plan area. Instead, uniform 10% goals where set for targeting Practices across the Roseau River watershed for sediment, TN, and TP.

Across all targeted conservation treatment groups, sediment, TN, and TP reductions can be achieved for an average of $2,155/ton/year, $146/lbs./year, and $3,226/lbs./year, respectively, at the outlet of the Roseau River Watershed. Across all treatment groups, field management (i.e., source reduction) practices, such as conservation tillage and nutrient management, were the most cost-effective for reducing sediment and nutrient delivery. However, field management practices alone will not achieve the goals set for Lake Winnipeg.







TARGETED IMPLEMENTATION PROFILE: ROSEAU LAKE

MEASURABLE GOAL

Existing Load at Management Area Outlet:

-Sediment 45,553 tons/year, TP 54,452 lbs/year

Targeted Load Reduction at Outlet:

-Sediment 4,555 tons/year, 5,445 TP lbs/year

Cost: $13,873,553

TARGETING APPROACH

Structural Practices

- Sediment cost-effectiveness < $8,000/ton/year
- Sediment Reduction > 1 ton/year
- TP cost-effectiveness < $8,500/lbs./year
- TP Reduction > 1 lbs./year

Field Management

- Sediment cost-effectiveness < $600/ton/year
- Sediment Reduction > 1 ton/year
- TP cost-effectiveness < $1,000/lbs./year
- TP Reduction > 1 lbs./year

All Practices

- All values reported for reductions at the outlet of the Roseau Lake

PRACTICE SUMMARY

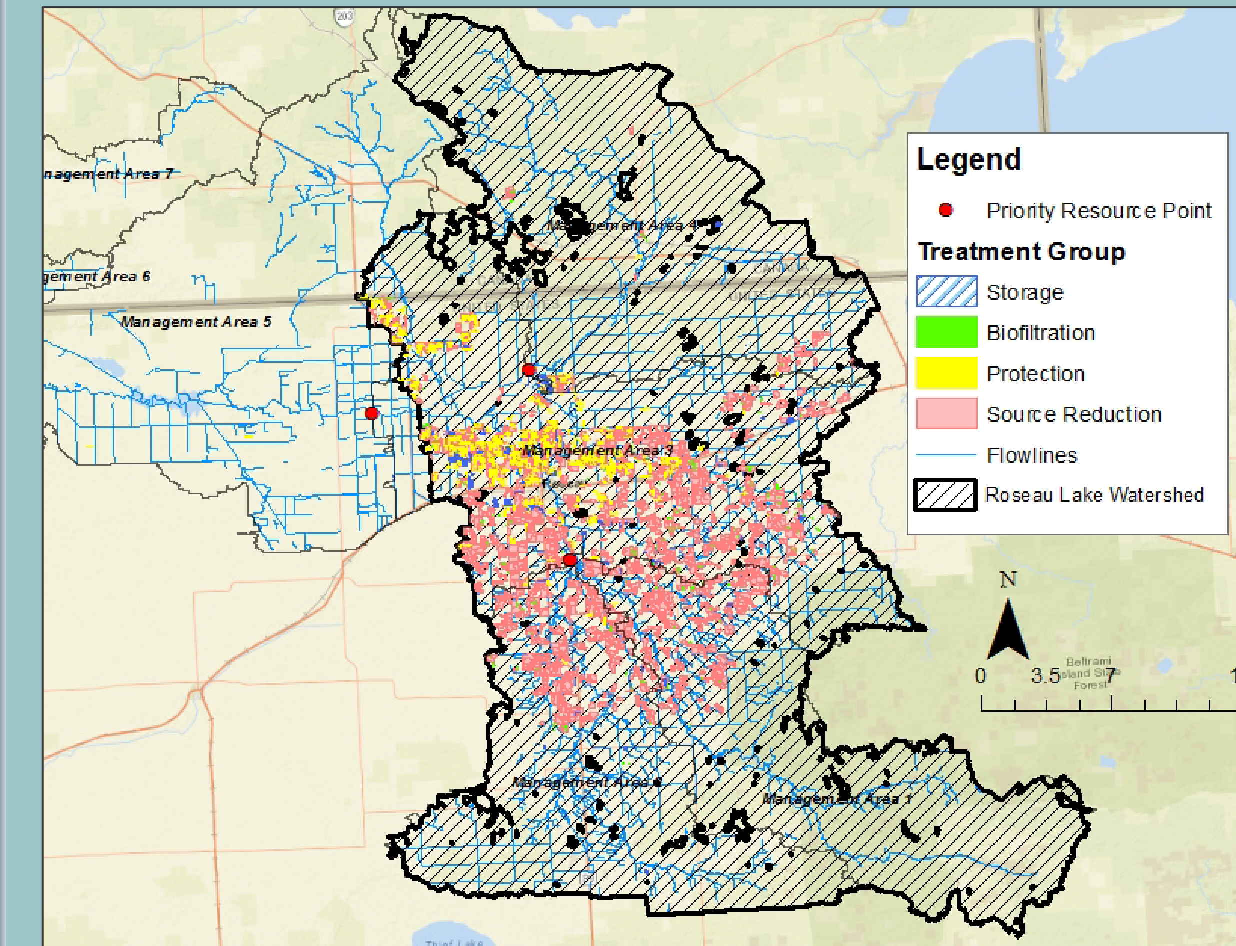
Below is a summary of Practices based on aggregated individual benefits and costs and the specific types of Practices that will be targeted within treatment groups. All values are reported for reductions at the outlet of the area.

	Treatment Group				
	Storage	Biofiltration	Protection	Source Reduction	*Totals*
Count	79	202	293	1,505	**2,079**
Sediment Reduction, Tons/year (CE*)	565 ($2,406)	1,156 ($4,485)	1,538 ($4,317)	9,297 ($403)	***12,556 ($1,427)***
TP Reduction, lbs./year (CE*)	335 ($3,369)	759 ($6,324)	656 ($7,306)	4,991 ($717)	***6,741 ($2,291)***
Cost	$1,040,489	$4,576,977	$4,793,869	$3,471,218	***$13,873,553***

Treatment Types

Storage	Filtration	Biofiltration	Protection	Source Reduction
• Drainage Water Management • Wetland Restoration • Water Control Structures • Water and Sediment Control Basins • Diversion	• Conservation Cover • Cover Crop • Filter Strips • Grassed Waterway • Riparian Buffers	• Denitrifying Bioreactor • Saturated Buffer	• Critical Area Planting • Grad Stabilization Structure • Tree/Shrub Establishment • Well Sealing • Septic System Upgrades • Upland Wildlife Habitat Management • Restoration and Management of Rare/ Declining Habitat • Prescribed Burning • Gravel Pit Reclamation	• Residue and Tillage Management • Nutrient Management

*(CE) – average cost-effectiveness in US $/mass removed/ year

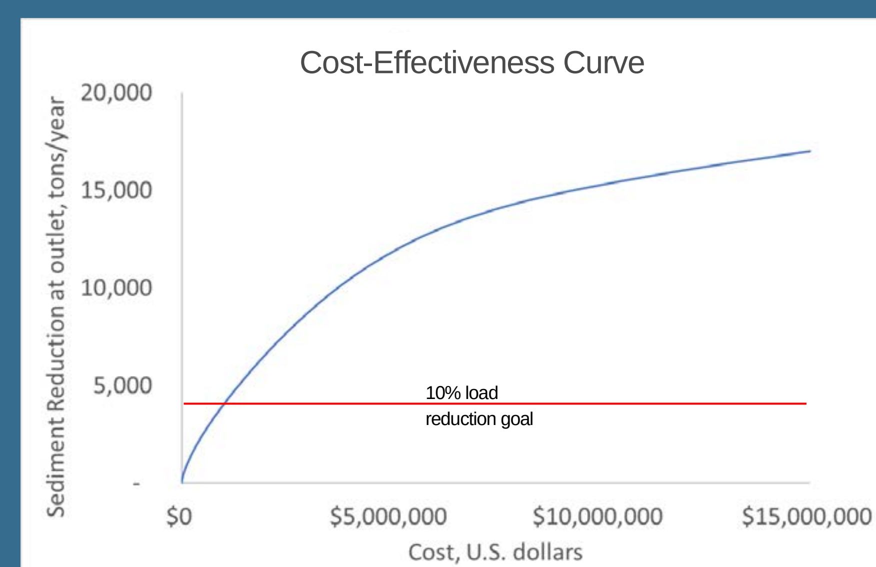


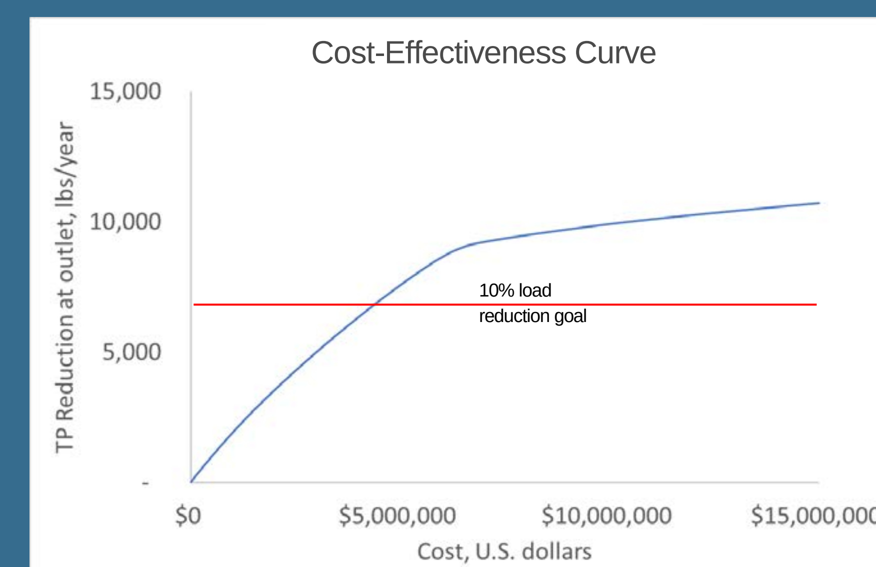
TAILORING IMPLEMENTATION

Roseau Lake was drained for agricultural purposes in the early 1900s. However, farming within the Roseau Lake bottom has been mostly abandoned due to frequent flooding. As part of a project to provide flood reduction benefits and habitat in the Roseau Lake bottom, practitioners are working to improve the quality of water delivered to Roseau Lake and onto the Red River and Lake Winnipeg.

The results of this project indicate that a 10% sediment and TP reduction goal at the outlet of Roseau Lake could be achieved. The results suggest that practitioners could plan to invest on average $1,427/ton/year of sediment and $2,291/lbs./year of TP reduced at the outlet of Roseau Lake.

Field management practices (i.e., source reduction), such as conservation tillage and nutrient management, were typically the most cost-effective practices for reducing both overland sediment and TP loading at the outlet of Roseau Lake.





TARGETED IMPLEMENTATION PROFILE: MANAGEMENT AREA 1

MEASURABLE GOAL

Existing Load at Management Area Outlet:

-Sediment 8,013 tons/year, TP 7,995 lbs/year

Targeted Load Reduction at Outlet:

-Sediment 801 tons/year, 800 TP lbs/year

Cost: $2,869,840

TARGETING APPROACH

Structural Practices

- Sediment cost-effectiveness < $8,000/ton/year
- Sediment Reduction > 1 ton/year
- TP cost-effectiveness < $8,500/lbs./year
- TP Reduction > 1 lbs./year

Field Management

- Sediment cost-effectiveness < $600/ton/year
- Sediment Reduction > 1 ton/year
- TP cost-effectiveness < $1,000/lbs./year
- TP Reduction > 1 lbs./year

All Practices

- All values reported for reductions at the outlet of the Roseau Lake

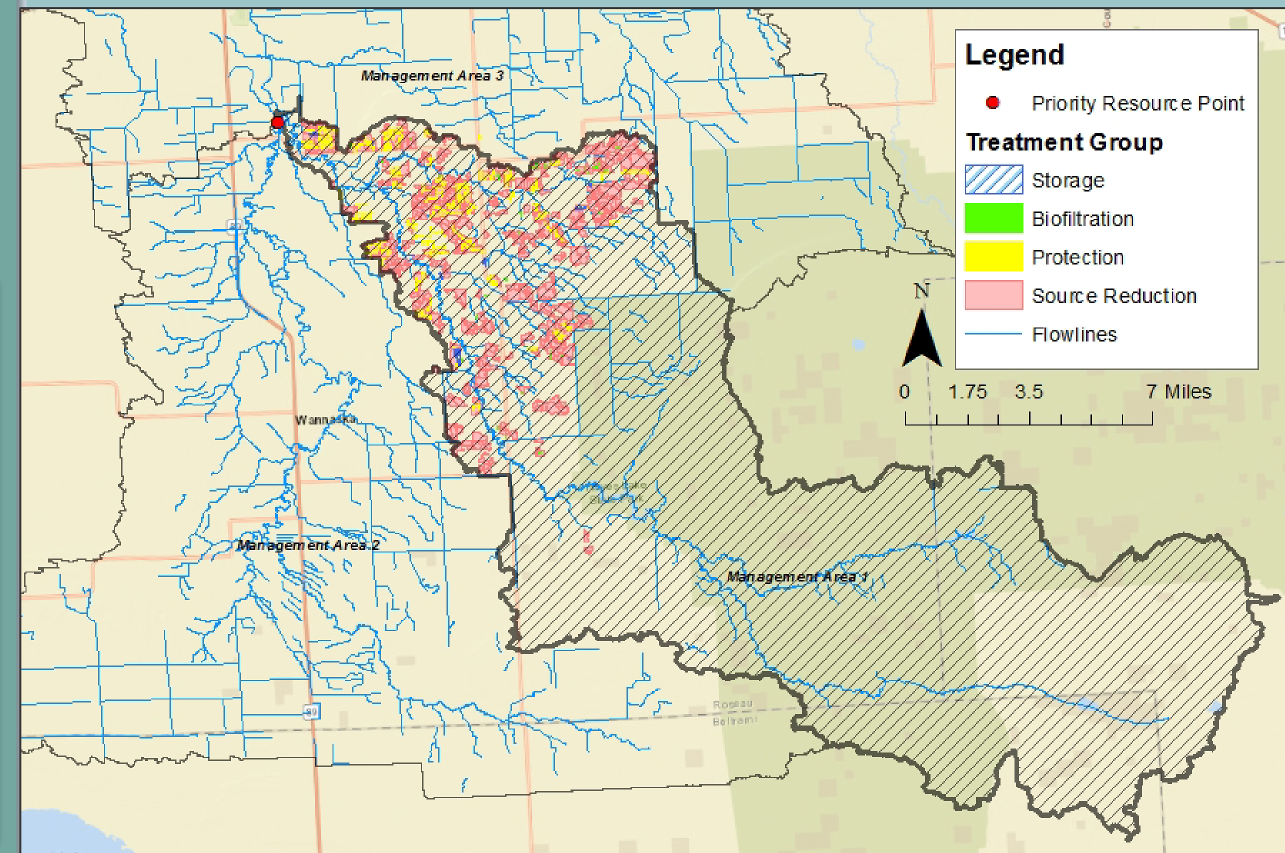
PRACTICE SUMMARY

Below is a summary of targeted conservation practices based on aggregated individual benefits and costs and the specific types of Practices that will be targeted within treatment groups. All values are reported for reductions at the outlet of the area.

