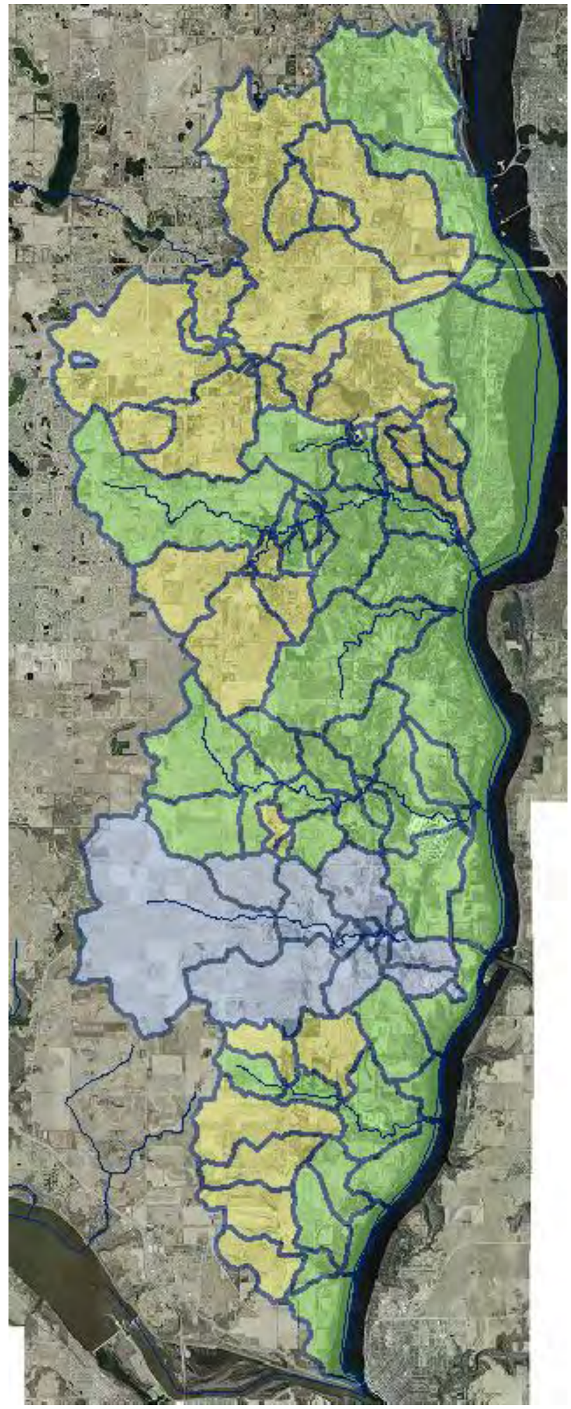
TOP50P! FINAL REPORT & RURAL SUBWATERSHED ANALYSIS PROTOCOL

June 30, 2013



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Top50P! Final Report & Rural Subwatershed Analysis Protocol

Washington Conservation District's Top50P Project

The **Fixing the Top 50 Rural Nonpoint Phosphorus Sources (Top50P)** project is a focused effort to identify, implement, and assess prioritized phosphorus reduction practices in rural areas directly tributary to Lake St. Croix. Priority areas include rural portions of Baytown Township, West Lakeland Township, Lakeland, Lake St. Croix Beach, Afton, and Denmark Township. Water resources in the project area include Kelle's Coulee, Trout Brook, and intermitted drainageways that discharge directly to Lake St. Croix. The program will work toward achieving 50-100 pounds of annual phosphorus reduction through the following efforts:

- Identify Top 50 Phosphorus Sources
- Prioritization and Cost-Benefit Analysis
- Landowner Outreach
- Design and Implementation of Top 5 Projects
- Load Reduction Assessment

Reduction of nutrient loading to Lake St. Croix is a priority in the Washington Conservation District's Comprehensive Plan and is a focus for the local work group of the Natural Resources Conservation Service (NRCS). Much of the project area has been underserved relative to other parts of Washington County because of the lack of a functioning watershed organization and limited funding for water quality project installations. This project will provide a critical boost to reducing loads from the area and develop priorities for future efforts as funding becomes available.

Funding for the Top50P project is provided through a grant from the St. Croix River Association (SCRA), with additional local grant match funding provided by the Middle St. Croix Watershed Management Organization (MSCWMO).

Subwatershed Selection

Many factors are considered when choosing which drainage area or subwatershed to analyze for potential water quality improvements using rural/agricultural BMP practices. Water quality monitoring data, non-degradation report modeling, and TMDL studies are just a few of the resources available to help identify priority waterbodies. Priority work supported by a local government unit with sufficient capacity (staff, funding, available data, etc.) to greater facilitate the analysis also ranks highly. The focus must always be on a high priority waterbody.

Lake St. Croix was chosen as the priority waterbody for the Top50P project due to its impaired status (impaired for total phosphorus), available water quality data, TMDL work, and the level of focus on the lake by local water quality agencies (cities, watershed organizations, nonprofits). The general project area is defined as all rural areas south of Minnesota Highway 36, draining to Lake St. Croix.

Subwatershed Analysis Methods

The process used for this analysis was modified from the Center for Watershed Protection's *Urban Stormwater Retrofit Practices,* Manuals 2 and 3 (Schueler, 2005, 2007). Locally relevant design considerations were also incorporated into the process (*NRCS eFOTG, Minnesota Board of Water and Soil Resources (BWSR), Minnesota Stormwater Manual*).

The rural subwatershed analysis process for this project includes five steps:

1. **Project Scoping** – Determine project objectives, meet with local experts, define preferred treatment options and criteria, and refine subwatershed focus area.
2. **Desktop Analysis** – Computer-based evaluation of catchments within the subwatershed.
3. **Field Investigation** – Evaluate focus areas and specific sites identified during Desktop Analysis.
4. **Treatment/Cost Analysis** – Estimate potential benefits of projects, prepare cost estimates, and rank projects in terms of cost/benefit.
5. **Reporting** – Prepare final report, including an executive summary outlining the cost/benefit results.

Step 1: Project Scoping

Project scoping includes determining the objectives of the BMP practices and the level of treatment desired. It involves meeting with government officials (city/township, county, watershed management organization, NRCS, etc.) to determine the issues in the subwatershed. This step also helps to define preferred BMP treatment options and BMP practice performance criteria. In order to create a manageable area to assess in large subwatersheds, a smaller focus area may be defined. The deliverable from this step is a meeting summary document outlining the project, partners, and the intended direction of the analysis work. An example meeting summary form is included in Appendix A.

Step 2: Desktop Analysis

Desktop analysis involves computer-based evaluation of the subwatersheds in the target project area. The overall goal of the desktop analysis is to flag sites within the project area that may be suitable for the installation of water quality BMPs. Using GIS-based modeling, areas with the highest potential for soil erosion and areas with the highest pollutant loading based on land cover will be flagged. Flagged areas are then set as priorities for guiding field work. The desktop portion of this process also identifies catchments or land area that can be excluded from detailed field work due to the lack of nutrient loading or soil loss potential, which are dependent on site conditions such as soil types and slope steepness. The desktop portion of the analysis also removes landlocked catchments from consideration that do not drain to a target surface water resource.

ArcGIS Models for Catchment Evaluation

ArcGIS version 9.2 with spatial analyst was used to assess soil erosion potential and nutrient loading within the target project area in southern Washington County. Three analyses were completed that could be used independently or in combination to identify top target project areas. Those analyses include the Revised Universal Soil Loss Equation (RUSLE), the Simple Method, and Delivery Ratio, which identified catchments that were directly contributing to Lake St. Croix and those that were landlocked and did not pose a threat to the water quality of Lake St. Croix.

To complete the three analyses outlined above, the following GIS data layers were used:

Data Layer Name	Source
Digital Soil Maps	http://soildatamart.nrcs.usda.gov/SDM%20Web%20Application/default.aspx
Elevation Data	2' Contours from Washington County
Project Wide Digital Elevation Model	10m x 10m DEM created from 2' contours
Washington County Land Cover	Minnesota Land Cover Classification System data (2007) layer obtained from the MN DNR data deli. http://deli.dnr.state.mn.us/
Precipitation Data	Constant data layer created for Washington County based on information from the Washington Conservation District's water monitoring program.
Subwatershed/catchment data	Subwatershed information obtained from the MN DNR as part of the Statewide Auto-Catchment dataset. Contact Sean Vaughn (Sean.Vaughn@state.mn.us) for more information on project status and data availability.

RUSLE Analysis

The first empirical model developed in ArcGIS for this project was the RUSLE model, which is capable of predicting soil erosion potential on a cell-by-cell basis. RUSLE is calculated as:

$$A = R * K * L * S * C * P$$

A = Average annual soil loss potential in tons/acre/year
R = Rainfall-runoff erosivity factor
K = Soil erodibility factor
L = Slope length factor
S = Slope steepness factor
C = Cover management factor
P = Conservation practice factor

Data Layers and Manipulations Used in RUSLE Analysis

Soils (K-factor): Soils data for Washington County was obtained from the USDA's soil data mart, which provided the Soil Survey Geographic (SSURGO) database for Washington County. Information on "soil erodibility" is contained in this data set and is known as the K-factor. Using the "feature to raster" tool in ArcToolbox, a K-factor raster was created for the project area.

Elevation: Digital Elevation Models (DEM) with a ten-meter resolution were obtained from Washington County's GIS department. DEMs were generated from the County's 2-foot contour data. DEMS can be created from contour information using the "topo to raster" tool in ArcToolbox.

Land Cover (C-factor): Minnesota Land Cover Classification System (MLCCS) data were used to assign the appropriate c-values to specific land cover types. Washington County's MLCCS data were updated in 2007 and is available on the Minnesota DNR's GIS Data Deli. To assign c-values to each land cover type a C-factor field was added to the MLCCS attribute table and C-factor values were assigned to each cover type based predetermined values outlined in Appendix A. A raster data set of C-values was then created using the "feature to raster" tool in ArcToolbox where C-values were used in the input field when prompted.

Rainfall/Precipitation (R-factor): Annual rainfall information was obtained from the Washington Conservation District's water monitoring team which tracks a running average for annual rainfall in Stillwater, Washington County, Minnesota. The R-factor for the RUSLE model was obtained from this data set. A constant raster was created for the R-factor using the "create constant raster" tool in ArcToolbox.

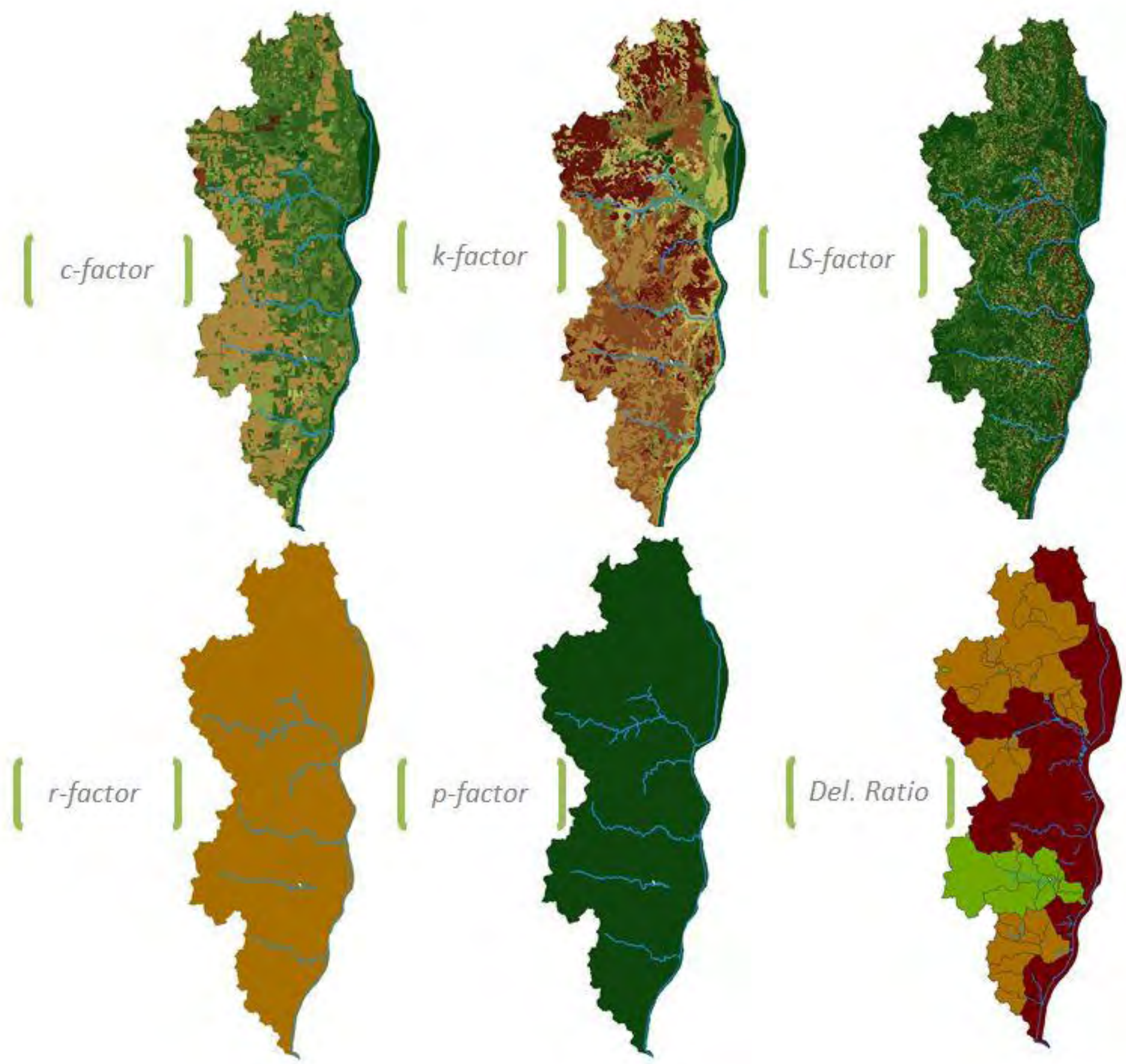
Length/Slope (LS-factor): The Length/Slope (LS) raster dataset required calculation using Spatial Analyst in ArcGIS (version 9.2). An empirical equation derived from the USDA's Agricultural Handbook Number 537 (Wischmeier and Smith 1978), Moore and Burch (1986) and Breiby (2006). The equation used for this project was taken from Breiby (2006) and is as follows:

$$LS = (\text{Flow Accumulation grid} * \text{cell size} / 22.13)^{0.4} * (\text{Sin}(\text{Slope grid} * 0.01745) / 0.0896)^{1.4} * 1.4$$

First, a 10 meter x 10 meter Digital Elevation Model was obtained from Washington County which was created using the County's detailed two-foot contour information. The Fill Sink feature was first used to prep the DEM for analysis. A Slope Grid raster dataset was then created using the 10meter x 10meter Digital Elevation Model (DEM). The "slope" tool in Spatial Analyst was used to create the slope grid. A flow direction raster grid was then created from the 10m x 10m DEM using the "flow direction" tool in spatial analyst. The "flow direction" grid was then used to create a "flow accumulation" grid using the flow accumulation grid in spatial analyst. The "flow accumulation" grid and the slope grid were then used in the equation above to generate the LS grid for use in the RUSLE calculation.

Conservation Practice Factor (P-factor): The p-factor dataset was also generated by creating a constant raster with the value of 1 as conservation practices were not considered in the RUSLE calculation. The P-factor will change once project implementation has occurred and may be used to estimate project benefits.

