Technical Memorandum

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Board of Water and Soil Resources
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Subject: Adding practice types to PTMApp-Desktop
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Project: 7775-0016 Ph. 15 Desktop Enhancement: Benefits Analysis

PURPOSE AND LOCAL GOVERNMENT BUSINESS NEED

The Prioritize, Target, and Measure Application (PTMApp) supports the business needs of local governments and organizations implementing conservation efforts to protect or restore water quality, including: water policy development, watershed planning, conservation practice implementation strategizing, accountability reporting, fiscal planning, communication program creation, and landowner engagement. A User Needs Assessment completed in 2019 identified a need to align the conservation practice outputs from PTMApp with specific Natural Resource Conservation Service (NRCS) practice codes, such as water and sediment control basins (NRCS code 638) or cover crops (NRCS code 340).

This technical memorandum describes how PTMApp-Desktop has been enhanced to meet this local government business need. Briefly, the following enhancements were made to PTMApp, each of which are described in detail below:

- PTMApp treatment groups were divided and changed to NRCS practice codes
- Methods for targeting and quantifying benefits of water and sediment control basins (WASCOB) were changed
- Updates were made to the treatment efficiencies of individual conservation practices to capture recent data on specific NRCS practice codes
- Updates were made to the methods to estimate installation costs incurred by the producer/landowner based on specific NRCS practice codes and updated cost data

It is important to note that this enhancement results in modifications to both PTMApp-Desktop and PTMApp-Web. This technical memorandum focuses on the modifications to PTMApp-Desktop and discusses the implications and necessary enhancements for PTMApp-Web to accommodate the use of the enhancements made to the PTMApp-Desktop data.

ACKNOWLEDGEMENTS

This technical memorandum describes enhancement made to PTMApp-Desktop through a range of partners and funding support. The initial work was supported with Clean Water Funds from the Clean Water Land & Legacy Amendment by the Minnesota Board of Soil and Water Resources, Minnesota Geospatial Information Office, and Minnesota IT Services with the technical work being led by Houston Engineering, Inc.

Additional support was provided for these enhancements by the North Dakota Department of Environmental Quality using 319 program funding from the U.S. Environmental Protection Agency. The International Water Institute led this additional technical work.

The partnership needed to complete these enhancements was enabled through an innovative software licensing agreement between the States of Minnesota and North Dakota that allows both States to work on developing and enhancing PTMApp

PARTNERS AND FUNDING SUPPORT

CONCEPTUAL DESIGN

The initial creation of PTMApp-Desktop and the Toolbar incorporated six conservation practice "treatment groups" based upon the physical, chemical, and/or biological processes by which they provide water treatment to remove sediment, total phosphorus (TP), and total nitrogen (TN). This decision was driven by feedback from a blue-ribbon panel of intended PTMApp users prior to the operational deployment of the toolbar. The decision was driven by:

- A feeling that specific NRCS practice codes may be viewed as prescriptive
- Uncertainty that enough research existed to support targeting based upon specific NRCS practice codes

Since PTMApp was created, the use of the Agricultural Conservation Planning Framework (ACPF; Tomer *et al*., 2015) has shown that producers/landowners are more receptive to conservation practice targeting information based upon specific NRCS practice codes as they most often provide the basis for communication between landowners/produces and conservation personnel. In addition, numerous research articles and summary documents have been created such as the Agricultural BMP Handbook for Minnesota (Lenhart and Peterson, 2017), which provide much more detail regarding potential treatment efficiencies of many of the individual conservation practices included in this update. Installation cost estimates have also been updated annually since the creation of PTMApp-Desktop, and those recent cost figures are presented in this update. Estimated conservation practice installation costs are based on 2019 EQIP payment rates for Minnesota. Although EQIP values represent cost-share payments, they may approximate installation costs incurred by the producer/landowner because EQIP cost-share typically offsets 50-75% (up to 90%) of the installation cost. In addition, they do not capture the life cycle cost of a practice (e.g., maintenance expenses and forgone income).

The connection between PTMApp conservation practices and NRCS code also allows for smoother incorporation of information regarding location; size; and sediment, phosphorus, and nitrogen removal efficiency of implemented conservation practices into the BWSR conservation tracking system - eLINK.

This section describes:

- PTMApp-Desktop Integration – the areas of the toolbar affected by this enhancement
- Technical Methods – the changes to technical approaches within PTMApp-Desktop affected by this enhancement

PTMAPP-DESKTOP INTEGRATION

A significant amount of groundwork for the transition from treatment groups to individual NRCS conservation practice codes has already been laid [BMP Suitability Enhancement Memo (February 2018) - https://ptmapp.bwsr.state.mn.us/User/Documentation]. This was accomplished through a previous update to the Best Management Practice (BMP) Suitability Module, one of the major modules in the Toolbar. Upon running the updated BMP suitability module, the Toolbar produces a series of geospatial data products that identify potential locations on the landscape for the placement of structural and management conservation practices. These come in the form of 24 raster data layers, one for each of the individual NRCS code (**Table 1**) conservation practice types within PTMApp. The 24 conservation practice types were chosen from the complete

list of 170 NRCS conservation practices based on the types of practices that are most commonly installed by producers/landowners, and by the practices that can adequately be sited within a GIS environment. Each raster layer provides feasible locations for a given conservation practice type based on NRCS design and installation criteria. Beginning with version 2.2.83 of the PTMApp-Desktop toolbar, users have had access to these individual conservation practice raster layers in the processing.gdb.

Table 1. The 24 individual conservation practice layers produced by the PTMApp-Desktop Toolbar, with relationship to the treatment group structure.

Raster Layer Name	Conservation Practice Name	NRCS Practice Code	Treatment Group Code	PTMApp Treatment Method
bin_pond	Farm Pond/Wetland	378	1	Storage
bin_drain	Drainage Water Management	554	1	Storage
bin_wascob	Water and Sediment Control Basin	638	1	Storage
bin_reg_wet	Regional Wetland/Pond	656_1†	1	Storage
bin_nut_wet	Large Wetland Restoration	656_2†	1	Storage
bin_riparian*	Riparian Buffer	390	2	Filtration
bin_filtst	Filtration Strip	393	2	Filtration
bin_satbuff	Saturated Buffer	604	3	Biofiltration
bin_denit	Denitrifying Bioreactor	605	3	Biofiltration
bin_inftrech	Infiltration Trench/Small Infiltration Basin	350‡	4	Infiltration
bin_ditch2s	Multi-stage Ditch (open channel)	582	4	Infiltration
bin_crit_plant	Critical Area Planting	342	5	Protection
bin_protect	Grade Stabilization	410	5	Protection
bin_gwater	Grassed Waterway	412	5	Protection
bin_shore	Lake and Wetland Shoreline Restoration	580	5	Protection
bin_peren	Perennial Crops	327	6	Source Reduction
bin_no_till*	No till	329	6	Source Reduction
bin_covcrop	Cover Crops	340	6	Source Reduction
bin_red_till*	Reduced till	345	6	Source Reduction
bin_forage*	Forage / Biomass Planting	512	6	Source Reduction
bin_grazing*	Prescribed Grazing	528	6	Source Reduction
bin_no3	Nutrient Management of Groundwater	590_1†	6	Source Reduction
bin_p_mgmt*	Nutrient Management for Phosphorus	590_2†	6	Source Reduction
bin_n_mgmt*	Nutrient Management for Nitrogen	590_3†	6	Source Reduction

* New layers added during this update

† _# was used to differentiate practices with the same NRCS code but different suitability criteria.