	Treatment Group				
	Storage	Biofiltration	Protection	Source Reduction	*Totals*
Count	8	44	72	316	**440**
Sediment Reduction, Tons/year (CE*)	37 ($3,468)	324 ($3,806)	361 ($4,109)	1,852 ($364)	***2,574 ($1,358)***
TP Reduction, lbs./year (CE*)	19 ($4,195)	176 ($5,991)	155 ($7,447)	1,008 ($615)	***1,358 ($2,336)***
Cost	$77,355	$1,030,140	$1,148,528	$613,817	***$2,869,840***

Treatment Types				
Storage	Filtration	Biofiltration	Protection	Source Reduction
• Drainage Water Management • Wetland Restoration • Water Control Structures • Water and Sediment Control Basins • Diversion	• Conservation Cover • Cover Crop • Filter Strips • Grassed Waterway • Riparian Buffers	• Denitrifying Bioreactor • Saturated Buffer	• Critical Area Planting • Grad Stabilization Structure • Tree/Shrub Establishment • Well Sealing • Septic System Upgrades • Upland Wildlife Habitat Management • Restoration and Management of Rare/ Declining Habitat • Prescribed Burning • Gravel Pit Reclamation	• Residue and Tillage Management • Nutrient Management

*(CE) – average cost-effectiveness in US $/mass removed/ year

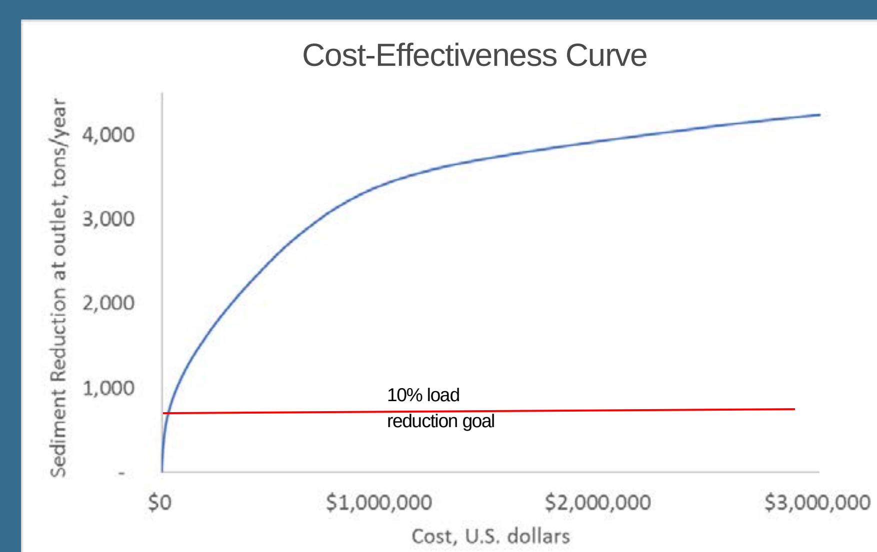


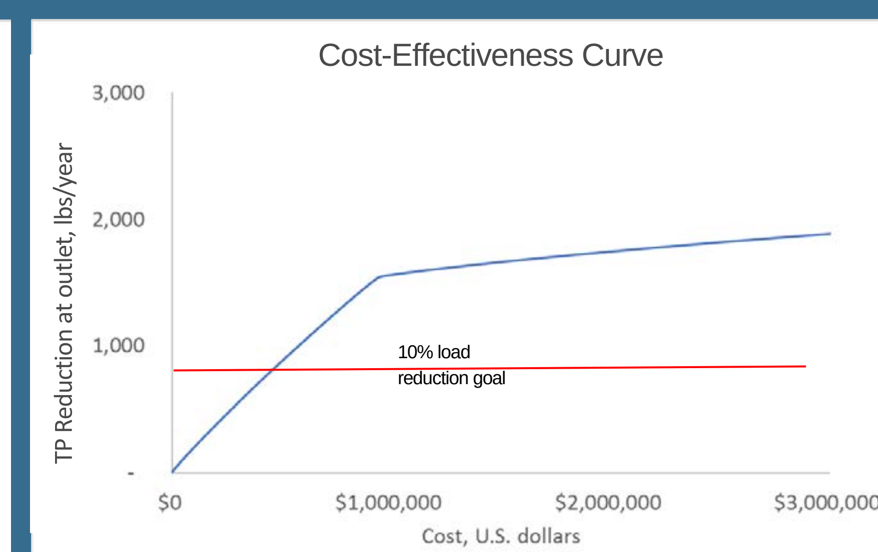
TAILORING IMPLEMENTATION

While the targeted Practices from this assessment should provide sufficient progress for reaching sediment and TP management goals, there is no guarantee that all practices can be implemented.

These results provide three key findings:

1. Treating overland flow in Management Area 1 has the potential to reach the 10% load reduction goals for the area
2. Source Reduction (field management) is the most cost-effective treatment option
3. On average, practitioners can expect to invest $1,358/ton of sediment and $2,336/lbs. of TP reduced at the outlet of the management area per year





TARGETED IMPLEMENTATION PROFILE: MANAGEMENT AREA 2

MEASURABLE GOAL

Existing Load at Management Area Outlet:

-Sediment 11,875 tons/year, TP 13,548 lbs/year

Targeted Load Reduction at Outlet:

-Sediment 1,188 tons/year, 1,355 TP lbs/year

Cost: $5,080,980

TARGETING APPROACH

Structural Practices

- Sediment cost-effectiveness < $8,000/ton/year
- Sediment Reduction > 1 ton/year
- TP cost-effectiveness < $8,500/lbs./year
- TP Reduction > 1 lbs./year

Field Management

- Sediment cost-effectiveness < $600/ton/year
- Sediment Reduction > 1 ton/year
- TP cost-effectiveness < $1,000/lbs./year
- TP Reduction > 1 lbs./year

All Practices

- All values reported for reductions at the outlet of the Roseau Lake

PRACTICE SUMMARY

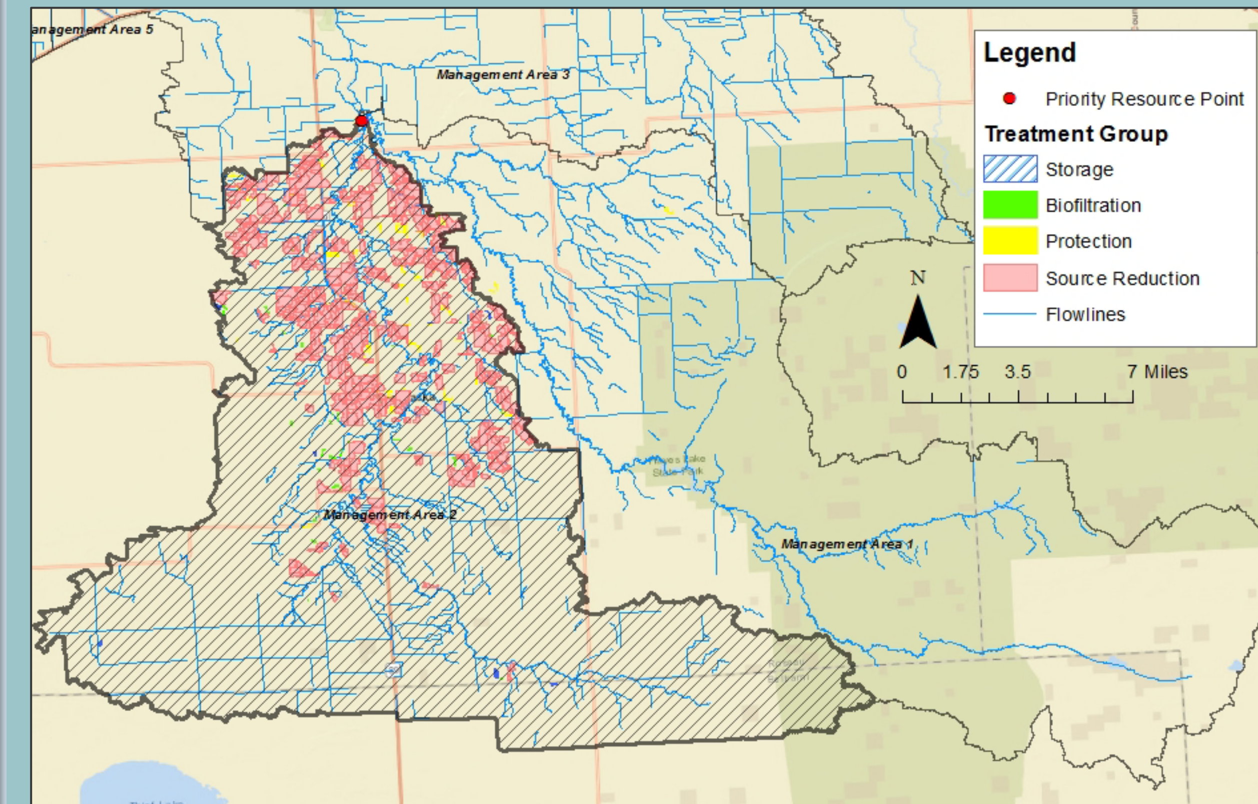
Below is a summary of targeted conservation practices based on aggregated individual benefits and costs and the specific types of Practices that will be targeted within treatment groups. All values are reported for reductions at the outlet of the area.

	Treatment Group				
	Storage	Biofiltration	Protection	Source Reduction	*Totals*
Count	15	69	170	450	**647**
Sediment Reduction, Tons/year (CE*)	113 ($1,676)	424 ($4,674)	720 ($3,998)	2,247 ($407)	***3,503 ($1,778)***
TP Reduction, lbs./year (CE*)	41 ($3,502)	281 ($6,158)	324 ($7,357)	1,469 ($603)	***2,114 ($2,940)***
Cost	$139,789	$1,685,492	$2,381,943	$873,755	***$5,080,980***

Treatment Types

Storage	Filtration	Biofiltration	Protection	Source Reduction
• Drainage Water Management • Wetland Restoration • Water Control Structures • Water and Sediment Control Basins • Diversion	• Conservation Cover • Cover Crop • Filter Strips • Grassed Waterway • Riparian Buffers	• Denitrifying Bioreactor • Saturated Buffer	• Critical Area Planting • Grad Stabilization Structure • Tree/Shrub Establishment • Well Sealing • Septic System Upgrades • Upland Wildlife Habitat Management • Restoration and Management of Rare/ Declining Habitat • Prescribed Burning • Gravel Pit Reclamation	• Residue and Tillage Management • Nutrient Management

*(CE) – average cost-effectiveness in US $/mass removed/ year

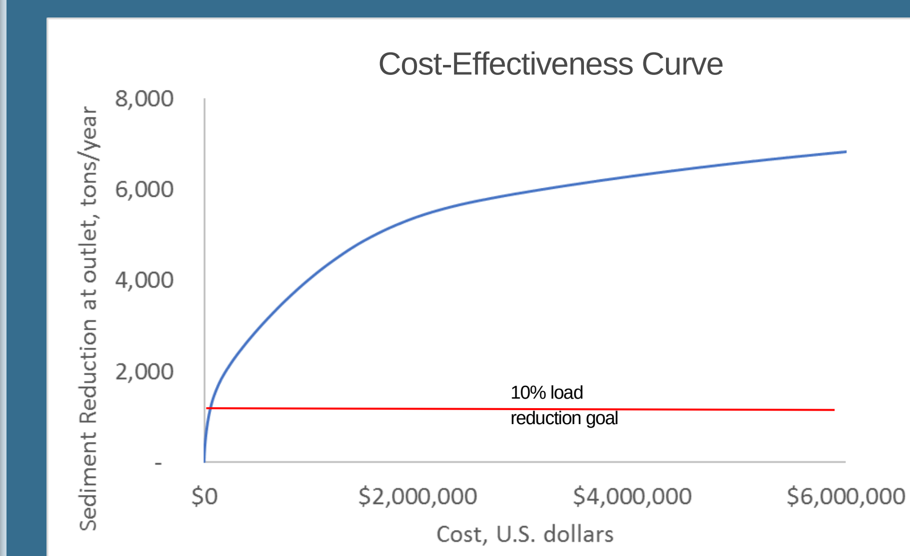


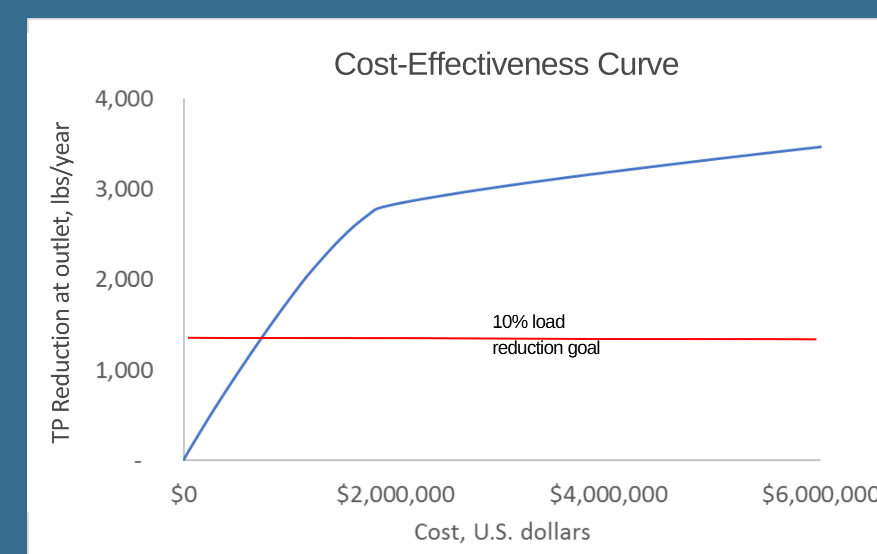
TAILORING IMPLEMENTATION

While the targeted Practices from this assessment should provide sufficient progress for reaching sediment and TP management goals, there is no guarantee that all Practices can be implemented.

