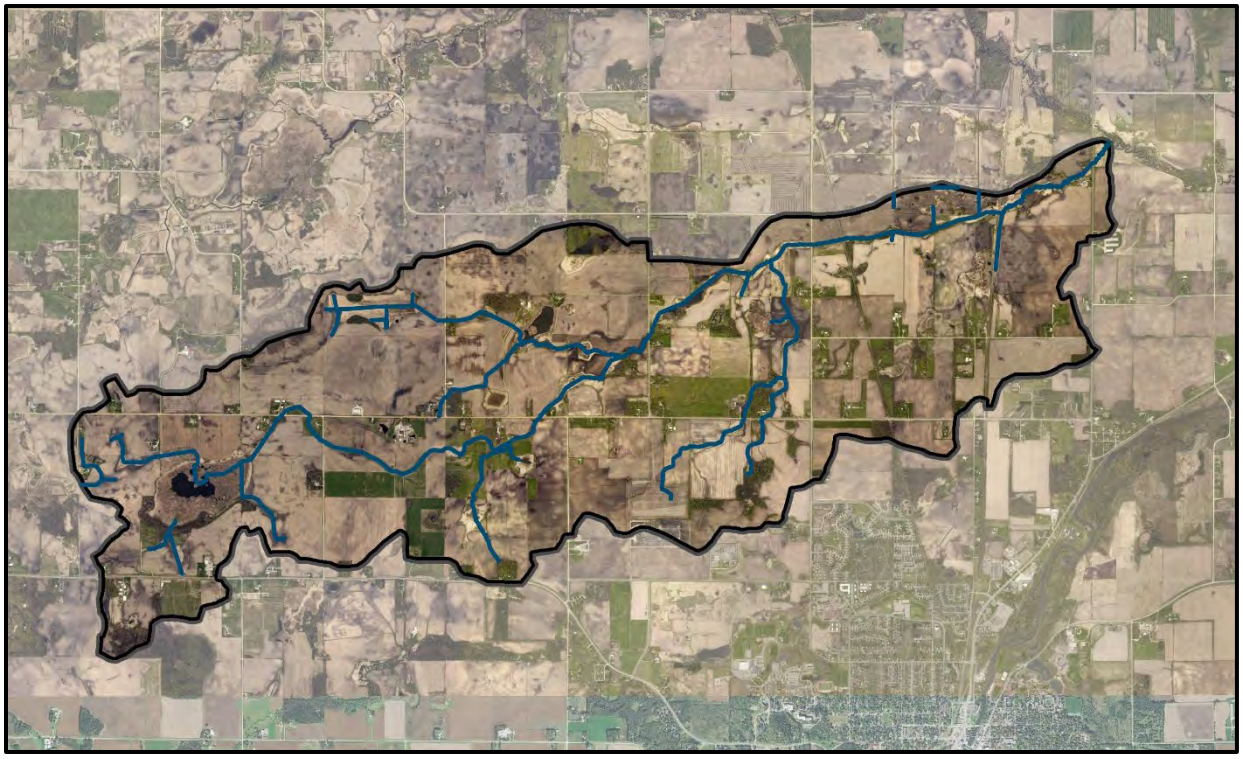
SUBWATERSHED ANALYSIS

FOR

Mud Creek

DAKOTA COUNTY, MN

June 2023



Prepared by:

DAKOTA COUNTY
SOIL & WATER
CONSERVATION DISTRICT

CLEAN WATER LAND & LEGACY AMENDMENT

4100 220th Street West, Suite 102 | Farmington, MN 55024 | (651) 480-7777 |
www.dakotacountyswcd.org

PARTNERS IN LAND AND WATER CONSERVATION

This report details a rural sub-watershed analysis (SWA) that was completed to generate recommended locations for implementing conservation practices. The SWA prioritizes and targets future efforts of the Dakota County Soil and Water Conservation District (SWCD) and its various partners at a subwatershed scale. This document should be considered one part of an overall watershed restoration plan. Additional watershed restoration efforts include educational outreach, stream restoration, riparian zone management, upstream discharge reductions, upland native plant community restoration, pollutant source control and other rural best management practices.

Results of this analysis are based on the development of conceptual project-specific best management practices that provide pollutant source reductions and water quality treatment on the landscape. Relative comparisons are then made between projects to determine where a stronger focus should occur to further design and initiate implementation efforts. Final designs for each project will need to be developed to obtain more refined estimates of the pollution removal amounts reported herein. This typically occurs after the procurement of committed partnerships and funds relative to the specific target project.

The pollutant removal estimates may be used to prioritize practices within the Mud Creek subwatershed and for grant applications but in no case should this data be used to represent actual pollutant removal until after installation is complete and site-specific modeling and/or monitoring data is available.

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Executive Summary

Mud Creek is a stream that flows approximately 7 miles through the southwestern portion of Dakota County and is a tributary to Chub Creek, the Cannon River, and Lake Byllesby. The Mud Creek subwatershed encompasses approximately 9.9 square miles and includes some rolling hills and landlocked wetlands. Land use is primarily agricultural.

The SWCD has been coordinating various subwatershed analyses (SWAs) throughout the rural portions of Dakota County. This SWA focused on Mud Creek and a total of 6,342 acres were included in this analysis. Because Mud Creek is a tributary to Chub Creek, the Cannon River, and Lake Byllesby, pollutants originating from this subwatershed are a concern due to the potential impact to downstream water resources. Through analysis of existing monitoring data and through coordination with the North Cannon River Watershed Management Organization (NCRWMO), sediment has been identified as the primary pollutant of concern for this analysis.

Land management practices recommended throughout this the subwatershed include proper use of cover crops, appropriate nutrient management, irrigation water management, conservation crop rotation, and conservation tillage. Although the land management practices were not analyzed for pollutant reduction, it is likely that they have a greater benefit than structural practices within the subwatershed due to their ability to prevent the transport of sediment and other nutrients. These land management practices are also able to address multiple pollutants and are critical to improving surface and groundwater in the Mud Creek subwatershed and in receiving waterbodies.

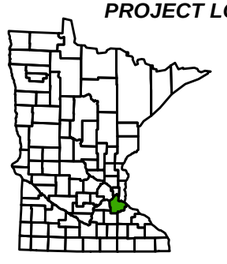
This report details an analysis focused on identifying and assessing potential sediment reduction Best Management Practices (BMPs) in the contributing drainage areas to Mud Creek. Residue management and cover crops are BMPs that were identified as much-needed BMPs throughout the study area during the field reconnaissance stage of this analysis. These BMPs were not modeled for this report due to the large number of conventionally tilled acres and lack of an accurate treatment analysis model for pollutant reduction. It has been and will continue to be, however, an ongoing goal of the Dakota County SWCD to promote these BMPs throughout the Mud Creek subwatershed, especially in areas dominated by erosive soils and high potential for pollutant delivery.

Potential projects were identified through a series of steps that included desktop analysis, field reconnaissance, and identifying site-specific constraints and characteristics. After feasible projects were identified, potential sediment reductions were calculated, and preliminary cost estimates were compiled. The projects were then ranked based on the cost per ton of sediment removal over a 10-year life cycle. The top 51 practices are identified and prioritized by cost effectiveness.

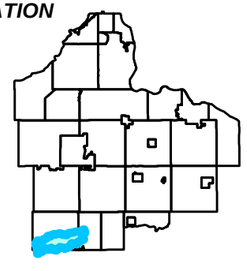
This report includes maps of the proposed location and aerial extent of recommended BMP projects within the Mud Creek subwatershed to provide a general understanding and approach to reducing sediment loss and improving water quality. If a specific project outlined in this report is selected for installation, site specific designs, landowner agreements, and funding sources must be secured in order to implement the BMP. The collection of projects listed in this report should be updated on a regular basis as new projects or new technologies are identified.

Source: (Aerial) Dakota County 2021

PROJECT LOCATION



Dakota County
State of Minnesota



Mud Creek
Subwatershed

Mud Creek Subwatershed

Potential Practices

- Grade Stabilization
- Water and Sediment Control Basin
- Waterway
- Stream Stabilization
- Filter Strip / Critical Area Planting
- Wetland Restoration
- Mud Creek Subwatershed

0 0.5 1 2 Miles

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Summary of Potential BMPs

Rank	Feasibility Code	Feature ID (Township-section-1/4-#)	BMP Type	Size	Units	Sediment Reduction (ton/yr)	Estimated Project Cost	Cost/Ton of Sediment Reduction
1	II	WTR-18-04-01	Grassed Waterway	650	Lin. Feet	17.64	$9,370	$53
2	III	WTR-18-03-01	Wetland Restoration	7	Acres	110.00	$63,400	$58
3	II	GNV-26-02-05	Grassed Waterway	920	Lin. Feet	14.66	$10,720	$73
4	II	GNV-20-04-02	Grassed Waterway	2,400	Lin. Feet	21.00	$18,120	$86
5	III	GNV-26-02-01	Grassed Waterway	1,000	Lin. Feet	12.75	$11,120	$87
6	II	GNV-26-02-03	Grassed Waterway	825	Lin. Feet	11.73	$10,245	$87
7	II	GNV-24-03-03	Grassed Waterway	560	Lin. Feet	9.80	$8,920	$91
8	III	WTR-19-02-03	Wetland Restoration	56	Acres	434.35	$406,400	$94
9	II	GNV-22-02-01	Grassed Waterway	550	Lin. Feet	8.73	$8,870	$102
10	II	GNV-26-02-04	Grassed Waterway	420	Lin. Feet	7.35	$8,220	$112
11	II	GNV-22-04-01	Grassed Waterway	840	Lin. Feet	8.40	$10,320	$123
12	II	GNV-27-02-01	Grassed Waterway	1,100	Lin. Feet	9.03	$11,620	$129
13	II	GNV-22-04-02	Grassed Waterway	280	Lin. Feet	5.39	$7,520	$140
14	III	GNV-24-02-01	Wetland Restoration	14	Acres	80.50	$112,400	$140
15	II	GNV-28-04-01	Grassed Waterway	480	Lin. Feet	5.74	$8,520	$148
16	II	GNV-30-01-08	Grassed Waterway	1,300	Lin. Feet	8.40	$12,620	$150
17	II	GNV-20-04-01	Grassed Waterway	525	Lin. Feet	4.59	$8,745	$190
18	II	GNV-13-03-01	Grassed Waterway	550	Lin. Feet	4.46	$8,870	$199
19	II	GNV-23-01-01	Grassed Waterway	500	Lin. Feet	3.94	$8,620	$219
20	II	GNV-13-04-01	Grassed Waterway	330	Lin. Feet	3.51	$7,770	$222
21	I	GNV-30-04-01	Grassed Waterway	720	Lin. Feet	4.21	$9,720	$231
22	III	GNV-26-02-02	Grassed Waterway	350	Lin. Feet	3.35	$7,870	$235
23	II	GNV-30-01-07	Grassed Waterway	480	Lin. Feet	3.40	$8,520	$251
24	III	WTR-18-01-01	Wetland Restoration	2	Acres	10.45	$28,400	$272