‡ There is no NRCS code for infiltration basins, however sediment basins (NRCS code 350) can be designed to prioritize infiltration.

This enhancement was driven largely around converting these raster grids into polygon files that replace the treatment groups previously output from PTMApp. Functionally, PTMApp is moving from six different treatment group polygons to 24 specific NRCS practice code polygons. Following this, several updates were necessary (downstream functions and tools) to allow for processing of the 24 individual conservation practice polygon feature classes. **Table 2** provides a summary of the tools inside of PTMApp affected by these enhancements, along with a description of the affects.

Table 2. Tools inside of PTMApp-Desktop affected by the enhancements of this update, along with a general description of how the tool is affected.

PTMApp-Desktop Tool	Description
BMP Suitability	Will now output 24 individual polygon feature classes based upon NRCS practice codes instead of 6 treatment group feature classes
Exclusion Areas	Will now allow the user to exclude areas by specific NRCS practice codes instead of 6 treatment groups
Ingest ACPF	The ACPF outputs will now relate to PTMApp's specific NRCS practice codes, instead of treatment groups. See **Table 8** for details.
Screen BMP	Will now allow the user to screen conservation practices by specific NRCS practice codes instead of treatment groups
Reduction Ratio	Users will not notice a change, but additional technical methods were added to accommodate for treatment provided by WASCOBs, described in the technical methods section below.
Reduction Efficiencies	A table in the base.gdb input catalog (table_treat) will now accommodate individual NRCS practices codes instead of treatment groups
Cost Analysis	Will now estimate costs for specific NRCS practice codes instead of treatment groups. In addition, an optional minimum cost for implementing a conservation practice will be added

TECHNICAL METHODS

This enhancement and update to the PTMApp-Desktop Toolbar consists of applying the treatment group equations to the newly created conservation practice layers (based on NRCS practice codes), and thereby changes the PTMApp language for NRCS structural and management practices. Although the reduction ratios used for estimating treatment volume are applied based on the treatment group each conservation practice falls within, reduction efficiencies have been updated for individual NRCS practices as data were available. For the most part, the overall treatment group framework for estimating water quality benefits and installation costs will remain the same but will be updated and further refined to better align with commonly used conservation practice nomenclature.

To help users better understand the Toolbar changes, and to provide a pathway for comparing results generated on a previous Toolbar version, the technical methods of the update are explained for each tool or dataset affected by the enhancement.

BMP Suitability Module - BMP Suitability

A majority of the individual NRCS practice codes have been output as raster layers since version 2.2.83 of the toolbar was released. Each raster layer presents feasible areas on the landscape for the installation of individual conservation practice type based on NRCS installation guidelines. Areas of the raster grid that are assigned a value of 1 are suitable for conservation practice installation. All other areas are unsuitable. Suitability criteria have been assigned to seven new conservation practice layers that were added as part of this update. These suitability criteria can be seen in **Table 3**.

Table 3. Suitability criteria for the seven new raster layers.

Conservation Practice Name	Treatment Group Code	PTMApp Treatment Method	Geospatial Selection Criteria	Selection Criteria Description
Riparian Buffer (bin_riparian)	2	Filtration	NLCD Value = 82 100ft buffer around fac_acres >=20 100ft buffer around nhd_wtrbd that intersect fac_acres >=20	NLCD land cover must be Cultivated Crops. Practices must be within 100ft buffer surrounding drainage pathways larger than 20 acres or a 100ft buffer of NHD high resolution waterbodies that intersect drainage pathways larger than 20 acres.
No Tillage (bin_no_till)	6	Source Reduction	NLCD Value = 82	NLCD land cover must be Cultivated Crops.
Reduced Tillage (bin_red_till)				
Prescribed Grazing (bin_grazing)			NLCD Value = 71 or 81 Mean suitable ranking of >=4. See **Table 4** for details.	NLCD land cover must be Herbaceous or Hay/Pasture Land with low crop productivity, steep slope, and high sediment delivery ratio will be identified as preference areas for implementing the practice.
Forage / Biomass Planting (bin_forage)			NLCD Value = 82 Mean suitable ranking of >=4. See **Table 5** for details.	NLCD land cover must be Cultivated Crops Land with low crop productivity and high soil loss will be identified as preference areas for implementing the practice.
Nutrient Management for Phosphorus (bin_p_mgmt)			NLCD Value = 82	NLCD land cover must be Cultivated Crops.
Nutrient Management for Nitrogen (bin_n_mgmt)				

Table 4. Ranking criteria for the suitability data for Prescribed Grazing practices. A mean rank of 4 or greater is considered suitable.

Rank	Crop productivity Index (cpi)*	Slope	Sediment Deliver Ratio (overland_sdr)
1	81-100	0-4	< 0.6
2	61-80	4-8	0.6-0.7
3	41-60	8-12	0.7-0.8
4	21-40	12-16	0.8-0.9
5	0-20	>16	0.9-1.0

* Animal unit months per acre x1000 (AUM_ac_1K) is used in place of cpi where data are available – 1700-1301 (Rank 1), 1300-976 (Rank 2), 975-651 (Rank 3), 650-326 (Rank 4), 325-0 (Rank 5).

Table 5. Ranking criteria for the suitability data for Forage / Biomass Planting practices. A mean rank of 4 or greater is considered suitable.

Rank	Crop productivity Index (cpi)*	sed_mass_fl†
1	81-100	0-1.25
2	61-80	1.25-2.5
3	41-60	2.5-3.75
4	21-40	3.75-5
5	0-20	>5

* Rangeland productivity representative value (rsprod_r in lbs./acre) is used in place of cpi where data are available – 6800-5441 (Rank 1), 5440-4081 (Rank 2), 4080-2721 (Rank 3), 2720-1361 (Rank 4), 1360-0 (Rank 5).

† Annual sediment load across catchment delivered to the catchment outlet in tons/acre/year.

Aggregation from individual conservation practice raster layers (e.g. bin_drain, bin_nut_wet, bin_pond, bin_reg_wet, bin_wascob) to the treatment group raster layers (e.g. bmp_storage), and finally to treatment group polygon feature classes (e.g. storage) no longer occurs as a process within the Toolbar. Instead, the "bin_" layers are converted directly to polygon feature classes (**Table 6**), each with its own attribute table (**Figures 1 and 2**). Individual BMP polygons within each feature class are screened based on size and contributing watershed area (**Table 7**).