These results provide three key findings:

1. Treating overland flow in Management Area 2 has the potential to reach the 10% load reduction goals for the area
2. Source Reduction (field management) is the most cost-effective treatment option
3. On average, practitioners can expect to invest $1,778/ton of sediment and $2,940/lbs. of TP reduced at the outlet of the management area per year





TARGETED IMPLEMENTATION PROFILE: MANAGEMENT AREA 3

MEASURABLE GOAL

Existing Load at Management Area Outlet:

-Sediment 47,551 tons/year, TP 55,082 lbs/year

Targeted Load Reduction at Outlet:

-Sediment 4,775 tons/year, 5,508 TP lbs/year

Cost: $14,393,239

TARGETING APPROACH

Structural Practices

- Sediment cost-effectiveness < $8,000/ton/year
- Sediment Reduction > 1 ton/year
- TP cost-effectiveness < $8,500/lbs./year
- TP Reduction > 1 lbs./year

Field Management

- Sediment cost-effectiveness < $600/ton/year
- Sediment Reduction > 1 ton/year
- TP cost-effectiveness < $1,000/lbs./year
- TP Reduction > 1 lbs./year

All Practices

- All values reported for reductions at the outlet of the Roseau Lake

PRACTICE SUMMARY

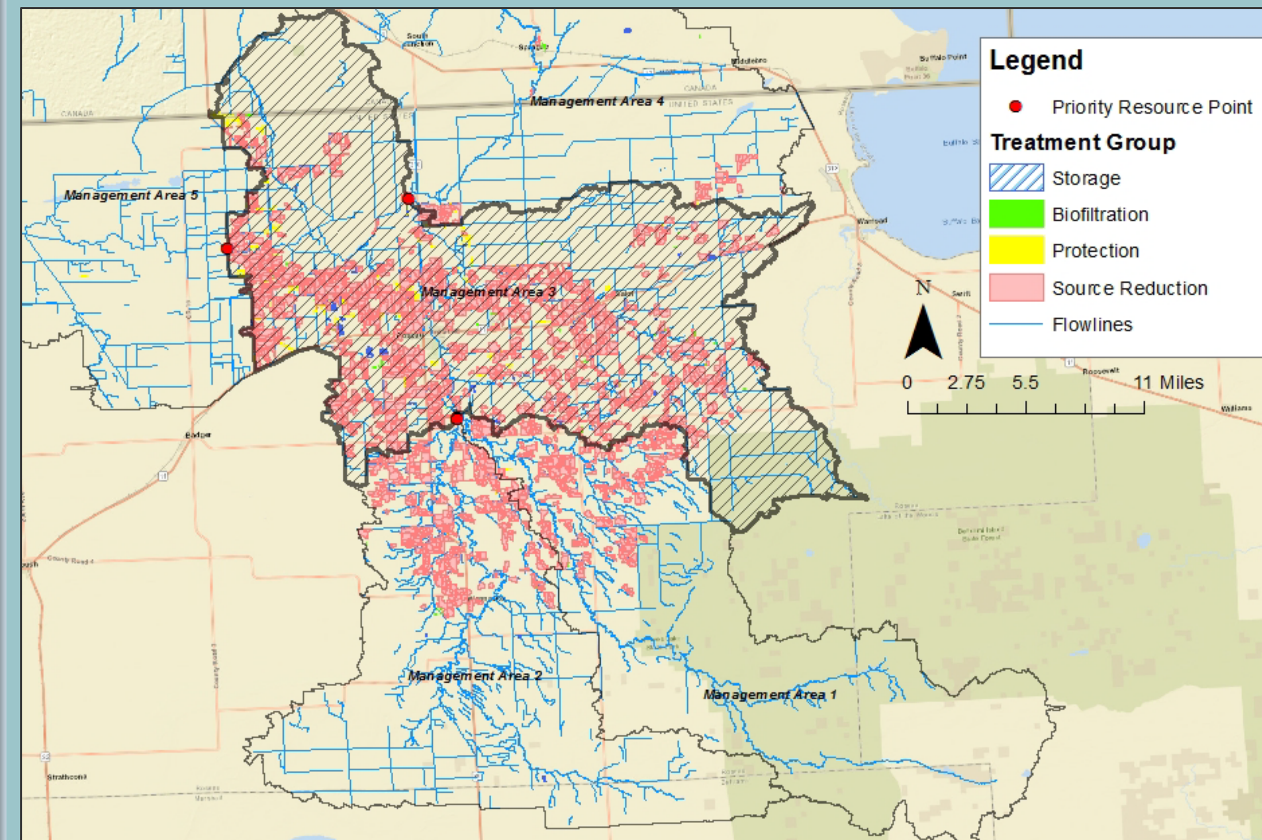
Below is a summary of targeted conservation practices based on aggregated individual benefits and costs and the specific types of Practices that will be targeted within treatment groups. All values are reported for reductions at the outlet of the area.

	Treatment Group				
	Storage	Biofiltration	Protection	Source Reduction	*Totals*
Count	82	191	324	1,589	**2,186**
Sediment Reduction, Tons/year (CE*)	588 ($2,418)	1,094 ($4,476)	1,675 ($4,400)	9,805 ($408)	***13,162 ($1,430)***
TP Reduction, lbs./year (CE*)	337 ($3,526)	709 ($6,394)	735 ($7,159)	5,326 ($723)	***7,107 ($2,278)***
Cost	$1,100,749	$4,307,513	$5,270,713	$3,714,264	***$14,393,239***

Treatment Types

Storage	Filtration	Biofiltration	Protection	Source Reduction
• Drainage Water Management • Wetland Restoration • Water Control Structures • Water and Sediment Control Basins • Diversion	• Conservation Cover • Cover Crop • Filter Strips • Grassed Waterway • Riparian Buffers	• Denitrifying Bioreactor • Saturated Buffer	• Critical Area Planting • Grad Stabilization Structure • Tree/Shrub Establishment • Well Sealing • Septic System Upgrades • Upland Wildlife Habitat Management • Restoration and Management of Rare/ Declining Habitat • Prescribed Burning • Gravel Pit Reclamation	• Residue and Tillage Management • Nutrient Management

*(CE) – average cost-effectiveness in US $/mass removed/ year

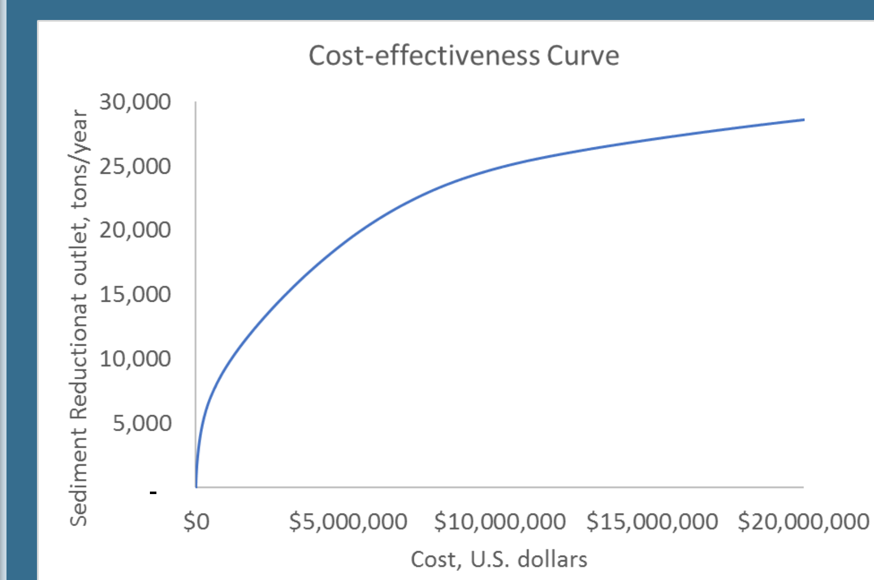


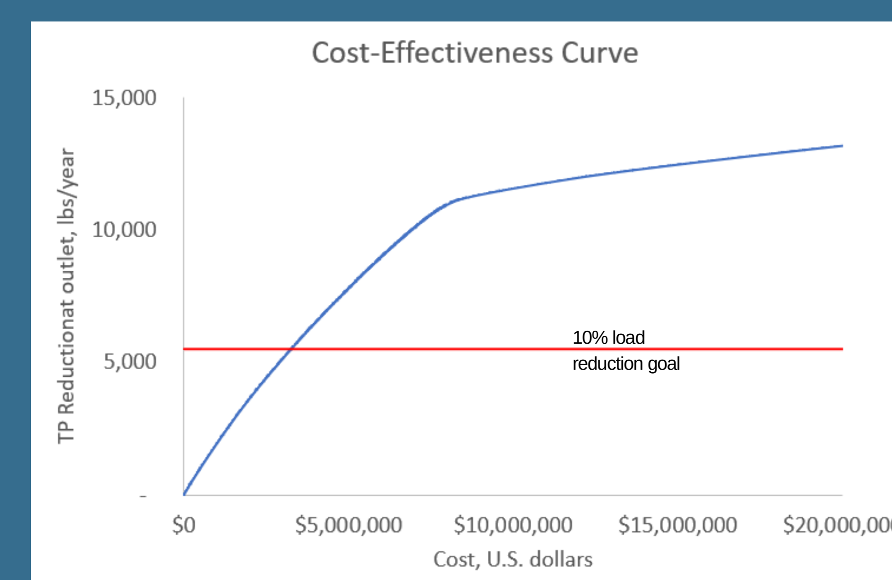
TAILORING IMPLEMENTATION

While the targeted Practices from this assessment should provide sufficient progress for reaching sediment and TP management goals, there is no guarantee that all Practices can be implemented.

These results provide three key findings:

1. Treating overland flow in Management Area 3 has the potential to reach the 10% load reduction goals for the area
2. Source Reduction (field management) is the most cost-effective treatment option
3. On average, practitioners can expect to invest $1,430/ton of sediment and $2,278/lbs. of TP reduced at the outlet of the management area per year





TARGETED IMPLEMENTATION PROFILE: MANAGEMENT AREA 4

MEASURABLE GOAL

Existing Load at Management Area Outlet:

-Sediment 1,833 tons/year, TP 9,121 lbs./year

Targeted Load Reduction at Outlet:

-Sediment 183 tons/year, 912 TP lbs./year

Cost: $942,819

TARGETING APPROACH

Structural Practices

- Sediment cost-effectiveness < $8,000/ton/year
- Sediment Reduction > 1 ton/year
- TP cost-effectiveness < $8,500/lbs./year
- TP Reduction > 1 lbs./year

Field Management

- Sediment cost-effectiveness < $600/ton/year
- Sediment Reduction > 1 ton/year
- TP cost-effectiveness < $1,000/lbs./year
- TP Reduction > 1 lbs./year