Rank	Feasibility Code	Feature ID (Township-section-1/4-#)	BMP Type	Size	Units	Sediment Reduction (ton/yr)	Estimated Project Cost	Cost/Ton of Sediment Reduction
25	III	GNV-21-03-01	Grassed Waterway	320	Lin. Feet	2.80	$7,720	$276
26	II	GNV-27-01-01	Grassed Waterway	880	Lin. Feet	3.66	$10,520	$288
27	II	GNV-30-01-05	Water & Sediment Control Basin	1	Each	3.85	$11,120	$289
28	II	GNV-26-01-02	Grassed Waterway	230	Lin. Feet	2.21	$7,270	$328
29	I	GNV-30-04-02	Grassed Waterway	240	Lin. Feet	1.91	$7,320	$383
30	II	GNV-30-01-06	Water & Sediment Control Basin	1	Each	2.91	$11,120	$383
31	II	GNV-28-01-01	Grassed Waterway	440	Lin. Feet	2.10	$8,320	$396
32	II	GNV-26-01-04	Grassed Waterway	180	Lin. Feet	1.34	$7,020	$524
33	II	GNV-23-03-02	Water & Sediment Control Basin	1	Each	2.10	$11,120	$530
34	II	GNV-22-02-02	Grassed Waterway	240	Lin. Feet	1.37	$7,320	$536
35	II	GNV-23-03-01	Grassed Waterway	1200	Lin. Feet	2.13	$12,120	$570
36	II	GNV-24-03-02	Grassed Waterway	160	Lin. Feet	1.12	$6,920	$618
37	II	GNV-19-03-01	Grassed Waterway	360	Lin. Feet	1.15	$7,920	$690
38	II	WTR-19-02-01	Grassed Waterway	340	Lin. Feet	1.08	$7,820	$722
39	II	GNV-28-04-02	Grassed Waterway	480	Lin. Feet	1.05	$8,520	$811
40	II	GNV-26-01-03	Grassed Waterway	75	Lin. Feet	0.79	$6,495	$825
41	II	GNV-23-04-01	Grassed Waterway	460	Lin. Feet	0.98	$8,420	$861
42	II	GNV-24-03-01	Water & Sediment Control Basin	1	Each	1.09	$11,120	$1,017
43	II	GNV-26-03-01	Grassed Waterway	160	Lin. Feet	0.64	$6,920	$1,085
44	II	GNV-28-04-03	Water & Sediment Control Basin	1	Each	1.02	$11,120	$1,090
45	I	GNV-30-01-01	Grassed Waterway	370	Lin. Feet	0.64	$7,970	$1,250
46	I	GNV-30-01-02	Grassed Waterway	720	Lin. Feet	0.77	$9,720	$1,271
47	II	WTR-19-02-02	Grassed Waterway	150	Lin. Feet	0.48	$6,870	$1,437
48	II	GNV-26-01-01	Grassed Waterway	90	Lin. Feet	0.43	$6,570	$1,517
49	II	WTR-19-03-01	Grassed Waterway	350	Lin. Feet	0.46	$7,870	$1,693
50	I	GNV-30-01-03	Grassed Waterway	300	Lin. Feet	0.38	$7,620	$2,010
51	I	GNV-30-01-04	Grassed Waterway	240	Lin. Feet	0.34	$7,320	$2,153

Document Overview

The Mud Creek Subwatershed Analysis (SWA) is a watershed management tool developed to proactively identify and prioritize potential BMP projects based on performance and cost effectiveness. This process is intended, ultimately, to assist local water management organizations and partner agencies in maximizing the value of each dollar spent.

The methods and analysis behind this document provide the ability to quickly assess subwatersheds for optimal locations for BMPs that are most appropriate and feasible based on analyzed site conditions. While this analysis is accurate and sufficient for that purpose, estimated final construction costs and pollutant removals will need to be refined once projects are selected for construction. Construction projects should be considered as only one part of an overall watershed restoration plan that includes, but is not limited to, educational outreach, upstream discharge reductions, and pollutant source control.

This document is organized into three sections including Methods, Cost/Benefit Analysis Ranking, and Project Profiles for the proposed BMP's. References used in the assessment protocol and appendices provide additional information relevant to the assessment. Each section is briefly described below:

Methods

The Methods section outlines the general procedures used when assessing the subwatershed. It details the processes of *Project Scoping, Desktop Analysis, Field Reconnaissance, and Cost/Treatment Analysis*. This protocol attempts to provide a sufficient level of detail to rapidly assess watersheds and catchments of variable scales and land uses. It provides the assessor defined project goals that aid in quickly narrowing down multiple potential sites to a point where the assessor can look critically at site-specific design options that affect BMP selection.

Cost/Benefit Analysis Ranking

Projects that are 1) most able to address the project goals, 2) are compatible with current land use and 3) appear to have reasonable design, installation and maintenance costs were chosen for a cost/benefit analysis and ranked (see Table 3). The list is sorted by cost per ton of sediment treated by the BMP over a duration (i.e. life-cycle) of 10 years, the typical minimum maintenance period for publicly-funded projects on private land. The final cost per ton of treatment value includes installation and maintenance costs. While sediment is used as the primary ranking tool in this report, project priority would be very similar when projects are ranked for phosphorus reduction due to the correlation between the reduction of sediment and the reduction of phosphorus.

Project Profiles

Each BMP that was identified through the analysis was given its own unique identification code to coincide with the project location, type, and number. This identification code is used to reference each individual project. Within the *Project Profiles* section, BMPs are grouped by section, township,

and range to most easily identify the physical location of each project.

A rendered aerial photo highlights the specific locations identified for each grouping. Additional field inspections may be required to verify project feasibility, but the most ideal locations for BMP project installations based on available data are identified here. Paired with each aerial photograph is a description of the typical land use, soil types, topography, and other relevant information for each section.

The Land Management Recommendation section describes cultural practices that are encouraged as part of ongoing land management. A BMP Cost Benefit Analysis table provides for the direct comparison of the expected amount of treatment within a section per invested dollar estimated. In most cases, several BMP's were reviewed with the most feasible ones recommended based on how it fits with current use of the land, efficiency of pollutant reduction, and estimated cost.

Methods

Step #1: Project Scoping

Determining the resource of concern and the subsequent drainage area to analyze is the first step in the assessment process. Water quality monitoring data, inclusion on Minnesota's impaired waters list, availability of accurate GIS data, and availability of other plans or assessments are a few of the considerations in determining which waterbodies are a priority.

Mud Creek

Dakota County SWCD has been completing SWAs throughout the agricultural portions of Dakota County, with a goal of covering all agricultural portions of the county within a SWA. To date, 8 SWAs are complete and each of the SWAs have focused on catchments that drain to a specific tributary major river. This SWA focused on the catchments that drain to Mud Creek in southwestern Dakota County.

Mud Creek is located within the Cannon River watershed and under the authority of the North Cannon River Watershed Management Organization (NCRWMO). The NCRWMO has set a surface water goal to protect and improve the water quality of streams, rivers, and lakes such that each use is "fully supporting" for its use designations according to MN State Standards. As a strategy to accomplish that goal, the NCRWMO aims to provide cost share assistance to landowners to install BMPs that reduce pollution in surface waters, such as grassed waterways, streambank and shoreline stabilization, feedlot improvements, nutrient management, tile outlet and wood chip bioreactors, crop irrigation management, riparian buffers, etc. (NCRWMO Plan 2013).

The NCRWMO is in the process of updating their watershed management plan with anticipated adoption of a 4th generation plan in July 2023. The draft plan identifies Mud Creek as a priority resource and the implementation table identifies establishing conservation practices including cover crops, grassed waterways, water and sediment control basins, filter strips, stream and shoreline protections, wetland restorations, establishment of perennial vegetation, nutrient management planning (NCRWMO Draft Plan 2023).

Mud Creek was targeted for this subwatershed analysis because Mud Creek was identified as one of the top priorities for implementing projects. It was also chosen due to its ability to protect downstream water resources. Dakota County SWCD Staff coordinated with NCRWMO staff in selection of the Mud Creek subwatershed for this analysis to identify specific BMPs.

Mud Creek is a stream that flows approximately 7 miles through the southwestern portion of Dakota county and is a tributary to Chub Creek, the Cannon River, and Lake Byllesby. The contributing watershed of Mud Creek encompasses approximately 9.9 square miles (6,342 acres) and includes

some rolling hills and landlocked wetlands. Land use is primarily agricultural, most of which is row crop agriculture. Because Mud Creek is a tributary to Chub Creek, the Cannon River, and Lake Byllesby, pollutants originating from the subwatershed are a concern due to their potential impact to downstream water resources.

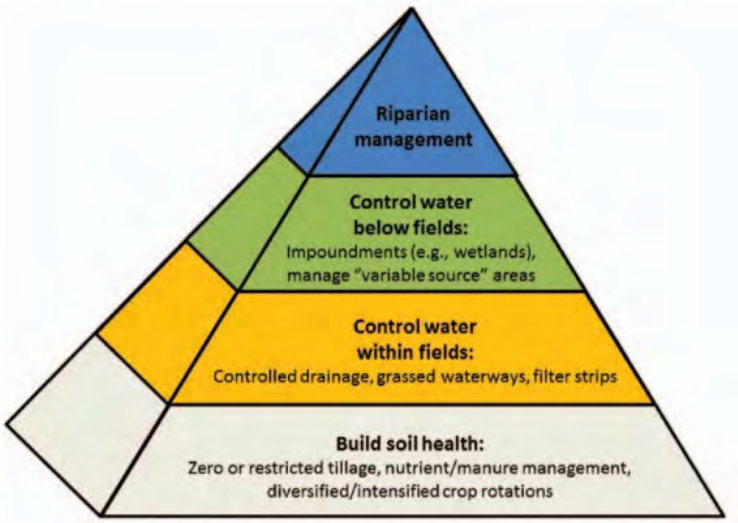
Water quality monitoring in this watershed has been performed in various locations along Mud Creek. Recent monitoring has been focused at the crossing of Highway 3 in Waterford Township. This includes monitoring once per month from April to October. Monitoring parameters include transparency, conductivity, dissolved oxygen, chlorophyll-a, pH, total suspended solids, temperature, nitrates, phosphorus, and *E. coli*.

Mud Creek is impaired for fecal coliform (bacteria) and has been included on Minnesota's Impaired Waters List since 2006. Recent monitoring data has also indicated very low dissolved oxygen from midsummer through fall and *E. coli* spikes occurring mid-summer and remaining high through the fall. Chlorophyll-a, nitrate, total phosphorus, and total suspended solid levels have been fairly low all seasons, but can become elevated during rain runoff events. Downstream, Chub Creek is impaired for fecal coliform (bacteria) and macroinvertebrates, the Cannon River is impaired for turbidity and macroinvertebrates, and Lake Byllesby is impaired for excess nutrients.

Through analysis of existing monitoring data and through coordination with the NCRWMO, sediment has been identified as the primary pollutant of concern for this analysis. Since sediment is a major contributor to total suspended solids, contributes to high turbidity within the river, is detrimental to aquatic life, and is closely corelated to phosphorus, reducing sediment will have the ability to protect downstream resources. The Dakota County SWCD, in coordination with the NCRWMO, determined that projects will be prioritized based on the potential to reduce sediment loads from reaching surface waters.

Due to the close association between sediment and phosphorus, many of the identified BMPs would rank similarly when ranked by their cost-benefit ratio with regards to phosphorus reduction. Pollutants including fecal coliform and nitrates are a concern for this subwatershed and are not overlooked. While these pollutants can be addressed partially by structural BMPs, they are most effectively address by non-structural land management practices. As such, the land management practices identified in this subwatershed analysis are intended to address these pollutants along with sediment.