Each BMP feature class is created with an attribute table that essentially mirrors the format of pre-update attribute tables with two key exceptions. Two new columns of data will be added to each attribute table. One column will be labeled "NRCS_code" and will contain the individual conservation practice type, in the form of the NRCS conservation practice code (**Table 1**) and the second column will have the unq_BMP_ID and NRCS code concatenated, forming the "FULL_BMP_ID". Keeping the tables mostly the same will retain backwards compatibility for data comparison throughout previous versions of PTMApp-Desktop, but the addition of NRCS code data will allow for increased functionality necessary to function properly in PTMApp-Desktop.

As part of the last step of the BMP Suitability tool, the attribute tables for each individual conservation practice feature class are built, including all of the attributes needed for the downstream Benefits Analysis module and

Cost Analysis module tools. Prior to this update, the attribute tables of each treatment group feature class contained 30 columns of "NULL" values, all preceded with R_. For this update, these empty columns are removed to decrease the size of the conservation practice attribute tables and allow for easier data navigation. All of the necessary data relating to the R_ values continues to be held in table_ba_load_red and will continue to be created when that table is generated.

BMP Suitability Module – Exclusion Areas

The technical methods associated with this tool will function the same as in previous versions of the toolbar. However, users will now be able to exclude areas for specific NRCS practice codes.

BMP Suitability Module – Screen BMP

The technical methods for this tool will function the same. However, users will now be able to screen based upon specific NRCS practice codes.

BMP Suitability Module - Ingest ACPF

Prior to this PTMApp-Desktop update, the Toolbar created relationships between ACPF polygons and PTMApp treatment groups to estimate sediment, TP, and TN load reductions and to estimate installation cost for each ACPF practice polygon. The ACPF program is primarily used for locating feasible areas for BMP implementation on the landscape, using different suitability criteria than PTMApp. ACPF does not estimate load reductions and installation costs. These functions are now done through the Ingest ACPF tool within PTMApp. With the transition away from treatment groups in favor of individual conservation practice types, new relationships were created between each ACPF practice and the individual conservation practices output from the toolbar. **Table 8** provides these relationships and gives a brief rationale for each.

Table 6. New feature class layers that are standard geospatial data products as part of this update.

Raster Layer Name	Conservation Practice Name	Feature Class Name
bin_pond	Farm Pond/Wetland	bmp_pond
bin_drain	Drainage Water Management	bmp_drain
bin_wascob	Water and Sediment Control Basin	bmp_wascob
bin_reg_wet	Regional Wetland/Pond	bmp_reg_wet
bin_nut_wet	Large Wetland Restoration	bmp_nut_wet
bin_riparian	Riparian Buffer	bmp_riparian
bin_filtst	Filtration Strip	bmp_filtst
bin_satbuff	Saturated Buffer	bmp_satbuff
bin_denit	Denitrifying Bioreactor	bmp_denit
bin_inftrech	Infiltration Trench/Small Infiltration Basin	bmp_inftrech
bin_ditch2s	Multi-stage Ditch (open channel)	bmp_ditch2s
bin_crit_plant	Critical Area Planting	bmp_crit_plant
bin_protect	Grade Stabilization	bmp_protect
bin_gwater	Grassed Waterway	bmp_gwater
bin_shore	Lake and Wetland Shoreline Restoration	bmp_shore
bin_peren	Perennial Crops	bmp_peren
bin_no_till	No till	bmp_no_till
bin_covcrop	Cover Crops	bmp_covcrop
bin_red_till	Reduced tillage	bmp_red_till

Raster Layer Name	Conservation Practice Name	Feature Class Name
bin_grazing	Prescribed Grazing	bmp_grazing
bin_forage	Forage / Biomass Planting	bmp_forage
bin_no3	Nutrient Management of Groundwater	bmp_no3
bin_p_mgmt	Nutrient Management for Phosphorus	bmp_p_mgmt
bin_n_mgmt	Nutrient Management for Nitrogen	bmp_n_mgmt

Table 7. Default screening criteria used to create PTMApp-Desktop BMP feature class layers.

Suitable BMP Layers			Final Screening Criteria	
Feature Class Name	Conservation Practice Name	Treatment Group Code	BMP Surface Area (acres)	BMP Drainage Area (acres)
bmp_pond	Farm Pond/Wetland	1	>= 0.10	>= 1.00
bmp_drain	Drainage Water Management	1	>= 0.10	>= 1.00
bmp_wascob	Water and Sediment Control Basin	1	>= 0.03	>= 1.00
bmp_nut_wet	Large Wetland Restoration	1	>= 0.10	>= 1.00
bmp_reg_wet	Regional Wetland/Pond	1	>= 0.10	>= 1.00
bmp_riparian	Riparian Buffer	2	>= 0.33	>= 1.00
bmp_filtst	Filtration Strip	2	>= 0.33	>= 1.00
bmp_satbuff	Saturated Buffer	3	>= 0.04	>= 1.00
bmp_denit	Denitrifying Bioreactor	3	>= 0.011	>= 1.00
bmp_inftrech	Infiltration Trench/Small Infiltration Basin	4	>= 0.011	>= 1.00
bmp_ditch2s	Multi-stage Ditch (open channel)	4	>= 0.25	>= 1.00
bmp_crit_plant	Critical Area Planting	5	>= 0.25	>= 1.00 AND <= 250.0
bmp_protect[1]	Grade Stabilization	5	>= 0.25	>= 1.00 AND <= 250.0
bmp_gwater	Grassed Waterway	5	>= 0.25	>= 1.00 AND <= 250.0
bmp_shore[1]	Lake and Wetland Shoreline Restoration	5	>= 0.25	>= 1.00 AND <= 250.0
bmp_peren	Perennial Crops	6	>= 5.00	>= 1.00 AND <= 640.0
bmp_no_till	No till	6	>= 5.00	>= 1.00
bmp_covcrop	Cover Crops	6	>= 5.00	>= 1.00
bmp_red_till	Reduced till	6	>= 5.00	>= 1.00
bmp_grazing	Prescribed Grazing	6	>= 1.00	>= 1.00
bmp_forage	Forage / Biomass Planting	6	>= 1.00	>= 1.00
bmp_no3	Nutrient Management of Groundwater	6	>= 5.00	>= 1.00 AND <= 640.0
bmp_p_mgmt	Nutrient Management for Phosphorus	6	>= 5.00	>= 1.00
bmp_n_mgmt	Nutrient Management for Nitrogen	6	>= 5.00	>= 1.00

[1] Currently prioritized to find large-scale stabilization and restoration projects.