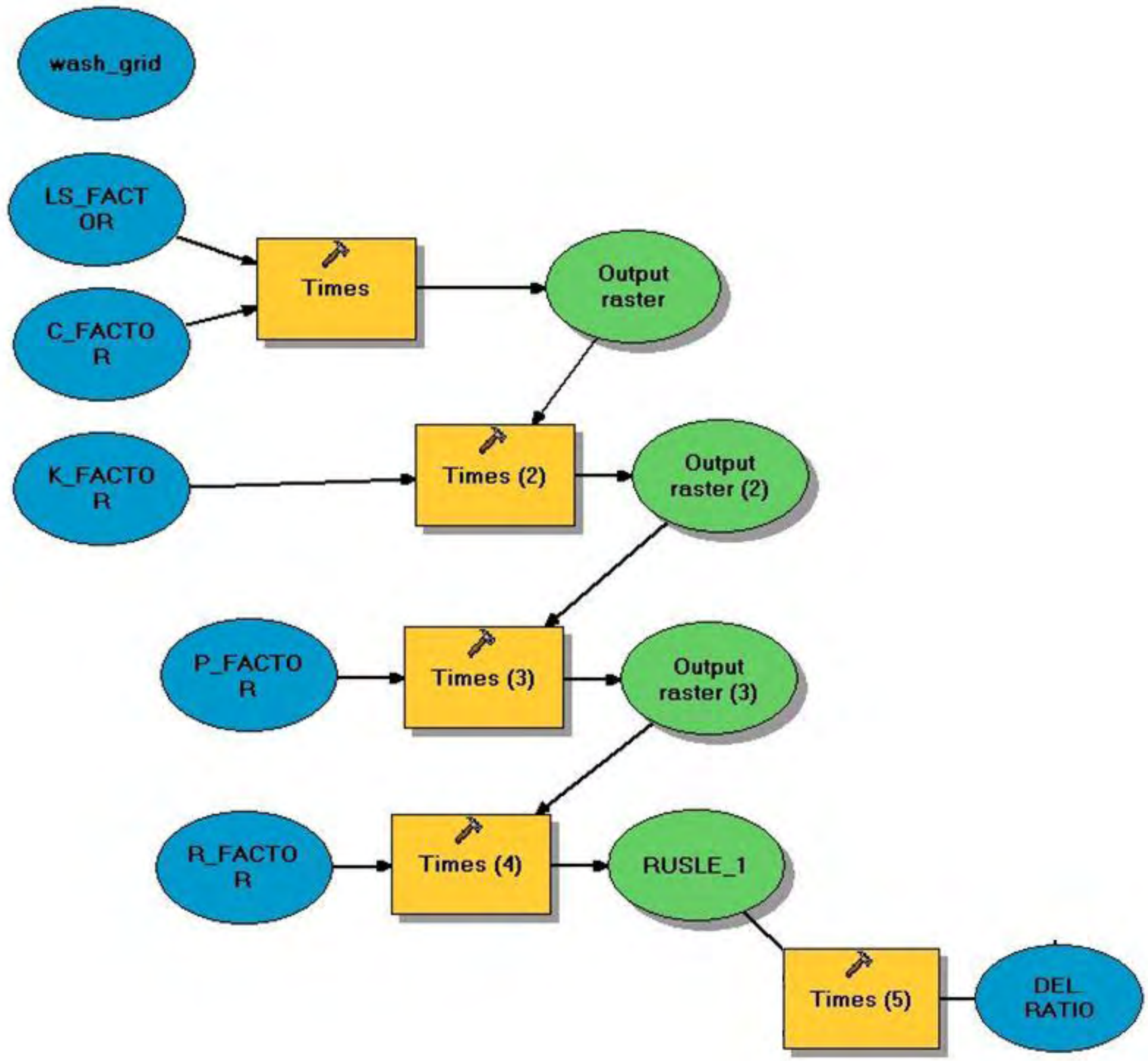
Catchment/Subwatershed Data/Delivery Ratio: Catchment data for the target project area was obtained from the Minnesota Department of Natural Resources (MN DNR) Fisheries Section. Catchment information was created by the MN DNR as part of an ongoing Watershed Delineation Project led by Lyn Bergquist, MN DNR GIS Coordinator, and Sean Vaughn, MN DNR GIS Hydrologist. DNR catchments range in size and can be as small as one acre. For this project, an additional field was added to the catchment attribute table. Each catchment was assigned a score between 0 and 1. A catchment score of zero means that the area is landlocked and does not overflow to Lake St. Croix. A score of 0.5 means that the catchment does overflow, but runoff travels through some type of treatment train prior to discharging to the St. Croix. A score of 1 means that runoff from the catchment discharges directly to Lake St. Croix.



Each of the data sets were generated at a 10-meter resolution (10meter x 10meter cell size) and snapped to the Washington County Minnesota Land Cover Classification System Grid, which was created County Wide by the Minnesota Department of Natural Resources. Snapping to the County Wide grid ensured proper alignment of the raster data sets to complete the analysis.

RUSLE Calculation

To run the RUSLE equation a small model was built using ModelBuilder in ArcGIS. The model was built to multiple the above factors together to assign a RUSLE score to each 10m x 10m cell within the project area. A figure depicting the model is shown below. The output of the RUSLE equation was then multiplied by the Delivery Ratio in an effort to determine which catchments did not impact water quality regardless of their RUSLE score.



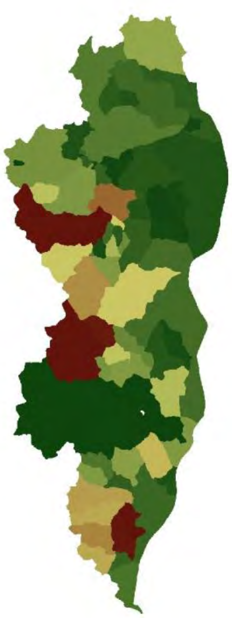
RUSLE equation model illustration from ArcGIS ModelBuilder

RUSLE Output

The results from the RUSLE analysis prior to multiplying by the delivery ratio are shown at left. Areas in green are areas with the lowest potential for soil erosion while areas in red are areas with the highest potential for soil erosion.

RUSLE x Delivery Ratio

The results of the RUSLE equation were then multiplied by the delivery ratio. Areas that were landlocked that did not drain to Lake St. Croix receive a score of zero regardless of soil erosion potential based on RUSLE.



RUSLE x Delivery Ratio Averaged by Catchment

The "zonal statistics" tool in ArcToolbox was then used to assign an average RUSLE x Delivery Ratio score to each catchment. Catchments shown in red are those with the highest soil erosion potential that have drainage that reaches Lake St. Croix.

The Simple Method

The second model built in ArcGIS for this project was the Simple Method using guidance from the Center for Watershed Protection. The simple method is used to estimate stormwater runoff pollutant loads and is based on impervious area, watershed drainage areas, estimated pollutant concentrations, and annual precipitation. In addition to RUSLE, the simple method was also used to estimate pollutant loading in the target project area.
The Simple Method estimates pollutant loading through the following equation:

L = P * Pj * Rv * C * A * 2.72/12

L = Load in pounds/year
P = Annual precipitation (inches), 33 inches per year was used in Washington County
Pj = rainfall correction factor, 0.9 is the literature value for the conversion factor
Rv = Volumetric runoff coefficient, an assigned value based on MLCCS cover type
EMC = Event Mean pollutant Concentration (mg/L), assigned value based on MLCCS cover type
A = Drainage area (acres)
2.72/12 = Unit conversion

Data Layers and Manipulations Used in Simple Method Analysis

Annual Rainfall/Precipitation (P-factor): Annual rainfall information was obtained from the Washington Conservation District's water monitoring team which tracks a running average for annual rainfall in Stillwater, Washington County, Minnesota. The P-factor in the SM model was obtained from this data set. A constant raster was created for the P-factor using the "create constant raster" tool in ArcToolbox.

Rainfall Correction (Pj-factor): The Pj-factor data set was generated by creating a constant raster with the value of 0.9, which is the conversion factor set by the Center for Watershed Protection.

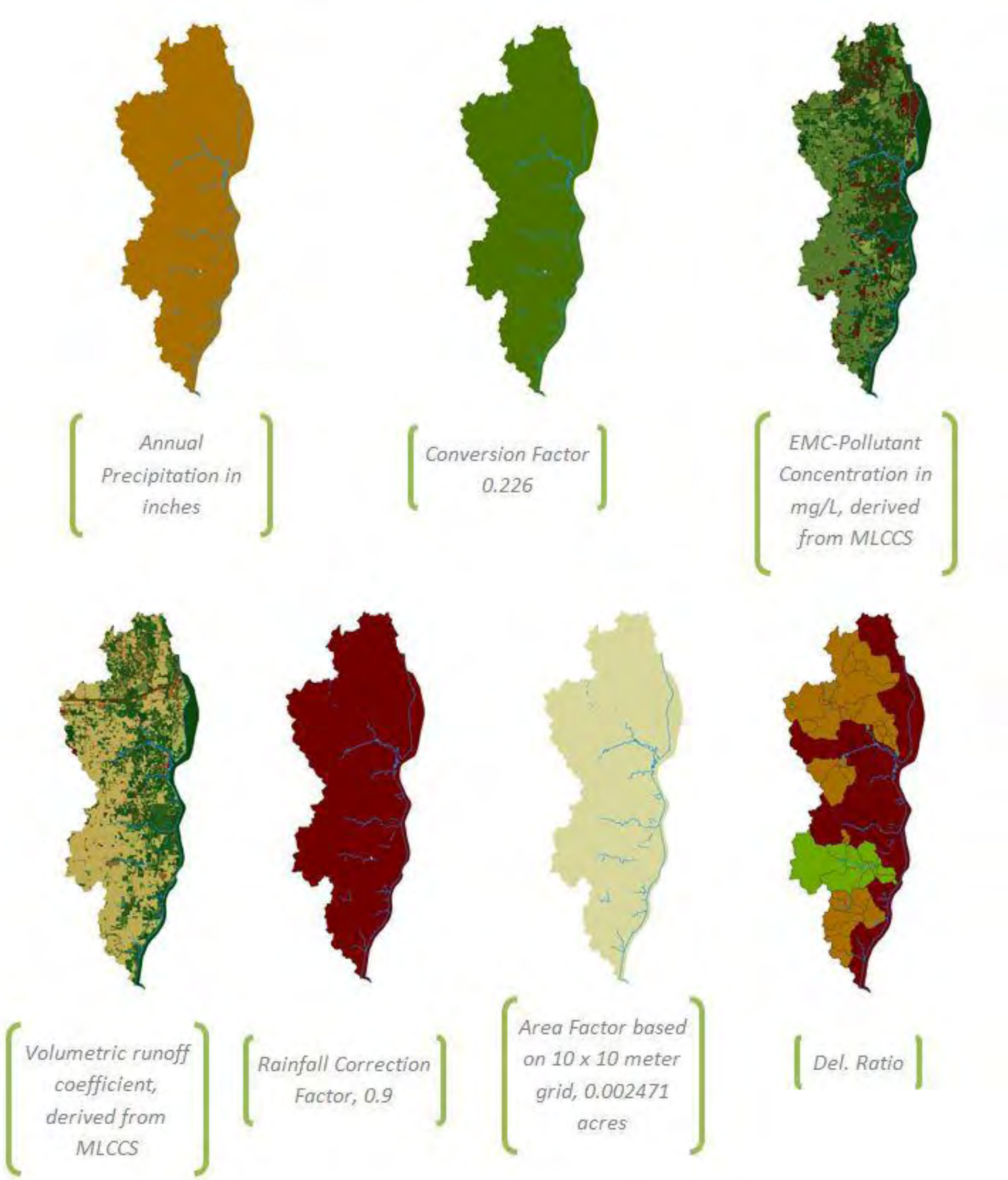
Land Cover Values (Rv-factor & EMC-factor): Minnesota Land Cover Classification System (MLCCS) data were used to assign the appropriate Rv-factors to specific land cover types. Washington County's MLCCS data were updated in 2007 and is available on the Minnesota DNR's GIS Data Deli. To assign Rv-values to each land cover type an Rv-factor field was added to the MLCCS attribute table and Rv-factor values were assigned to each cover type based predetermined values outlined in Appendix A. A raster data set of Rv-values was then created using the "feature to raster" tool in ArcToolbox where Rv-values were used in the input field when prompted.

This same method was used to create the EMC-factor for the Simple Method. To assign EMC-values to each land cover type an EMC-factor field was added to the MLCCS attribute table and EMC-factor values were assigned to each cover type based predetermined values outlined in Appendix A. A raster data set of EMC-values was then created using the "feature to raster" tool in ArcToolbox where EMC-values were used in the input field when prompted.

Drainage Area (A-factor): The a-factor or area factor data set was generated by creating a constant raster with the value of 0.002471, which is the portion of an acre that is found within a 10 meter x 10 meter cell area.

Catchment/Subwatershed Data/Delivery Ratio: Catchment data for the target project area was obtained from the Minnesota Department of Natural Resources (MN DNR) Fisheries Section. Catchment information was created by the MN DNR as part of an ongoing Watershed Delineation Project led by Lyn Bergquist, MN DNR GIS

Coordinator, and Sean Vaughn, MN DNR GIS Hydrologist. DNR catchments range in size and can be as small as one acre. For this project, an additional field was added to the catchment attribute table. Each catchment was assigned a score between 0 and 1. A catchment score of zero means that the area is landlocked and does not overflow to Lake St. Croix. A score of 0.5 means that the catchment does overflow, but runoff travels through some type of treatment train prior to discharging to the St. Croix. A score of 1 means that runoff from the catchment discharges directly to Lake St. Croix.

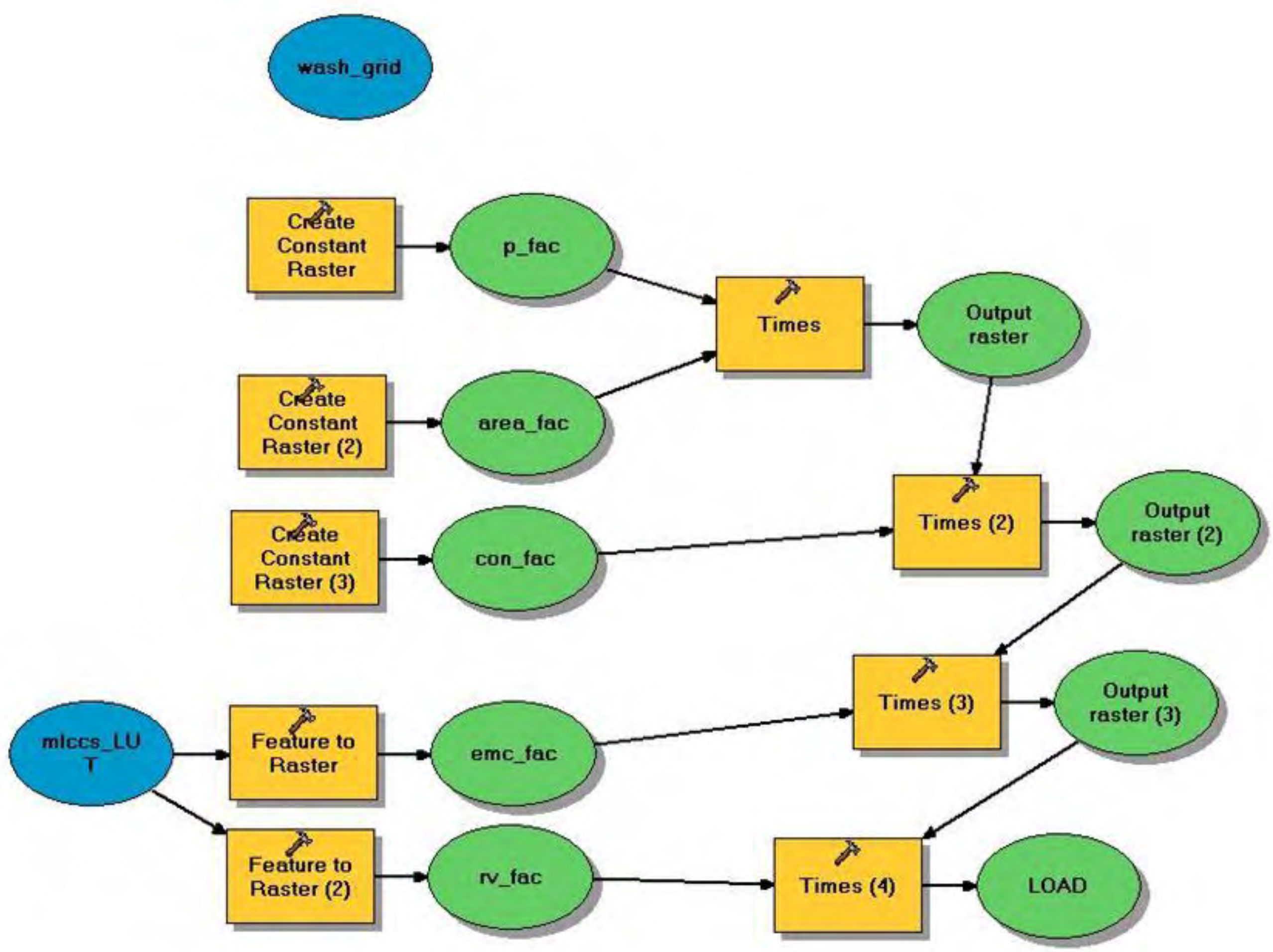


Each of the data sets were generated at a 10-meter resolution (10meter x 10meter cell size) and snapped to the Washington County Minnesota Land Cover Classification System Grid, which was created County Wide by the

Minnesota Department of Natural Resources. Snapping to the County Wide grid ensured proper alignment of the raster data sets to complete the analysis.