It is important to note that this subwatershed analysis does not explicitly identify and rank practices that may be adopted within fields in order to build soil health, maintain residue cover, improve nutrient use efficiency, reduce runoff, and reduce nutrient leaching. These practices, including cover crops, no-till, proper nutrient management, and alternative crop systems, are recommended on virtually any field and all landowners are



Land management practices provide foundation to agricultural watershed management (Agricultural Conservation Planning Framework)

encouraged to implement them. These land management practices are recommended as a high priority and may have greater water quality benefit than most structural BMPs. Because the practices are applicable on most landscapes throughout the Mud Creek subwatershed, they are not specifically identified in the cost-benefit rankings but are nonetheless recommended as a high priority.

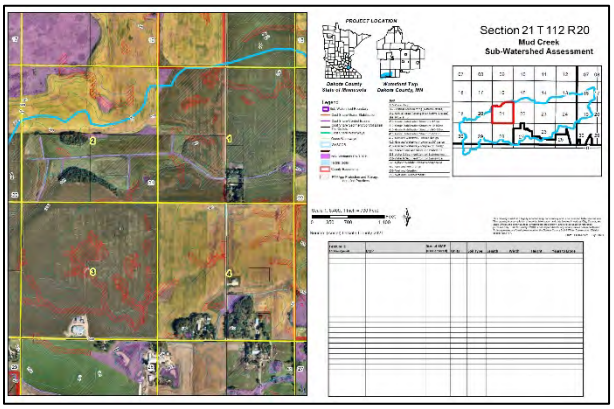
This analysis is not intended to address flooding or surface water quantity issues on a large scale. Projects such as wetland restorations or water and sediment control basins identified within this analysis are for the primary purpose of erosion and sediment reduction. Separate efforts are currently underway by Dakota County and the Dakota County SWCD to study the watershed on a larger scale, analyze rural flow patterns, identify flood prone areas, and identify wetland and water retention projects from a watershed perspective.

Step #2: Desktop Analysis

The purpose of the desktop analysis is to narrow the amount of field reconnaissance and other time-consuming tasks that would be needed to complete the SWA by identifying and prioritizing potential projects within the subwatershed which would likely yield the greatest pollutant (sediment) reductions. Desktop analysis primarily compiles existing data to highlight the locations where BMPs would be most beneficial.

The desktop analysis involves computer-based scanning of the subwatershed for potential retrofit projects. Accurate GIS data is extremely valuable in conducting the desktop review. Some of the most important GIS layers included: 1-foot topography, soils, watershed and subcatchment boundaries, parcel boundaries, land cover, stream and ditch networks, wetland inventory, culverts, database of existing conservation practices, and high resolution aerial photography (all years that were available).

Topographic data was used to identify steep slopes, areas of concentrated flow, and depressional areas that may be suitable for treatment of runoff and storage within the watershed. Aerial photography was used to identify locations that had indicators of surface erosion from concentrated flow. Photography from multiple years and varied seasons was used to identify issues such as gully erosion that may not have been evident in a single aerial photo due to recent tillage activity, cropping rotations, or variations in weather. Soils information was used to identify highly erodible soils and hydric soils to determine the appropriate BMP for a specific location.



Existing data including PTMApp outputs was analyzed, and maps were created to aid in field reconnaissance.

Outputs from the Prioritize, Target, and Measure Application (PTMApp) were also used in the desktop analysis (BWSR 2021). PTMApp-identified protection and storage practices data was overlayed with other data layers to further highlight opportunities for the installation of sediment

reduction practices.

As a tool for the field reconnaissance, maps were created for each 1-mile by 1-mile section showing the desktop identified BMPs with relevant information including 2021 aerial photos, parcel boundaries, landowner information, existing and previously installed BMPs, wetlands, PTMApp outputs, and contour lines. Staff from the Dakota County SWCD office used the maps to verify the feasibility and effectiveness of each BMP.

Step #3: Field Reconnaissance

Using the created maps for each section as a guide, field investigations were 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 also revealed BMP opportunities that could have gone unnoticed using only a 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 when possible.

Example of a location identified for a grassed waterway within the Mud Creek subwatershed.

Field reconnaissance was done in the spring when soil surfaces were visible and not obstructed by crops. BMPs that were deemed feasible were recorded and appropriate information was gathered to calculate the size, pollutant removal potential, and cost of the BMP. Linear BMPs such as grass waterways that spanned across more than one parcel were split on parcel boundaries and identified as two separate practices. This was done to appropriately estimate installation costs as they would likely need coordination with multiple landowners with separate agreements and design documents. It is important to note that BMPs spanning multiple parcels are likely to be contingent upon up gradient or downgradient practices being installed on adjacent properties for each of the BMPs to be effective.

BMPs were selected from the Natural Resources Conservation Service (NRCS) practice standards. Sites identified during the field reconnaissance were determined to be the best locations for BMP installations for pollutant treatment based on professional knowledge and experience. In general, locations of field-identified sites correlated to PTMApp-identified locations.

Example of a recently constructed a grassed waterway within the Mud Creek subwatershed

However, some PTMApp-identified locations had existing BMPs, not all field-identified sites were identified through PTMApp, and PTMApp identified some sites that were not compatible with existing farming operations. Field verification was needed to determine the appropriate practice type and location based on existing and future land use.

Following field reconnaissance, field maps and recorded notes were digitized in preparation for the cost-benefit ranking. Staff identified 51 potential locations that would benefit from BMP installations. Table 1 illustrates pollution reduction practices that were considered for each site.

Table 1. Pollution Reduction Practices

Practice & NRCS Code	Description
340 - Cover Crop	**Grasses, legumes, and forbs planted for seasonal vegetative cover.**
342 - Critical Area Planting (Native plants)	**Planting of permanent native grasses, usually on a field with steep slopes over 6%.**
393 - Filter Strip	**Strip of perennial grasses, forbs, and legumes planted along a stream, ditch, or wetland to capture sediment before it runs into the waterbody.**
410 - Grade Stabilization Structure	**A structure used in natural or constructed channels to slow the flow of water, stabilize the channel, and reduce erosion.**
412 - Grassed Waterway	**A perennially vegetated conveyance to reduce erosion where there is concentrated flow of water.**
580 - Stream and Shoreline Protection	**Treatments to stabilize and protect the banks of streams to prevent the loss of soil and reduce the offsite or downstream effects of sediment resulting from bank erosion.**
638 - Water & Sediment Control Basin	**An earthen embankment which temporarily traps water and sediment running off cropland upslope, thereby slowing the flow of runoff and allowing sediment to drop out of suspension.**
657 – Wetland Restoration	**Restoring hydrology and vegetation on a former or degraded wetland site. Restored wetlands can filter sediment from runoff and reduce pollutant loading to downstream water resources.**

Step #4: Cost/Treatment Analysis

After feasible BMP projects were identified, potential sediment reductions were calculated and preliminary cost estimates compiled. The projects were then ranked based on the cost per ton of sediment removal per year, over a 10-year life-cycle. The final value for the cost per pound of treatment includes construction and installation. The top-ranking projects have the lowest cost per ton of sediment removal.

Treatment Analysis

Modeling of the sediment loading for each selected BMP, before and after project installation, was completed with the Board of Water and Soil Resources (BWSR) Pollution Reduction Estimator and inputs from RUSLE2 as needed. Distance to surface water was calculated based on distances between the project and identified watercourses from the Dakota County SWCD's surface water inventory. For wetland restorations, sediment loads were calculated using RUSLE2 for each contributing drainage area. Sediment reductions were then calculated using maximum drainage area to wetland size ratios along with percent reduction values from the Minnesota Stormwater Manual.

The sediment reduction estimates associated with the installation of each project should be considered as pollutant reduction to surface waters within the Mud Creek subwatershed, but not necessarily pollutant load reductions to Mud Creek, Chub Creek, or the Cannon River. It is important to note that reported treatment levels are dependent upon optimal site selection and sizing. Not all locations and sizes will yield the same results. The pollutant removal estimates may be used to prioritize practices within the Mud Creek subwatershed and for grant applications but in no case should this data be used to represent actual pollutant removal until after installation is complete and site-specific modeling and/or monitoring data is available.

Cost estimates

Each project was assigned estimated costs for design and installation based on a recent analysis of costs for similar projects installed in Dakota County from 2018 to 2022. The averaged costs used in the calculations can be found in the Appendix. An annual cost per ton of sediment removal was then calculated for the 10-year life-cycle. In the final evaluation and ranking, the estimated project costs for each BMP are listed.

Cost/Benefit and Project Ranking Table

More detail regarding each specific project can be found in the *Project Profiles* pages of this report. In addition to ranking, a "Feasibility Code" was assigned to each project as shown in Table 2. The purpose of this code is to provide a basic indication of the feasibility or "reasonable likelihood" the listed project would be applied and installed by the landowner on a voluntary basis. The selected code is based on relative success Dakota County SWCD staff has had in promoting the selected BMP project type through promotional efforts, landowner engagement initiatives conducted in recent history, and previous work with the project landowner.

The following criteria apply to each of the three codes used:

Table 2. Project Feasibility Codes

Code	Considerations
I	**High likelihood: practice is not dependent on installation of other practices or coordination with other landowners, the landowner has a history of cooperation with SWCD/NRCS, practice does not hinder farmability and/or installation cost is not prohibitive**
II	**Medium likelihood: practice may be dependent on installation of one or two other conservation practices and coordination with additional landowners, landowner is willing to work with SWCD/NRCS, practice does not severely hinder farmability and/or cost is not prohibitive**
III	**Low likelihood: project requires installation of other practices in order to be effective and coordination with multiple landowners, landowner has not previously worked with SWCD/NRCS, practice disrupts ability to farm the field and/or installation cost is prohibitive**

Table 3 summarizes the identified potential projects within the study area. Potential projects are listed from most cost effective to least cost effective, based on cost per ton of sediment removed over the life-cycle timeframe.

Cost estimates represent design and construction costs for each project installed on that particular site. Depending on complexity, additional project costs ranging from 25% to 50% of the construction cost should be added to account for project outreach and promotion. The reported treatment levels are dependent upon optimal siting and sizing which would be completed during the actual design phase of the proposed project, as well as obtaining landowner cooperation. Due to changing land use over time, these project profiles should be re-assessed periodically to update BMP suitability and priority ranking.