All Practices

- All values reported for reductions at the outlet of the Roseau Lake

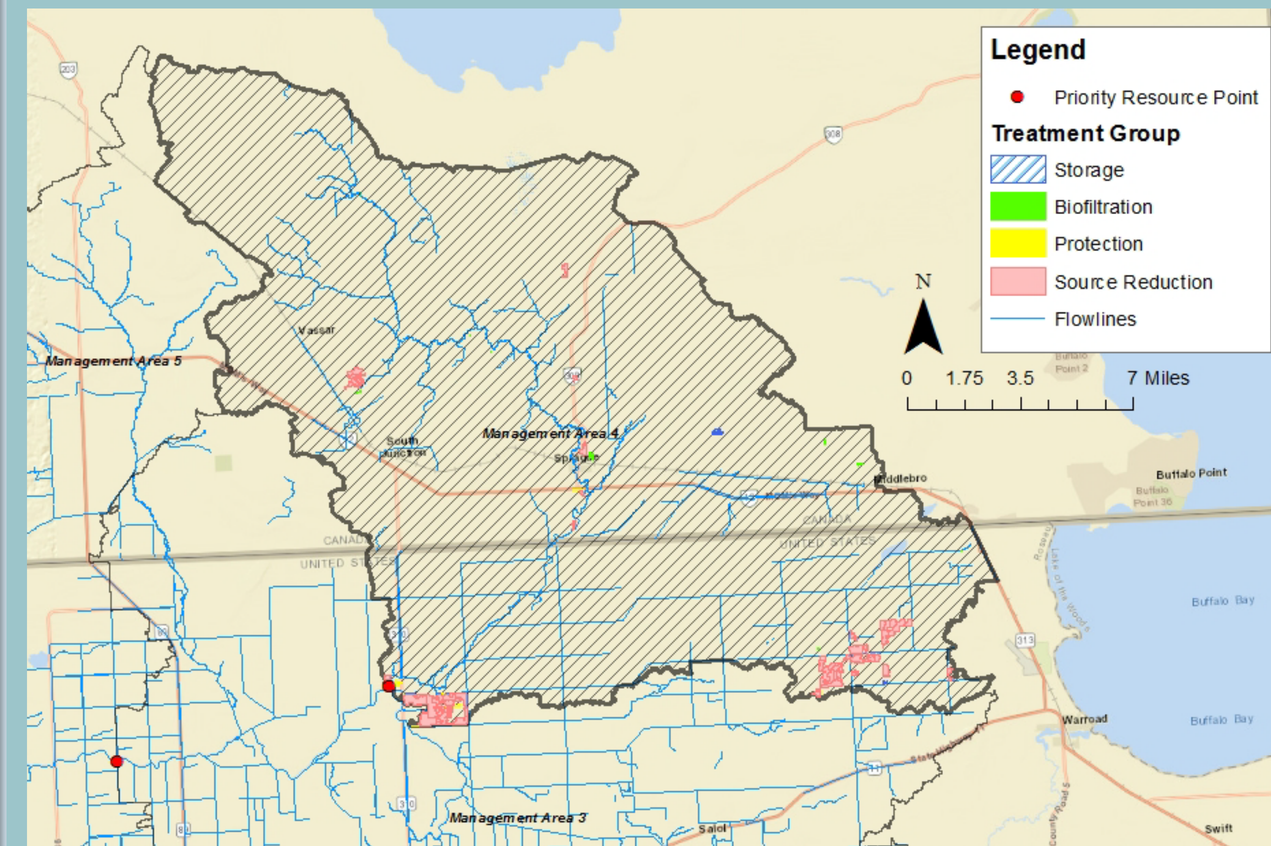
PRACTICE SUMMARY

Below is a summary of targeted conservation practices based on aggregated individual benefits and costs and the specific types of Practices that will be targeted within treatment groups. All values are reported for reductions at the outlet of the area.

	Treatment Group				
	Storage	**Biofiltration**	**Protection**	**Source Reduction**	***Totals***
Count	10	16	13	54	**93**
Sediment Reduction, Tons/year (CE*)	117 ($2,935)	75 ($5,296)	124 ($3,090)	303 ($427)	***618 ($1,906)***
TP Reduction, lbs./year (CE*)	62 ($3,3531)	57 ($6,537)	38 ($6,238)	195 ($649)	***352 ($2,753)***
Cost	$213,295	$367,733	$242,191	$119,599	*$942,819*

Treatment Types				
Storage	**Filtration**	**Biofiltration**	**Protection**	**Source Reduction**
• Drainage Water Management • Wetland Restoration • Water Control Structures • Water and Sediment Control Basins • Diversion	• Conservation Cover • Cover Crop • Filter Strips • Grassed Waterway • Riparian Buffers	• Denitrifying Bioreactor • Saturated Buffer	• Critical Area Planting • Grad Stabilization Structure • Tree/Shrub Establishment • Well Sealing • Septic System Upgrades • Upland Wildlife Habitat Management • Restoration and Management of Rare/ Declining Habitat • Prescribed Burning • Gravel Pit Reclamation	• Residue and Tillage Management • Nutrient Management

*(CE) – average cost-effectiveness in US $/mass removed/ year

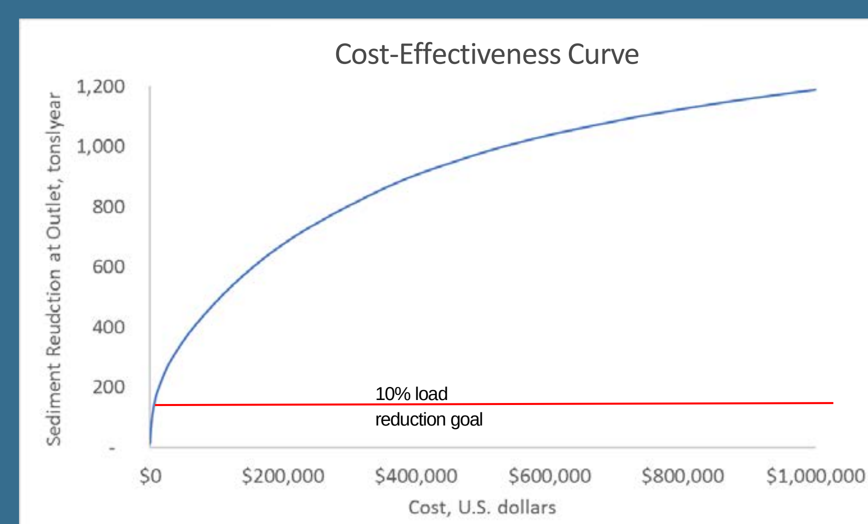


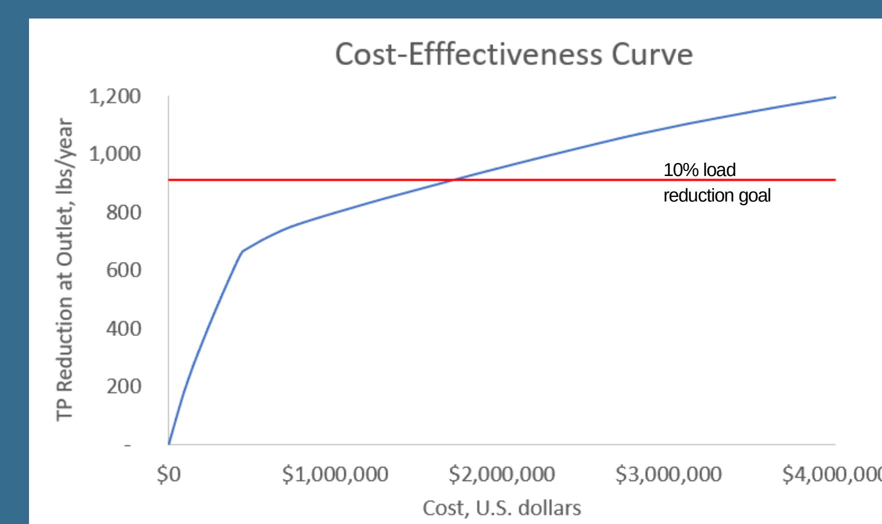
TAILORING IMPLEMENTATION

While the targeted Practices from this assessment should provide sufficient progress for reaching sediment and TP management goals, there is no guarantee that all Practices can be implemented.

These results provide three key findings:

1. Treating overland flow in Management Area 4 has the potential to reach the 10% load reduction goals for the area
2. Source Reduction (field management) is the most cost-effective treatment option
3. On average, practitioners can expect to invest $1,906/ton of sediment and $2,753/lbs. of TP reduced at the outlet of the management area per year





TARGETED IMPLEMENTATION PROFILE: MANAGEMENT AREA 5

MEASURABLE GOAL

Existing Load at Management Area Outlet:

-Sediment 55,339 tons/year, TP 54,877 lbs/year

Targeted Load Reduction at Outlet:

-Sediment 5,539 tons/year, 5,488 TP lbs/year

Cost: $13,265,167

TARGETING APPROACH

Structural Practices

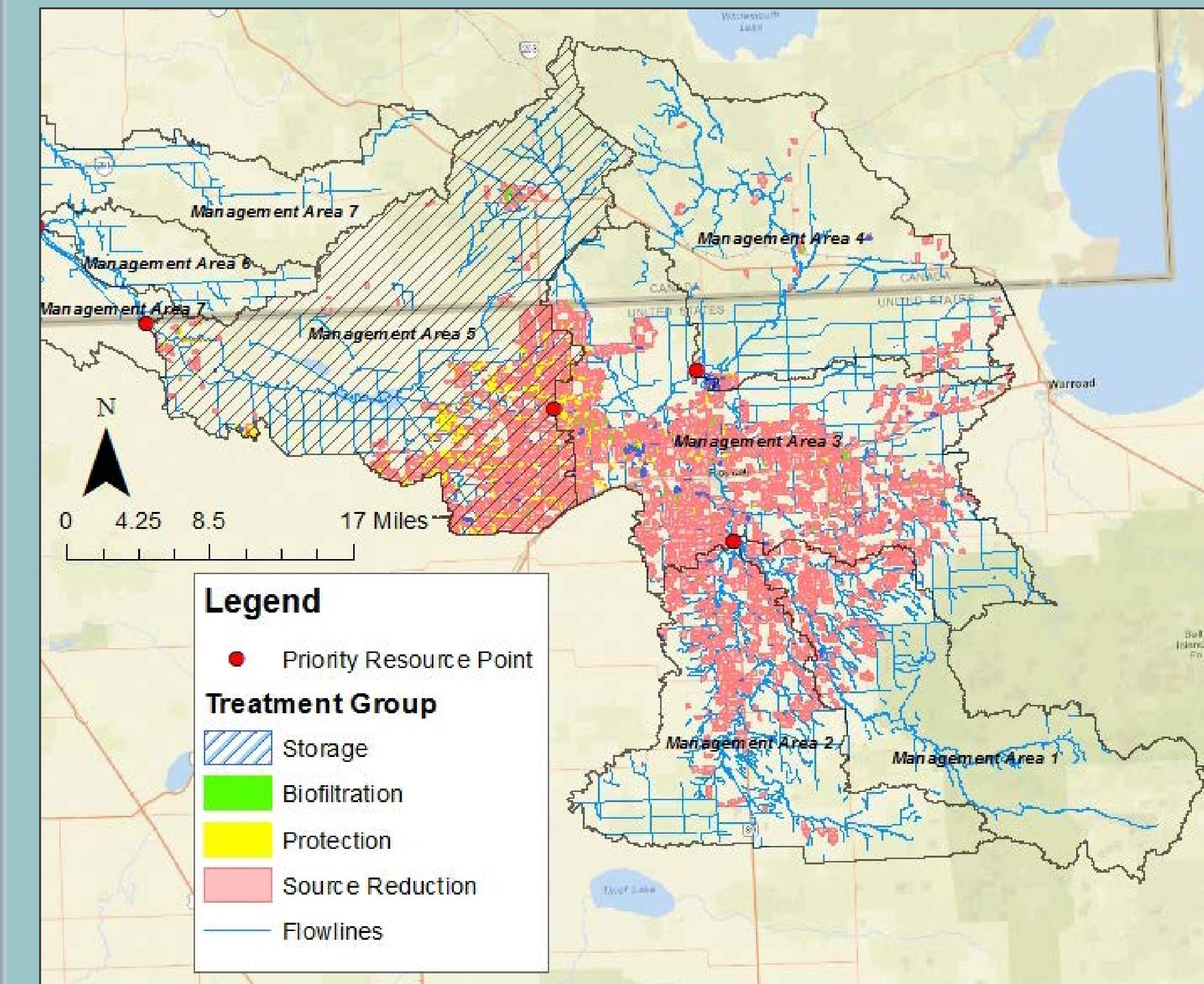
- Sediment cost-effectiveness < $8,000/ton/year
- Sediment Reduction > 1 ton/year
- TP cost-effectiveness < $10,000/lbs./year
- TP Reduction > 0.5 lbs./year

Field Management

- Sediment cost-effectiveness < $1,500/ton/year
- Sediment Reduction > 1 ton/year
- TP cost-effectiveness < $2,500/lbs./year
- TP Reduction > 1 lbs./year

All Practices

- All values reported for reductions at the outlet of the Roseau Lake



TAILORING IMPLEMENTATION

While the targeted Practices from this assessment should provide sufficient progress for reaching sediment and TP management goals, there is no guarantee that all Practices can be implemented.

These results provide three key findings:

1. Treating overland flow in Management Area 5 has the potential to reach the 10% load reduction goals for the area
2. Source Reduction (field management) is the most cost-effective treatment option
3. On average, practitioners can expect to invest $1,007/ton of sediment and $1,879/lbs. of TP reduced at the outlet of the management area per year

PRACTICE SUMMARY

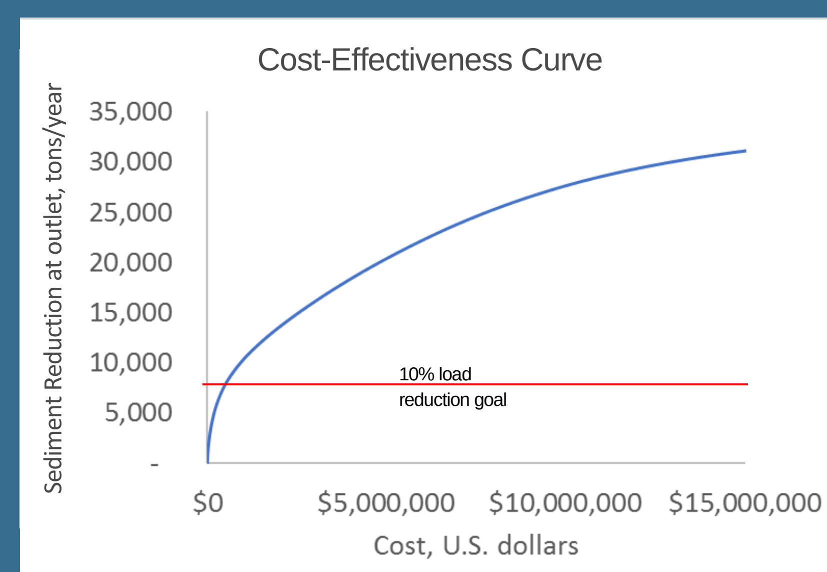
Below is a summary of targeted conservation practices based on aggregated individual benefits and costs and the specific types of Practices that will be targeted within treatment groups. All values are reported for reductions at the outlet of the area.