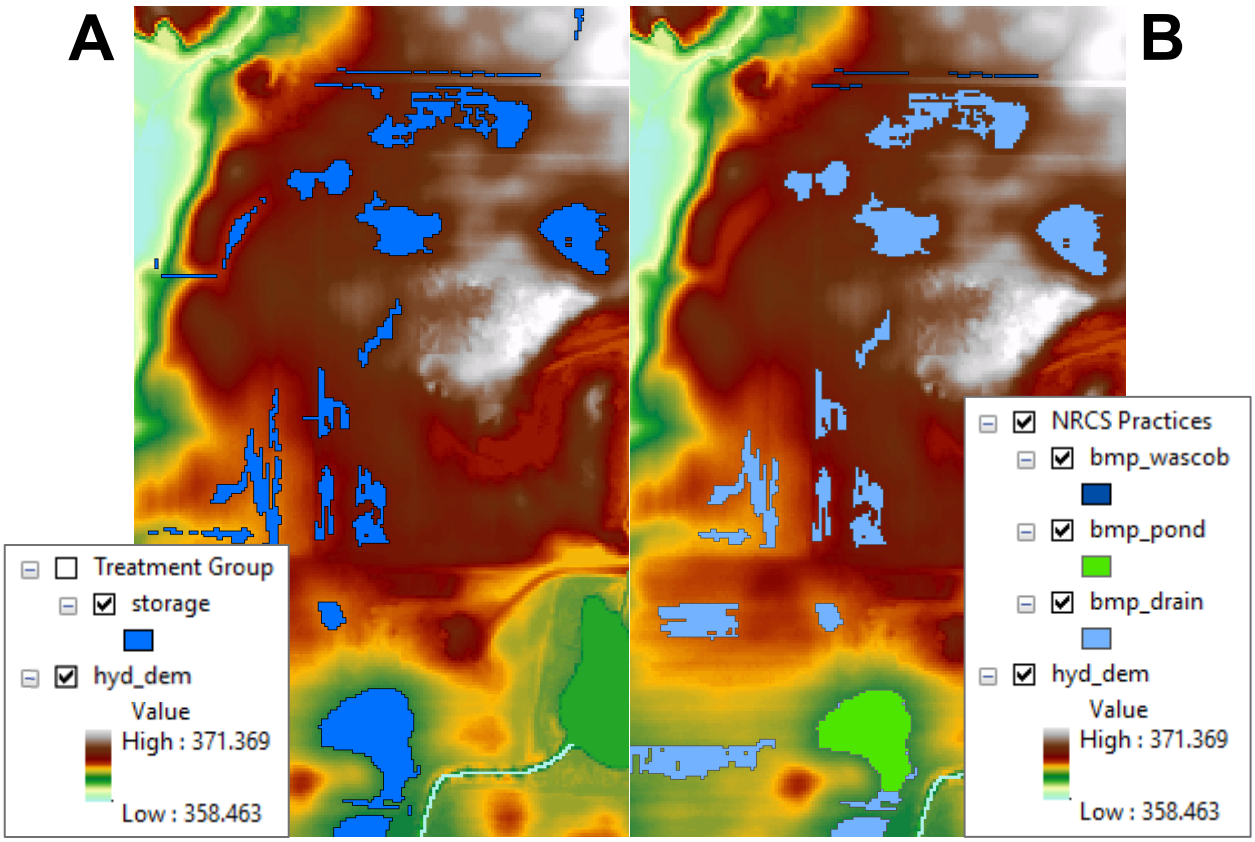

Figure 1. An illustration of the changes to BMP Suitability tool output. The image on the left (A) shows the treatment group output (storage practices) prior to this update, and the image on the right (B) shows the NRCS code practice outputs (bmp_wascob, bmp_pond, bmp_drain, etc.) that result from the updated toolbar.

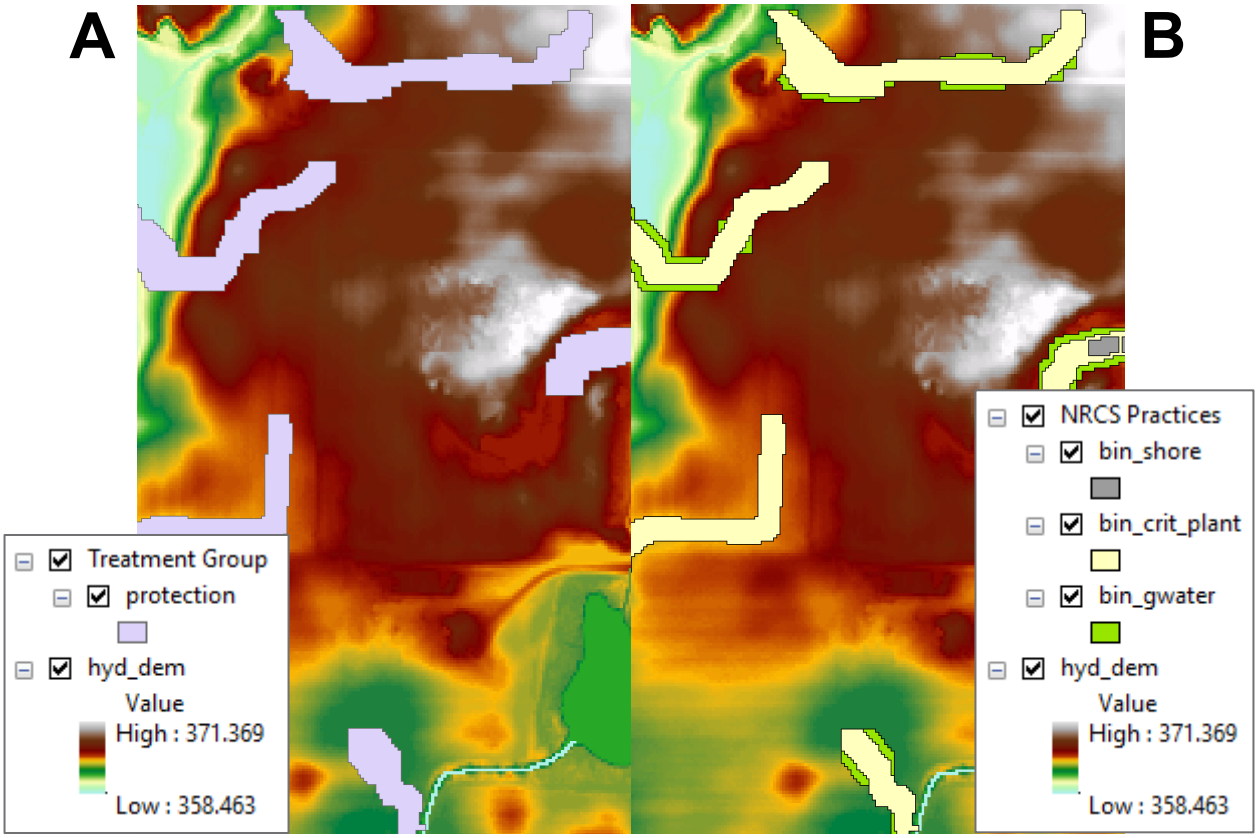

Figure 2. An illustration of the changes to BMP Suitability tool output. The image on the left (A) shows the treatment group output (protection practices) prior to this update, and the image on the right (B) shows the NRCS code practice outputs (bmp_shore, bmp_crit_plant, bmp_gwater, etc.) that result from the updated toolbar.