Table 3. Summary of Potential BMPs

Rank	Feasibility Code	Feature ID (Township-section-1/4-#)	BMP Type	Size	Units	Sediment Reduction (ton/yr)	Estimated Project Cost	Cost/Ton of Sediment Reduction
1	II	WTR-18-04-01	Grassed Waterway	650	Lin. Feet	17.64	$9,370	$53
2	III	WTR-18-03-01	Wetland Restoration	7	Acres	110.00	$63,400	$58
3	II	GNV-26-02-05	Grassed Waterway	920	Lin. Feet	14.66	$10,720	$73
4	II	GNV-20-04-02	Grassed Waterway	2,400	Lin. Feet	21.00	$18,120	$86
5	III	GNV-26-02-01	Grassed Waterway	1,000	Lin. Feet	12.75	$11,120	$87
6	II	GNV-26-02-03	Grassed Waterway	825	Lin. Feet	11.73	$10,245	$87
7	II	GNV-24-03-03	Grassed Waterway	560	Lin. Feet	9.80	$8,920	$91
8	III	WTR-19-02-03	Wetland Restoration	56	Acres	434.35	$406,400	$94
9	II	GNV-22-02-01	Grassed Waterway	550	Lin. Feet	8.73	$8,870	$102
10	II	GNV-26-02-04	Grassed Waterway	420	Lin. Feet	7.35	$8,220	$112
11	II	GNV-22-04-01	Grassed Waterway	840	Lin. Feet	8.40	$10,320	$123
12	II	GNV-27-02-01	Grassed Waterway	1,100	Lin. Feet	9.03	$11,620	$129
13	II	GNV-22-04-02	Grassed Waterway	280	Lin. Feet	5.39	$7,520	$140
14	III	GNV-24-02-01	Wetland Restoration	14	Acres	80.50	$112,400	$140
15	II	GNV-28-04-01	Grassed Waterway	480	Lin. Feet	5.74	$8,520	$148
16	II	GNV-30-01-08	Grassed Waterway	1,300	Lin. Feet	8.40	$12,620	$150
17	II	GNV-20-04-01	Grassed Waterway	525	Lin. Feet	4.59	$8,745	$190
18	II	GNV-13-03-01	Grassed Waterway	550	Lin. Feet	4.46	$8,870	$199
19	II	GNV-23-01-01	Grassed Waterway	500	Lin. Feet	3.94	$8,620	$219
20	II	GNV-13-04-01	Grassed Waterway	330	Lin. Feet	3.51	$7,770	$222
21	I	GNV-30-04-01	Grassed Waterway	720	Lin. Feet	4.21	$9,720	$231
22	III	GNV-26-02-02	Grassed Waterway	350	Lin. Feet	3.35	$7,870	$235
23	II	GNV-30-01-07	Grassed Waterway	480	Lin. Feet	3.40	$8,520	$251
24	III	WTR-18-01-01	Wetland Restoration	2	Acres	10.45	$28,400	$272

Rank	Feasibility Code	Feature ID (Township-section-1/4-#)	BMP Type	Size	Units	Sediment Reduction (ton/yr)	Estimated Project Cost	Cost/Ton of Sediment Reduction
25	III	GNV-21-03-01	Grassed Waterway	320	Lin. Feet	2.80	$7,720	$276
26	II	GNV-27-01-01	Grassed Waterway	880	Lin. Feet	3.66	$10,520	$288
27	II	GNV-30-01-05	Water & Sediment Control Basin	1	Each	3.85	$11,120	$289
28	II	GNV-26-01-02	Grassed Waterway	230	Lin. Feet	2.21	$7,270	$328
29	I	GNV-30-04-02	Grassed Waterway	240	Lin. Feet	1.91	$7,320	$383
30	II	GNV-30-01-06	Water & Sediment Control Basin	1	Each	2.91	$11,120	$383
31	II	GNV-28-01-01	Grassed Waterway	440	Lin. Feet	2.10	$8,320	$396
32	II	GNV-26-01-04	Grassed Waterway	180	Lin. Feet	1.34	$7,020	$524
33	II	GNV-23-03-02	Water & Sediment Control Basin	1	Each	2.10	$11,120	$530
34	II	GNV-22-02-02	Grassed Waterway	240	Lin. Feet	1.37	$7,320	$536
35	II	GNV-23-03-01	Grassed Waterway	1200	Lin. Feet	2.13	$12,120	$570
36	II	GNV-24-03-02	Grassed Waterway	160	Lin. Feet	1.12	$6,920	$618
37	II	GNV-19-03-01	Grassed Waterway	360	Lin. Feet	1.15	$7,920	$690
38	II	WTR-19-02-01	Grassed Waterway	340	Lin. Feet	1.08	$7,820	$722
39	II	GNV-28-04-02	Grassed Waterway	480	Lin. Feet	1.05	$8,520	$811
40	II	GNV-26-01-03	Grassed Waterway	75	Lin. Feet	0.79	$6,495	$825
41	II	GNV-23-04-01	Grassed Waterway	460	Lin. Feet	0.98	$8,420	$861
42	II	GNV-24-03-01	Water & Sediment Control Basin	1	Each	1.09	$11,120	$1,017
43	II	GNV-26-03-01	Grassed Waterway	160	Lin. Feet	0.64	$6,920	$1,085
44	II	GNV-28-04-03	Water & Sediment Control Basin	1	Each	1.02	$11,120	$1,090
45	I	GNV-30-01-01	Grassed Waterway	370	Lin. Feet	0.64	$7,970	$1,250
46	I	GNV-30-01-02	Grassed Waterway	720	Lin. Feet	0.77	$9,720	$1,271
47	II	WTR-19-02-02	Grassed Waterway	150	Lin. Feet	0.48	$6,870	$1,437
48	II	GNV-26-01-01	Grassed Waterway	90	Lin. Feet	0.43	$6,570	$1,517
49	II	WTR-19-03-01	Grassed Waterway	350	Lin. Feet	0.46	$7,870	$1,693
50	I	GNV-30-01-03	Grassed Waterway	300	Lin. Feet	0.38	$7,620	$2,010
51	I	GNV-30-01-04	Grassed Waterway	240	Lin. Feet	0.34	$7,320	$2,153

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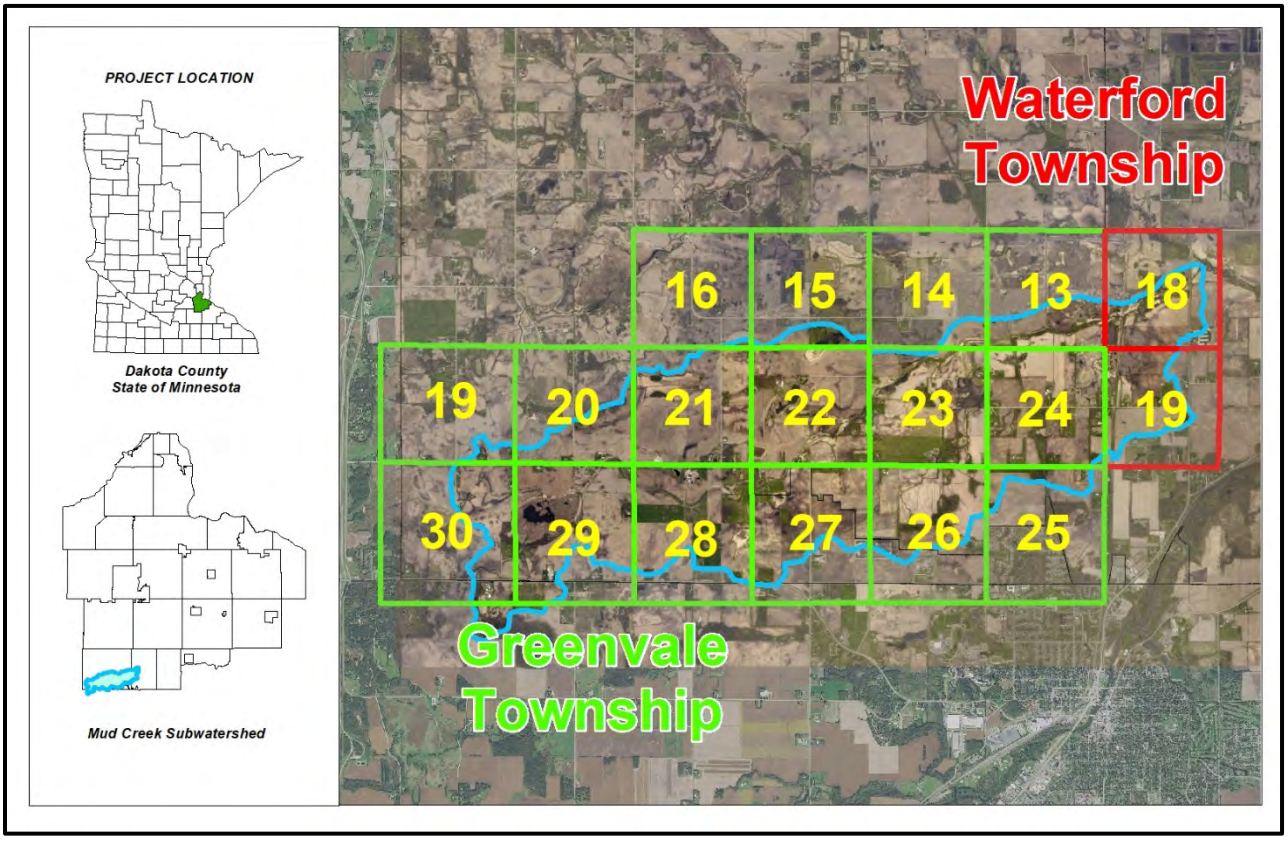
Project Profiles

The following pages provide definition and detailed assessments for each of the projects identified through the field reconnaissance and subsequent evaluation of each BMP. For organizational purposes the selected projects are grouped by section, as shown below. The one-mile sections are identified by the township name and section number. Projects are displayed with 2021 aerial imagery and Dakota County parcel boundaries. Individual projects are identified by a unique number and project specific information is included in the BMP Cost Benefit Analysis table.

The Project Profiles are part of the subwatershed analysis and should be retained with the document to provide context for identified BMPs. The drawings are neither legally recorded maps nor surveys and are not intended to be used as such. The drawings are a compilation of records, information, and data located in various City, County, and State Offices and other sources, affecting the areas shown, and are to be used for reference purposes only. Dakota County SWCD is not responsible for any inaccuracies herein contained. If discrepancies are found, please contact the Dakota County Soil and Water Conservation District at 651-480-7777.

Project Profile Reference Sections



Greenvale Township, Section 13

Description:

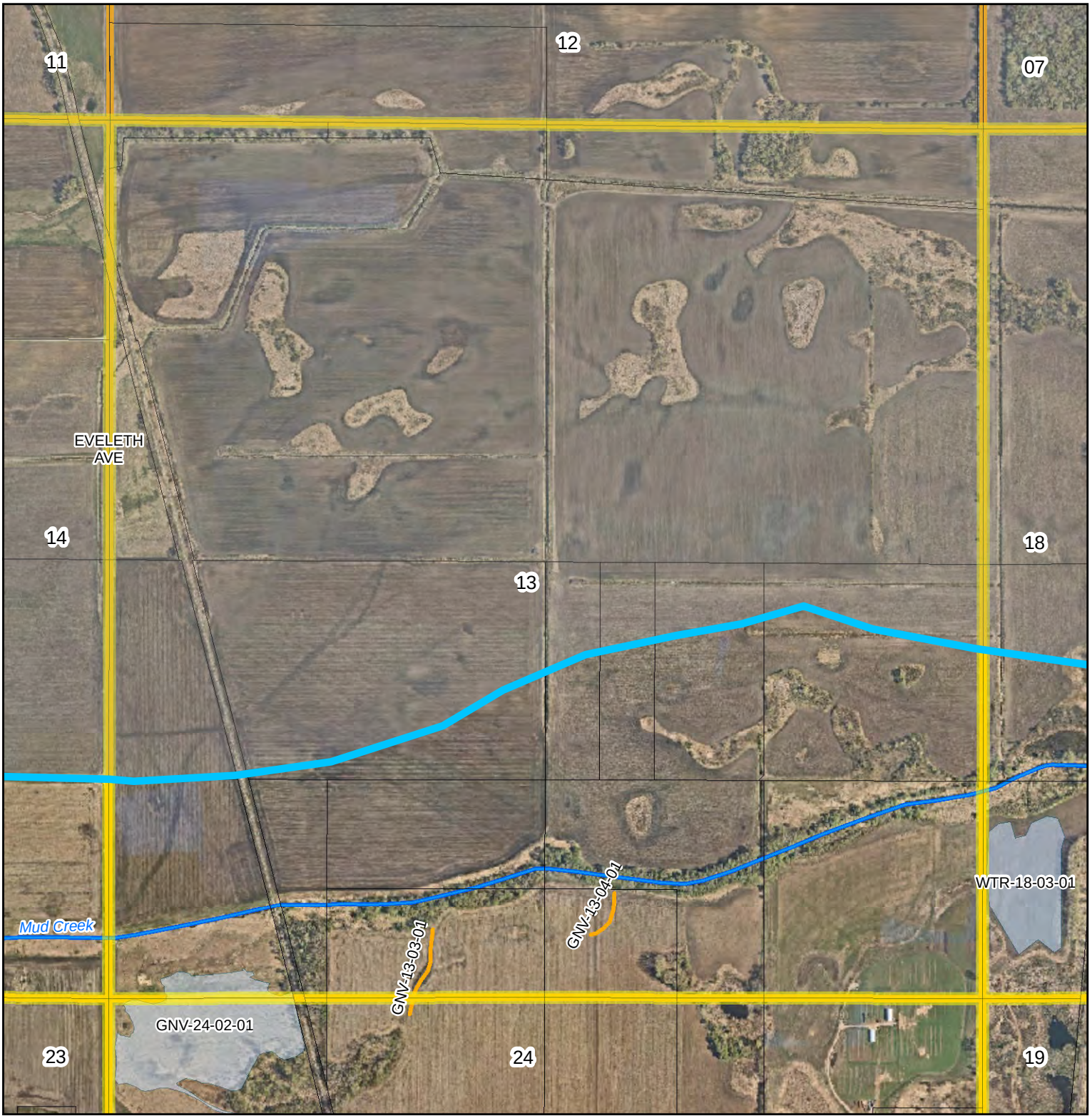
The area of the Mud Creek Subwatershed that lies within Section 13 of Greenvale Township is approximately 228 acres. It consists primarily of agricultural cropland and several wetlands. Mud Creek flows through the southern half of this section and has wetlands on both sides of the channel. Conventional tillage practices are utilized on the majority of the cropland. Mayer silt loam and Glencoe silty loam with 0 to 1 percent slopes are the predominant soil types.