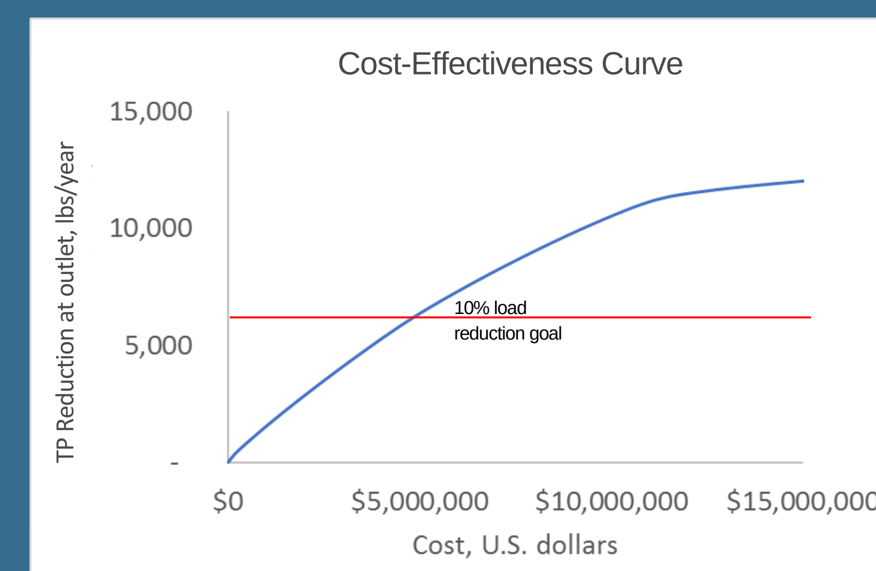
	Treatment Group				
	Storage	Biofiltration	Protection	Source Reduction	*Totals*
Count	93	103	194	2,6188	**3008**
Sediment Reduction, Tons/year (CE*)	570 ($2,314)	548 ($4,969)	944 ($3,397)	14,298 ($628)	***16,360 ($1,007)***
TP Reduction, lbs./year (CE*)	225 ($4,788)	317 ($7,806)	262 ($8,599)	7,731 ($1,045)	***8,535 ($1,879)***
Cost	$1,022,627	$2,368,397	$2,266,613	$7,607,530	***$13,265,167***

Treatment Types

Storage	Filtration	Biofiltration	Protection	Source Reduction
• Drainage Water Management • Wetland Restoration • Water Control Structures • Water and Sediment Control Basins • Diversion	• Conservation Cover • Cover Crop • Filter Strips • Grassed Waterway • Riparian Buffers	• Denitrifying Bioreactor • Saturated Buffer	• Critical Area Planting • Grad Stabilization Structure • Tree/Shrub Establishment • Well Sealing • Septic System Upgrades • Upland Wildlife Habitat Management • Restoration and Management of Rare/ Declining Habitat • Prescribed Burning • Gravel Pit Reclamation	• Residue and Tillage Management • Nutrient Management

*(CE) – average cost-effectiveness in US $/mass removed/ year





TARGETED IMPLEMENTATION PROFILE: MANAGEMENT AREA 6

MEASURABLE GOAL

Existing Load at Management Area Outlet:

-Sediment 69 tons/year, TP 3,456 lbs./year

Targeted Load Reduction at Outlet:

-Sediment 7 tons/year, TP 346 lbs./year

Cost: $119,938

TARGETING APPROACH

Structural Practices

- Sediment cost-effectiveness < $8,000/ton/year
- Sediment Reduction > 1 ton/year
- TP cost-effectiveness < $8,500/lbs./year
- TP Reduction > 1 lbs./year

Field Management

- Sediment cost-effectiveness < $600/ton/year
- Sediment Reduction > 1 ton/year
- TP cost-effectiveness < $1,000/lbs./year
- TP Reduction > 1 lbs./year

All Practices

- All values reported for reductions at the outlet of the Roseau Lake

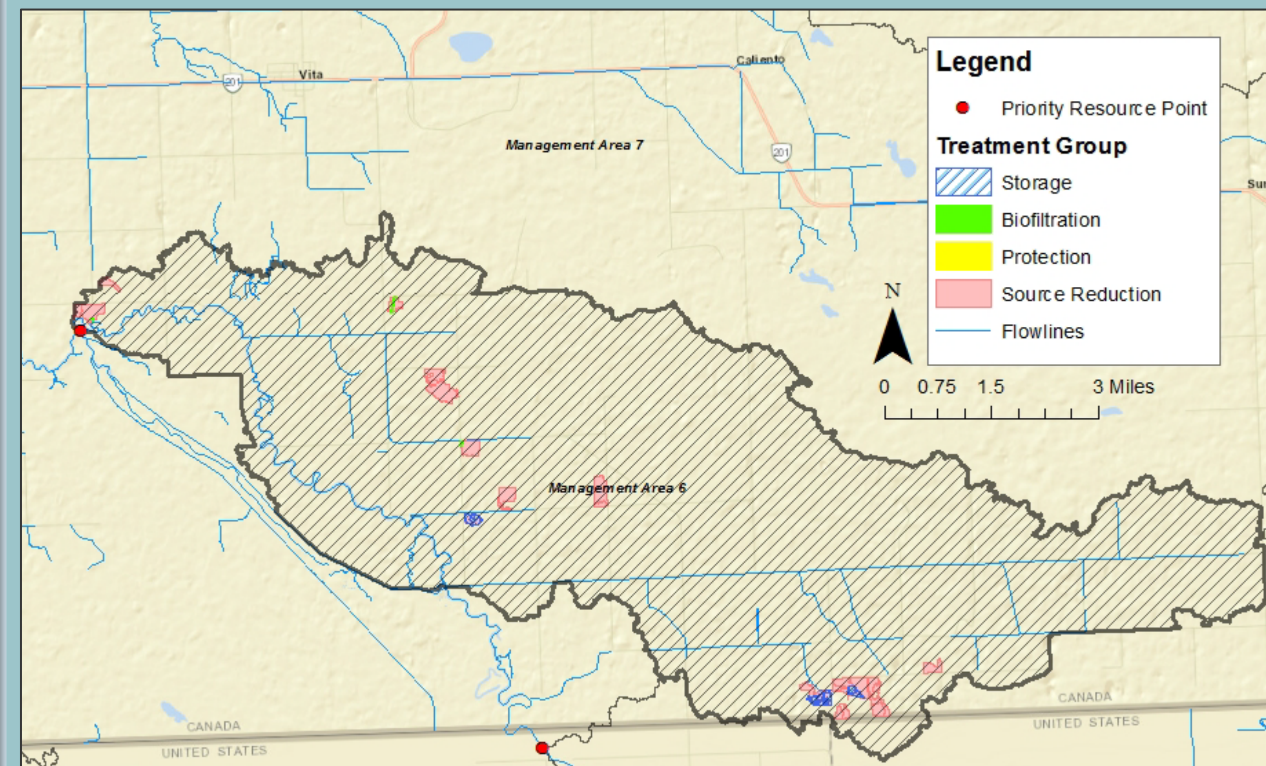
PRACTICE SUMMARY

Below is a summary of targeted conservation practices based on aggregated individual benefits and costs, and the specific types of practices that will be targeted within treatment groups. All values are reported for reductions at the outlet of the area.

	Treatment Group				
	Storage	Biofiltration	Protection	Source Reduction	*Totals*
Count	3	3	-	27	**33**
Sediment Reduction, Tons/year (CE*)	2 ($9,779)	4 ($33,620)	-	16 ($2,700)	***22 ($6,154)***
TP Reduction, lbs./year (CE*)	4 ($5,398)	16 ($6,136)	-	55 ($864)	***74 ($1,741)***
Cost	$15,362	$71,502	-	$33,074	***$119,938***

Treatment Types				
Storage	**Filtration**	**Biofiltration**	**Protection**	**Source Reduction**
• Drainage Water Management • Wetland Restoration • Water Control Structures • Water and Sediment Control Basins • Diversion	• Conservation Cover • Cover Crop • Filter Strips • Grassed Waterway • Riparian Buffers	• Denitrifying Bioreactor • Saturated Buffer	• Critical Area Planting • Grad Stabilization Structure • Tree/Shrub Establishment • Well Sealing • Septic System Upgrades • Upland Wildlife Habitat Management • Restoration and Management of Rare/ Declining Habitat • Prescribed Burning • Gravel Pit Reclamation	• Residue and Tillage Management • Nutrient Management

*(CE) – average cost-effectiveness in US $/mass removed/ year

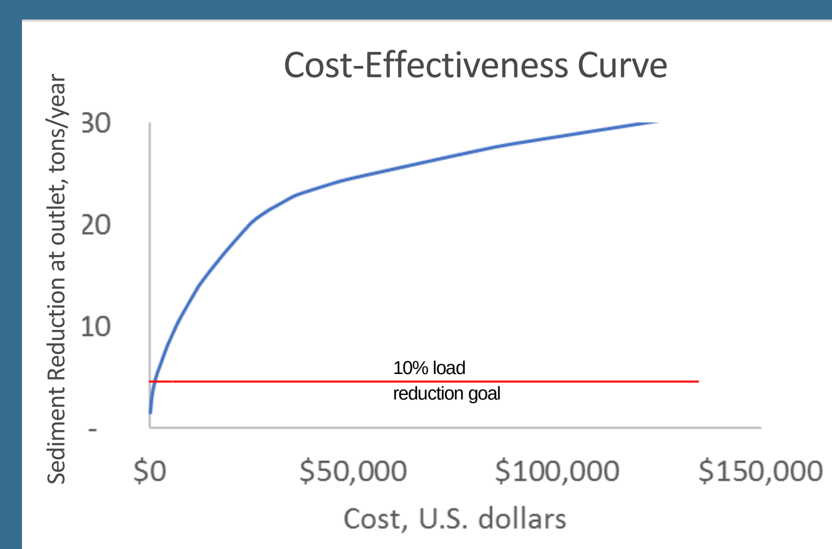


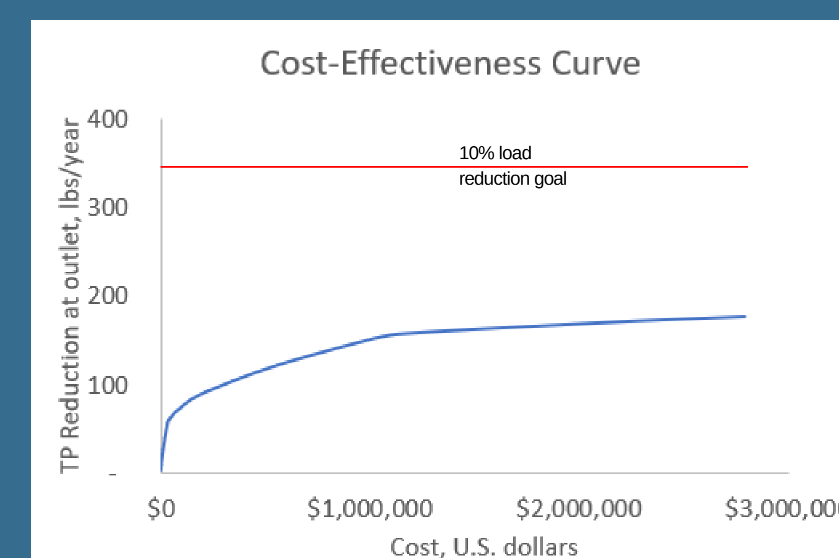
TAILORING IMPLEMENTATION

While the targeted Practices from this assessment should provide sufficient progress for reaching sediment management goals, there is no guarantee that all Practices can be implemented. Moreover, in this watershed overland treatment alone is unlikely to allow practitioners to hit a 10% phosphorus load reduction goal.