Simple Method Calculation

To run the Simple Method equation a small model was built using ModelBuilder in ArcGIS. The model was built to multiple the above factors together to assign a Simple Method output score to each 10m x 10m cell within the project area. A figure depicting the model is shown below. The output of the Simple Method equation was then multiplied by the Delivery Ratio in an effort to determine which catchments did not impact water quality regardless of their Simple Method score.



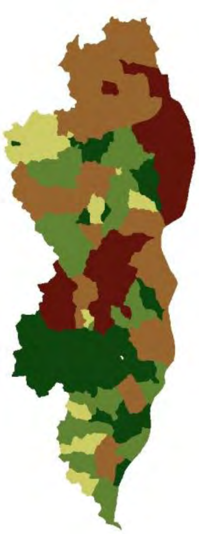
Simple equation model illustration from ArcGIS ModelBuilder

Simple Method Output

The results from the Simple Method analysis prior to multiplying by the delivery ratio are shown at left. Areas in green are areas with the lowest loading associated with land cover type erosion while areas in red are areas with the loading associated with land cover type.

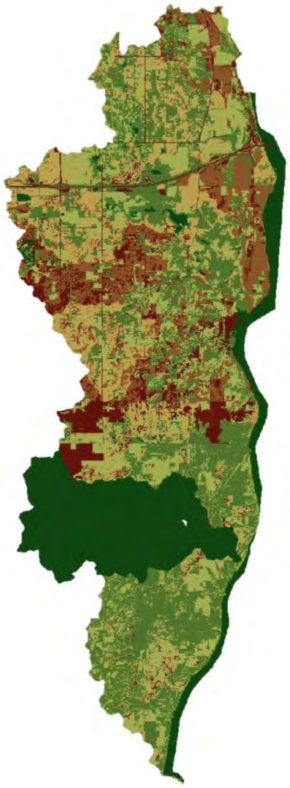
Simple Method x Delivery Ratio

The results of the Simple Method analysis were then multiplied by the delivery ratio. Areas that were landlocked that did not drain to Lake St. Croix received a score of zero regardless of the loading associated with land cover types.



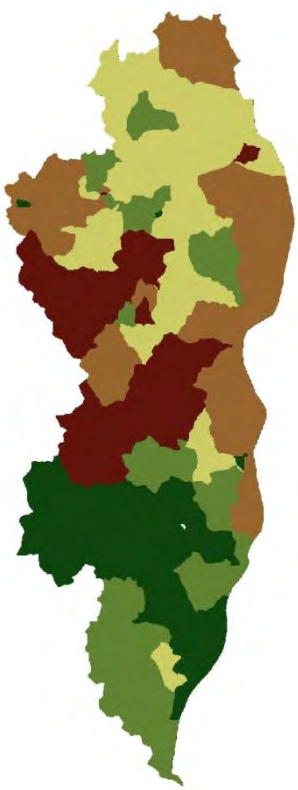
Simple Method x Delivery Ratio Averaged by Catchment

The "zonal statistics" tool in ArcToolbox was then used to assign an average Simple Method x Delivery Ratio score to each catchment. Catchments shown in red are those with the highest loading associated with land cover type that have drainage that reaches Lake St. Croix.



Final Analysis – Combining RUSLE and Simple Method Outputs

In the final analysis, the RUSLE output and the Simple method output (multiplied by a conversion factor of 12,417.15 to give equal weighting) were added together then multiplied by the delivery ratio. Areas in red are those which have the highest potential pollutant loading to Lake St. Croix. Green areas have the lowest pollutant loading potential or no pollutant loading potential if not delivering to Lake St. Croix. The outputs of this equation are unitless, but can be used for comparison and ranking purposes.



Final Analysis – Combining RUSLE and Simple Method Outputs – Catchment Averages

In the final analysis, the RUSLE output and the Simple method output (multiplied by a conversion factor of 12,417.15 to give equal weighting) were added together then multiplied by the delivery ratio. The output of this equation was then averaged by catchment using the "zonal statistics" tool in ArcGIS Toolbox. The outputs of this equation are essentially unitless, but does allow for uniform comparison and ranking of catchments. Once catchments are ranked, field work can then be targeted on the ground.

Desktop Preparations for Field Work

After priority catchments have been identified, additional desktop analysis must be done to prepare for field work. Field maps are prepared during this step and should include base data layers such as air photos, topographic contour lines, catchment lines, parcel lines (differentiate between public and private ownership), public right-of-way, political divisions, and land cover. Experienced BMP designers should scan the GIS data looking for clues in the landscape that may suggest certain BMP practice locations. For example, a watercourse through an agricultural field can be identified from 2-foot contour data lines, and an existing grassed waterway (or lack thereof) could be spotted by looking at an air photo. Headcutting ravines at the edges of fields are also relatively easy to identify using these methods. Potential BMPs should be noted on the maps for field verification.

Hard copies of field maps should be prepared, with priority catchments broken up into areas no larger than one section (1 square mile, or 640 acres). The largest practicable map size should be used; for the Top50P project, the printed field maps were 22” x 34” (ANSI D).

Desktop Analysis – Pollutant Sources/Features and Potential BMP Practices

Source/Feature	Potential BMP Practices
Feedlots	Add clean water diversions, install manure management structures, install filter strips, implement nutrient management plan, relocate feedlot
Ravines	Grade stabilization structures, in-ravine stabilization
Row Crops	Install buffers, modify tillage practices, install cover crops, convert critical areas to permanent cover (native or non-native), install terraces, install windbreaks
Streambanks	Bank stabilization, buffers, in-stream revetments
Septic	Failing septic systems (typically cannot be identified without field work)
Manure Application	Manure management plan, install additional capacity at facility, change timing of application, increase distance from surface water
In-Field Drainageways	Add or improve existing grassed waterways and sediment basins; install off-line infiltration basins or sand-iron filters
Invasive Species	Remove and convert to native cover

Step 3: Field Investigation

After identifying potential BMP practice locations through the desktop analysis, a field investigation was conducted to evaluate as many sites as possible to test assumptions and identify site-limiting factors for BMP design. Site constraints were assessed to determine the most feasible BMP options as well as eliminate sites from consideration. The field investigation revealed BMP opportunities that could have gone unnoticed during desktop analysis. During the investigation, the drainage area and other mapped data was verified. Public right-of-way and public land within priority catchments was used as a starting point for visual assessment. Potential BMP locations that were identified during the Desktop Analysis step but could not be seen from public areas were visited by contacting individual landowners and scheduling formal site visits.

WCD developed a field protocol for the Top50P project that includes specific requirements for standardized field investigations. It is very important to follow a standardized procedure, especially when multiple staff will be working on the project. The following Field Protocol was used for the Top50P project:

Top50P Standardized Field Protocol

Materials Needed: Base maps with required data, camera, binoculars, GPS, 100’ tape, crop residue tape, credentials and business cards, marked vehicle, Top50P Field Key.

Minimum Data for Base Maps: Air photos, Top50P Spatial Prioritization information (assigned score), soils information (including HEL soils), elevation contours (2-foot), land cover (MLCCS), NWI data, surface water, hydro division (catchments), political division (city/township, watershed, etc.), land division (sections, down to QQ sections), public roads, land ownership (parcel data), public property (highlighted), areas of interest for field checks (HEL soils, steep slope areas, concentrated flow, sediment deposition areas, outlets, bare soil, invasive species, known existing BMPs, etc.).

Procedure:

1. Before fieldwork commences, WCD will identify and prioritize all catchments within the target area using the Top50P Spatial Prioritization protocol. Scores will be assigned to all catchments so that fieldwork may be conducted efficiently and within the highest-scoring catchments. Some catchments will be eliminated from the fieldwork queue based on low potential for P loading due to land cover, limited or no connection to surface waters, existing BMPs, or other factors.

2. Create hardcopy base maps. Base maps are needed for all land area within each priority catchment. Map scale should be no greater than 1 inch = 300 feet for proper interpretation of site features (smaller scale may be used). Each printed map should display the following: aerial photo, parcels, contours, and roads – this map is to be used for taking field notes. An overall large-scale location map is needed, showing the area covered by each base map.

3. Identify all potential viewing areas for each base map (typically public roadways and public property).

4. Use the Top50P Field Key to collect information about each site – To standardize the interpretation of observed site characteristics, the use of the Top50P Field Key is mandatory. Take legible field notes (using a dark-colored pen); record site characteristics, potential BMP locations, stormwater infrastructure locations, pour points, and any other pertinent information. Record critical locations using GPS (approximate locations by sketching on base maps).

5. Scan field notes and create a digital file for all field-checked areas.

6. Maintain a list of probable high-priority project areas not observable from public roadways or public property for individual follow-up site visits. Create a standardized packet of information for landowners that includes a description of the Top50P project, a map of the site, information about potential BMPs

and cost-share grants available, and other pertinent information. Conduct follow-up site visits with landowners.

7. For all potential BMP locations, evaluate cost-benefit potential using the Top50P BMP Cost Estimator tool. Using simple evaluation methods, staff will determine the expected P reduction due to BMP installations.

Field Key

The Top50P Field Key contains information on each type of potential sources of phosphorus in the study area, required field notes, BMP options, and method of pollutant removal calculation. Sources considered were active gully erosion, sheet and rill erosion, wind erosion, feedlots, land application of manure, agricultural fields, bluffs, streambank and shoreland areas, and low-density residential development. The entire document is included in Appendix A.

Active Gully Erosion

Definition – An erosion process characterized by incised and unstable (exposed soil) channels in the landscape. The active gully erosion process involves the concentration of surface water runoff within these channels and the dispersion of soil.

Field Determination Process – Active gully erosion must be identified in the field by observation; no determination of this erosion type may be made without field verification. Active gully erosion will meet the following criteria:

a. Erosion observed is within an area of concentrated flow.
b. Sediment transport is evident within the area of concentrated flow.

Field Notes – Field notes for active gully erosion will consist of the following:

a. Average depth and width of active gully.
b. Estimate for representative soil category (sand/silt/clay).
c. Estimate for number of years of active erosion needed to erode gully to current extents.
d. Distance to surface water (feet).
e. Location of outfall or connection to a stabilized area.
f. Existing BMPs in the contributing area or within the area of concentrated flow.
g. Sun exposure (sun/shade).
h. Presence of invasive species.
i. Land cover of contributing area (including crop types, if present).
j. Other pertinent information.

BMP Options – The following BMPs may be used to address active gully erosion (one BMP or a combination may be used):

a. Diversion
b. Grade stabilization structure
c. Grassed waterway
d. Water and sediment control basin

Phosphorus Estimation – BWSR Pollution Reduction Estimator (Water)

Examples of Active Gully Erosion:

Example sheet from the Top50P Field Key

Field Codes

The WCD developed a code key to standardize field notes. The following example contains all potential BMPs considered during the field work and codes for each (Also included in Appendix A):

Top 50 P! Practice Code Sheet

Code	Rural/Ag BMP
BFS	Buffer Strip
CTF	Contour Farming
COV	Cover Crop
DIV	Diversion
FTS	Filter Strip
GSS	Grade Stabilization Structure
GWW	Grassed Waterway
NMP	Nutrient Management Plan
PRG	Prescribed Grazing
RES	Residue Management
HAB	Habitat Restoration
SBP	Streambank Protection
SCR	Strip Cropping
TER	Terrace
SCB	Sediment Control Basin
WTC	Wetland Creation
WTE	Wetland Enhancement
WTR	Wetland Restoration
SEP	Septic Fix
FDF	Feedlot Fix

Code	Urban BMP
PND	Pond Retrofits
EXD	Extended Detention
WTP	Wet Pond
WET	Stormwater Wetland
INB	Infiltration Basin
SDC	Stormwater disconnect to pervious area
ICC	Inpervious Cover Conversion
RBR	Rain Barrels
CIS	Cisterns
DWL	French Drain/Dry Well
WTS	Wet Swale (vegetated swale with no underdrain)
WQP	Water Quality Swale (Dry Swale (swale with filtration media and drain tile)
USF	Underground Sand Filter
SSF	Structural Sand Filter (a surface filter including peat, compost, iron amendments, or similar)
RDG	Rain Leader Disconnect Raingardens
BRA	Simple Bioretention (no engineered soils or under-drains, but w/curb cuts and forebays)
BRB	Moderate Bioretention (Engineered soils, under-drains, curbcuts, forbays but no retaining walls)
BRC	Complex Bioretention (as BRB but with partial, or 1-3 ft. retaining walls)
DRD	Highly Complex Bioretention (as BRB but with perimeter or 3-5 ft. retaining walls)
STP	Stormwater Tree Pits
SPL	Stormwater Planter
PPG	Grass Gravel Permeable Pavement (sand base)
PPA	Permeable Asphalt (granite base)
PPC	Permeable Concrete (granite base)
PPP	Permeable Pavers (granite base)
EGR	Extensive Green Roof
IGR	Intensive Green Roof

Code	Existing Practice
Soy Beans	Use text to note existing crops (soy beans, corn, small grain, etc.)
EX___	Modifier for existing BMPs
__% Res.	% Residue for crop fields
C&G	Curb and Gutter
CB	Catchment Basin

Code	Site Visit/BMP Priortization
SV1	Highest Priority Site Visit
SV2	Nice To Have Site Visit
1	Prime: ideally situated within catchment, few physical constraints, little to no grading required, easy maintance
2	Alternate: a possible substitute for Prime location with oderate indicators

Code	Example
EX GWW	There is an existing Grassed Waterway in this location
GWW1	A perfect site/parcel for a Grassed Waterway
SCB2	An alternate site/parcel for a Sediment Basin, after all prime sites have been pursued

Step 4: Treatment/Cost Analysis

BMPs most likely to be conducive to addressing the project goals and appear to have reasonable design, installation, and maintenance were chosen for a cost/benefit analysis. Estimated costs included design, installation, and maintenance annualized across a 10-year period. The top 50 projects (listed by BMP type) were ranked by cost per pound of phosphorus removed annually.

Treatment Analysis

Total phosphorus removal potential for most proposed structural BMP practices was estimated using the recommended spreadsheet calculator for each practice type (*Choosing the best calculator for eLINK*, MN BWSR website). WinSLAMM was selected for modeling potential ponding, infiltration, and bioretention areas. The following table illustrates how the calculators were chosen for some BMPs:

Total Phosphorus Removal Calculation Selection

BMP Type	Calculation Method Used
Grass Waterway	BWSR Filter Strip (spreadsheet)
Water & Sediment Control Basin	BWSR Sheet/Rill (spreadsheet)
Feedlot	MinnFARM (spreadsheet)
Ravine (headcut)	BWSR Gully (spreadsheet)
Ponds/infiltration/bioretention	WinSLAMM
Cover Crop	Potential Soil Loss Comparison (RUSLE before/after)

The BWSR spreadsheets use inputs such as soil loss (before/after), distance to surface water, soil category (sand/silt/clay/peat), contributing drainage area, estimated volume of soil eroded during a given time period, and design factors to estimate the benefits of installing BMP practices.

MinnFARM uses specific farm data to estimate loading from feedlots. Only one feedlot project (with multiple potential BMP practices) was ranked. A site visit with the landowner was required to determine many of the MinnFARM inputs.