Land Management Recommendations:

The primary land use within this section is agricultural. Land management practices recommended throughout this section include proper use of cover crops, appropriate nutrient management, conservation crop rotation, and conservation tillage. Although the land management practices were not analyzed for pollutant reduction, it is likely that they have a greater benefit than structural practices within the watershed due to their ability to prevent the transport of sediment and other nutrients.

BMP Cost Benefit Analysis:

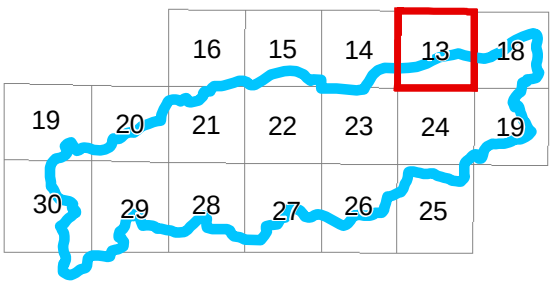
Feature ID (Township-section-1/4-#)	BMP/Project Name	Size	Units	Sediment Reduction (ton/yr)	Estimated Project Cost	Cost/Ton of Sediment Reduction
GNV-13-03-01	412 - Grassed Waterway - simple design	550	Lin. Feet	4.46	$8,870	$199
GNV-13-04-01	412 - Grassed Waterway - simple design	330	Lin. Feet	3.51	$7,770	$222



Source: (Aerial) Dakota County 2021

Township: Greenvale

Section: 13



Potential Practices

- Stream Stabilization
- Grade Stabilization
- Water and Sediment Control Basin
- Waterway
- Filter Strip / Critical Area Planting
- Wetland Restoration
- Existing SWCD Practices
- Existing SWCD Filter Strips
- Mud Creek Subwatershed

DAKOTA COUNTY
SOIL & WATER
CONSERVATION DISTRICT

0 400 800 1,600 Feet

N

Greenvale Township, Section 14

Description:

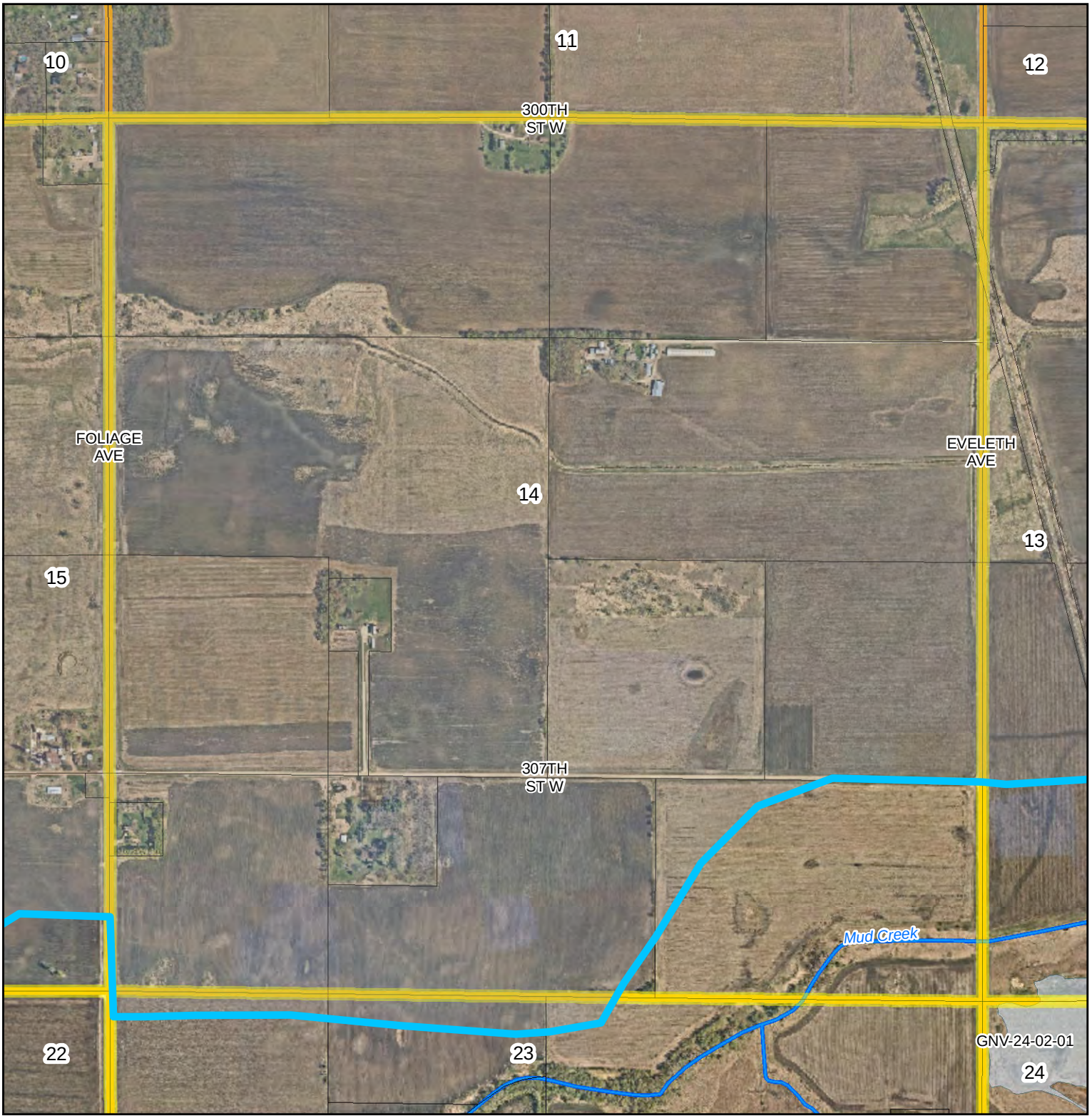
The area of the Mud Creek Subwatershed that lies within Section 14 of Greenvale Township is approximately 54 acres. It consists primarily of agricultural cropland with a few wetlands along Mud Creek which flows through the southeastern part of the section. Conventional tillage practices are utilized on the majority of the cropland. Webster clay loam with 0 to 2 percent slopes is the predominant soil type.

Land Management Recommendations:

The primary land use within this section is agricultural. Land management practices recommended throughout this section include proper use of cover crops, appropriate nutrient management, conservation crop rotation, and conservation tillage. Although the land management practices were not analyzed for pollutant reduction, it is likely that they have a greater benefit than structural practices within the watershed due to their ability to prevent the transport of sediment and other nutrients.

BMP Cost Benefit Analysis:

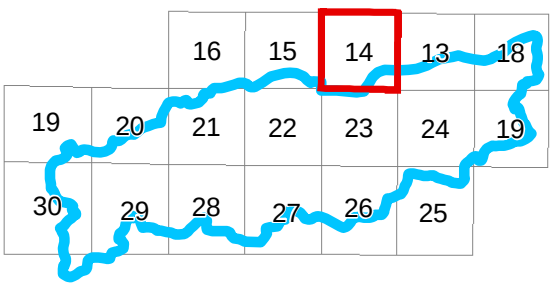
There were no structural practices that ranked high for cost-effectiveness identified in this section. Focus in this section should be on proper land management practices and non-structural best management practices.



Source: (Aerial) Dakota County 2021

Township: Greenvale

Section: 14



Potential Practices

- Stream Stabilization
- Grade Stabilization
- Water and Sediment Control Basin
- Waterway
- Filter Strip / Critical Area Planting
- Wetland Restoration
- Existing SWCD Practices
- Existing SWCD Filter Strips
- Mud Creek Subwatershed