Table 8. Relation between ACPF practice and PTMApp conservation practice type.

ACPF Conservation Practice	PTMApp Conservation Practice	PTMApp Treatment Group	Rationale for Relationship
Bioreactor	Denitrifying bioreactor	Biofiltration	Both (ACPF and PTMApp) refer to NRCS code 605
Contour buffer	Filtration Strip	Filtration	Similar removal efficiency and install cost. Note: contour buffers are in-field practices for protecting soil, filtration strips are edge of field practices for filtration.
Depressions	Farm Pond/Wetland	Storage	Both use depressions based on digital elevation models
Drainage Management	Drainage Water Management	Storage	Both refer to NRCS code 554
Grassed Waterways	Grassed Waterway	Protection	Both refer to grassed waterways
Nutrient Reduction Wetland	Large wetland restoration	Storage	Both refer to NRCS code 656 and both emphasize nutrient reduction.
Riparian Function (Deep rooted vegetation)	Riparian Buffer	Filtration	Similar removal efficiency and install cost. Note: filtration practices treat surface runoff via sedimentation of suspended particulates, whereas deep rooted vegetation planting is focused on preventing mobilization of material at the soil surface as stated in the ACPF manual.
Riparian Function (Multi-species buffer)	Riparian Buffer	Filtration	Similar removal efficiency and install cost. Note: filtration practices treat surface runoff via sedimentation of suspended particulates, whereas multi-species buffer planting is focused on preventing mobilization of material at the soil surface as stated in the ACPF manual.
Riparian Function (Stream bank stabilization)	Shoreline restoration and protection	Protection	Concrete block, rock chute, or riprap install will be equivalent.
Riparian Function (Stiff stemmed grasses)	Riparian Buffer	Filtration	Similar removal efficiency and install cost. Note: filtration practices treat surface runoff via sedimentation of suspended particulates, whereas stiff stemmed grass planting is focused on preventing mobilization of material at the soil surface as stated in the ACPF manual.
Saturated Buffer	Saturated Buffer	Biofiltration	Both refer to NRCS code 604
WASCOB	WASCOB	Storage	Both refer to NRCS code 638

Benefits Analysis Module – Reduction Ratio

The reduction ratio tool analyzes the amount of water that can be treated by a conservation practice compared to the amount of water delivered to that conservation practice. For this update, reduction ratios for the new conservation practice layers were estimated based on the treatment method of each conservation practice. For instance, individual storage-type practices (e.g. nutrient reduction wetlands, WASCOBs, etc.) receive the existing storage treatment group reduction ratio analysis.

Only one modification was made to the reduction ratio tool. Prior to this update, the method for estimating a treatment volume for WASCOBs was insufficient as they are output as linear features. A new search filter was added to analyze the topography of the landscape along the linear path where the WASCOB could be constructed. In short, the filter determines the maximum elevation within a 0.5 acre search area along the linear feature. The difference in elevation between the lowest elevation along the linear feature and the maximum elevation within the search radius is used to estimate a ponding depth behind the potential WASCOB embankment (**Figure 3**). This depth is applied to the potential ponding area behind the WASCOB to estimate the treatment volume of the conservation practice, providing an avenue to estimate the water holding capacity of the landscape surrounding a potential WASCOB location. This method for estimating WASCOB storage volume was successfully applied to support a Targeted Watershed Demonstration project in the Sand Hill River Watershed.

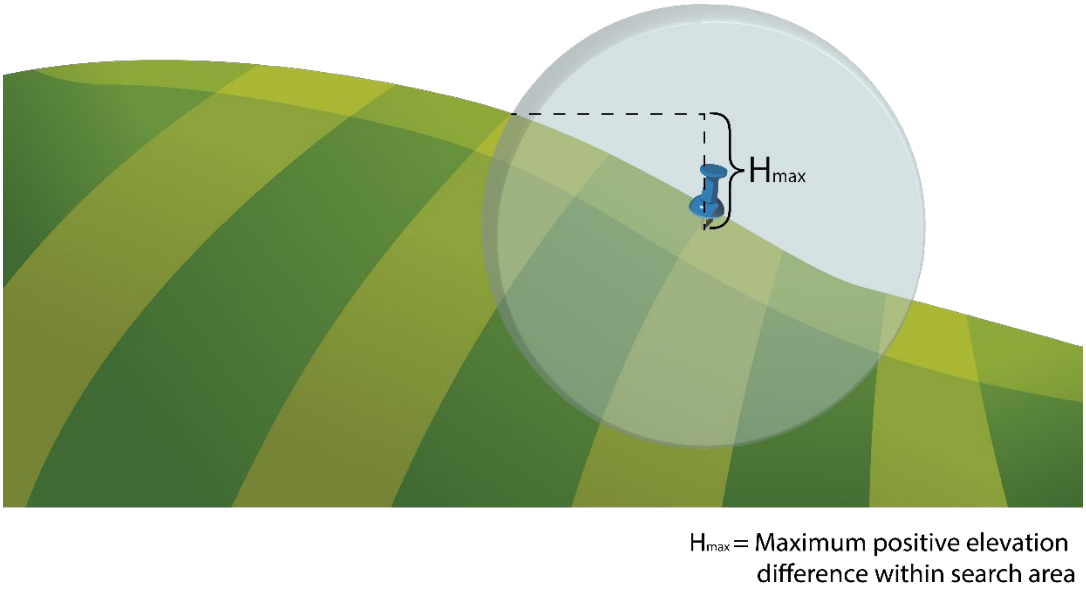

Figure 3. WASCOB volume estimation. H_{max} is used to determine potential ponding height and volume behind an embankment of height H_{max}.

Benefits Analysis Module – Reduction Efficiency

To accommodate the transition from treatment groups to individual conservation practice types, table_treat was rebuilt and updated to include all of the new individual conservation practice types, and to incorporate as much new treatment efficiency data as possible. **Table 9** shows the updated table_treat. The statistics needed to generate the updated table_treat were pulled first from the Ag BMP Handbook (Lenhart and Peterson, 2017). In the absence of sufficient data to characterize the treatment efficiency of an individual practice type, aggregated treatment group information was used. The values in table_treat are able to be modified by the user within the base.gdb based on local knowledge of reduction efficiencies.

Benefits Analysis Module – Attach to Catchments

The technical methods associated with this tool will function the same as in previous versions of the toolbar.

Cost Analysis Module – Cost Analysis

The toolbar was updated to reflect the separation of treatment groups into individual conservation practices. New default costs were assigned to each of the individual conservation practice types based on 2019 EQIP cost estimates for installation/implementation of new conservation practices in Minnesota (**Table 10**).

A minimum conservation practice cost option has been provided as a checkbox within the user interface. If activated, this function operates simply as a “find and replace” option after costs are generated. Any value less than the proposed minimum cost would be changed to the minimum cost. Default minimum costs are assumed to be 25% of the typical practice installation cost (Lenhart and Peterson, 2017) and are presented in **Table 10**.