WinSLAMM uses an abundance of stormwater data from the upper Midwest and elsewhere to quantify runoff volumes and pollutant loads from urban areas. It is useful for determining the effectiveness of proposed stormwater control practices. It has detailed accounting of pollutant loading from various land uses, and allows the user to build a model “landscape” that reflects the actual landscape being considered. The user is allowed to place a variety of stormwater treatment practices that treat water from various parts of this landscape. It uses rainfall and temperature data from a typical year, routing stormwater through the user’s model for each storm. WinSLAMM was used for this project to determine potential TP removals for BMP practices that can be either urban or rural (pond retrofits, detention ponds, bioretention), and have a somewhat urban or rural residential drainage area.

Cost Estimates

Cost estimates incorporate design, installation, installation oversight, and maintenance over a 10-year period (contract and practice life of most typical BMP installations funded by cost-share). Design assistance from an engineer is assumed for large structural practices, practices involving complex stormwater treatment interactions, or practices posing a risk for flooding. No site-specific construction investigations were done as part of this assessment; cost estimates account for only general site considerations.

WCD developed a BMP Cost Estimator spreadsheet tool for the Top50P project using local BMP installation cost data and other estimated factors that are specific to WCD. Each BMP practice is quantified by its standard unit from the NRCS' Field Office Technical Guide (adopted by BWSR for the state cost-share program). For example, to estimate the cost of a grassed waterway, the length of the grassed waterway (in feet) would be entered into the spreadsheet.

BMP Cost Estimator							
BMP	Initial Construction Cost ($/unit)	Contracted Maintenance Cost ($/unit)	O & M Term (yr)	Design Cost for Average Site ($70/hr)	Installation Oversight Cost for Average Site ($70/hr)	Size of Proposed BMP (USER ENTERED)	Total Installation Cost (Includes design & 1-yr maintenance)
Contour Buffer Strips (AC)	$ 500.00	$ 10.00	10	$ 560.00	$ 280.00	10	$ 5,940.00
Contour Farming (AC)	$ 25.00	$ -	10	$ 560.00	$ 280.00	10	$ 1,090.00
Cover Crop (AC)	$ 25.00	$ -	10	$ 560.00	$ 280.00	40	$ 1,840.00
Diversions (LF)	$ 7.00	$ 0.25	10	$ 560.00	$ 280.00	500	$ 4,465.00
Filter Strip (AC)	$ 500.00	$ 10.00	10	$ 1,120.00	$ 560.00	10	$ 6,780.00
Grade Stabilization Structure - drainage area of 0 to 10 acres (NO)	$ 9,250.00	$ 100.00	10	$ 925.00	$ 462.50	1	$ 10,737.50
Grade Stabilization Structure - drainage area of 10 to 20 acres (NO)	$ 15,000.00	$ 150.00	10	$ 1,500.00	$ 750.00	1	$ 17,400.00
Grade Stabilization Structure - drainage area of 20 to 40 acres (NO)	$ 28,125.00	$ 200.00	10	$ 2,812.50	$ 1,406.25	1	$ 32,543.75
Grade Stabilization Structure - drainage area of 40 to 80 acres (NO)	$ 37,500.00	$ 250.00	10	$ 3,750.00	$ 1,875.00	1	$ 43,375.00
Grade Stabilization Structure - drainage area of 80 to 250 acres (NO)	$ 56,250.00	$ 300.00	10	$ 5,625.00	$ 2,812.50	1	$ 64,987.50
Grade Stabilization Structure - drainage area of 250 to 500 acres (NO)	$ 112,500.00	$ 350.00	10	$ 11,250.00	$ 5,625.00	1	$ 129,725.00
Grade Stabilization Structure - drainage area of greater than 500 acres (NO)	$ 150,000.00	$ 400.00	10	$ 15,000.00	$ 7,500.00	1	$ 172,900.00
Grassed Waterway (LF)	$ 4.00	$ 0.25	10	$ 1,120.00	$ 560.00	1,000	$ 5,930.00
Nutrient Management (AC)	$ 11.00	$ -	10	$ 560.00	$ 280.00	10	$ 950.00
Nutrient Management (NO)	$ 3,375.00	$ -	10	$ 560.00	$ 280.00	1	$ 4,215.00
Prescribed Grazing (AC)	$ 93.00	$ -	10	$ 560.00	$ 280.00	10	$ 1,770.00
Residue Management (AC)	$ 58.00	$ -	10	$ 560.00	$ 280.00	1	$ 898.00
Restoration and Management of Declining Habitats (AC)	$ 1,500.00	$ 500.00	15	$ 1,120.00	$ 560.00	10	$ 21,680.00
Streambank and Shoreline Protection (SF)	$ 7.00	$ 0.25	10	$ 2,240.00	$ 1,120.00	1,000	$ 10,610.00
Stripcropping (AC)	$ 98.00	$ -	10	$ 560.00	$ 280.00	10	$ 1,820.00
Terrace (LF)	$ 8.00	$ 0.25	10	$ 1,120.00	$ 560.00	1,000	$ 9,930.00
Water and Sediment Control Basin - drainage area of 0 to 10 acres (NO)	$ 8,438.00	$ 100.00	10	$ 843.80	$ 421.90	1	$ 9,803.70
Water and Sediment Control Basin - drainage area of 10 to 20 acres (NO)	$ 11,250.00	$ 150.00	10	$ 1,125.00	$ 562.50	1	$ 13,087.50
Water and Sediment Control Basin - drainage area of 20 to 40 acres (NO)	$ 16,875.00	$ 200.00	10	$ 1,687.50	$ 843.75	1	$ 19,606.25
Wetland Creation (AC)	$ 7,000.00	$ 45.00	10	$ 2,800.00	$ 1,400.00	10	$ 74,650.00
Wetland Enhancement (AC)	$ 3,000.00	$ 45.00	10	$ 2,800.00	$ 1,400.00	10	$ 34,650.00
Wetland Restoration (AC)	$ 3,000.00	$ 45.00	10	$ 2,800.00	$ 1,400.00	10	$ 34,650.00
Windbreak - per foot of single row, planted (LF)	$ 2.00	$ -	10	$ 560.00	$ 280.00	1,000	$ 2,840.00
Septic fix (NO)	$ 15,000.00	$ -	n/a	$ -	$ -	1	$ 15,000.00
Feedlot Fix - Pit - first 500,000 CF of storage (CF)	$ 1.55	$ 0.01	10	$ 11,200.00	$ 5,600.00	500,000	$ 795,050.00
Feedlot Fix - Pit - additional above 500,000 CF of storage (CF)	$ 1.13	$ 0.01	10	$ 11,200.00	$ 5,600.00	500,000	$ 585,050.00
Feedlot Fix - Treatment Swale (SF)	$ 4.00	$ 0.25	10	$ 2,800.00	$ 1,400.00	1,000	$ 8,450.00
Feedlot Fix - Relocation (NO)	$ 50,000.00	$ -	n/a	$ 11,200.00	$ 5,600.00	1	$ 66,800.00

WCD BMP Cost Estimator for Top50P Project

Evaluation and Ranking

The Top50P project results tables rank BMP practices by annual cost per pound of phosphorus treated. Because different calculation methods were used to develop the TP removal results for each type of practice, potential BMP practices can only be evaluated against other practices of the same type. The results tables contain the top potential grassed waterways, sediment basins, ravine, ponding areas, feedlots and other practices within the study area. During the installation phase of the Top50P project and beyond, the tables should be periodically updated to reflect installed BMP practices, practices that have been eliminated from consideration, and additional practices that may be identified. The results tables should be used to prioritize potential BMP practices but actual reported TP removal must always be modeled and determined after installation is complete.

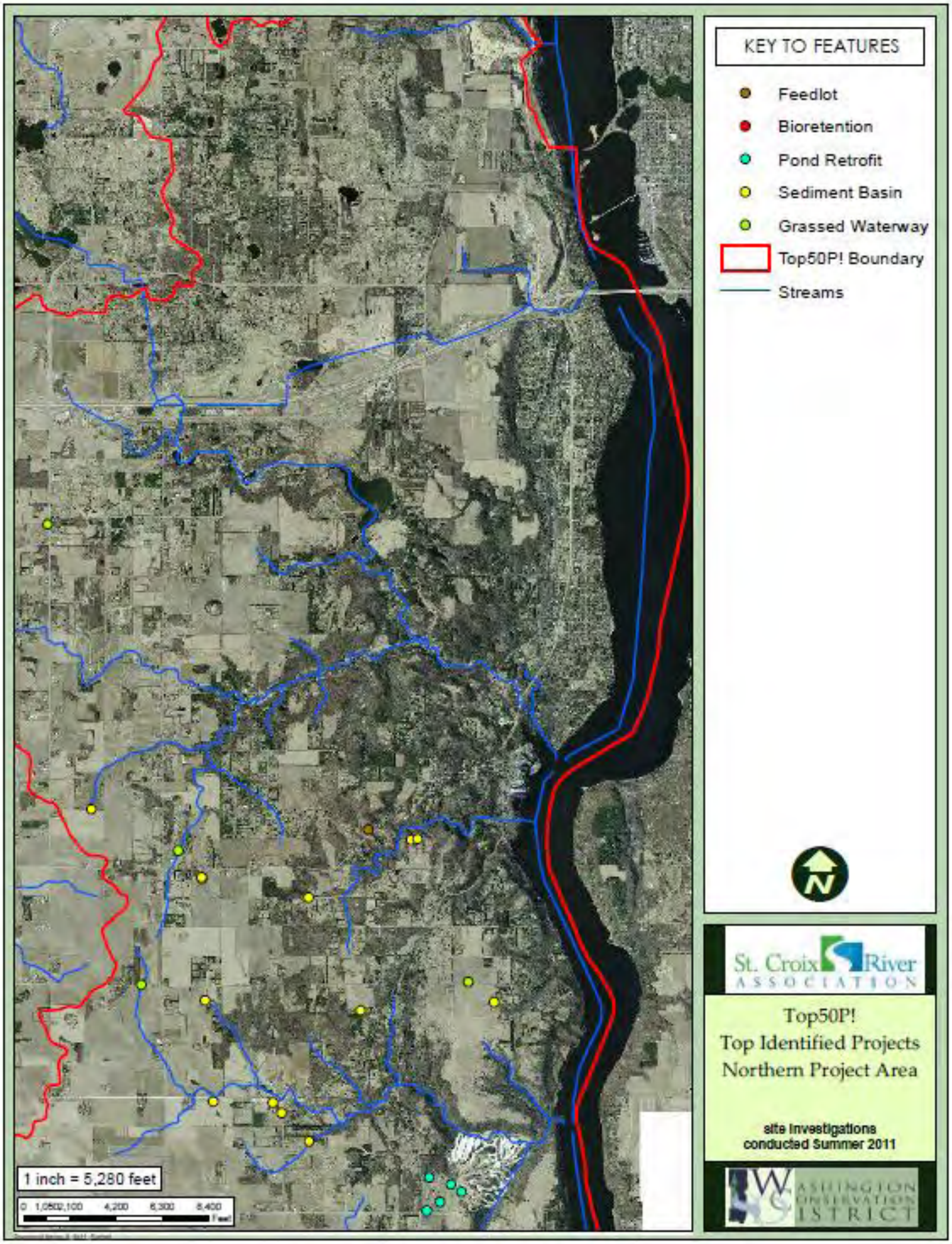
Top50P! Ranking

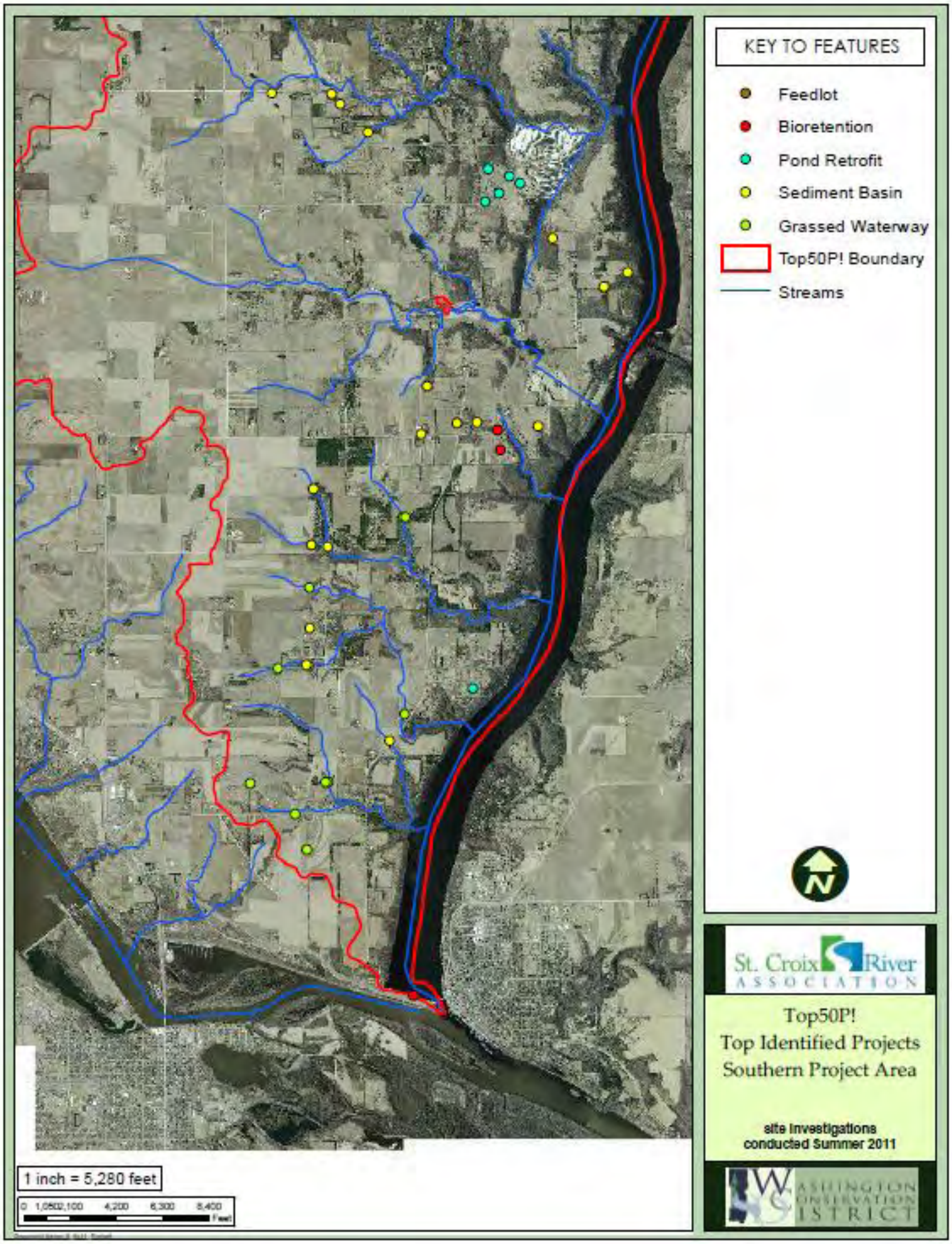
The following table summarizes the priority projects identified by the Top50P! field work. The primary practices identified include Grassed Waterways, Water and Sediment Control Basins, Feedlot Management, and Bioretention.

After the potential projects were identified, staff contacted the landowners of the effected properties to determine interest in implementing the targeted practices. Information about financial and technical assistance was conveyed to the landowners.