DAKOTA COUNTY SOIL & WATER CONSERVATION DISTRICT

0 400 800 1,600 Feet

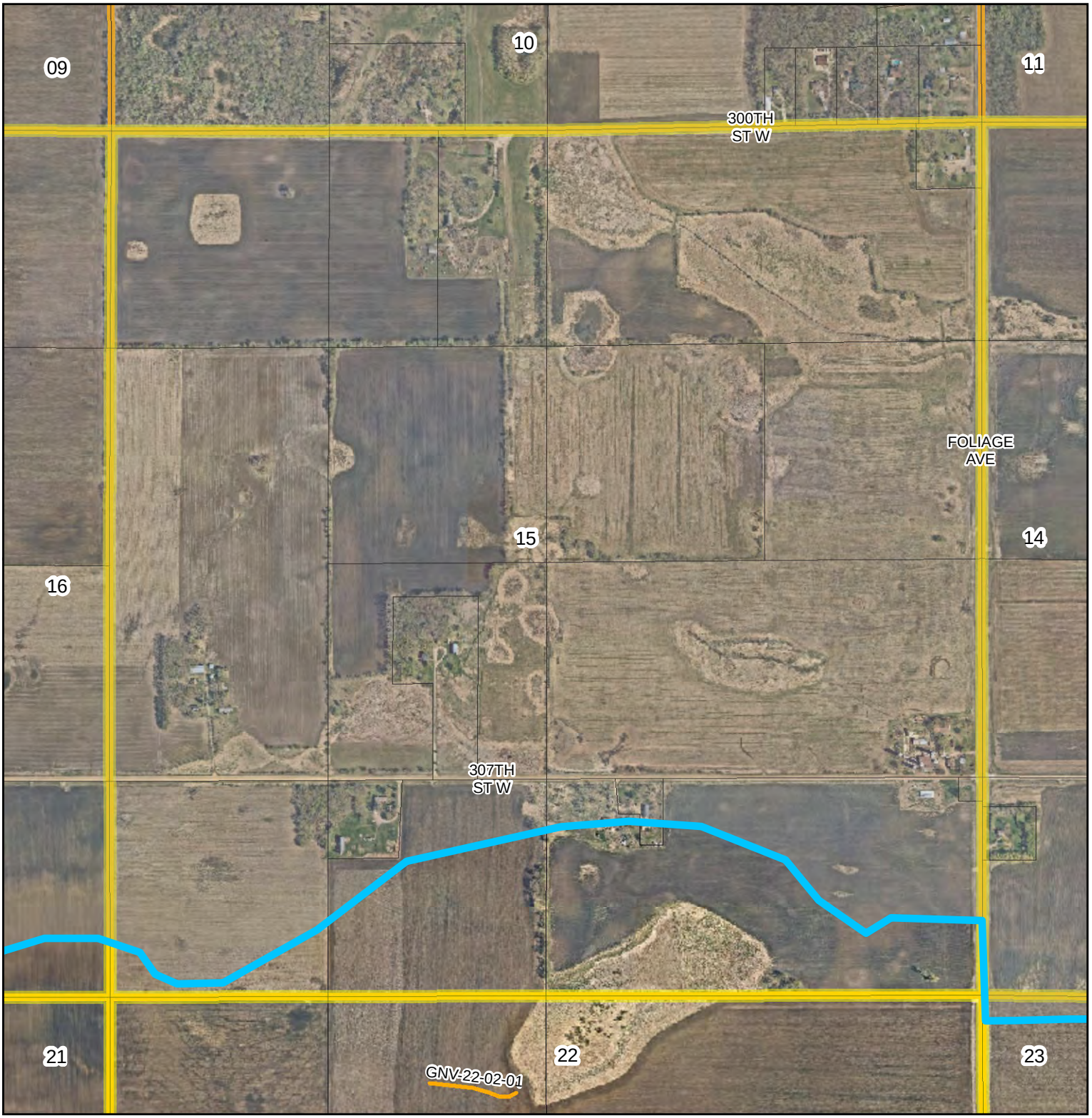
N

Greenvale Township, Section 15

Description:
The area of the Mud Creek Subwatershed that lies within Section 15 of Greenvale Township is approximately 79 acres. It consists primarily of agricultural cropland with several wetlands and part of a homesite. Conventional tillage practices are utilized on the majority of the cropland. Cordova clay loam with 0 to 2 percent slopes is the predominant soil type.

Land Management Recommendations:
The primary land use within this section is agricultural. Land management practices recommended throughout this section include proper use of cover crops, appropriate nutrient management, conservation crop rotation, and conservation tillage. Although the land management practices were not analyzed for pollutant reduction, it is likely that they have a greater benefit than structural practices within the watershed due to their ability to prevent the transport of sediment and other nutrients.

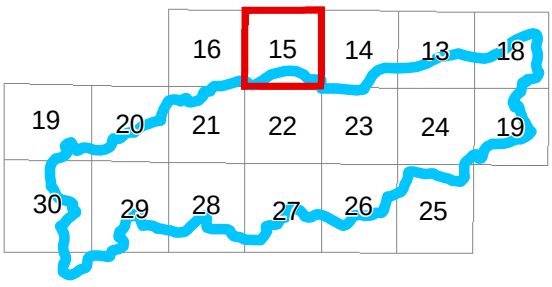
BMP Cost Benefit Analysis:
There were no structural practices that ranked high for cost-effectiveness identified in this section. Focus in this section should be on proper land management practices and non-structural best management practices.



Source: (Aerial) Dakota County 2021

Township: Greenvale

Section: 15



Potential Practices

- Stream Stabilization
- Grade Stabilization
- Water and Sediment Control Basin
- Waterway
- Filter Strip / Critical Area Planting
- Wetland Restoration

Existing SWCD Practices

Existing SWCD Filter Strips

Mud Creek Subwatershed

DAKOTA COUNTY SOIL & WATER CONSERVATION DISTRICT

0 400 800 1,600 Feet

N

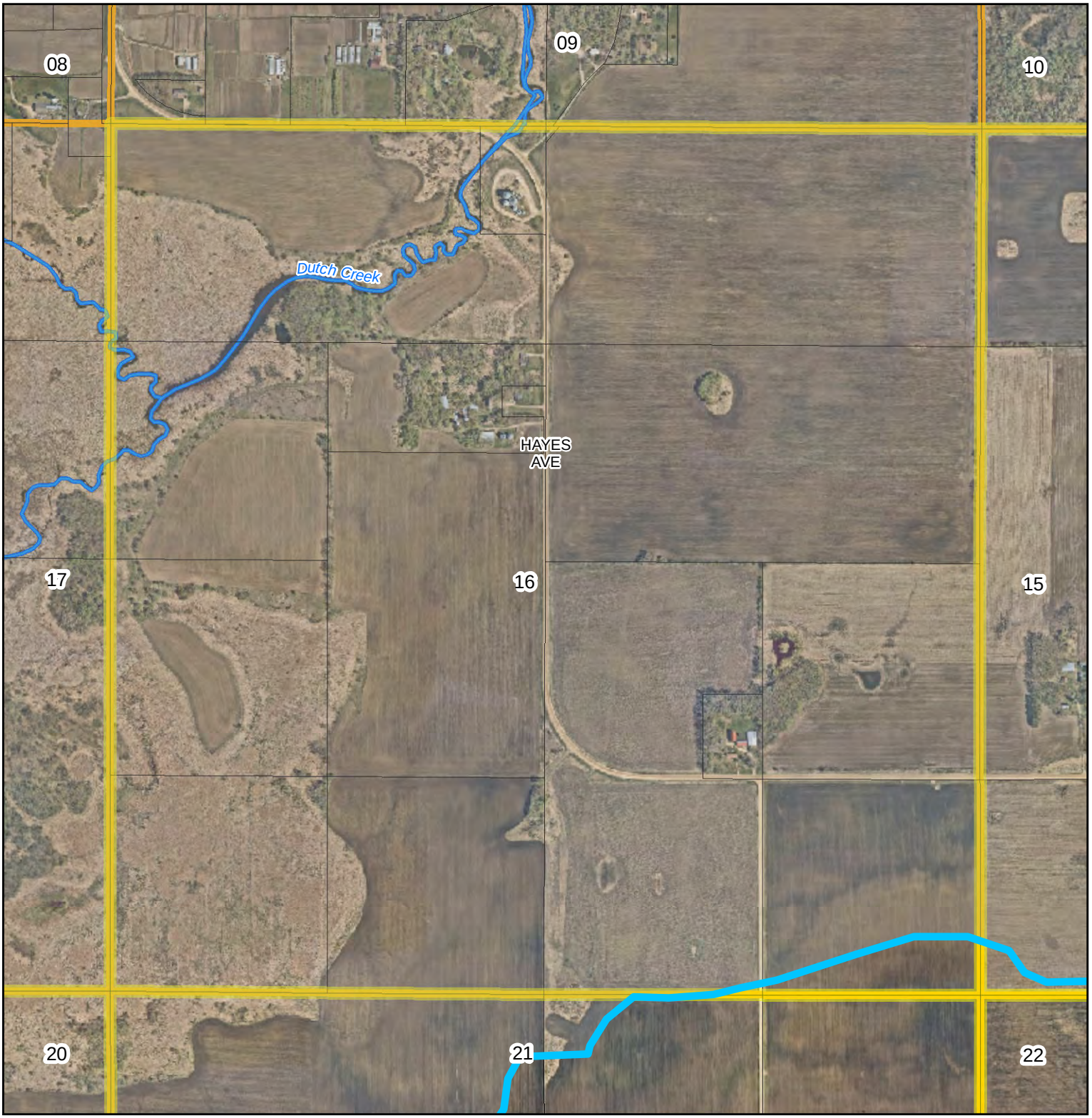
Greenvale Township, Section 16

Description:
The area of the Mud Creek Subwatershed that lies within Section 16 of Greenvale Township is approximately 8 acres. It consists of agricultural cropland. Conventional tillage practices are utilized on the majority of the cropland. Lester loam with 2-6% slopes and Cordova clay loam with 0-2% slopes are the predominant soil types.

Land Management Recommendations:
The primary land use within this section is agricultural. Land management practices recommended throughout this section include proper use of cover crops, appropriate nutrient management, conservation crop rotation, and conservation tillage. Although the land management practices were not analyzed for pollutant reduction, it is likely that they have a greater benefit than structural practices within the watershed due to their ability to prevent the transport of sediment and other nutrients.

BMP Cost Benefit Analysis:

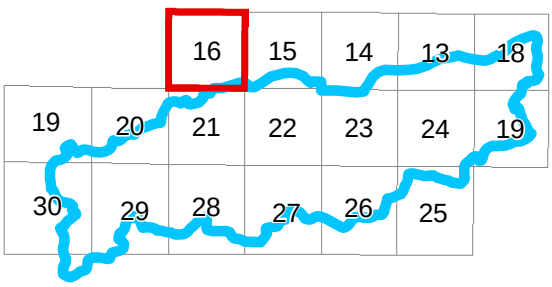
There were no structural practices that ranked high for cost-effectiveness identified in this section. Focus in this section should be on proper land management practices and non-structural best management practices.



Source: (Aerial) Dakota County 2021

Township: Greenvale

Section: 16



Potential Practices

- Stream Stabilization
- Grade Stabilization
- Water and Sediment Control Basin
- Waterway
- Filter Strip / Critical Area Planting
- Wetland Restoration
- Existing SWCD Practices
- Existing SWCD Filter Strips
- Mud Creek Subwatershed

DAKOTA COUNTY SOIL & WATER CONSERVATION DISTRICT

0 400 800 1,600 Feet

Greenvale Township, Section 19

Description:

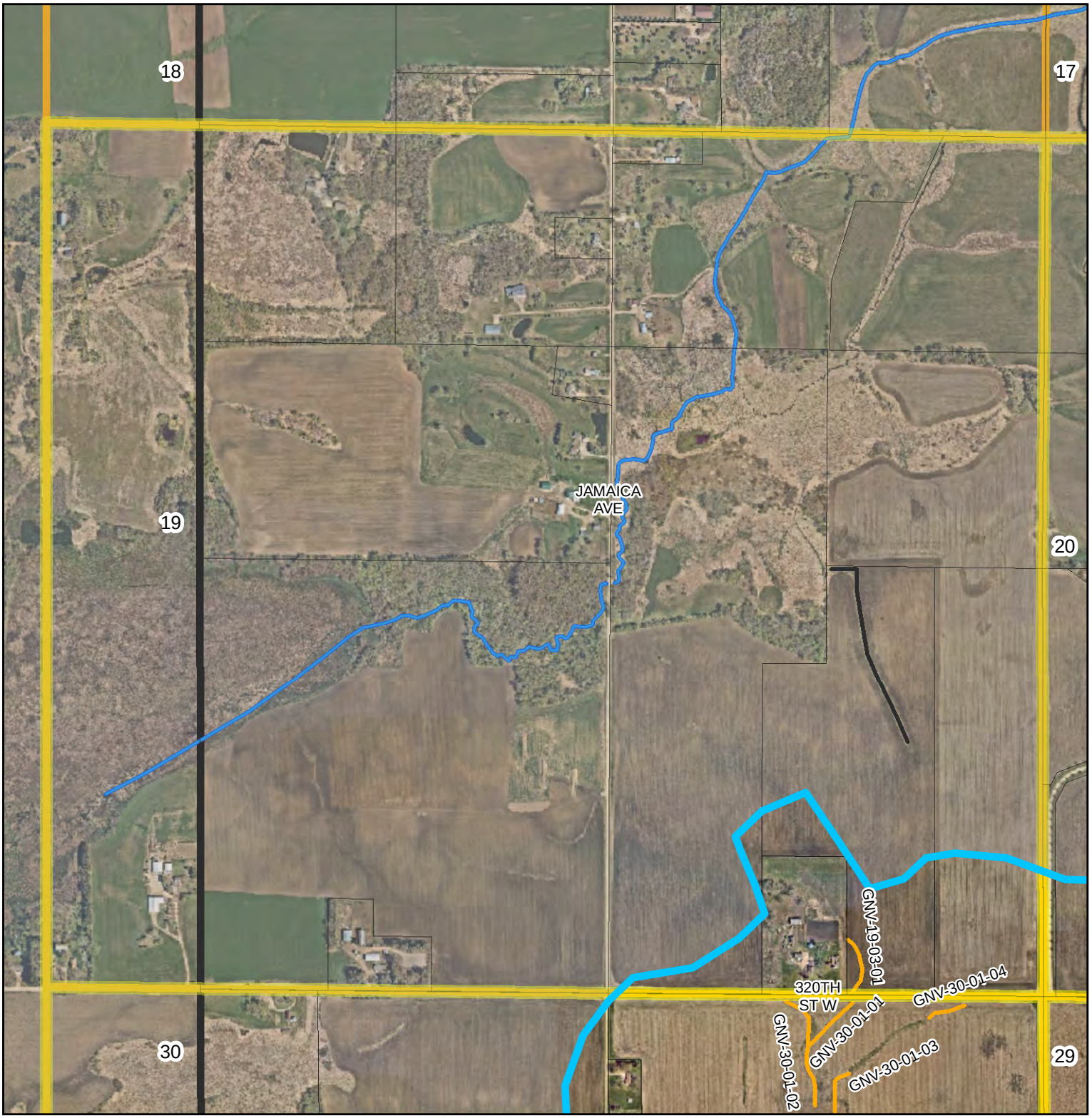
The area of the Mud Creek Subwatershed that lies within Section 19 of Greenvale Township is approximately 40 acres. It consists primarily of agricultural cropland and a homesite. Conventional tillage practices are utilized on the majority of the cropland. Le Sueur loam with 1-3% slopes, Lester loam with 2-6% slopes, Cordova clay loam with 0-2% slopes, and Hamel loam with 0-2% slopes are the predominant soil types.

Land Management Recommendations:

The primary land use within this section is agricultural. Land management practices recommended throughout this section include proper use of cover crops, appropriate nutrient management, conservation crop rotation, and conservation tillage. Although the land management practices were not analyzed for pollutant reduction, it is likely that they have a greater benefit than structural practices within the watershed due to their ability to prevent the transport of sediment and other nutrients.

BMP Cost Benefit Analysis:

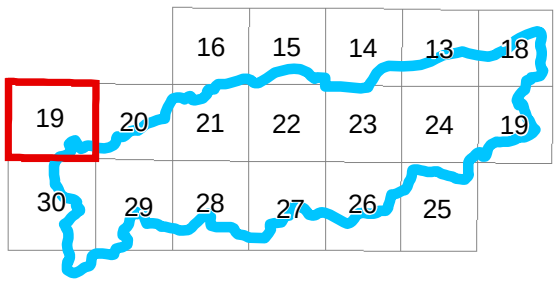
Feature ID (Township-section-1/4-#)	BMP/Project Name	Size	Units	Sediment Reduction (ton/yr)	Estimated Project Cost	Cost/Ton of Sediment Reduction
GNV-19-03-01	412 - Grassed Waterway - simple design	360	Lin. Feet	1.15	$7,920	$690



Source: (Aerial) Dakota County 2021

Township: Greenvale

Section: 19



Potential Practices

- Stream Stabilization
- Grade Stabilization
- Water and Sediment Control Basin
- Waterway
- Filter Strip / Critical Area Planting
- Wetland Restoration

Existing SWCD Practices

Existing SWCD Filter Strips

Mud Creek Subwatershed

DAKOTA COUNTY SOIL & WATER CONSERVATION DISTRICT

0 400 800 1,600 Feet

Greenvale Township, Section 20

Description:

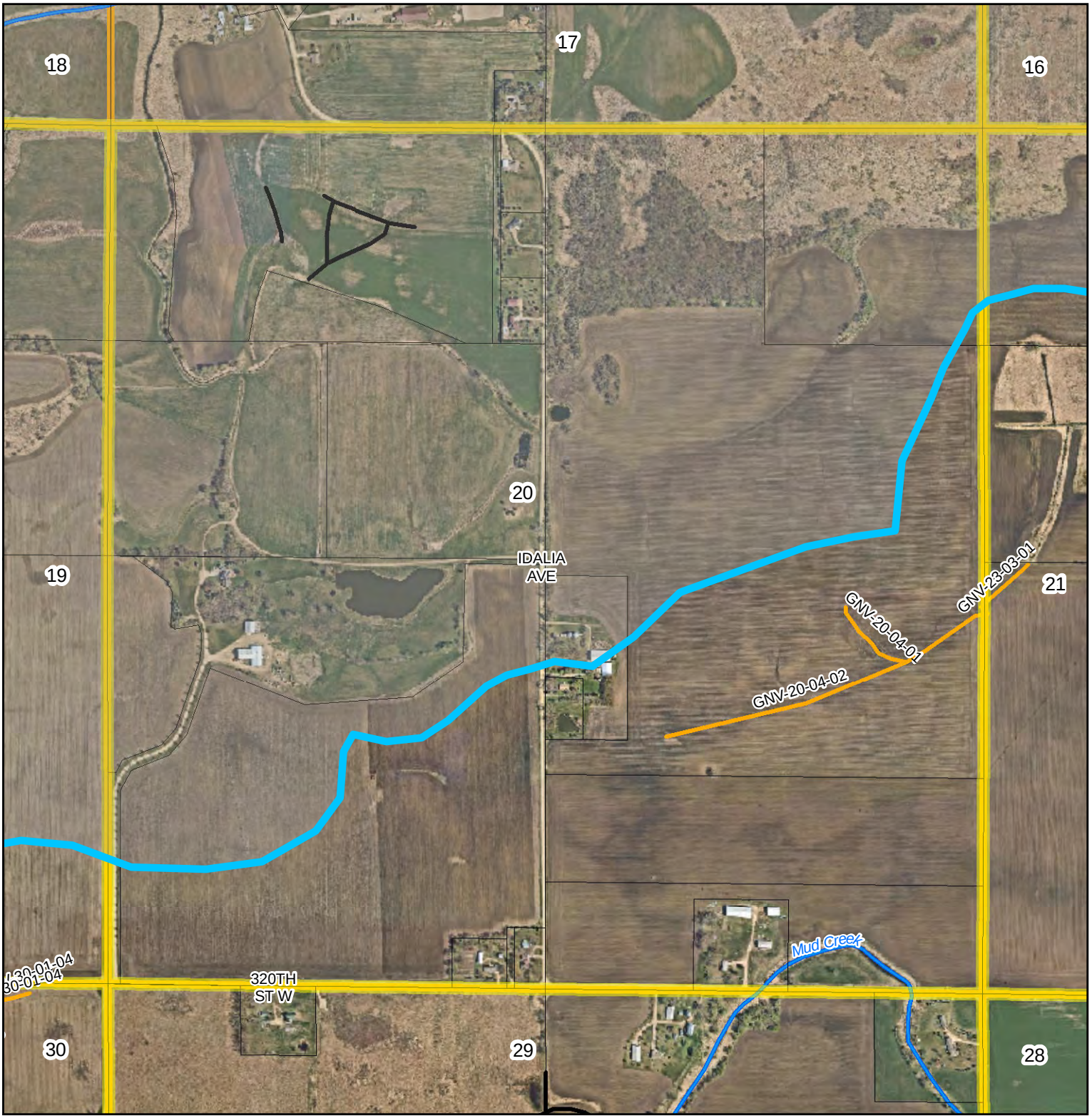
The area of the Mud Creek Subwatershed that lies within Section 20 of Greenvale Township is approximately 238 acres. It consists primarily of agricultural cropland and homesites. Some of the cropland is irrigated. Mud Creek flows through the southern portion with wetlands on both sides of the creek. Conventional tillage practices are utilized on the majority of the cropland. Le Sueur loam with 1-3% slopes is the predominant soil type.

Land Management Recommendations:

The primary land use within this section is agricultural. Land management practices recommended throughout this section include proper use of cover crops, appropriate nutrient management, irrigation water management, conservation crop rotation, and conservation tillage. Although the land management practices were not analyzed for pollutant reduction, it is likely that they have a greater benefit than structural practices within the watershed due to their ability to prevent the transport of sediment and other nutrients.

BMP Cost Benefit Analysis:

Feature ID (Township-section-1/4-#)	BMP/Project Name	Size	Units	Sediment Reduction (ton/yr)	Estimated Project Cost	Cost/Ton of Sediment Reduction
GNV-20-04-02	412 - Grassed Waterway - simple design	2400	Lin. Feet	21.00	$18,120	$86
GNV-20-04-01	412 - Grassed Waterway - simple design	525	Lin. Feet	4.59	$8,745	$190



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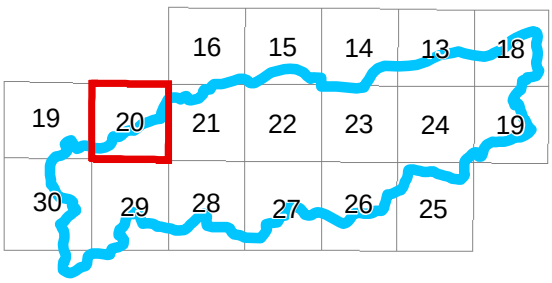
Township: Greenvale

Section: 20



Potential Practices

- Stream Stabilization
- Grade Stabilization
- Water and Sediment Control Basin
- Waterway
- Filter Strip / Critical Area Planting
- Wetland Restoration
- Existing SWCD Practices
- Existing SWCD Filter Strips
- Mud Creek Subwatershed