Table 9. Updated table_treat (separated into three sections for readability in this memorandum)

BMP_Group	NRCS_name	GrpCode	NRCS_code	Sed_Q1	Sed_Q2	Sed_Q3	Sed_min	Sed_max	Sed_k	SedStud	SedSites	Source	Edited
bmp_pond	Farm Pond/Wetland	1	378	0.24	0.77	0.87	-86.00	1.00	0.19	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_drain	Drainage Water Management	1	554	0.24	0.69	0.87	-86.00	1.00	0.40	NA	NA	WERF BMP Database (Detention Basins,	KSG 3/11/16
bmp_wascob	Water and Sediment Control	1	638	0.64	0.88	0.99	-86.00	1.00	0.46	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_reg_wet	Regional Wetland/Pond	1	656_1	0.24	0.75	0.87	-86.00	1.00	0.24	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_nut_wet	Large Wetland Restoration	1	656_2	0.24	0.75	0.87	-86.00	1.00	0.24	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_riparian	Riparian Buffer	2	390	0.74	0.76	0.84	0.00	0.99	4.00	NA	NA	Minnesota Agricultural BMP Handbook	MRD 6/29/2020
bmp_filtst	Filtration Strip	2	393	0.74	0.76	0.84	0.00	0.99	4.00	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_satbuff	Saturated Buffer	3	604	0.65	0.84	0.93	-47.00	1.00	0.47	NA	NA	WERF BMP Database (Media Filter)	KSG 3/11/16
bmp_denit	Denitrifying Bioreactor	3	605	0.65	0.84	0.93	-47.00	1.00	0.47	NA	NA	WERF BMP Database (Media Filter)	KSG 3/11/16
bmp_inftrech	Infiltration Trench/Small Infiltration Basin	4	350	0.85	0.95	1.00	0.17	1.00	0.50	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_ditch2s	Multi-stage Ditch (open channel)	4	582	0.58	0.90	0.94	0.17	0.98	0.13	NA	NA	WERF BMP Database (Infiltration Basins)	KSG 3/11/16
bmp_crit_plant	Critical Area Planting	5	342	1.00	1.00	1.00	1.00	1.00	1.00	NA	NA	Could not find data. Assume 100% is	KSG 3/11/16
bmp_protect	Grade Stabilization	5	410	0.98	0.99	1.00	0.99	1.00	1.00	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_gwater	Grassed Waterway	5	412	0.94	0.96	0.98	0.94	1.00	1.00	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_shore	Lake and Wetland Shoreline Restoration	5	580	1.00	1.00	1.00	1.00	1.00	1.00	NA	NA	Could not find data. Assume 100% is stabilized and protected.	KSG 3/11/16
bmp_peren	Perennial Crops	6	327	0.13	0.70	0.96	-3.84	0.96	0.46	NA	NA	Minnesota Agricultural BMP Handbook	SCK 6/28/2020
bmp_no_till	No-till	6	329	0.78	0.79	0.85	0.77	0.90	6.00	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_covcrop	Cover Crops	6	340	0.50	0.70	0.90	0.32	0.92	1.00	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_red_till	Reduced tillage	6	345	0.43	0.61	0.68	0.06	0.99	0.39	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_forage	Forage / Biomass Planting	6	512	0.13	0.96	0.99	-3.84	0.96	0.04	NA	NA	Minnesota Agricultural BMP Handbook	MRD 6/29/2020
bmp_grazing	Prescribed Grazing	6	528	0.35	0.39	0.43	0.10	0.90	1.00	NA	NA		MRD 6/29/2020
bmp_no3	Nutrient Management of Groundwater	6	590_1	0.15	0.39	0.62	-3.84	0.90	0.96	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_p_mgmt	Nutrient Management for Phosphorus	6	590_2	0.15	0.39	0.62	-3.84	0.90	0.96	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_n_mgmt	Nutrient Management for Nitrogen	6	590_3	0.15	0.39	0.62	-3.84	0.90	0.96	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020

BMP_Group	NRCS_name	GrpCode	NRCS_code	TP_Q1	TP_Q2	TP_Q3	TP_min	TP_max	TP_k	TPStud	TPSites	Source1	Edited1
bmp_pond	Farm Pond/Wetland	1	378	0.01	0.72	0.73	-207.00	0.99	0.01	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_drain	Drainage Water Management	1	554	0.01	0.55	0.69	-207.00	0.99	0.26	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_wascob	Water and Sediment Control	1	638	0.01	0.76	0.80	-207.00	0.99	0.05	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_reg_wet	Regional Wetland/Pond	1	656_1	0.35	0.53	0.75	-207.00	0.99	1.22	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_nut_wet	Large Wetland Restoration	1	656_2	0.46	0.50	0.58	-207.00	0.99	2.00	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_riparian	Riparian Buffer	2	390	0.43	0.55	0.66	0.02	0.93	0.92	NA	NA	Minnesota Agricultural BMP Handbook	MRD 6/29/2020
bmp_filtst	Filtration Strip	2	393	0.43	0.55	0.66	0.02	0.93	0.92	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_satbuff	Saturated Buffer	3	604	0.17	0.50	0.66	-6.21	0.99	0.48	NA	NA	WERF BMP Database (Media Filter)	KSG 3/11/16
bmp_denit	Denitrifying Bioreactor	3	605	0.17	0.50	0.66	-6.21	0.99	0.48	NA	NA	WERF BMP Database (Media Filter)	KSG 3/11/16
bmp_inftrech	Infiltration Trench/Small Infiltration Basin	4	350	0.70	0.85	1.00	-0.08	1.00	1.00	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_ditch2s	Multi-stage Ditch (open channel)	4	582	0.00	0.24	0.63	-0.08	0.76	1.63	NA	NA	WERF BMP Database (Infiltration Basins)	KSG 3/11/16
bmp_crit_plant	Critical Area Planting	5	342	1.00	1.00	1.00	1.00	1.00	1.00	NA	NA	Could not find data. Assume 100% is	KSG 3/11/16
bmp_protect	Grade Stabilization	5	410	1.00	1.00	1.00	1.00	1.00	1.00	NA	NA	Could not find data. Assume 100% is	KSG 3/11/16
bmp_gwater	Grassed Waterway	5	412	1.00	1.00	1.00	1.00	1.00	1.00	NA	NA	Could not find data. Assume 100% is	KSG 3/11/16
bmp_shore	Lake and Wetland Shoreline Restoration	5	580	1.00	1.00	1.00	1.00	1.00	1.00	NA	NA	Could not find data. Assume 100% is stabilized and protected.	KSG 3/11/16
bmp_peren	Perennial Crops	6	327	0.01	0.84	0.85	-2.07	0.87	0.01	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_no_till	No-till	6	329	0.67	0.75	0.88	-0.22	0.91	1.63	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_covcrop	Cover Crops	6	340	0.01	0.67	0.68	-2.07	0.87	0.02	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_red_till	Reduced tillage	6	345	0.44	0.55	0.61	-0.22	0.97	0.55	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_forage	Forage / Biomass Planting	6	512	0.01	0.84	0.85	-2.07	0.87	0.01	NA	NA	Minnesota Agricultural BMP Handbook	MRD 6/29/2020
bmp_grazing	Prescribed Grazing	6	528	0.32	0.35	0.39	0.10	0.90	1.33	NA	NA		MRD 6/29/2020
bmp_no3	Nutrient Management of Groundwater	6	590_1	0.17	0.24	0.36	0.14	0.91	1.71	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_p_mgmt	Nutrient Management for Phosphorus	6	590_2	0.17	0.24	0.36	0.14	0.91	1.71	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_n_mgmt	Nutrient Management for Nitrogen	6	590_3	0.00	0.00	0.00	0.00	0.00	1.00	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020