Top50P! Rank	Project ID	TP Load (lb/yr)	TP Removal (lb/yr)	Estimated Installation Cost	Estimated Cost Per lb TP
1	Grassed Waterway 13	247.41	98.964	$7,713.78	$31.18
2	Grassed Waterway 17	330.9	132.36	$12,388.49	$37.44
3	Grassed Waterway 14	129.08	51.632	$7,395.18	$57.29
4	Grassed Waterway 10	101.15	40.46	$6,110.14	$60.41
5	Grassed Waterway 1	94.26	37.704	$5,965.52	$63.29
6	Grassed Waterway 16	106.57	42.628	$7,218.64	$67.74
7	Grassed Waterway 3	170.69	68.276	$12,051.20	$70.60
8	Grassed Waterway 7	84.11	33.644	$5,986.24	$71.17
9	Grassed Waterway 9	99.92	39.968	$7,705.32	$77.11
10	Grassed Waterway 15	101.54	40.616	$12,787.63	$125.94
11	Grassed Waterway 5	101.5	40.6	$13,093.74	$129.00
12	Grassed Waterway 21	47.25	18.9	$7,066.30	$149.55
13	Grassed Waterway 12	124.97	49.988	$18,704.80	$149.67
14	Sediment Basin 25	256.03	204.824	$33,084.38	$161.53
15	Grassed Waterway 18	111.3	44.52	$20,176.90	$181.28
16	Grassed Waterway 11	74.45	29.78	$15,963.20	$214.42
17	Sediment Basin 22	175.36	140.288	$33,084.38	$235.83
18	Grassed Waterway 6	23.95	9.58	$6,199.49	$258.85
19	Sediment Basin 9	138.49	110.792	$33,084.38	$298.62
20	Grassed Waterway 8	18.77	7.508	$5,832.81	$310.75
21	Sediment Basin 2	184.54	147.632	$46,784.94	$316.90
22	Grassed Waterway 20	19.67	7.868	$6,653.67	$338.26
23	Sediment Basin 21	106.64	85.312	$33,084.38	$387.80
24	Grassed Waterway 19	11.13	4.452	$4,849.19	$435.69
25	Sediment Basin 19	66.64	53.312	$23,395.91	$438.85
26	Feedlot 1	17	6	$2,652.50	$442.08
27	Sediment Basin 3	84.53	67.624	$33,084.38	$489.24
28	Sediment Basin 24	83.54	66.832	$33,084.38	$495.04
29	Sediment Basin 13	31.75	25.4	$13,087.50	$515.26
30	Sediment Basin 12	111.21	88.968	$46,784.94	$525.86
31	Sediment Basin 1	71.74	57.392	$33,084.38	$576.46
32	Sediment Basin 17	41.49	33.192	$23,395.91	$704.87
33	Grassed Waterway 4	10.73	4.292	$7,718.54	$719.34
34	Sediment Basin 14	20.15	16.12	$13,087.50	$811.88
35	Sediment Basin 27	20.22	16.04	$15,000.00	$935.16
36	Sediment Basin 11	24.09	19.272	$19,606.25	$1,017.34
37	Sediment Basin 8	37.33	29.864	$33,084.38	$1,107.83
38	Sediment Basin 23	10.53	8.424	$9,803.70	$1,163.78
39	Feedlot 2	17	14.8	$24,900.25	$1,682.45
40	Sediment Basin 16	14.43	11.544	$19,606.25	$1,698.39
41	Sediment Basin 15	9.5	7.6	$13,087.50	$1,722.04
42	Sediment Basin 18	13.68	10.944	$19,606.25	$1,791.51
43	Sediment Basin 7	12.51	10.008	$19,606.25	$1,959.06
44	Sediment Basin 5	5.3	4.24	$9,803.70	$2,312.19
45	Sediment Basin 6	13.33	10.664	$33,084.38	$3,102.44
46	Detention Pond 3	7.17	3.52	$24,754.00	$7,032.39
47	Sediment Basin 4	1.26	1.008	$9,803.70	$9,725.89
48	Sediment Basin 10	1.92	1.536	$19,606.25	$12,764.49
49	bioretention 1	1.74833	0.613664	$8,285.00	$13,500.87
50	Detention Pond 6	6.866	3.557	$52,282.00	$14,698.34
51	Detention Pond 3	7.17	5.8794	$125,000.00	$21,260.67
52	bioretention 2	0.355	0.1862	$4,971.00	$26,697.10
53	bioretention 3	1.232	0.75867	$26,050.00	$34,336.40
54	Detention Pond 1	2.939	0.366	$14,181.68	$38,747.76
55	Detention Pond 2	5.173	0.623	$30,124.64	$48,354.16
56	Pond Retrofit 4	1.574	0.124	$9,607.88	$77,482.90
57	Detention Pond 6	2.939	2.40998	$250,000.00	$103,735.30
58	Sediment Basin 20	0.02	0.016	$9,803.70	$612,731.25
59	Pond Retrofit 5	0.917	0.043	$54,300.44	$1,262,800.93

note: Projects were numberd before rankings were decided


KEY TO FEATURES
Feedlot
Bioretention
Pond Retrofit
Sediment Basin
Grassed Waterway
Top50P! Boundary
Streams
N
St. Croix River Association
Top50P!
Top Identified Projects
Northern Project Area
site investigations
conducted Summer 2011
Washington Conservation District
1 inch = 5,280 feet
0 1,050 2,100 4,200 6,300 8,400
Feet


KEY TO FEATURES
Feedlot
Bioretention
Pond Retrofit
Sediment Basin
Grassed Waterway
Top50P! Boundary
Streams
N
St. Croix River Association
Top50P!
Top Identified Projects
Southern Project Area
site investigations conducted Summer 2011
Washington Conservation District
1 inch = 5,280 feet
0 1,050 2,100 4,200 6,300 8,400 Feet

Step 5: Implementation

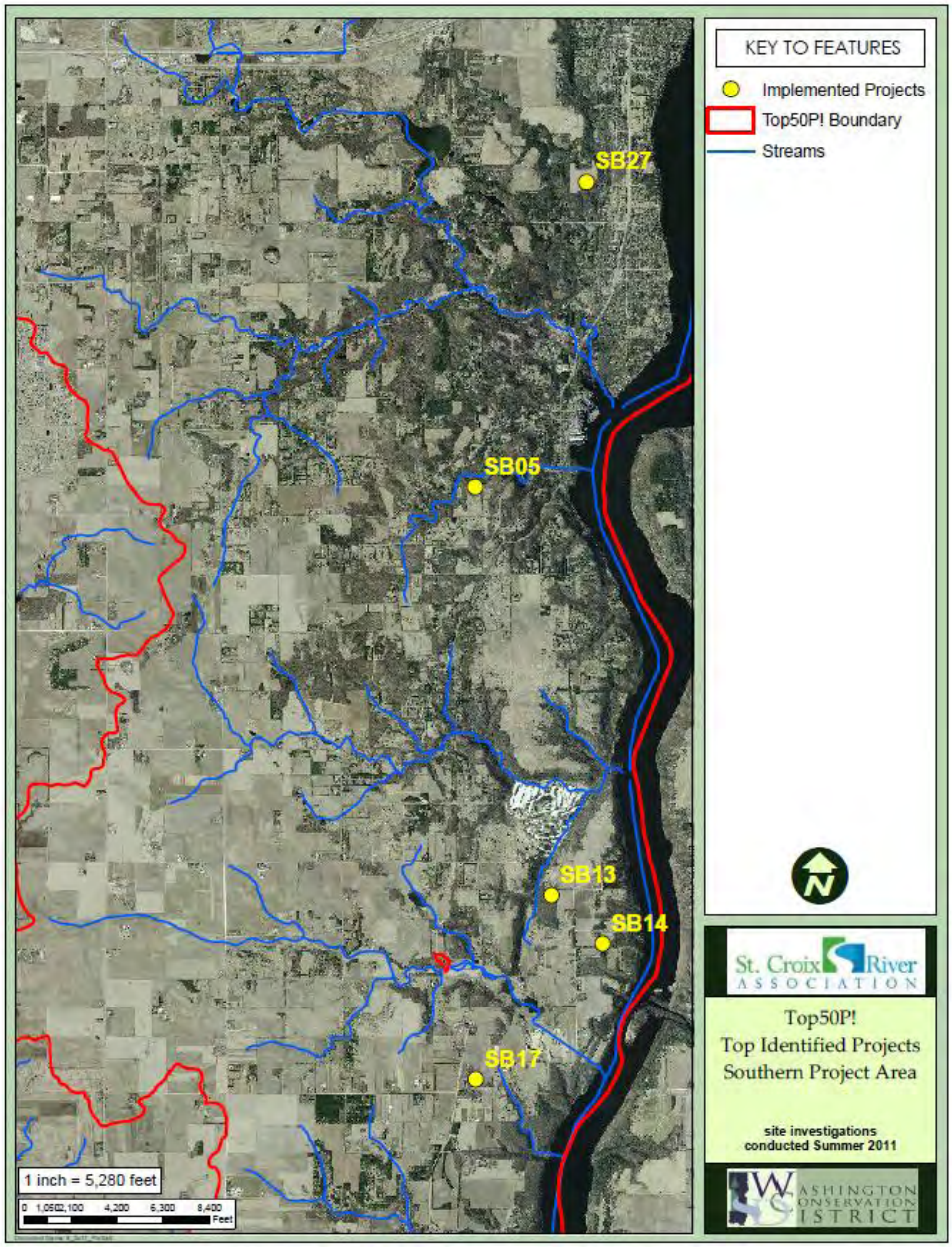
Of the 59 priority projects identifed, five were determined to have a high potential for rapid implementation. These Top5 projects include the following project IDs:

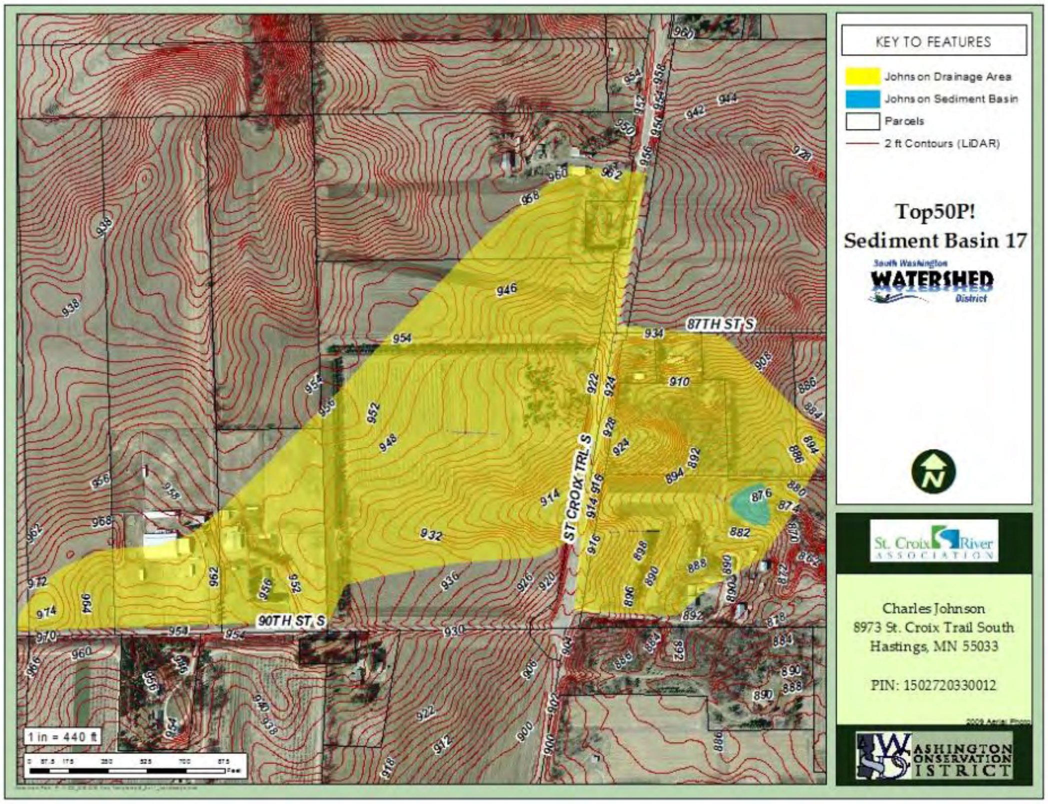
Project ID	Rank
Sediment Basin 5	44
Sediment Basin 13	29
Sediment Basin 14	34
Sediment Basin 17	32
Sediment Basin 27	35

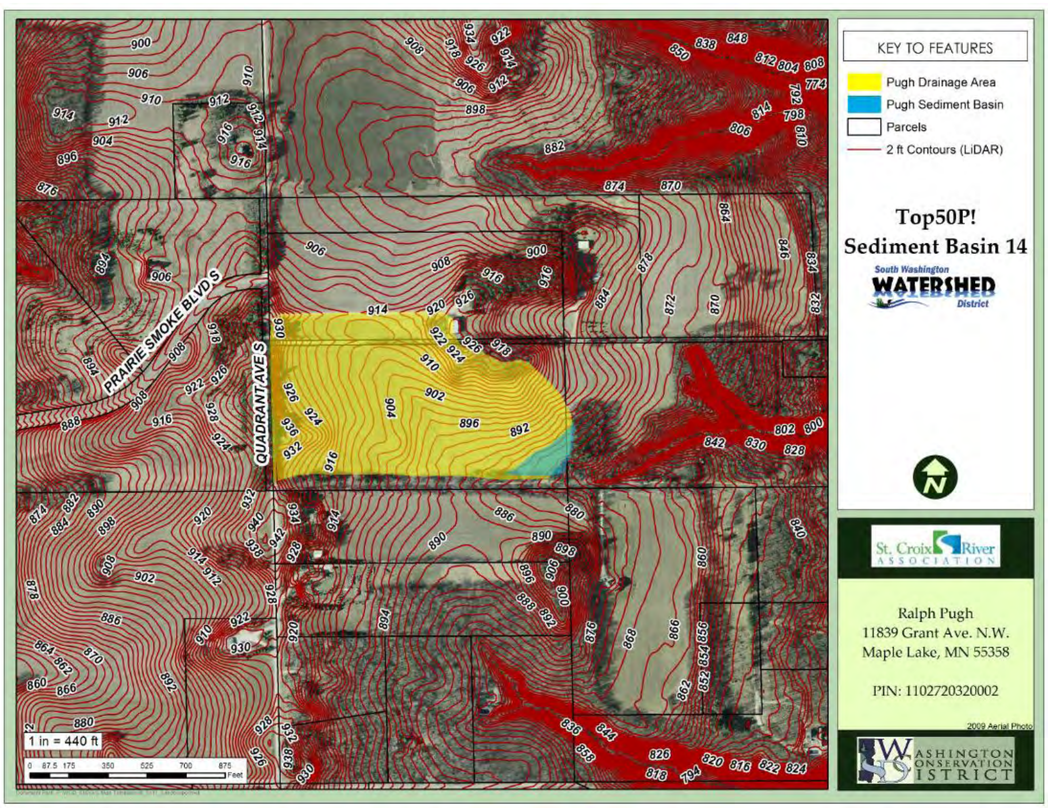
Total Phosphorus load reduction for these five projects: 163.04 Pounds.

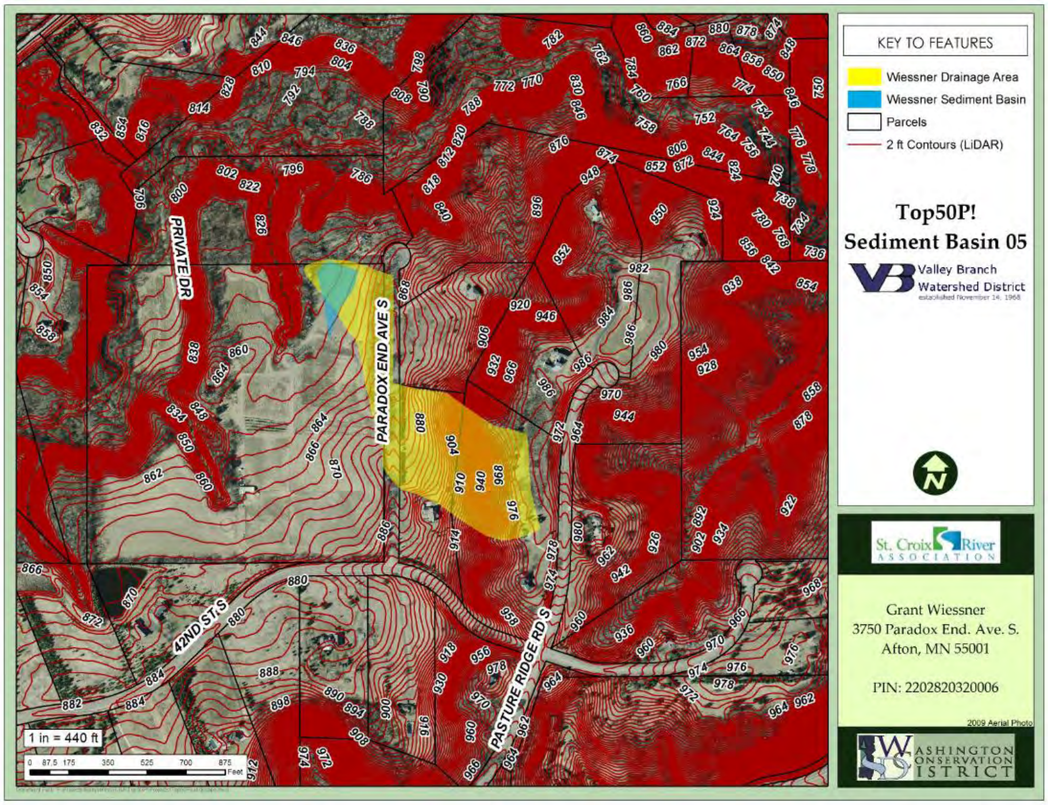
The drawings on the following pages show the topgraphy, drainage area, and sediment basin location for each of the five projects installed.