These results provide three key findings:

1. Treating overland flow in Management Area 6 has the potential to reach the 10% load reduction goals for sediment in the area
2. Source Reduction (field management) is the most cost-effective treatment option
3. On average, practitioners can expect to invest $6,154/ton of sediment and $1,741/lbs. of TP reduced at the outlet of the management area per year





TARGETED IMPLEMENTATION PROFILE: MANAGEMENT AREA 7

MEASURABLE GOAL

Existing Load at Management Area Outlet:

-Sediment 53,090 tons/year, TP 54,755 lbs./year

Targeted Load Reduction at Outlet:

-Sediment 5,309 tons/year, 5,476 TP lbs./year

Cost: $9,174,206

TARGETING APPROACH

Structural Practices

- Sediment cost-effectiveness < $8,000/ton/year
- Sediment Reduction > 1 ton/year
- TP cost-effectiveness < $10,000/lbs./year
- TP Reduction > 0.5 lbs./year

Field Management

- Sediment cost-effectiveness < $1,500/ton/year
- Sediment Reduction > 1 ton/year
- TP cost-effectiveness < $2,500/lbs./year
- TP Reduction > 1 lbs./year

All Practices

- All values reported for reductions at the outlet of the Roseau Lake

PRACTICE SUMMARY

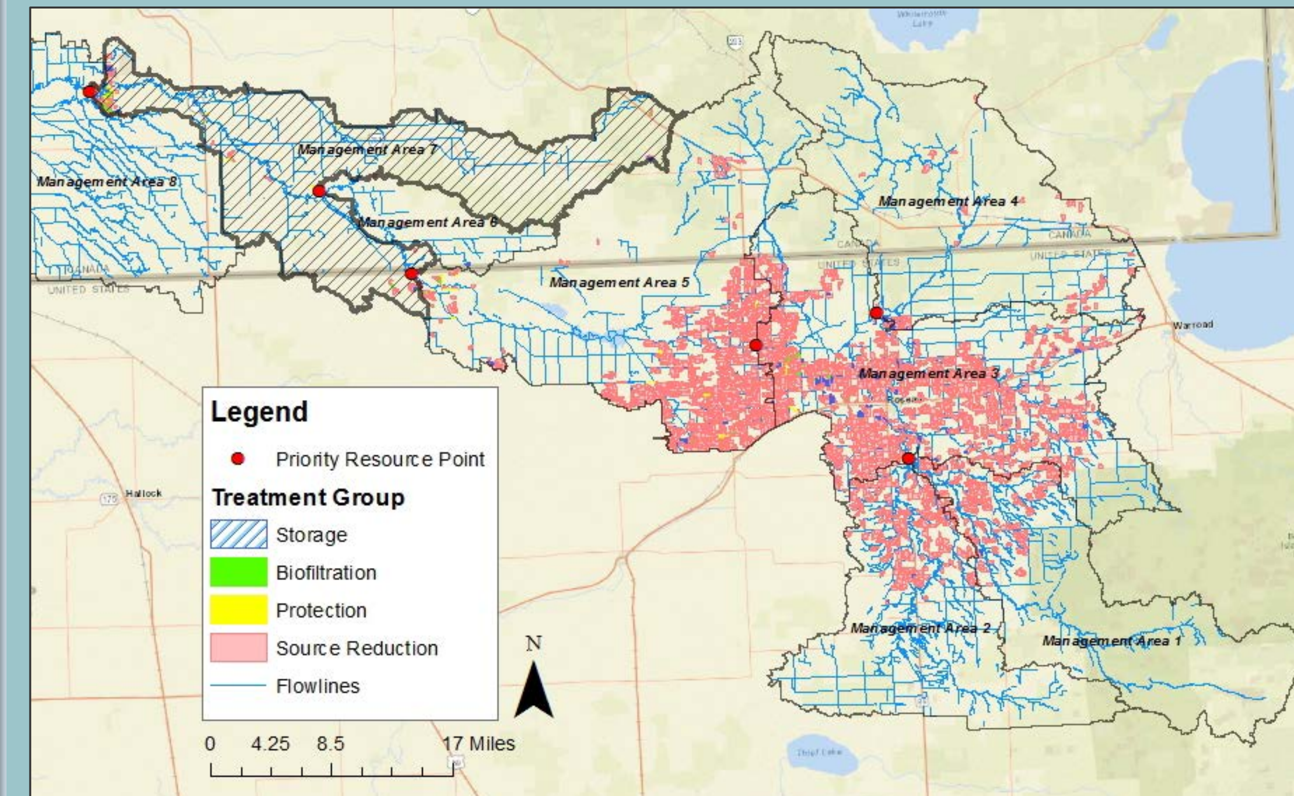
Below is a summary of targeted conservation practices based on aggregated individual benefits and costs and the specific types of Practices that will be targeted within treatment groups. All values are reported for reductions at the outlet of the area.

	Treatment Group				
	Storage	Biofiltration	Protection	Source Reduction	*Totals*
Count	79	55	31	1,937	**2,102**
Sediment Reduction, Tons/year (CE*)	441 ($2,531)	315 ($5,276)	125 ($3,205)	11,458 ($676)	***12,339 ($903)***
TP Reduction, lbs./year (CE*)	157 ($5,993)	256 ($6,687)	37 ($7,232)	4,852 ($1,422)	***5,301 ($1,818)***
Cost	$887,080	$1,476,515	$272,820	$6,546,791	***$9,174,206***

Treatment Types

Storage	Filtration	Biofiltration	Protection	Source Reduction
• Drainage Water Management • Wetland Restoration • Water Control Structures • Water and Sediment Control Basins • Diversion	• Conservation Cover • Cover Crop • Filter Strips • Grassed Waterway • Riparian Buffers	• Denitrifying Bioreactor • Saturated Buffer	• Critical Area Planting • Grad Stabilization Structure • Tree/Shrub Establishment • Well Sealing • Septic System Upgrades • Upland Wildlife Habitat Management • Restoration and Management of Rare/ Declining Habitat • Prescribed Burning • Gravel Pit Reclamation	• Residue and Tillage Management • Nutrient Management

*(CE) – average cost-effectiveness in US $/mass removed/ year

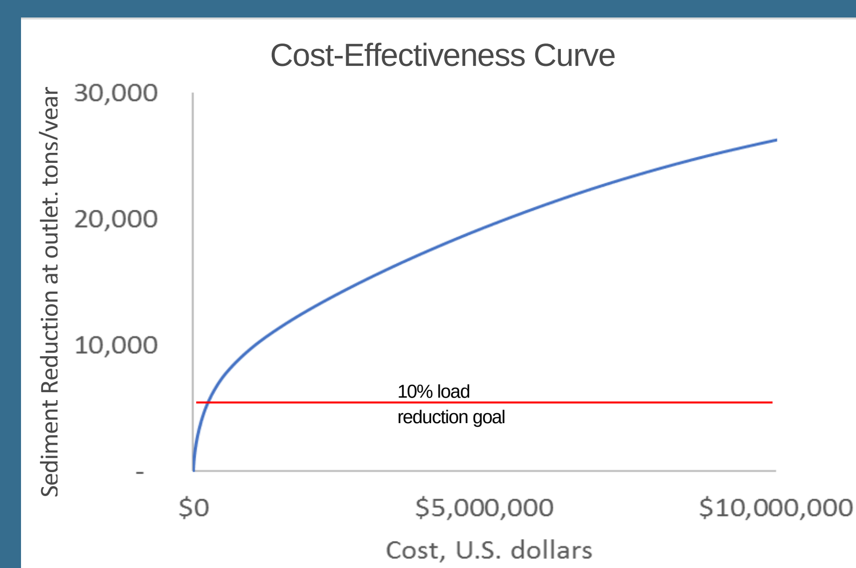


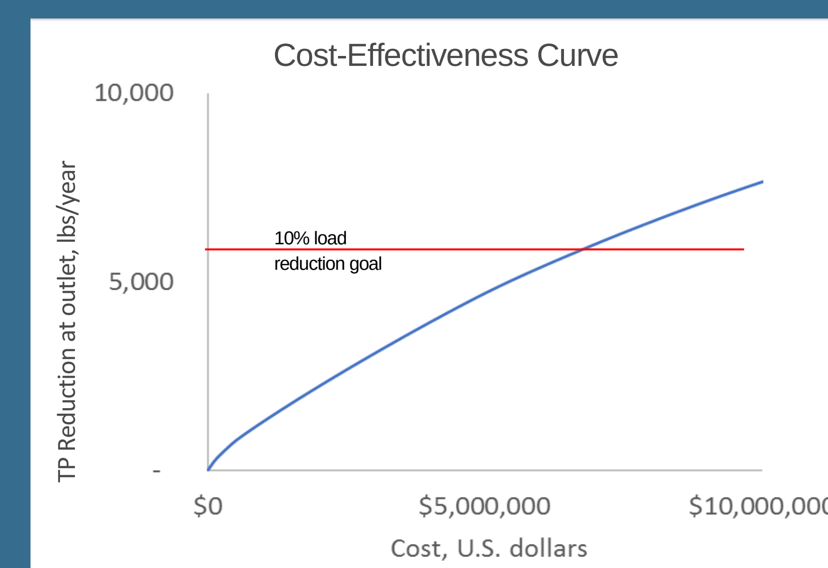
Tailoring Implementation

While the targeted Practices from this assessment should provide sufficient progress for reaching sediment and TP management goals, there is no guarantee that all Practices can be implemented.

These results provide three key findings:

1. Treating overland flow in Management Area 7 has the potential to reach the 10% load reduction goals for the area
2. Source Reduction (Field Management) is the most cost-effective treatment option
3. On average, practitioners can expect to invest $903/ton of sediment and $1,818/lbs. of TP reduced at the outlet of the management area per year





5 REFERENCES

Board of Water and Soil Resources (BWSR). 2016. 2016 Nonpoint Priority Funding Plan.

Minnesota Pollution Control Agency (MPCA). 2014. The Minnesota Nutrient Reduction Strategy. September 2014.

Houston Engineering, Inc. (HEI). 2014a. Categorization of best management practices and conservation practices for estimating pollutant removal effectiveness part 1. Technical memorandum to the Minnesota Board of Water and Soil Resources.

Houston Engineering, Inc. (HEI). 2014b. Categorization of best management practices and conservation practices for estimating pollutant removal effectiveness part 2. Technical memorandum to the Minnesota Board of Water and Soil Resources.

Houston Engineering, Inc. (HEI). 2014c. Water quality decision support application enhance geographic information system water quality data products. Technical memorandum to the Minnesota Board of Water and Soil Resources.

Houston Engineering, Inc. (HEI). 2015. Methods for estimating the benefits of multiple best management and conservation practices. Technical memorandum to the Minnesota Board of Water and Soil Resources.

APPENDIX A. Data Requirements Technical Memorandum

Technical Memorandum

To: Tracy Halstensgard
Roseau River Watershed District

Jason Vanrobaeys
Agriculture and Agri-Food Canada

From: Kris Guentzel; Drew Kessler, PhD
Houston Engineering, Inc.

Through: Chuck Fritz
The International Water Institute

Subject: PTMApp-Desktop Data Requirements

Date: February 23, 2017

Project: Roseau Lake PTMApp (HEI ID 5489-006)

BACKGROUND AND PURPOSE

A multi-national, public-private stakeholder group including The Roseau River Watershed District (RRWD), Agriculture and Agri-Food Canada (AAFC), the Province of Manitoba, the Seine Rat River Conservation District, the International Water Institute (IWI), and Houston Engineering, Inc. (HEI), have agreed to work together to develop a targeted implementation plan that identifies best management and conservation practices for improving water quality in the Roseau River Watershed (RRW) by utilizing the Prioritize, Target, and Measure Application for desktop (PTMApp-Desktop). PTMApp-Desktop was developed with a State of Minnesota Board of Water and Soil Resources (BWSR) grant by partners including the Red River Watershed Management Board, IWI and HEI. Through its development and implementation, PTMApp-Desktop has utilized geospatial inputs developed in the United States. The purpose of this technical memorandum is to communicate the input data requirements needed to run PTMApp-Desktop, so that Canadian collaborators can adjust Canadian geospatial data to work in PTMApp-Desktop.

There are two key datasets needed to run PTMApp-Desktop, a processing input dataset and a base data catalog. The processing inputs include hydro-conditioned digital elevation model (DEM) products, travel time rasters, a curve number raster, soils data, Revised Universal Soil Loss Equation (RUSLE) inputs, and points where data will be extracted from PTMApp-Desktop, called a priority resource point feature class (**Table 1**). These inputs will later be used in PTMApp-Desktop to estimate sediment, total phosphorus (TP), and total nitrogen (TN) loads generated in areas draining to the outlet of the RRW; determine the locations of feasible agricultural best management practices (BMPs) in the watershed; and estimate the water quality benefit of these BMPs in reducing sediment, TP, and TN loading to priority resource locations in the RRW.

To apply PTMApp–Desktop outside the United States, geospatial inputs must be created which sufficiently match the data type, accuracy, and resolution of data generated in the United States. The RRW includes areas in both Minnesota and Manitoba and will require data inputs from both the United States and Canada that must be mosaicked within geographic information systems (GIS) software. The US and Canadian datasets must be of a similar type, use the same units, and have the same geospatial resolution. This technical memorandum seeks to establish a common understanding of the input data requirements for PTMApp-Desktop, and document how Canadian inputs will be generated to match the data requirements of PTMApp-Desktop.

Table 4: Prioritize, Target, and Measure Application for Desktop (PTMApp-Desktop) typical data inputs.

Input Data	PTMApp-Desktop Products and Description
Hydrologically-Conditioned DEM Products	Raw DEM, Hydro-DEM, Flow Direction (FDR) raster, flow accumulation (FAC) raster
Travel Time Raster	Travel time from cell to cell for surface hydrology
Curve Number Raster	Soils and land use data used to compute a curve number, which represents abstractions from precipitation
Soils (SSURGO) polygon merged with attributes from the database	Soils information used in evaluating conservation practice feasibility, the RUSLE equation, and other uses
Revised Universal Soil Loss Equation (RUSLE) Inputs	Parameters for RUSLE
Priority Resource Point Feature Class	Locations within the watershed where information is required.

PTMAPP-DESKTOP DATA REQUIREMENTS AND PROCESSING DECISIONS

This section defines the geospatial environment settings for processing, the data processing options, and the base data and processing data requirements for PTMApp-Desktop.

GEOSPATIAL ENVIRONMENTS FOR ROSEAU RIVER WATERSHED

Table 2 shows the global geospatial environment settings that will be enforced for running PTMApp-Desktop for the RRW. Project partners are required to adhere to these settings when developing and delivering input data for use in PTMApp-Desktop. Changes or nonadherence to these geospatial environments will result in additional effort that may require a change in the scope of services for this project.

Table 5: Global geospatial environment settings recommended for the Roseau River Watershed.