BMP_Group	NRCS_name	GrpCode	NRCS_code	TN_Q1	TN_Q2	TN_Q3	TN_min	TN_max	TN_k	TNStud	TNSites	Source2	Edited2
bmp_pond	Farm Pond/Wetland	1	378	0.06	0.82	0.88	-69.67	1.00	0.08	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_drain	Drainage Water Management	1	554	0.37	0.52	0.60	-69.67	1.00	0.53	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_wascob	Water and Sediment Control	1	638	0.06	0.57	0.88	-69.67	1.00	0.61	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_reg_wet	Regional Wetland/Pond	1	656_1	0.26	0.68	0.98	-69.67	1.00	0.71	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_nut_wet	Large Wetland Restoration	1	656_2	0.43	0.68	0.91	-69.67	1.00	0.92	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_riparian	Riparian Buffer	2	390	0.44	0.59	0.82	-0.01	0.93	1.53	NA	NA	Minnesota Agricultural BMP Handbook	MRD 6/29/2020
bmp_filtst	Filtration Strip	2	393	0.44	0.59	0.82	-0.01	0.93	1.53	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_satbuff	Saturated Buffer	3	604	0.59	0.60	0.90	0.59	0.93	30.00	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_denit	Denitrifying Bioreactor	3	605	0.80	0.84	0.90	0.75	0.93	1.50	NA	NA	Bioreactor MN AG Database	KSG 3/11/16
bmp_inftrech	Infiltration Trench/Small Infiltration Basin	4	350	0.65	0.80	0.95	0.10	0.95	1.00	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_ditch2s	Multi-stage Ditch (open channel)	4	582	0.16	0.58	0.86	0.10	0.87	0.67	NA	NA	WERF BMP Database (Infiltration Basins)	KSG 3/11/16
bmp_crit_plant	Critical Area Planting	5	342	1.00	1.00	1.00	1.00	1.00	1.00	NA	NA	Could not find data. Assume 100% is	KSG 3/11/16
bmp_protect	Grade Stabilization	5	410	1.00	1.00	1.00	1.00	1.00	1.00	NA	NA	Could not find data. Assume 100% is	KSG 3/11/16
bmp_gwater	Grassed Waterway	5	412	1.00	1.00	1.00	1.00	1.00	1.00	NA	NA	Could not find data. Assume 100% is	KSG 3/11/16
bmp_shore	Lake and Wetland Shoreline Restoration	5	580	1.00	1.00	1.00	1.00	1.00	1.00	NA	NA	Could not find data. Assume 100% is stabilized and protected.	KSG 3/11/16
bmp_peren	Perennial Crops	6	327	0.00	0.33	0.91	-1.10	0.95	1.76	NA	NA	Minnesota Agricultural BMP Handbook	SCK 6/28/2020
bmp_no_till	No-till	6	329	0.59	0.69	0.79	-0.03	0.91	1.00	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_covcrop	Cover Crops	6	340	0.00	0.66	0.67	-1.10	0.95	0.02	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_red_till	Reduced tillage	6	345	0.31	0.54	0.56	-0.03	0.91	0.09	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_forage	Forage / Biomass Planting	6	512	0.00	0.33	0.91	-1.10	0.95	1.76	NA	NA	Minnesota Agricultural BMP Handbook	MRD 6/29/2020
bmp_grazing	Prescribed Grazing	6	528	0.31	0.34	0.37	0.10	0.90	1.00	NA	NA		MRD 6/29/2020
bmp_no3	Nutrient Management of Groundwater	6	590_1	0.10	0.15	0.18	-1.10	0.95	0.60	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_p_mgmt	Nutrient Management for Phosphorus	6	590_2	0.00	0.00	0.00	0.00	0.00	1.00	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020
bmp_n_mgmt	Nutrient Management for Nitrogen	6	590_3	0.10	0.15	0.18	-1.10	0.95	0.60	NA	NA	Minnesota Agricultural BMP Handbook	SCK 5/18/2020

Table 10. Updated unit cost structure for conservation practices (based on 2019 EQIP payment rates) and default minimum unit cost values.