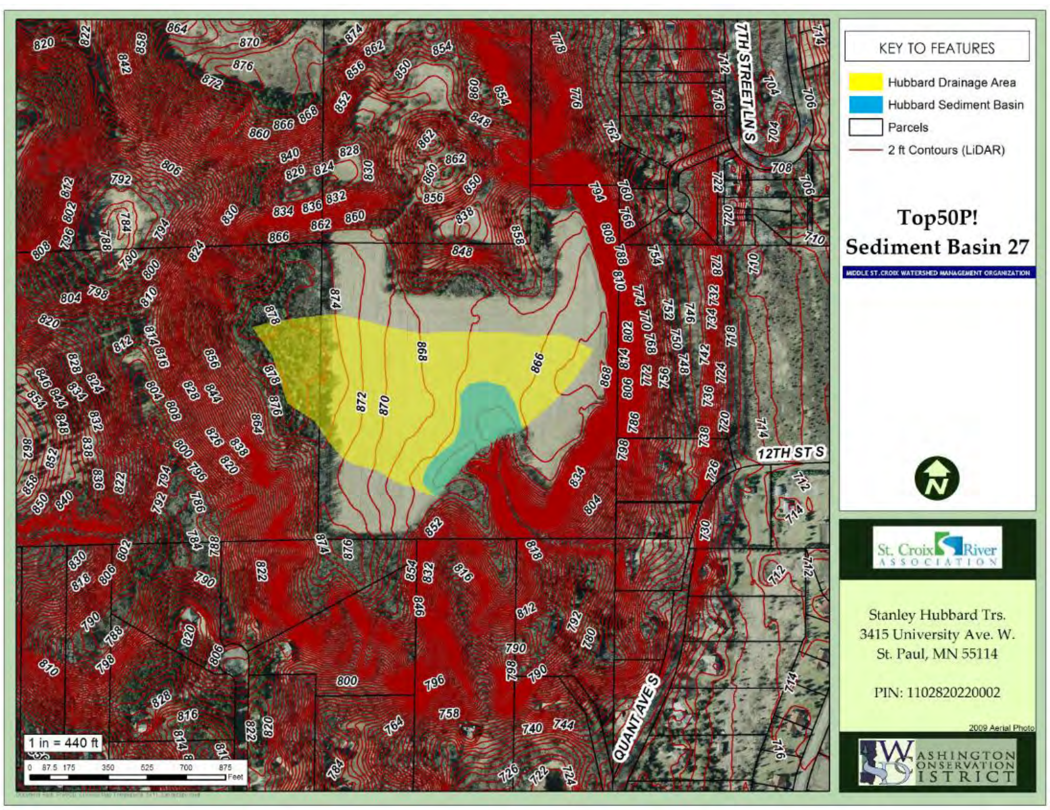
See Appendix B for Fact sheets for each of the projects implemented.

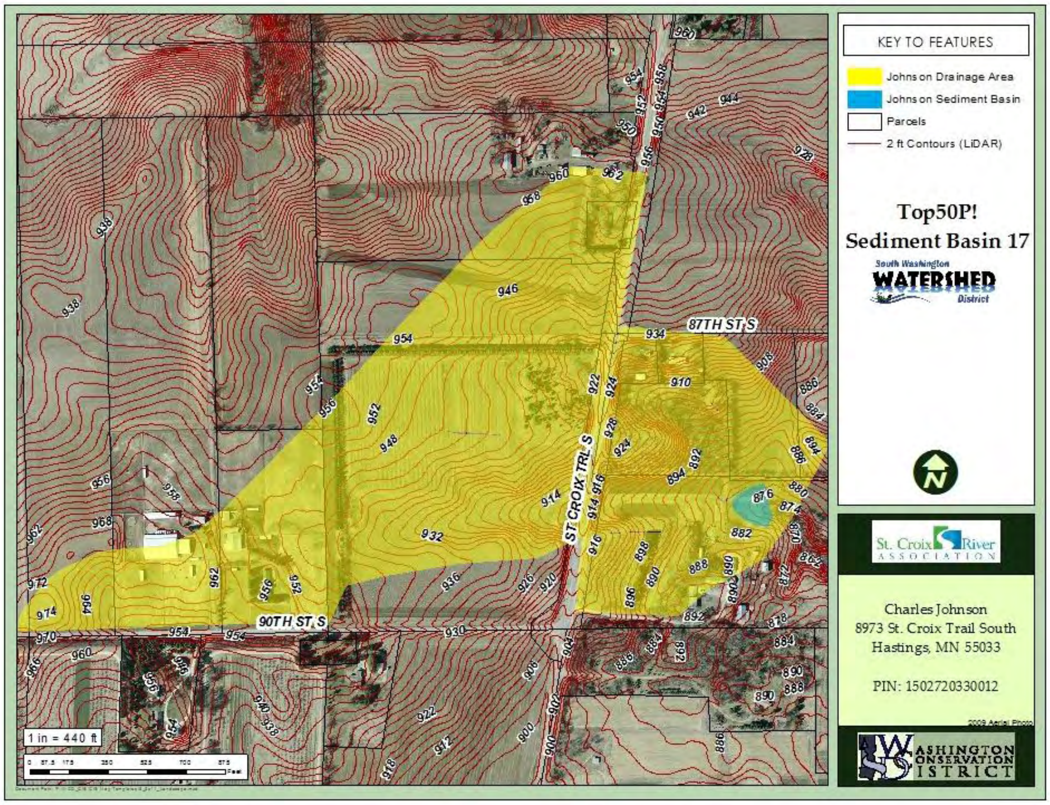



KEY TO FEATURES
Johnson Drainage Area
Johnson Sediment Basin
Parcels
2 ft Contours (LiDAR)
Top50P!
Sediment Basin 17
South Washington
WATERSHED
District
87TH ST S
ST CROIX TRL S
90TH ST S
1 in = 440 ft
St. Croix River Association
Charles Johnson
8973 St. Croix Trail South
Hastings, MN 55033
PIN: 1502720330012
2009 Aerial Photo
Washington Conservation District


KEY TO FEATURES
Pugh Drainage Area
Pugh Sediment Basin
Parcels
2 ft Contours (LiDAR)
Top50P!
Sediment Basin 14
South Washington
WATERSHED
District
PRAIRIE SMOKE BLVD S
QUADRANT AVE S
1 in = 440 ft
St. Croix River Association
Ralph Pugh
11839 Grant Ave. N.W.
Maple Lake, MN 55358
PIN: 1102720320002
2009 Aerial Photo
Washington Conservation District


KEY TO FEATURES
Wiessner Drainage Area
Wiessner Sediment Basin
Parcels
2 ft Contours (LiDAR)
Top50P!
Sediment Basin 05
Valley Branch Watershed District
St. Croix River Association
Grant Wiessner
3750 Paradox End. Ave. S.
Afton, MN 55001
PIN: 2202820320006
2009 Aerial Photo
Washington Conservation District
PRIVATE DR
PARADOX END AVE S
PASTURE RIDGE RD S
42ND ST S
1 in = 440 ft
0 87.5 175 350 525 700 875
Feet


KEY TO FEATURES
Hubbard Drainage Area
Hubbard Sediment Basin
Parcels
2 ft Contours (LiDAR)
Top50P!
Sediment Basin 27
MIDDLE ST. CROIX WATERSHED MANAGEMENT ORGANIZATION
St. Croix River Association
Stanley Hubbard Trs.
3415 University Ave. W.
St. Paul, MN 55114
PIN: 1102820220002
2009 Aerial Photo
Washington Conservation District
7TH STREET LN S
12TH ST S
QUANT AVE S
1 in = 440 ft
0 87.5 175 350 525 700 875
Feet


KEY TO FEATURES
Johnson Drainage Area
Johnson Sediment Basin
Parcels
2 ft Contours (LiDAR)
Top50P!
Sediment Basin 17
South Washington WATERSHED District
St. Croix River Association
Charles Johnson
8973 St. Croix Trail South
Hastings, MN 55033
PIN: 1502720330012
2009 Aerial Photo
Washington Conservation District
87TH ST S
90TH ST S
ST CROIX TRL S
1 in = 440 ft

Appendix A

Contents:

1. Example Scoping Document

2. C-factor, Rv-factor, & EMC-factor Table

3. Top50P Field Key

4. Top50P Field Codes

1: *Example Scoping Document*

Sample Subwatershed – EWD

I. Partners	
3.10.2011	1:00 - 3:00
Meeting called by	Washington Conservation District (WCD)
Type of meeting	Planning and Scoping
Facilitator	Pete Young (WCD)
Note taker	Jay Riggs (WCD)
Other Attendees	Amy Carolan (Example Watershed District), Andy Schilling (WCD), City of Stillwater

II. Needs and Capabilities Assessment

1 hour

Discussion

Establish LGU interest level and regulatory drivers that will shape watershed goals and evaluate existing local retrofit capa city and needs.

Conclusions

1. Regulatory drivers
2. Data availability (GIS layers, monitoring info, reports, plans, etc.)
3. EWD, community capabilities: BMP Program, maintenance of stormwater infrastructure
4. Government and non-government partnerships
5. Residents' knowledge of water quality issues; common concerns (algae, water clarity, etc.)
6. Key community contacts: media, politicians, local groups/associations, local outreach opportunities
7. Funding resources (for assessment, outreach, and future projects)
8. Listed species of concern in subwatershed

Action Items	Person Responsible	Deadline
ITEM 1	WCD	ASAP
ITEM 2	WCD	ASAP
ITEM 3	EWD	DATE
ITEM 4	EWD	DATE
ITEM 5	CITY	DATE
ITEM 6	WCD	DATE

III. Existing Data Analysis

20 minutes

Discussion

Define key problems and impairments in the watershed; target retrofit efforts to assist in shaping goals a nd objectives through analysis of historical data; identify quantity, quality and resolution of existing data and additional resources required.

Data Needed or Revision	Task	Partner	Deadline
DATA NEEDED 1	OBTAIN	CITY	ASAP
DATA NEEDED 2	OBTAIN	EWD	ASAP
DATA NEEDED 3	OBTAIN	EWD	ASAP

Pollutant/WQ Problem of Concern	Partner
1. TP	EWD
2. Volume	CITY, EWD
3. TSS	CITY, EWD
4. Non-native/invasive vegetation	CITY, EWD
5. POLLUTANT 5	EWD

Action Items	Person Responsible	Deadline
Talk to City/Watershed to obtain shapefiles	WCD STAFF 1	ASAP
ACTION ITEM 2	MCD STAFF 1	ASAP
ACTION ITEM 3	WCD STAFF 2	ASAP