Roseau River Watershed Geospatial Environment Settings	
Coordinate System	NAD 83, UTM Zone 15N
Snap Raster	Flow Accumulation Grid ['fac_total']
Cell Size	5 meter x 5 meter

DATA PROCESSING OPTIONS FOR PTMAPP-DESKTOP

Table 3 shows HEI's and the IWI's recommendation for PTMApp-Desktop data processing options for the RRW. Changes to these options later in the project will result in additional effort that may require a change in the Scope of Services for this project. HEI and the IWI expect that the project partners will provide alternative suggestions, if any, to the recommendations in **Table 3** before this technical memorandum is finalized.

Table 6: Data processing options for Prioritize, Target, and Measure Application for Desktop (PTMApp-Desktop) in the Roseau River Watershed.

Data Processing Options for PTMApp-Desktop	Recommended Action
Perform Lake Routing	Yes
Scale PTMApp-Desktop Data to Monitoring or Modeled Data	No
Adjust Data Ranks Based Upon Local Information	No
Exclude Areas for Best Management Practice Targeting	No

PTMAPP-DESKTOP BASE DATA REQUIREMENTS

PTMApp-Desktop base data inputs should be summarized in a single geodatabase. PTMApp-Desktop currently requires these inputs to be included in a geodatabase titled 'base' and saved in a folder titled 'Input'. **Table 4** lists the base dataset typically provided for PTMApp-Desktop projects. Only the feature classes with a 'Yes' in the column titled 'Used in PTMApp Desktop Processing' will need to be created for areas in Canada. These feature classes must fit the data type, description, and requirements shown in **Table 4**. While the other base data inputs produce useful information for watershed planning, they are not required for processing data in PTMApp-Desktop. Upon request, a base geodatabase for Minnesota can be provided for reference.

Table 7: Specific Prioritize, Target, and Measure Application for Desktop (PTMApp-Desktop) base data inputs.

Data Name	Geospatial Data Type*	Raster Requirements (Pixel Type, Depth)	Data Source**	Description and Units (if applicable)	Used In PTMApp-Desktop Processing
asslake	Shapefile - Polygon		MPCA	MPCA Assessed Lakes	
assstrm	Shapefile - Line		MPCA	MPCA Assessed Streams	
asswet	Shapefile - Polygon		MPCA	MPCA Assessed Wetlands	
bdrkgeo	Shapefile - Polygon		MGC	Bedrock Geology	
bound_cnty	Shapefile - Polygon		MGC	County Boundaries	
bound_huc10	Shapefile - Polygon		USDA	HUC10 Watershed Boundary	
bound_huc12	Shapefile - Polygon		USDA	HUC12 Watershed Boundary	
bound_ms4	Shapefile - Polygon		MPCA	MS4 boundaries	
bound_muni	Shapefile - Polygon		MGC	Municipality Boundaries	
bound_state	Shapefile - Polygon		MGC	Minnesota State Boundary	
bound_tnshp	Shapefile - Polygon		MGC	Township Boundaries	
bound_wtrdist	Shapefile - Polygon		MGC	Watershed District Boundaries	
ecoldtyp	Shapefile - Polygon		MGC	Ecological Land Types	
ecoreg	Shapefile - Polygon		MGC	Ecoregions	
feedlots	Shapefile - Point		MPCA	Feedlots in Minnesota	
flow_dnr	Shapefile - Point		MGC	Flow monitoring gages (MnDNR)	
flow_mpca	Shapefile - Point		MPCA	Flow monitoring gages (MPCA)	
flow_usgs	Shapefile - Point		USGS	Flow monitoring gages within HUC10 (USGS)	
gwsus	Shapefile - Polygon		MGC	Groundwater Susceptibility	
implake	Shapefile - Polygon		MPCA	MPCA Impaired lakes	

Data Name	Geospatial Data Type*	Raster Requirements (Pixel Type, Depth)	Data Source**	Description and Units (if applicable)	Used In PTMApp-Desktop Processing
impstrm	Shapefile - Line		MPCA	MPCA Impaired streams	
impwet	Shapefile - Polygon		MPCA	MPCA Impaired wetlands	
Lakes_route	Shapefile - Polygon		User-Created	Lake polygons to be included in lakes routing	Yes
landuse	Raster	8 Bit Signed Integer	MRLC	2011 National Land Cover Database	Yes
mn_rainfall_10	Raster	32 Bit Floating Point;	NOAA	Minnesota Statewide Rainfall – 10-year 24-hour Atlas 14 (inches x 1000)	Yes
mn_rainfall_2	Raster	32 Bit Floating Point;	NOAA	Minnesota Statewide Rainfall – 2-year 24-hr Atlas 14 (inches x 1000)	Yes
nhd_flow	Shapefile - Line		USGS	NHD Flowline Data	Yes
nhd_wtrbd	Shapefile - Polygon		USGS	NHD Waterbodies Data	
nwi	Shapefile - Polygon		USFWS	National Wetland Inventory	Yes
roads	Shapefile - Line		MnDOT	Minnesota Trunk Highway system	
rroads	Shapefile - Line		MnDOT	Railroads	
samp_bio	Shapefile - Point		MPCA	MPCA Biological Assessment Sites	
samp_wq	Shapefile - Point		MPCA	MPCA Water Quality Sampling Locations (Rivers, Streams, and Lakes)	
soils	Shapefile - Polygon		MGC	US General Soil Map (STATSGO2)	
surfgeo	Shapefile - Polygon		MGC	Surficial Geology	
table_treat†	Table		PTMApp	Lookup table to match BMP groups and efficiencies	Yes
topo	Raster	8 Bit Unsigned Integer	MGC	Topography (Units: meters)	

Data Name	Geospatial Data Type*	Raster Requirements (Pixel Type, Depth)	Data Source**	Description and Units (if applicable)	Used In PTMApp-Desktop Processing
wellprtct	Shapefile - Polygon		MGC	Wellhead Protection Areas	
wldrfg	Shapefile - Polygon		MGC	Wildlife Refuge Inventory	
wma	Shapefile - Polygon		MGC	Wildlife Management Areas	
wpa	Shapefile - Polygon		MGC	Waterfowl Production Areas	

* For shapefiles, this column also describes the geometry

** Abbreviations: HUC - Hydrologic Unit Code; MGC - Minnesota Geospatial Commons; MnDNR - Minnesota Department of Natural Resources; MnDOT - Minnesota Department of Transportation; MPCA - Minnesota Pollution Control Agency; MRLC - Multi-Resolution Land Characteristics Consortium; NOAA - National Oceanic and Atmospheric Administration; USDA - United States Department of Agriculture; USFWS - United States Fish and Wildlife Service; USGS - United States Geological Survey

†table_treat does not need to be generated for the Canadian side of the project area. The table currently available on the United States side of the project area will work for the entire project area.

PTMAPP-DESKTOP PROCESSING DATA REQUIREMENTS

PTMApp-Desktop processing data inputs should be summarized in a single geodatabase. PTMApp-Desktop currently requires these inputs be summarized in a geodatabase and saved in a folder titled 'Input'. **Appendix A** lists the processing dataset necessary to run PTMApp-Desktop. Each of these feature classes and rasters will need to be created fitting the data type, description, and requirements shown in **Appendix A**. Upon request, a processing geodatabase for the Minnesota portion of the RRW can be provided for reference. Note, **Appendix A** is a more detailed description of the data highlighted in **Table 1**.

DEFINITION OF DATA INPUTS FROM CANADA

This section is being used to provide Canadian project collaborators an opportunity to define the Canadian geospatial datasets that will be used to meet the PTMApp-Desktop base and processing input data requirements. HEI and the IWI expect that the Canadian collaborators will finish drafting the tables in this section during their review of the draft version of this technical memorandum. Once completed, these tables will define the Canadian geospatial datasets that can be adapted for use in PTMApp-Desktop.

PTMAPP-DESKTOP BASE AND PROCESSING DATA CONVERSIONS FROM CANADIAN GEOSPATIAL DATA

Appendix B and Appendix C outline the PTMApp-Desktop base and processing geospatial data requirements, respectively, and identify and describe the source and format of data from Canada that will be used to satisfy these requirements for utilizing PTMApp-Desktop within the RRW. For quality assurance / quality control (QA/QC) purposes, and to reasonably assure that Canadian data can be applied alongside its United States counterpart data, **Appendix B and Appendix C** should be used to document the source and name of the Canadian data to be used, as well as a description of the data and the conversion process used to match the data with those outlined in **Table 4** (i.e. the United States PTMApp-Desktop base data) and **Appendix A** (i.e. the United States PTMApp-Desktop processing data). For **Appendix B**, Canadian data only needs to meet PTMApp-Desktop base requirements (as listed in **Table 4**) if the feature class or raster is used by PTMApp-Desktop to create PTMApp products. Only the feature classes and rasters listed in **Table 4** with a 'Yes' in the column titled 'Used in PTMApp Desktop Processing' fit this description.

Appendix A: **User-provided Prioritize, Target, and Measure Application for Desktop (PTMApp-Desktop) processing data feature classes and rasters.**

Data Name	Geospatial Data Type	Raster Requirements (Pixel Type, Depth, Resolution)	Units (if applicable)	Typical Value Range (if applicable)*	Description
bound_1w1p	Shapefile - Polygon				Project area (e.g. boundary for One Watershed One Plan (1W1P) planning area).
curve_num	Raster	8 Bit Signed Integer		0-100	Curve number raster.
ds_tt	Raster	32 Bit Floating Point	hours	0-300	Accumulated downstream travel time.
fac_total	Raster	32 Bit Floating Point		$0\text{-}10^{10}$	Flow accumulation from hyd_dem.
fdr_total	Raster	8 Bit Unsigned Integer		1-128	Flow direction raster from hyd_dem. Values are in the eight-direction (D8) flow model format.
hyd_dem	Raster	32 Bit Floating Point	meters	comparable to raw_dem values	Hydrologically conditioned digital elevation model. Values should be comparable to (but probably not exactly equal to) raw_dem elevation value range.
p_res_pts	Shapefile - Point				Point locations of priority resources and/or plan regions.
raw_dem	Raster	32 Bit Floating Point	meters	based off reference value (e.g. meters above sea level)	Non-conditioned digital elevation model.
rusle_c	Raster	32 Bit Floating Point		0.001-0.2	Revised Universal Soil Loss Equation (RUSLE) - Cover management factor.
rusle_kw	Raster	32 Bit Floating Point	Ton-acre-hours per hundred foot-tons per inch	0.05-0.43	RUSLE - Soil erodibility factor.

Data Name	Geospatial Data Type	Raster Requirements (Pixel Type, Depth, Resolution)	Units (if applicable)	Typical Value Range (if applicable)*	Description
rusle_m	Raster	8 Bit Signed Integer		0.00001-1	RUSLE - m-weight factor. Typically assigned to a value of 1 unless local knowledge available, if using values other than 1 raster must be 32 bit floating point.
rusle_p	Raster	8 Bit Signed Integer		1	RUSLE - Support practice factor. Typically assigned to a value of 1 unless local knowledge available, if using values other than 1 raster must be 32 bit floating point.
rusle_r	Raster	32 Bit Floating Point	Hundreds of foot-ton-inches per acre per hour	50-150	RUSLE - rainfall-runoff erosivity factor.
sssurgo_cpi	Raster	8 Bit Signed Integer		0-100	Soil Survey Geographic Database (SSURGO) - Crop Productivity Index.
ssurgo_dtgw	Raster	8 Bit Signed Integer		0-201	SSURGO - Depth to groundwater.
ssurgo_hs	Raster	8 Bit Signed Integer		Yes or No	SSURGO - Hydric Soils (binary).
tt_grid	Raster	32 Bit Floating Point	seconds	0-200	Cell to cell travel time.
us_tt	Raster	32 Bit Floating Point	hours	0-300	Accumulated upstream travel time.

* Typical values include the range of values seen in previous PTMApp projects in the Upper Midwest. Actual values may be outside this range for other areas.