PTMApp Conservation Practice Name	NRCS Practice Name	PTMApp Treatment Group Code	Treatment Group	NRCS Codes	Previous Values		Updated Values				
					Cost per unit	Units	Cost per unit	Units	Typical Units Installed	Typical Cost	Suggested PTMApp Minimum Cost
bmp_pond	Farm Pond/Wetland	1	Storage	378	$ 2.70	cubic yard	$ 812.05	acre	1	$ 812.05	$ 203.01
bmp_drain	Drainage Water Management	1	Storage	554	$ 2.70	cubic yard	$ 5.54	acre	50	$ 277.00	$ 277.00
bmp_wascob	Water and Sediment Control Basin	1	Storage	638	$ 2.70	cubic yard	$ 4,500.00	each	1	$ 4,500.00	$ 4,500.00
bmp_reg_wet	Regional Wetland/Pond	1	Storage	656_1	$ 2.70	cubic yard	$ 20,439.57	acre	0.25	$ 5,109.89	$ 1,277.47
bmp_nut_wet	Large Wetland Restoration	1	Storage	656_2	$ 2.70	cubic yard	$ 20,439.57	acre	0.25	$ 5,109.89	$ 1,277.47
bmp_riparian*	Riparian Buffer	2	Filtration	390	NA	NA	$ 1,065.87	acre	3.00	$ 3,197.61	$ 799.40
bmp_filtst	Filtration Strip	2	Filtration	393	$ 474.07	acre	$ 496.08	acre	1	$ 496.08	$ 124.02
bmp_satbuff	Saturated Buffer	3	Biofiltration	604	$ 44.92	cubic yard	$ 1,367.78	acre†	0.92	$ 1,258.36	$ 1,258.36
bmp_denit	Denitrifying Bioreactor	3	Biofiltration	605	$ 44.92	cubic yard	$ 38.02	cu. yd‡	200	$ 7,604.00	$ 1,896.25
bmp_inftrech	Infiltration Trench/Small Infiltration Basin	4	Infiltration	350	$ 27,199.29	acre	$ 36.45	sq. yd'	111	$ 4,045.95	$ 1,011.49
bmp_ditch2s	Multi-stage Ditch (open channel)	4	Infiltration	582	$ 27,199.29	acre	$ 4,036.56	acre†	1.25	$ 5,045.70	$ 1,261.43
bmp_crit_plant	Critical Area Planting	5	Protection	342	$ 2,133.35	acre	$ 293.77	acre	1	$ 293.77	$ 73.44
bmp_protect	Grade Stabilization	5	Protection	410	$ 2,133.35	acre	$ 53.10	sq. yd	80	$ 4,248.00	$ 1,062.00
bmp_gwater	Grassed Waterway	5	Protection	412	$ 2,133.35	acre	$ 1,062.86	acre†	2.5	$ 2,657.16	$ 664.29
bmp_shore	Lake and Wetland Shoreline Restoration	5	Protection	580	$ 2,133.35	acre	$ 37.98	sq. yd	111	$ 4,215.78	$ 1,053.95
bmp_peren	Perennial Crops	6	Source Reduction	327	$ 30.87	acre	$ 480.80	acre	1	$ 480.80	$ 120.20
bmp_no_till	No Tillage	6	Source Reduction	329	NA	NA	$ 11.03	acre	100	$ 1,103.00	$ 275.75
bmp_covcrop	Cover Crops	6	Source Reduction	340	$ 30.87	acre	$ 33.52	acre	40	$ 1,340.80	$ 335.20
bmp_red_till	Reduced Tillage	6	Source Reduction	345	NA	NA	$ 11.03	acre	100	$ 1,103.00	$ 275.75
bmp_forage*	Forage / Biomass Planting	6	Source Reduction	512	NA	NA	$ 44.84	acre	40	$ 1,793.60	$ 448.40
bmp_grazing*	Prescribed Grazing	6	Source Reduction	528	NA	NA	$ 6.34	acre	40	$ 253.60	$ 63.40
bmp_no3	Nutrient Management of Groundwater	6	Source Reduction	590_1	$ 30.87	acre	$ 6.84	acre	40	$ 273.60	$ 68.40
bmp_p_mgmt	Nutrient Management for Phosphorus	6	Source Reduction	590_2	NA	NA	$ 6.84	acre	40	$ 273.60	$ 68.40
bmp_n_mgmt	Nutrient Management for Nitrogen	6	Source Reduction	590_3	NA	NA	$ 6.84	acre	40	$ 273.60	$ 68.40

* Costs are based on 2020 EQIP payment rates
† EQIP payment rate based on linear feet. An assumed practice width was applied to bmp_satbuff, bmp_ditch2s, and bmp_gwater (50ft, 60ft, and 100ft, respectively).
‡ Volume was calculated based on an assumed 1/8" runoff across the drainage area of the BMP
' EQIP payment rate based on cubic yards. A practice depth of 1.5 yd was assumed.

PTMAPP-WEB INTEGRATION

This update to the PTMApp-Desktop Toolbar modifies the geospatial data products that are used by PTMApp-Web. As a result, some modifications to PTMApp-Web were necessary. As with the changes to PTMApp-Desktop, changes to the PTMApp-Web user interface will be minimal as a result of this upgrade, resulting in little functional or process variation from recent versions. For the most part, existing functionality within PTMApp-Web will look, function, and query/display data similarly. This will allow a smooth transition for existing users.

PTMApp-Web will be updated to utilize both legacy (existing) data sets and the new/updated datasets created after this update to the PTMApp-Desktop toolbar. The PTMApp-Web code will be modified to recognize the two new data columns in the attribute tables (NRCS_code and FULL_BMP_ID) associated with the new conservation practice feature classes. If those columns of data are present within the available data and attribute tables, the increased functionality necessary to work with the updated conservation practice layers will be unlocked.

The updated user interface will allow the user to display data for either PTMApp treatment groups or individual NRCS conservation practice types, depending on the available data. If the data being queried within PTMApp-Web does not contain the NRCS_code and FULL_BMP_ID columns, the user will be able to query and display treatment group information, but the option to query individual NRCS practices will not be available. On the other hand, if the NRCS_code and FULL_BMP_ID columns are present within the queried data, the option to query and display individual NRCS practice types will be available, but the option to display PTMApp treatment groups will not be available.

LIMITATIONS

With the transition from six treatment groups to 24 individual conservation practice feature classes, there is the potential for a performance decrease within PTMApp-Desktop due to the increased number of geospatial data products being generated. Over time and through incremental improvements to the Toolbar, the processing speed of tools within the toolbar will increase, however due to the increased volume of data manipulation, post-update processing times may be longer regardless.

Although the data available through this update will provide increased communication ability among various user groups and improved water quality benefit and installation cost estimates, the sheer abundance of data may prove overwhelming for certain users. There is room for future improvement to the PTMApp-Desktop Toolbar or PTMApp-Web to help users more easily navigate the intricacies and minutiae within the data.

Another limitation that may need to be addressed by the user on a case-by-case basis is the potential for overlapping, mutually exclusive conservation practices. For instance, if a farm pond and a bioreactor are sited on the same piece of land, only one of those conservation practices can be installed. On the positive side is the option for the field-scale flexibility where a landowner has the option to choose which conservation practice is more desirable to install. However, from a large-scale planning perspective, if locations like these are not managed during data analysis, erroneous duplication of sediment, TP, and TN reduction estimates as well as expected installation costs may occur.

Default installation unit costs may also prove limiting if the user does not evaluate the feasibility of the default values. Temporal, spatial, and methodological variability, as well as economies of scale (for some practices), exist within the installation cost of any conservation practice. A review of expected installation/implementation costs for each conservation practice type should be conducted prior to using the PTMApp-Desktop Toolbar.

OPTIONS FOR FUTURE UPDATES

The change from PTMApp treatment groups to individual NRCS conservation practice types allows for increased flexibility for future updates to PTMApp functionality. **Table 11** provides a list of potential updates that could be prioritized for to 2021-2022 fiscal year.

Table 11. Concepts for proposed updates to PTMApp.

Adding a "User Defined" conservation practice tool		
Concept	Integration	Level of Effort
PTMApp ingests user defined polygons that represent locations of current or future conservation practices, assigns those polygons one of the NRCS practice codes, and estimates water quality benefits resulting from the implementation of those conservation practices.	This will become a new tool within the BMP Suitability module	Moderate to High
Creating additional treatment methodology		
Concept	Integration	Level of Effort
Implementation of some of the specific conservation practices defined by this update (or through future PTMApp updates) fundamentally change the landscape characteristics that reduction ratio and reduction efficiency calculations are based on. To overcome this, a new treatment group will be created that will modify certain input data layers [e.g. Length-Slope factor, (ls_factor)] to represent the physical changes to the landscape.	This will update the BMP Suitability tool and will have implications to all downstream tools that utilize data produced by the BMP Suitability tool.	Moderate to High
Updating BMP Suitability Criteria		
Concept	Integration	Level of Effort
Further update BMP suitability criteria based on NRCS installation standards and locations where specific conservation practice types will be most effective.	This will update the BMP Suitability tool	Low

REFERENCES

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