2: C-Factor, Rv-Factor, & EMC-Factor Table

C_NUM	C_ALPHA	C_TEXT	EMC	C_FACTOR	RV
11110	1.tt.CC.I10.	4% to 10% impervious cover with coniferous trees	0.04000	0.00250	0.11300
11114	1.tt.CC.I10.cRC.	Eastern red cedar (woodland) with 4-10% impervious cover	0.04000	0.00250	0.11300
11116	1.tt.CC.I10.cPR.	Planted red pine with 4-10% impervious cover	0.04000	0.00250	0.11300
11119	1.tt.CC.I10.cPC.	Other planted conifers with 4-10% impervious cover	0.04000	0.00250	0.11300
11210	1.tt.CD.I10.	4% to 10% impervious cover with deciduous trees	0.04000	0.00250	0.11300
11211	1.tt.CD.I10.cOA.	Oak (forest or woodland) with 4-10% impervious cover	0.04000	0.00250	0.11300
11212	1.tt.CD.I10.cNH.	Northern hardwood (forest) with 4-10% impervious cover	0.04000	0.00250	0.11300
11214	1.tt.CD.I10.cBG.	Boxelder-green ash (forest) with 4-10% impervious cover	0.04000	0.00250	0.11300
11215	1.tt.CD.I10.cAB.	Aspen-birch (forest) with 4-10% impervious cover	0.04000	0.01000	0.11300
11216	1.tt.CD.I10.cAF.	Aspen (forest, woodland) with 4-10% impervious cover	0.04000	0.01000	0.11300
11217	1.tt.CD.I10.cPA.	Planted ash with 4-10% impervious cover	0.04000	0.00250	0.11300
11219	1.tt.CD.I10.cPD.	Other deciduous trees with 4-10% impervious cover	0.04000	0.00250	0.11300
11300	1.tt.CM.	Artificial surfaces with mixed coniferous and deciduous tree cover	0.00000	0.01000	0.00000
11310	1.tt.CM.I10.	4% to 10% impervious cover with mixed coniferous/deciduous trees	0.04000	0.01000	0.11300
11311	1.tt.CM.I10.cMF.	Mixed pine-hardwood (forest) with 4-10% impervious cover	0.04000	0.01000	0.11300
11312	1.tt.CM.I10.cWH.	White pine-hardwood (forest) with 4-10% impervious cover	0.04000	0.00250	0.11300
11314	1.tt.CM.I10.cPM.	Planted mixed coniferous/deciduous trees with 4-10% impervious cover	0.04000	0.00250	0.11300
12112	1.ss.CS.I10.cGL.	Long grasses with planted coniferous and/or deciduous shrubs, 4-10% im	0.04000	0.01000	0.11300
12210	1.ss.CE.I10.	4% to 10% impervious cover with coniferous and/or deciduous shrubs an	0.04000	0.01000	0.11300
13100	1.hh.CT.	Artificial surfaces with perennial grasses with sparse trees	0.00000	0.00300	0.00000
13114	1.hh.CT.I10.cGS.	Short grasses and mixed trees with 4-10% impervious cover	0.32000	0.00300	0.11300
13115	1.hh.CT.I10.cGL.	Long grasses and mixed trees with 4-10% impervious cover	0.04000	0.00300	0.11300
13124	1.hh.CT.I25.cGS.	Short grasses and mixed trees with 11-25% impervious cover	0.32000	0.00300	0.21200
13134	1.hh.CT.I50.cGS.	Short grasses and mixed trees with 26-50% impervious cover	0.32000	0.00300	0.39200
13211	1.hh.CG.I10.cGS.	Short grasses with 4-10% impervious cover	0.32000	0.00200	0.11300
13221	1.hh.CG.I25.cGS.	Short grasses with 11-25% impervious cover	0.32000	0.00200	0.21200
13231	1.hh.CG.I50.cGS.	Short grasses with 26-50% impervious cover	0.32000	0.00200	0.39200
13241	1.hh.CG.I75.cGS.	Short grasses with 51-75% impervious cover	0.32000	0.00200	0.61700
14200	1.mv.EE.	Exposed earth	0.00000	0.80000	0.00000
23111	2.ph.CT.pUS.cGS.	Short grasses with sparse tree cover on upland soils	0.32000	0.10000	0.30000
31130	3.ce.UP.nRP.	Red pine forest	0.04000	0.00100	0.02000
31140	3.ce.UP.nWF.	White pine forest	0.04000	0.01000	0.02000
31210	3.ce.WB.nTS.	Tamarack swamp	0.03000	0.00100	0.02000
31211	3.ce.WB.nTS.nTE.	Tamarack swamp seepage subtype	0.03000	0.00100	0.02000
31212	3.ce.WB.nTS.nTM.	Tamarack swamp minerotrophic subtype	0.03000	0.00100	0.02000
31213	3.ce.WB.nTS.nTP.	Tamarack swamp sphagnum subtype	0.03000	0.00100	0.02000
32110	3.da.UP.nOA.	Oak forest	0.04000	0.01000	0.02000
32111	3.da.UP.nOA.nOL.	Oak forest red maple subtype	0.04000	0.00200	0.02000
32112	3.da.UP.nOA.nOM.	Oak forest mesic subtype	0.04000	0.01000	0.02000
32113	3.da.UP.nOA.nOD.	Oak forest dry subtype	0.04000	0.00200	0.02000
32120	3.da.UP.nNH.	Northern hardwood forest	0.04000	0.00200	0.02000
32131	3.da.UP.nPB.nPN.	Paper birch forest northern hardwoods subtype	0.04000	0.00200	0.02000
32140	3.da.UP.nAB.	Aspen-birch forest	0.04000	0.01000	0.02000
32141	3.da.UP.nAB.nAN.	Aspen-birch forest northern hardwoods subtype	0.04000	0.00200	0.02000
32150	3.da.UP.nMB.	Maple-basswood forest	0.04000	0.01000	0.02000
32160	3.da.UP.nAF.	Aspen forest	0.04000	0.00200	0.02000
32170	3.da.UP.nAT.	Altered/non-native deciduous forest	0.04000	0.01000	0.02000
32200	3.da.WA.	Temporarily flooded deciduous forest	0.04000	0.00200	0.02000
32210	3.da.WA.nFF.	Floodplain forest	0.04000	0.00200	0.02000
32211	3.da.WA.nFF.nFM.	Floodplain forest silver maple subtype	0.04000	0.01000	0.02000
32220	3.da.WA.nLH.	Lowland hardwood forest	0.04000	0.01000	0.02000
32230	3.da.WA.nAF.	Aspen forest - temporally flooded	0.04000	0.00200	0.02000
32240	3.da.WA.nAT.	Altered/non-native temporarily flooded deciduous forest	0.04000	0.00200	0.02000
32310	3.da.WB.nBA.	Black ash swamp	0.03000	0.01000	0.02000
32311	3.da.WB.nBA.nBE.	Black ash swamp seepage subtype	0.03000	0.01000	0.02000
32320	3.da.WB.nMH.	Mixed hardwood swamp	0.03000	0.00200	0.02000
32321	3.da.WB.nMH.nMS.	Mixed hardwood swamp seepage subtype	0.03000	0.00200	0.02000
32330	3.da.WB.nAF.	Aspen forest - saturated soils	0.03000	0.01000	0.02000
32340	3.da.WB.nAT.	Altered/non-native saturated soils deciduous forest	0.03000	0.00200	0.02000
32410	3.da.WC.nBA.	Black ash swamp - seasonally flooded	0.03000	0.00200	0.02000
32420	3.da.WC.nMH.	Mixed hardwood swamp - seasonally flooded	0.03000	0.00200	0.02000
32430	3.da.WC.nAT.	Altered/non-native seasonally flooded deciduous forest	0.03000	0.00200	0.02000
33110	3.cd.UP.nMF.	Mixed pine-hardwood forest	0.04000	0.01000	0.02000
33140	3.cd.UP.nWH.	White pine-hardwood forest	0.04000	0.00200	0.02000
41130	4.ce.UP.nRC.	Eastern Red Cedar woodland	0.04000	0.00100	0.02500
42110	4.da.UP.nAW.	Aspen woodland	0.04000	0.01000	0.02500
42120	4.da.UP.nOW.	Oak woodland-brushland	0.04000	0.01000	0.02500
42130	4.da.UP.nAT.	Altered/non-native deciduous woodland	0.04000	0.00300	0.02500
42210	4.da.WA.nAT.	Altered/non-native deciduous woodland - temporarily flooded	0.04000	0.00300	0.02500
42300	4.da.WB.	Saturated deciduous woodland	0.03000	0.00300	0.02500
42310	4.da.WB.nAT.	Altered/non-native deciduous woodland - saturated	0.03000	0.00300	0.02500
42410	4.da.WC.nAT.	Altered/non-native deciduous woodland - seasonally flooded	0.03000	0.00300	0.02500
43110	4.cd.UP.nAT.	Altered/non-native mixed woodland	0.04000	0.00300	0.02500
51111	5.ce.WB.nOB.nOL.	Open sphagnum bog intermediate subtype	0.03000	0.01000	0.02500
51120	5.ce.WB.nPT.	Scrub tamarack poor fen	0.03000	0.00100	0.02500
52120	5.da.UP.nNT.	Native dominated disturbed upland shrubland	0.04000	0.01000	0.02500
52130	5.da.UP.nAT.	Altered/non-native dominated upland shrubland	0.04000	0.01000	0.02500
52210	5.da.WA.nNT.	Native dominated temporarily flooded shrubland	0.04000	0.00300	0.02500
52220	5.da.WA.nAT.	Altered/non-native dominated temporarily flooded shrubland	0.04000	0.01000	0.02500
52300	5.da.WB.	Saturated deciduous shrubland	0.03000	0.00300	0.02500
52310	5.da.WB.nSN.	Shrub fen	0.03000	0.01000	0.02500

3: Top50P Field Key

Top50P! Field Key

Table of Contents
(Potential Sources of Phosphorus for Rural Areas)

4: Top50P Field Codes

Top 50 P! Practice Code Sheet

Code	Rural/Ag BMP
BFS	Buffer Strip
CTF	Contour Farming
COV	Cover Crop
DIV	Diversion
FTS	Filter Strip
GSS	Grade Stabilization Structure
GWW	Grassed Waterway
NMP	Nutrient Management Plan
PRG	Prescribed Grazing
RES	Residue Management
HAB	Habitat Restoration
SBP	Streambank Protection
SCR	Strip Cropping
TER	Terrace
SCB	Sediment Control Basin
WTC	Wetland Creation
WTE	Wetland Enhancement
WTR	Wetland Restoration
SEP	Septic Fix
FDF	Feedlot Fix

Code	Urban BMP
PND	Pond Retrofits
EXD	Extended Detention
WTP	Wet Pond
WET	Stormwater Wetland
INB	Infiltration Basin
SDC	Stormwater disconnect to pervious area
ICC	Inpervious Cover Conversion
RBR	Rain Barrels
CIS	Cisterns
DWL	French Drain/Dry Well
WTS	Wet Swale (vegetated swale with no underdrain)
WQP	Water Quality Swale (Dry Swale (swale with filtration media and drain tile)
USF	Underground Sand Filter
SSF	Structural Sand Filter (a surface filter including peat, compost, iron amendments, or similar)
RDG	Rain Leader Disconnect Raingardens
BRA	Simple Bioretention (no engineered soils or under-drains, but w/curb cuts and forebays)
BRB	Moderate Bioretention (Engineered soils, under-drains, curbcuts, forbays but no retaining walls)
BRC	Complex Bioretention (as BRB but with partial, or 1-3 ft. retaining walls)
DRD	Highly Complex Bioretention (as BRB but with perimeter or 3-5 ft. retaining walls)
STP	Stormwater Tree Pits
SPL	Stormwater Planter
PPG	Grass.Gravel Permeable Pavement (sand base)
PPA	Permeable Asphalt (granite base)
PPC	Permeable Concrete (granite base)
PPP	Permeable Pavers (granite base)
EGR	Extensive Green Roof
IGR	Intensive Green Roof

Code	Existing Practice
Soy Beans	Use text to note existing crops (soy beans, corn, small grain, etc.)
EX ___	Modifier for existing BMPs
___% Res.	% Residue for crop fields
C&G	Curb and Gutter
CB	Catchment Basin

Code	Site Visit/BMP Priortization
SV1	Highest Priority Site Visit
SV2	Nice To Have Site Visit
1	Prime: ideally situated within catchment, few physical constraints, little to no grading required, easy maintance
2	Alternate: a possible substitute for Prime location with oderate indicators

Code	Example
EX GWW	There is an existing Grassed Waterway in this location
GWW1	A perfect site/parcel for a Grassed Waterway
SCB2	An alternate site/parcel for a Sediment Basin, after all prime sites have been pursued

Appendix B

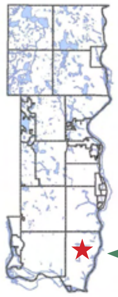
Project Fact Sheets

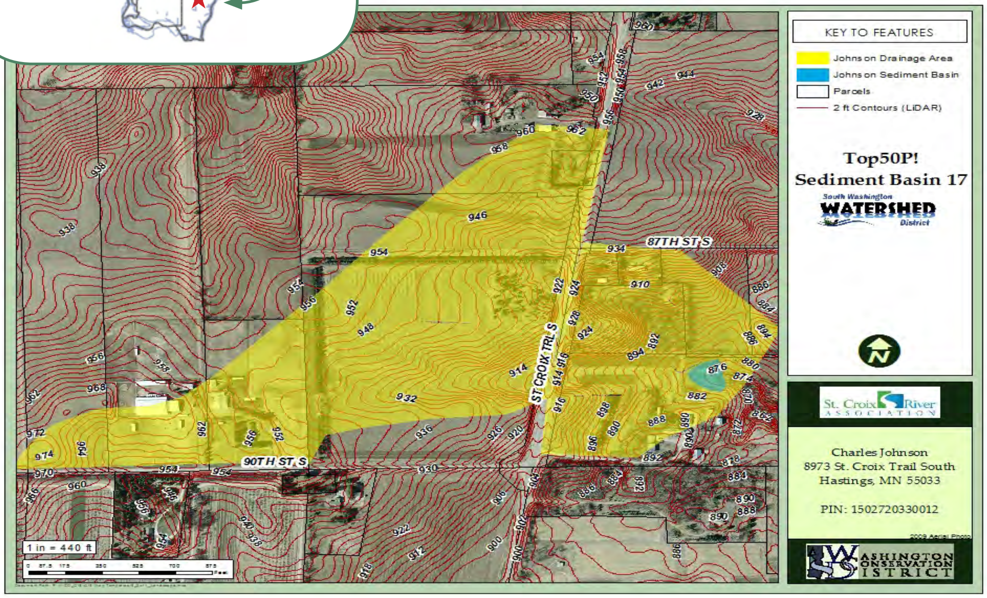
Top50P! Sediment Basin 17
~Charles Johnson~

Project Overview: In 2012, the Washington Conservation District (WCD) and the Natural Resource Conservation Service (NRCS) worked with Charles Johnson to design and install a sediment basin on his property in Denmark Twp. to prevent further erosion to an existing gully. The sediment basin treats runoff from 77 acres of land, preventing future downstream erosion and allowing pollutants from the upper reaches of the watershed to settle out before the water flows downstream to the St. Croix River.

Above: A pipe coming out of the berm controls the rate at which runoff discharges to the gully below.

Location:
Denmark Twp., MN
St. Croix River Basin





Practice:
Water and Sediment Control Basin (WASCOB)

Constructed:
November 2012

Watershed:
South Washington, St. Croix River Basin

Pollution Reduction:
- Total Phosphorus: 33.2 lb/yr
- Total Soil: 95.7 T/yr
- Total Suspended Solids: 18.3 T/yr

Distance to St. Croix:
4000 ft

WASHINGTON CONSERVATION DISTRICT

South Washington WATERSHED District

St. Croix River ASSOCIATION

Top50P! Sediment Basin 17
~Charles Johnson~

Location: Section 15, T27N, R20W, Denmark Township, MN

Drainage Area:
77.8 acres

WASCOB Size:
0.522 acres

Project Costs:
SCRA: $17,044.96
SWWD: $5,681.66
Landowner: $6,271.95
TOTAL COST - $28,998.57

Benefits:
- Prevents erosion of downstream gully
- Allows sediment and other pollutants to settle out before water flows downstream to the St. Croix River

May I Visit?
Please contact the WCD for more information.

651-275-1136
www.mnwcd.org

Introduction

The WCD and NRCS partnered in the survey and design of Sediment Basin 17 on the Charles Johnson property. While working on a different conservation project on the Johnson property, WCD and NRCS staff discovered a gully that was forming in another location. Because Johnson's land was located within the Top50P! priority area, repairing the gully was added to a list of potential projects to be completed with Top50P! funding. The project ranked at the top of the list of projects to be implemented due to its location and projected pollution reduction.

Before: Runoff was creating a gully and erosion.

Project Information

The solution was to construct a water and sediment control basin (WASCOB) in the forming gully. The WASCOB controls the rate in which runoff water is discharged into the gully, preventing further erosion and degradation of the downstream gully, and backing the water up so that sediment and other pollutants can settle out before discharging into the gully. This practice will help with further erosion and will reduce pollution to the St. Croix River well into the future.

Challenges

The goal of this project was to slow down runoff and prevent further erosion to a gully. Due to the large drainage area - 77 acres - it was a challenge to construct a sediment basin with enough capacity to pond the large volume of water moving through the system without backing water up onto cropland. Finding enough fill to build the very large berm was also a challenge. To resolve these issues, the berm was moved further into the gully to keep the ponding water off of Johnson's cropland, and the fill needed for the project was found on the west side of St. Croix Trail S. and trucked to the east side of the road where the berm was constructed.

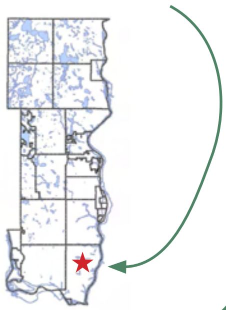
After: A berm backs up the runoff water, which outlets more slowly to the gully.

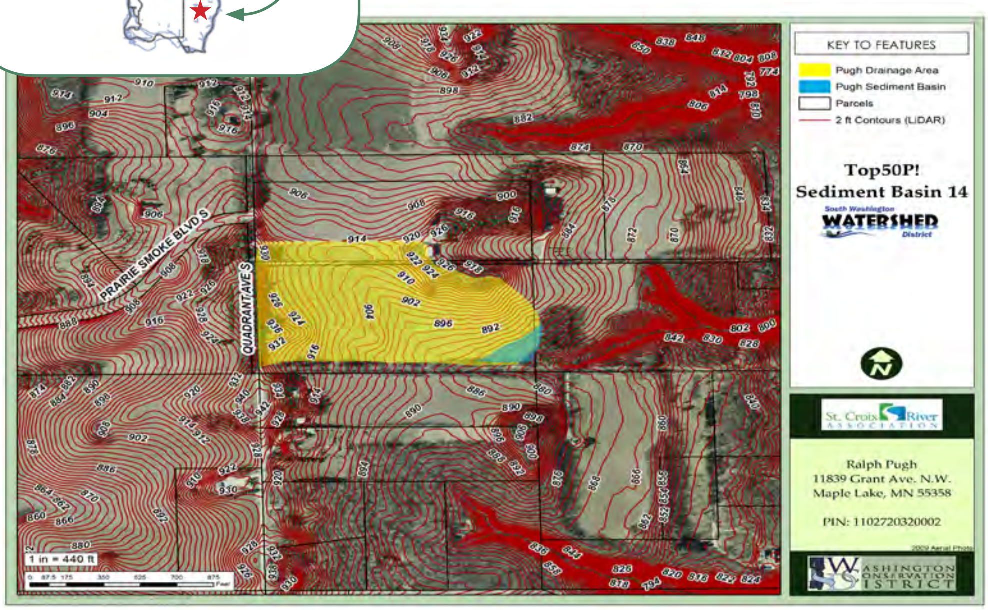
Top50P! Sediment Basin 14
~Ralph Pugh~

Project Overview: In 2012, the Washington Conservation District (WCD) worked with Ralph Pugh to design and install a sediment basin on his property in Denmark Twp. to stop erosion and prevent a gully from forming. The sediment basin treats runoff from 20 acres of land, preventing future downstream erosion and allowing pollutants from the upper reaches of the watershed to settle out before the water flows downstream to the St. Croix River.

Above: An outlet structure and erosion control materials prevent runoff from causing further erosion.