Appendix B: **Outline of data provenance and process for converting Canadian geospatial datasets to match inputs from Minnesota geospatial datasets for use in the Roseau River Watershed Prioritize, Target, and Measure for Desktop (PTMApp-Desktop) project. For each row, please list the Canadian data name, its source, and a brief description of the dataset and how it was converted to match the corresponding United States dataset.**

PTMApp-Desktop Geospatial Data		Canadian Geospatial Data			
Data Name	**Geospatial Type**	**Data Origin Name**	**Geospatial Type**	**Source**	**Description (and Method for Conversion)**
asslake	Shapefile - Polygon	NA	Shapefile - Polygon		No assessed water bodies in Manitoba
assstrm	Shapefile - Line	NA	Shapefile - Line		No assessed water bodies in Manitoba
asswet	Shapefile - Polygon	NA	Shapefile - Polygon		No assessed water bodies in Manitoba
bdrkgeo	Shapefile - Polygon	Bedrock Geology 1:1000000	Shapefile - Polygon	Manitoba GIS Library	
bound_cnty	Shapefile - Polygon	R.M. Boundaries	Shapefile - Polygon	Manitoba GIS Library	
bound_huc10	Shapefile - Polygon	Manitoba Gross and Effective Watersheds	Shapefile - Polygon	Manitoba GIS Library	
bound_huc12	Shapefile - Polygon	Manitoba Gross and Effective Watersheds	Shapefile - Polygon	Manitoba GIS Library	
bound_ms4	Shapefile - Polygon	Drainage Basins	Shapefile - Polygon	National Atlas of Canada	
bound_muni	Shapefile - Polygon	R.M. Boundaries	Shapefile - Polygon	Manitoba GIS Library	
bound_state	Shapefile - Polygon	Manitoba Provincial Boundary	Shapefile - Polygon	Manitoba GIS Library	

PTMApp-Desktop Geospatial Data		Canadian Geospatial Data			
Data Name	**Geospatial Type**	**Data Origin Name**	**Geospatial Type**	**Source**	**Description (and Method for Conversion)**
bound_tnshp	Shapefile - Polygon	Continuous Township Fabric	Shapefile - Polygon	Manitoba GIS Library	
bound_wtrdist	Shapefile - Polygon	Manitoba Conservation Districts	Shapefile - Polygon	Manitoba GIS Library	
ecoldtyp	Shapefile - Polygon	Terrestrial Ecozones (Regions and Districts)	Shapefile - Polygon	Manitoba GIS Library	
ecoreg	Shapefile - Polygon	Terrestrial Ecozones (Regions and Districts)	Shapefile - Polygon	Manitoba GIS Library	
feedlots	Shapefile - Point	NA	Shapefile - Point		No feedlots dataset in Manitoba
flow_dnr	Shapefile - Point	Manitoba Hydrometric Stations	Shapefile - Point	Environment and Climate Change Canada (Water Survey of Canada Hydrometric Stations)	
flow_mpca	Shapefile - Point	Manitoba Hydrometric Stations	Shapefile - Point	Environment and Climate Change Canada (Water Survey of Canada Hydrometric Stations)	
flow_usgs	Shapefile - Point	Manitoba Hydrometric Stations	Shapefile - Point	Environment and Climate Change Canada (Water Survey of Canada Hydrometric Stations)	

PTMApp-Desktop Geospatial Data		Canadian Geospatial Data			
Data Name	**Geospatial Type**	**Data Origin Name**	**Geospatial Type**	**Source**	**Description (and Method for Conversion)**
gwsus	Shapefile - Polygon	Groundwater vulnerability data based on soil properties (texture/permeability/drainage) is available by soil polygon	Shapefile - Polygon	AAFC	
implake	Shapefile - Polygon	NA	Shapefile - Polygon		Lake polygons will be derived from MB waterbodies, shape modification needed to account for highest FAC value
impstrm	Shapefile - Line	NA	Shapefile - Line		No impaired water body assessments in Manitoba
impwet	Shapefile - Polygon	NA	Shapefile - Polygon		No impaired water body assessments in Manitoba
landuse	Raster	2011 Canadian Crop Inventory	Raster	AAFC	Need to fill border gap. Assign based on adjacent land use and aerial photography in collaboration with US.
mn_rainfall_10	Raster	IDF curves for Glenlea and Indian Bay weather stations	Raster	Environment and Climate Change Canada	2 nearby (within about 50km) weather stations (Glenlea and Indian Bay) have intensity-duration-frequency curves that could be used to assign/interpolate rainfall values (mm/hr) along with US data

PTMApp-Desktop Geospatial Data		Canadian Geospatial Data			
Data Name	**Geospatial Type**	**Data Origin Name**	**Geospatial Type**	**Source**	**Description (and Method for Conversion)**
mn_rainfall_2	Raster	IDF curves for Glenlea and Indian Bay weather stations	Raster	Environment and Climate Change Canada	2 nearby (within about 50km) weather stations (Glenlea and Indian Bay) have intensity-duration-frequency curves that could be used to assign/interpolate rainfall values (mm/hr) along with US data
nhd_flow	Shapefile - Line	MB 1:20000 Water Line Features (Seamless)	Shapefile - Line	Manitoba GIS Library	Needed for identifying certain BMPs like riparian buffers
nhd_wtrbd	Shapefile - Polygon	MB 1:20000 Water Area Features (Seamless)	Shapefile - Polygon	Manitoba GIS Library	
nwi	Shapefile - Polygon	Southern Peatland Wetland Inventory (2013)	Shapefile - Polygon	Manitoba Habitat Heritage Corporation	Covers about 85% of the Canadian portion of the watershed (Western portion not included). Need to compare attributes with US data.
roads	Shapefile - Line	MB 1:20000 Transportation Line Features (Seamless)	Shapefile - Line	Manitoba GIS Library	
rroads	Shapefile - Line	MB 1:20000 Transportation Line Features (Seamless)	Shapefile - Line	Manitoba GIS Library	
samp_bio	Shapefile - Point	NA	Shapefile - Point		

PTMApp-Desktop Geospatial Data		Canadian Geospatial Data			
Data Name	**Geospatial Type**	**Data Origin Name**	**Geospatial Type**	**Source**	**Description (and Method for Conversion)**
samp_wq	Shapefile - Point	Water quality sampling locations (long term 05OD001, and new locations)	Shapefile - Point	Province of Manitoba and Seine Rat River Conservation District	
soils	Shapefile - Polygon	MB Seamless Soils	Shapefile - Polygon	AAFC	Need to compare attributes for display with US.
surfgeo	Shapefile - Polygon	Surficial Geology 1:250000	Shapefile - Polygon	Manitoba GIS Library	
table_treat	Table	NA	Table		BMP treatment efficacy. Evaluate US table, compare to local research results where applicable. Reach consensus with US and Canadian collaborators. Updated version of April 2017 available at HEI
topo	Raster	LiDAR	Raster		Convert 1m to 5m grid
wellprtct	Shapefile - Polygon	NA	Shapefile - Polygon		
wldrfg	Shapefile - Polygon	NA	Shapefile - Polygon		federal
wma	Shapefile - Polygon	NA	Shapefile - Polygon		state
wpa	Shapefile - Polygon	NA	Shapefile - Polygon		federal

Appendix C: **Outline of data provenance and process for converting Canadian geospatial datasets to match processing data from Minnesota geospatial datasets for use in the Roseau River Watershed Prioritize, Target, and Measure for Desktop (PTMApp-Desktop) project. For each row, please list the Canadian data name, its source, and a brief description of the dataset and how it was converted to match the corresponding United States dataset**

United States Geospatial Data		Canadian Geospatial Data			
Data Name	**Geospatial Type**	**Data Name**	**Geospatial Type**	**Source**	**Description (and Method for Conversion)**
bound_1w1p	Shapefile - Polygon		Shapefile - Polygon		Merge Canadian watershed boundary with US after merger of conditioned DEM. Assess current boundary based on conditioned Lidar DEM.
curve_num	Raster		Raster		Use lookup table for land use and hydrological soil group provided by IWI
ds_tt	Raster		Raster		After merged conditioned DEM
fac_total	Raster		Raster		After merged conditioned DEM
fdr_total	Raster		Raster		After merged conditioned DEM
hyd_dem	Raster		Raster		Merge conditioning inputs and LiDAR DEM with US, then condition the seamless international DEM

United States Geospatial Data		Canadian Geospatial Data			
Data Name	**Geospatial Type**	**Data Name**	**Geospatial Type**	**Source**	**Description (and Method for Conversion)**
p_res_pts	Shapefile - Point		Shapefile - Point	Province and SRRCD	Stream confluences, potential project locations, water quality and hydrometric stations, and mouth of Roseau, better include more than less points to start with, snap points to FAC
raw_dem	Raster	LiDAR 1m	Raster	Province	Convert to 5m
rusle_c	Raster	2011 Canadian Crop Inventory	Raster	AAFC	Use Canadian land cover data and look up table used in US provided by IWI
rusle_kw	Raster	MB Soils	Raster	AAFC	Need to convert to matching units. Canadian range 0 - 0.05, US range 0 – 0.43.
rusle_m	Raster	2011 Canadian Crop Inventory	Raster	AAFC	Use Canadian land cover data and look up table used in US provided by IWI
rusle_p	Raster	NA	Raster		Use default of "1" as per US
rusle_r	Raster		Raster		Extend US method or data to include Canadian portion (Grit)

United States Geospatial Data		Canadian Geospatial Data			
Data Name	**Geospatial Type**	**Data Name**	**Geospatial Type**	**Source**	**Description (and Method for Conversion)**
sssurgo_cpi	Raster	Land Suitability Rating System from MB Soils	Raster	AAFC	
ssurgo_dtgw	Raster	MB soils drainage classes	Raster	AAFC	Depth in cm
ssurgo_hs	Raster	MB soils drainage classes	Raster	AAFC	Very poor and possibly poor drainage class
tt_grid	Raster		Raster		After merged conditioned DEM. Use n value adjustments for lakes and wetlands provided by IWI.
us_tt	Raster		Raster		After merged conditioned DEM. As above.

APPENDIX B. Progress Towards Goal Table

This table provides an estimate of the total load reduction at the outlet of the Management Area if all the targeted Practices upstream of the Management Area were implemented. These load reductions will differ from the sum of the load reductions in the Practice Summary (in the Targeted Implementation Profiles) as these estimates include upstream and downstream treatment by other conservation practices (i.e. treatment trains).

Management Area	Sediment Reduced (tons/yr)	Total Phosphorus Reduced (lbs./yr)
Roseau River Outlet (8)	Forthcoming	Forthcoming
Roseau Lake	Forthcoming	Forthcoming
1	Forthcoming	Forthcoming
2	Forthcoming	Forthcoming
3	Forthcoming	Forthcoming
4	Forthcoming	Forthcoming
5	Forthcoming	Forthcoming
6	Forthcoming	Forthcoming
7	Forthcoming	Forthcoming

Reviewer Comments

Comment #	Reviewer	Entity	Comment	Change Made (Y/N)	Revision
1	Jason V	0.2	Executive Summary - Page 1 – include additional Canadian partners as per the comment in the document	Y	Text has been added to the document to include "additional Canadian partners"
2	Jason V	3.31	Table 1 - Page 7 – 0.25 tons of P/year may be too restrictive. Investigate a lower rate in future versions, to include more project, especially storage projects – next phase?	Y	Agreed. These values can be tailored based on local knowledge of the watershed and desired outcomes of the PTMApp application.
3	Jason V	3.4	Page 9 – typo change to "at"	Y	Changed in text.
4	Jason V	3.42	Table 2 - Page 10 – refine with local cost data in next phase?	Y	Agreed. These values can be tailored based on local knowledge of costs within the watershed.
5	Jason V	3.43	Table 3 - Page 11 - typo change to "ton"	Y	Changed in text.
6	Jason V	4.1	Page 14 - Targeted implementation plan - No filtration practices included – explain why – uncertain efficacy for nutrients?	Y	the filtration practices column was removed from the targeted implmentation tables.
7	Jason V	4.1	Page 14 - Targeted implementation plan - Cost for this goal is likely accurate but it seems insurmountable, detailed plan at a smaller watershed with realistic and achievable targets in next phase?	Y	Agree completely. Hope that this is just the start of the use of this data.
8	Jason V	4.1	Page 14 - Targeted implementation plan - Practice efficacy needs to be investigated further, especially related to sediment and particulate / dissolved nutrients – next phase?	Y	Practice efficacy is based on empirical observations. These values could be refined based on local knowledge of existing conditions within the atershed.
9	Jason V	4.1	Page 14 - Targeted implementation plan - typo change to "were"	Y	Changed in text.
10	Matthew Fischer	3.4	Table 3 - In the Targeting Criteria column, it says "Structural Practices (Source Reduction)" in each row. I believe the "(Source Reduction)" should be removed or replaced.	Y	Since all rows within the table included "Source Reduction", all occurrences were removed from the table and the text in the table description was modified.
11	Matthew Fischer	3.6	Section 3.6 - Management Area Map - It says that the Management Area Maps contain the critical sediment loss areas and upstream drainage area, but those don't appear to actually be on the maps.	Y	This text has been removed. Those layers had not been generated as part of this assessment.
12	Matthew Fischer	4	Section 4 - Under the Roseau Lake bullet it says, "However, farming within the Roseau Lake bottom has been abandoned due to frequent flooding." This is not completely true as some areas of the lake bottom continue to be farmed. Could say "mostly abandoned" or ask the WD staff for input. (The statement quoted above is also included in the Tailoring Implementation box in the Targeted Implementation Profile for Roseau Lake and should also be changed there.)	Y	The text has been modified to incorporate local knowledge of management in the area.
13	Matthew Fischer	4	Section 4 - The next sentence goes on to say that "partners are actively pursuing a project to restore Roseau Lake". Recommend replacing the word "restore" with "rehabilitate" as that is more accurate.	Y	Agreed. Restoration implies a complete return to historic conditions wheras rehabilitation is the repair and replacement of essential ecosystem structures and functions in the context of ecoregional attainability in order to achieve specified objectives. The text has been changed.
14	Matthew Fischer	4	Targeted implementation profiles - Question: Is the Cost shown in the Measurable Goal box an annual cost or total cost? In section 3.6 it says the cost is based on annual life cycle cost, but in section 3.4 it says, "For practices where costs where estimated using life cycle estimates, the annual cost was multiplied by 20 years to estimate the total cost of implementation of the targeted practices." Please clarify.	Y	The multiplication was not done. This text has been removed and clarification added.
15	Matthew Fischer	4.1	Targeted implementation profiles - Filtration Practices: I expressed my concern about this at the meeting. Please include an explanation in the report as to why these are not showing up, and how if you were looking at sediment alone they would likely be some of the most cost effective practices in the watershed after source reduction. That appears to be the case from what I was seeing in PTMApp web.	Y	The filtration column was removed and an explanation provided that reads… "Available monitoring data suggests that filtration practices may service as a source of Total Phosphorus. However, monitoring data also suggests that filtration practices can be an effective method for trapping sediment. Had this study focused solely on sediment, filtration practices would've likely been part of the targeted practices."
16	PN	3.31	Can the parameters for the treatment types be changed so that more priority locations show up on the maps? Current maps could be primary locations and if more locations were identified, these could be secondary locations to target. For example, if one storage BMP is proposed and we have an unwilling landowner, it would be helpful to have other priority locations on the map.	Y	Using storage BMPs as the example, there were 8,862 originally selected, but after the less efficient areas were removed there were only 1,854 remaining. Any of the removed BMP's could be mapped and implemented, however they will likely be less cost-effective than the remaininig 1,854.