Location:
Denmark Twp., MN
St. Croix River Basin





Practice:
Water and Sediment Control Basin (WASCOB)

Constructed:
December 2012

Watershed:
South Washington,
St. Croix River Basin

Pollution Reduction:
- Total Phosphorus: 45.9 lb/yr
- Total Soil: 107.05 T/yr
- Total Suspended Solids: 39.63 T/yr

Distance to St. Croix:
2000 ft

WASHINGTON CONSERVATION DISTRICT

South Washington WATERSHED District

St. Croix River ASSOCIATION

Top50P! Sediment Basin 14
~Ralph Pugh~

Location: Section 11, T27N, R20W, Denmark Township, MN

Drainage Area:
19.6 acres

WASCOB Size:
0.687 acres

Project Costs:
SCRA: $10,288.50
SWWD: $3,429.58
Landowner: $8,593.56
TOTAL COST - $22,311.24

Benefits:
- Prevents erosion from creating a downstream gully
- Allows sediment and other pollutants to settle out before water flows downstream to the St. Croix River

May I Visit?
Please contact the WCD for more information.

651-275-1136
www.mnwcd.org

Introduction
Sediment Basin 14 was identified through the Top50P process and was modified to include a grade stabilization structure after active gully erosion was discovered during the field work phase of the project.


Above: Surveying the field before building the sediment basin.

The Challenge
The Challenge of the project was to stop the active gully erosion that was starting to erode and cut into the agricultural field. To do this, the runoff from the agricultural field needed to be captured in order to reduce the rate in which it is discharged into the gully.

The Solution
The solution was to construct a water and sediment control basin (WASCOB) where the gully was starting to erode into the field. The WASCOB backs water up into the field, controlling the rate at which the runoff from the field discharges into the gully. The water backs up less than 24 hours when runoff occurs, allowing for pollutants to settle out before discharging into the gully. The upper reaches of the gully were also stabilized to prevent further erosion. This project will reduce pollution to the St. Croix River well into the future.

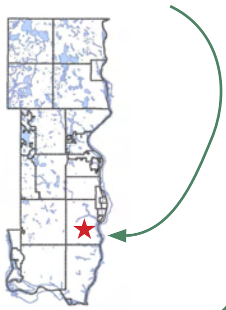

After: A berm at the back corner of the field allows water to temporarily pond before flowing out more slowly through the outlet structure.

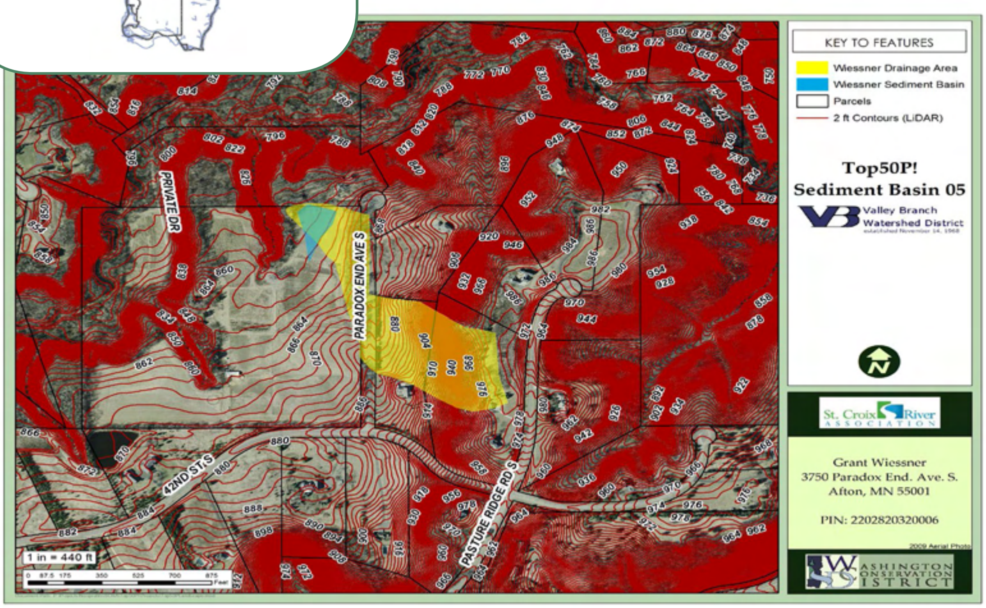
Top50P! Sediment Basin 05
~ Grant Wiessner ~

Project Overview: In 2013, the Washington Conservation District (WCD) worked with Grant Wiessner to design and install a sediment basin and stabilize a gully on his property in Afton, which drains to Kelle's Creek. The sediment basin treats runoff from 11 acres of land, preventing further erosion and allowing pollutants from the upper reaches of the watershed to settle out before reaching the creek, which flows downstream to the St. Croix River.

Above: The newly constructed berm and rate control structure before seeding.

Location:
Afton, MN
St. Croix River Basin





Practice:
Water and Sediment Control Basin (WASCOB)

Constructed:
June 2013

Watershed:
Valley Branch,
St. Croix River Basin

Pollution Reduction:
- Total Phosphorus: 42.5 lb/yr
- Total Soil: 38.25 T/yr
- Total Suspended Solids: 40.5 T/yr

Distance to Kelle's Creek: 875 ft

Top50P! Sediment Basin 05
~ Grant Wiessner ~

Location: Section 22, T.028N., R.020W., Afton, MN

Drainage Area:
10.57 acres

WASCOB Size:
0.707 acres

Project Costs:
SCRA: $10,142.50
Landowner: $4,798.72
TOTAL COST - $14,941.22

Benefits:

- Prevents erosion and repairs an existing gully
- Allows sediment and other pollutants to settle out before water flows downstream to Kelle's Creek and the St. Croix River

May I Visit?
Please contact the WCD for more information.

651-275-1136
www.mnwcd.org

Introduction

The sediment basin 05 project came about when Grant Wiessner called the Washington Conservation District for technical and financial assistance through the Valley Branch Watershed District to repair gullies forming on his property. WCD staff saw the property on a site visit and noted the gullies, which were added to the Top50P! project list. With a willing landowner and a sizable load reduction estimate, the project ranked highly for implementation.

Above: WCD employee Adam King surveys the gully on the Wiessner property.

The Challenge

The challenge of this project was to prevent runoff from draining into the actively eroding gully and stabilize the sides of the gully to prevent future erosion.

After: A berm at the back corner of the field allows water to temporarily pond before flowing out more slowly through the outlet structure into the gully.

The Solution

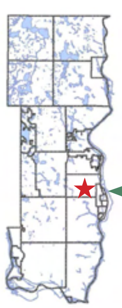
The solution was to build a water and sediment control basin that ponds runoff, settling out pollutants before the water enters a pipe that transports water into the gully. Grade stabilization techniques were used on the sides of the gully to decrease further erosion. This project will reduce pollution to Kelle's Creek and the St. Croix River well into the future..

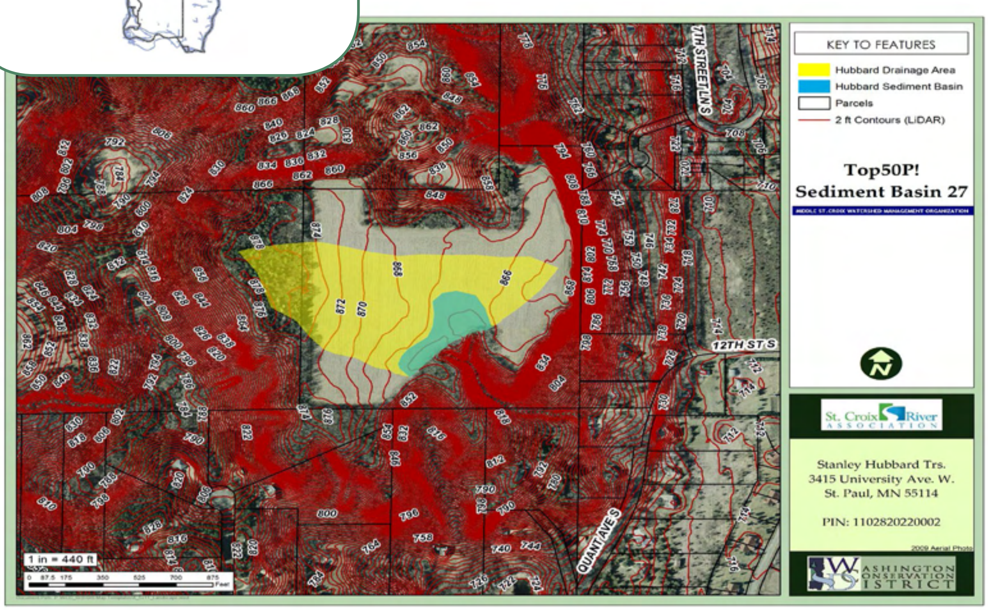
Top50P! Sediment Basin 27
~ Stanley Hubbard ~

Project Overview: In 2013, the Washington Conservation District (WCD) worked with Stanley Hubbard to design and install a sediment basin on his property in Lakeland to prevent further erosion to an actively forming gully. The sediment basin treats runoff from 17 acres of land, preventing further erosion and allowing pollutants from the upper reaches of the watershed to settle out before flowing downstream to the St. Croix River.

Above: Runoff water from rain and melting snow pond behind the berm instead of flowing straight into a gully in the woods.

Location:
Lakeland, MN
St. Croix River Basin





Practice:
Water and Sediment Control Basin (WASCOB)

Constructed:
June 2013

Watershed:
Middle St. Croix,
St. Croix River Basin

Pollution Reduction:
- Total Phosphorus: 16.04 lb/yr
- Total Soil: 58.43 T/yr
- Total Suspended Solids: 10.16 T/yr

Distance to St. Croix:
4000 ft

Washington Conservation District

St. Croix River Association

Top50P! Sediment Basin 27
~ Stanley Hubbard ~

Location: Section 11, T.028N, R.020W, Lakeland, MN

Drainage Area:
16.6 acres

WASCOB Size:
2.096 acres

Project Costs:
SCRA: $17,850.43
MSCWMO: $500.00
Landowner: $17,454.82
TOTAL COST - $35,305.25

Benefits:
- Prevents further erosion to an existing gully
- Allows sediment and other pollutants to settle out before water flows downstream to the St. Croix River

May I Visit?
Please contact the WCD for more information.

651-275-1136
www.mnwcd.org

Introduction

During the Afton-Lakeland Gully Inventory conducted by Middle St. Croix WMO, two potential sites were identified for sediment basin projects. Because the property is located within the Top50P! priority area, the sediment basins were added to the list of potential projects for Top50P! funding. Of the two, sediment basin 27 placed higher on the list because of its actively eroding gully.

Before: One of the eroding gullies on the Hubbard property.

The Challenge

The challenge of sediment basin 27 was to reduce the overland flow and halt the actively eroding gully from encroaching onto the agricultural field.

The Solution

The solution was to build a water and sediment control basin (WASCOB). The WASCOB controls the rate in which water is discharged into the gully, preventing further erosion and degradation of the downstream gully, and backing the water up, allowing for sediment and other pollutants to settle out before discharging into the gully. This practice will help with further erosion and reduce the pollutants to the St. Croix River well into the future.

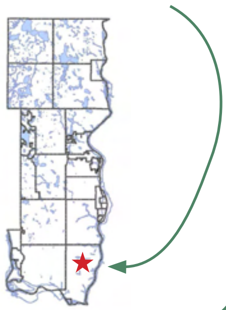
After: A berm along the edge of the field allows water to temporarily pond before flowing out more slowly through an outlet structure into the woods.

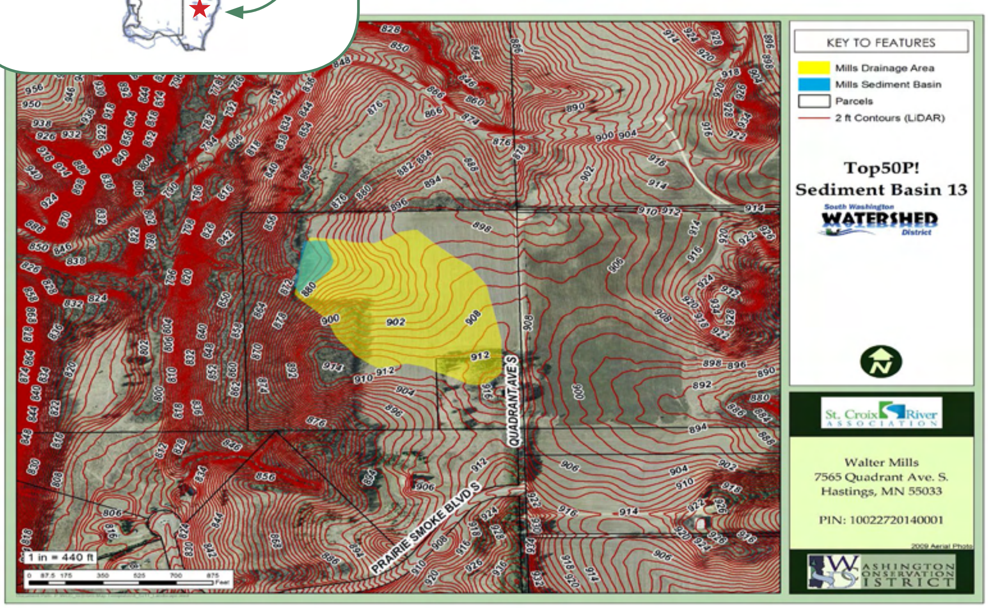
Top50P! Sediment Basin 13
~ Walter Mills ~

Project Overview: In 2013, the Washington Conservation District (WCD) worked with Walter Mills to design and install a sediment basin on his property in Denmark Twp. to stop erosion and prevent a gully from eroding further into his farm field. The sediment basin treats runoff from 14 acres of land, preventing future downstream erosion and allowing pollutants from the upper reaches of the watershed to settle out before the water reaches Trout Brook, which flows downstream to the St. Croix River.

Above: During construction, an orange pipe at the far end of the field marks the location of the new outlet structure.

Location:
Denmark Twp., MN
St. Croix River Basin





Practice:
Water and Sediment Control Basin (WASCOB)

Constructed:
June 2013

Watershed:
South Washington,
St. Croix River Basin

Pollution Reduction:
- Total Phosphorus: 25.4 lb/yr
- Total Soil: 47.58 T/yr
- Total Suspended Solids: 18.35 T/yr

Distance to Trout Brook: 6,450 ft

WASHINGTON CONSERVATION DISTRICT

South Washington WATERSHED District

St. Croix River ASSOCIATION

Top50P! Sediment Basin 13
~ Walter Mills ~

Location: Section 10, T.027N., R.020W., Denmark Township, MN

Drainage Area:
14.4 acres

WASCOB Size:
0.869 acres

Project Costs:
SCRA: $0
SWWD: $13,711.25
Landowner: $14,790.00
TOTAL COST - $28,501.25

Benefits:
- Prevents erosion from creating a downstream gully
- Allows sediment and other pollutants to settle out before water flows downstream to Trout Brook and the St. Croix River

May I Visit?
Please contact the WCD for more information.

651-275-1136
www.mnwcd.org

Introduction

The sediment basin 13 project was discovered through the Top50P! process. While field surveying, the area was marked for a site visit and a letter was sent to Walter Mills for a site visit. Jean Boyd (Walter's daughter) contacted the WCD because she had noticed erosion problems on the property. The site visit confirmed the erosion problems and an actively eroding gully was identified. The site made the list, and with a willing landowner the project was implemented.

Before: A gully was forming in the woods near the edge of the farm field, causing erosion and downstream pollution.

The Challenge

The challenge of the project was to control the rate in which water flows from the field and into the actively eroding gully and stop the gully from eroding further into the crop field.

Above: WCD employee Tara Kline surveys the field where the sediment basin will be built.

The Solution

The solution was to build a water and sediment control basin (WASCOB) to hold back water into the crop field in order to control the rate that runoff flows into the gully. While the water is backed up into the crop field, pollutants will be settled out before entering the gully. This practice will help with further erosion and reduce the pollutant load to Trout Brook and ultimately the St. Croix River for years to come.