DAKOTA COUNTY SOIL & WATER CONSERVATION DISTRICT

0 400 800 1,600 Feet

N

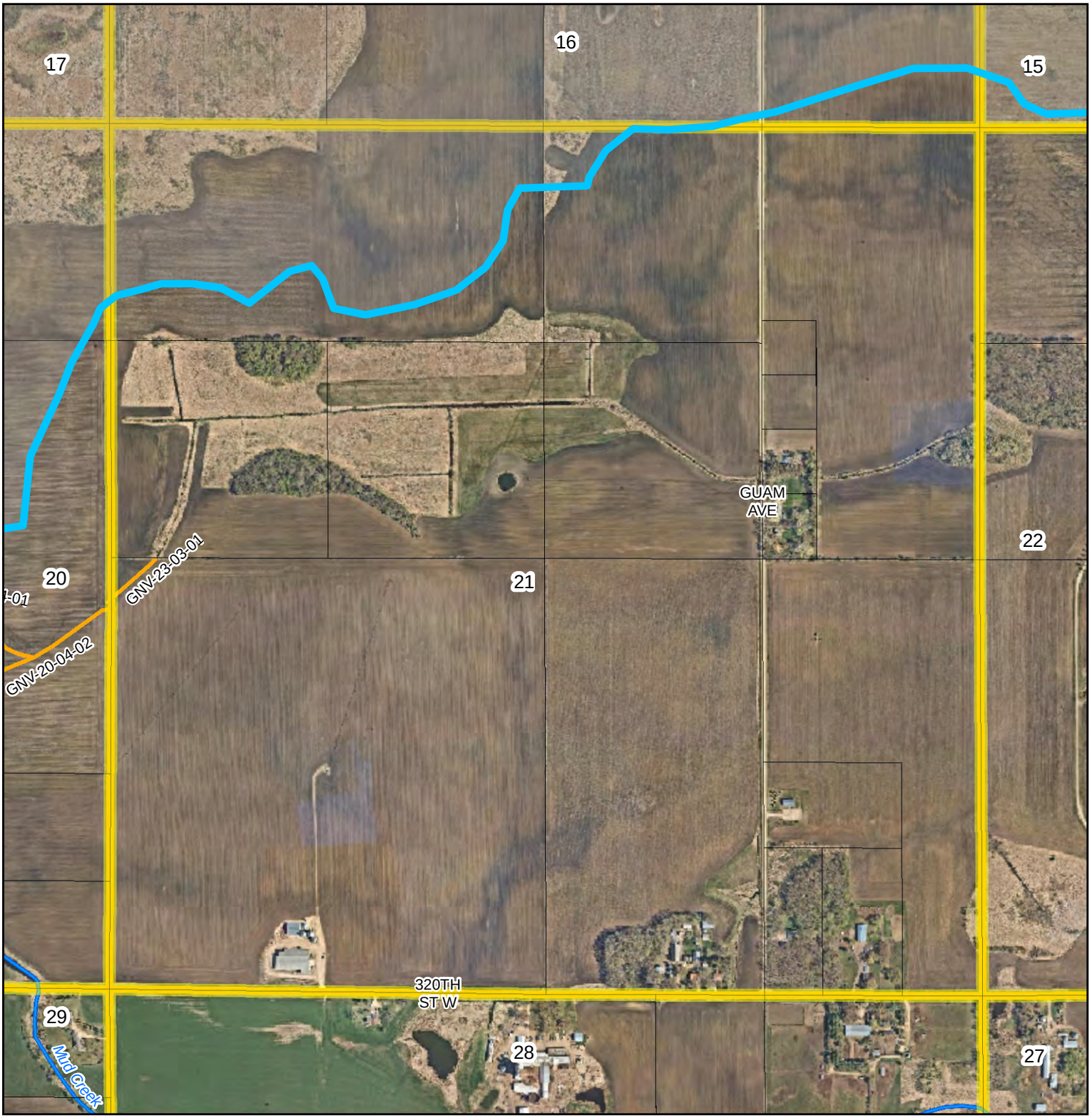
Greenvale Township, Section 21

Description:
The area of the Mud Creek Subwatershed that lies within Section 21 of Greenvale Township is approximately 580 acres. It consists primarily of agricultural cropland, a couple wetlands, and farm/homesites. Some of the cropland is irrigated. Conventional tillage practices are utilized on the majority of the cropland. Le Sueur loam with 1-3% slope is the predominant soil types.

Land Management Recommendations:
The primary land use within this section is agricultural. Land management practices recommended throughout this section include proper use of cover crops, appropriate nutrient management, irrigation water management, conservation crop rotation, and conservation tillage. Although the land management practices were not analyzed for pollutant reduction, it is likely that they have a greater benefit than structural practices within the watershed due to their ability to prevent the transport of sediment and other nutrients.

BMP Cost Benefit Analysis:

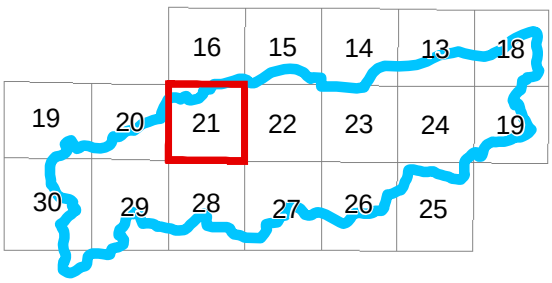
Feature ID (Township-section-1/4-#)	BMP/Project Name	Size	Units	Sediment Reduction (ton/yr)	Estimated Project Cost	Cost/Ton of Sediment Reduction
GNV-21-03-01	412 - Grassed Waterway - simple design	320	Lin. Feet	28.0	$7,720	$276



Source: (Aerial) Dakota County 2021

Township: Greenvale

Section: 21



Potential Practices

- Stream Stabilization
- Grade Stabilization
- Water and Sediment Control Basin
- Waterway
- Filter Strip / Critical Area Planting
- Wetland Restoration
- Existing SWCD Practices
- Existing SWCD Filter Strips
- Mud Creek Subwatershed

DAKOTA COUNTY SOIL & WATER CONSERVATION DISTRICT

0 400 800 1,600 Feet

N

Greenvale Township, Section 22

Description:

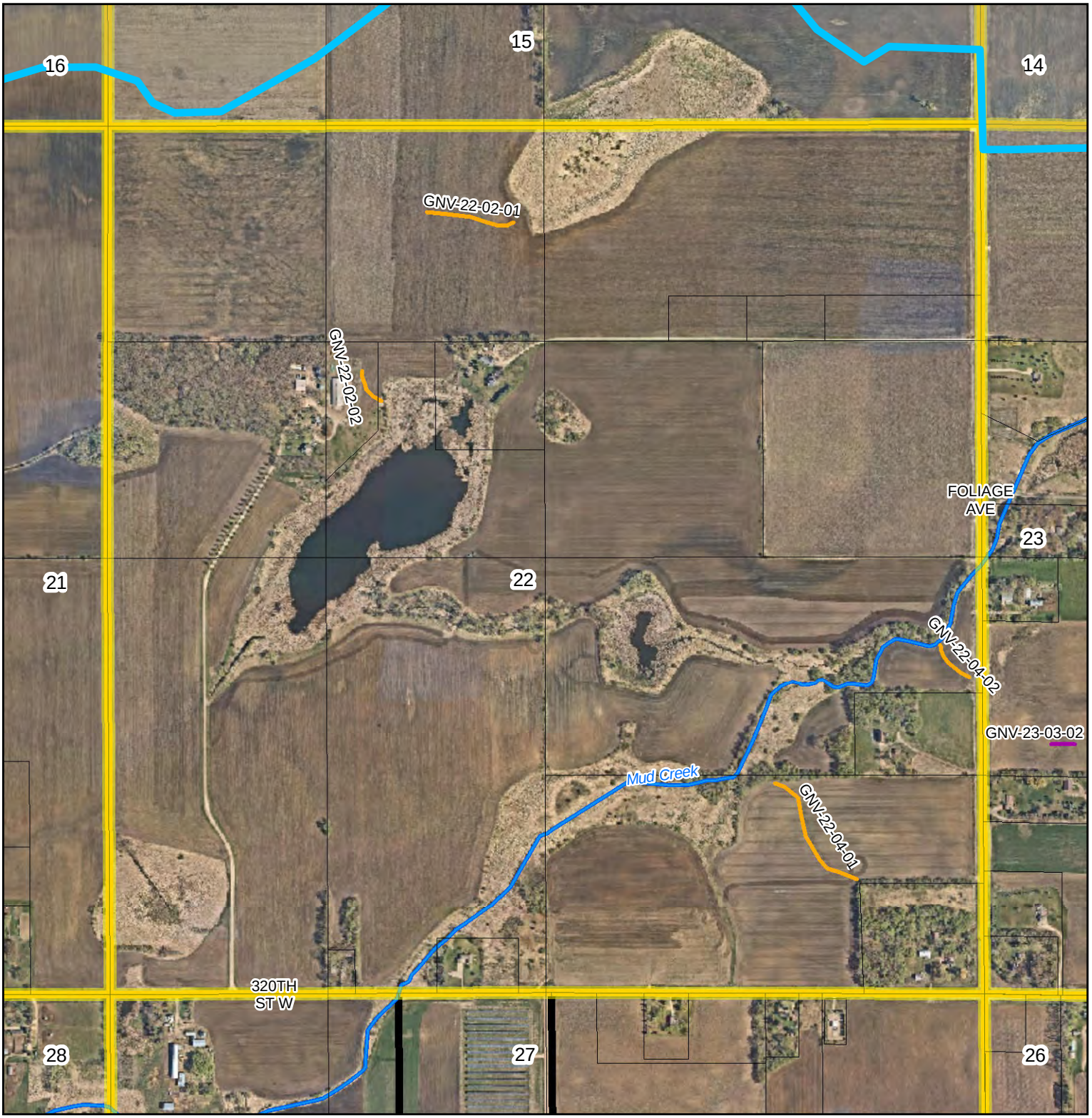
All 640 acres of Section 22 of Greenvale Township are in the Mud Creek Subwatershed. The area primarily consists of agricultural cropland, wetlands, riparian wetlands, deciduous woodland, and several homesites. Mud Creek flows through the southern portion of the section. Conventional tillage practices are utilized on the majority of the cropland. Le Sueur loam with 1-3% slopes and Marshan silty clay loam are the predominant soil types.

Land Management Recommendations:

The primary land use within this section is agricultural. Land management practices recommended throughout this section include proper use of cover crops, appropriate nutrient management, conservation crop rotation, and conservation tillage. For woodland areas, limiting the spread of invasive vegetation such as buckthorn is recommended. Although the land management practices were not analyzed for pollutant reduction, it is likely that they have a greater benefit than structural practices within the watershed due to their ability to prevent the transport of sediment and other nutrients.

BMP Cost Benefit Analysis:

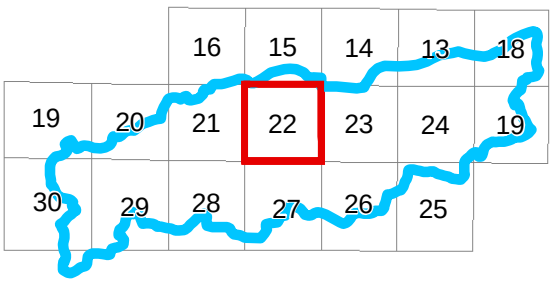
Feature ID (Township-section-1/4-#)	BMP/Project Name	Size	Units	Sediment Reduction (ton/yr)	Estimated Project Cost	Cost/Ton of Sediment Reduction
GNV-22-02-01	412 - Grassed Waterway - simple design	550	Lin. Feet	8.73	$8,870	$102
GNV-22-04-01	412 - Grassed Waterway - simple design	840	Lin. Feet	8.40	$10,320	$123
GNV-22-04-02	412 - Grassed Waterway - simple design	280	Lin. Feet	5.39	$7,520	$140
GNV-22-02-02	412 - Grassed Waterway - simple design	240	Lin. Feet	1.37	$7,320	$536



Source: (Aerial) Dakota County 2021

Township: Greenvale

Section: 22



Potential Practices

- Stream Stabilization
- Grade Stabilization
- Water and Sediment Control Basin
- Waterway
- Filter Strip / Critical Area Planting
- Wetland Restoration

Existing SWCD Practices

Existing SWCD Filter Strips

Mud Creek Subwatershed

DAKOTA COUNTY SOIL & WATER CONSERVATION DISTRICT

0 400 800 1,600 Feet

N

Greenvale Township, Section 23

Description:

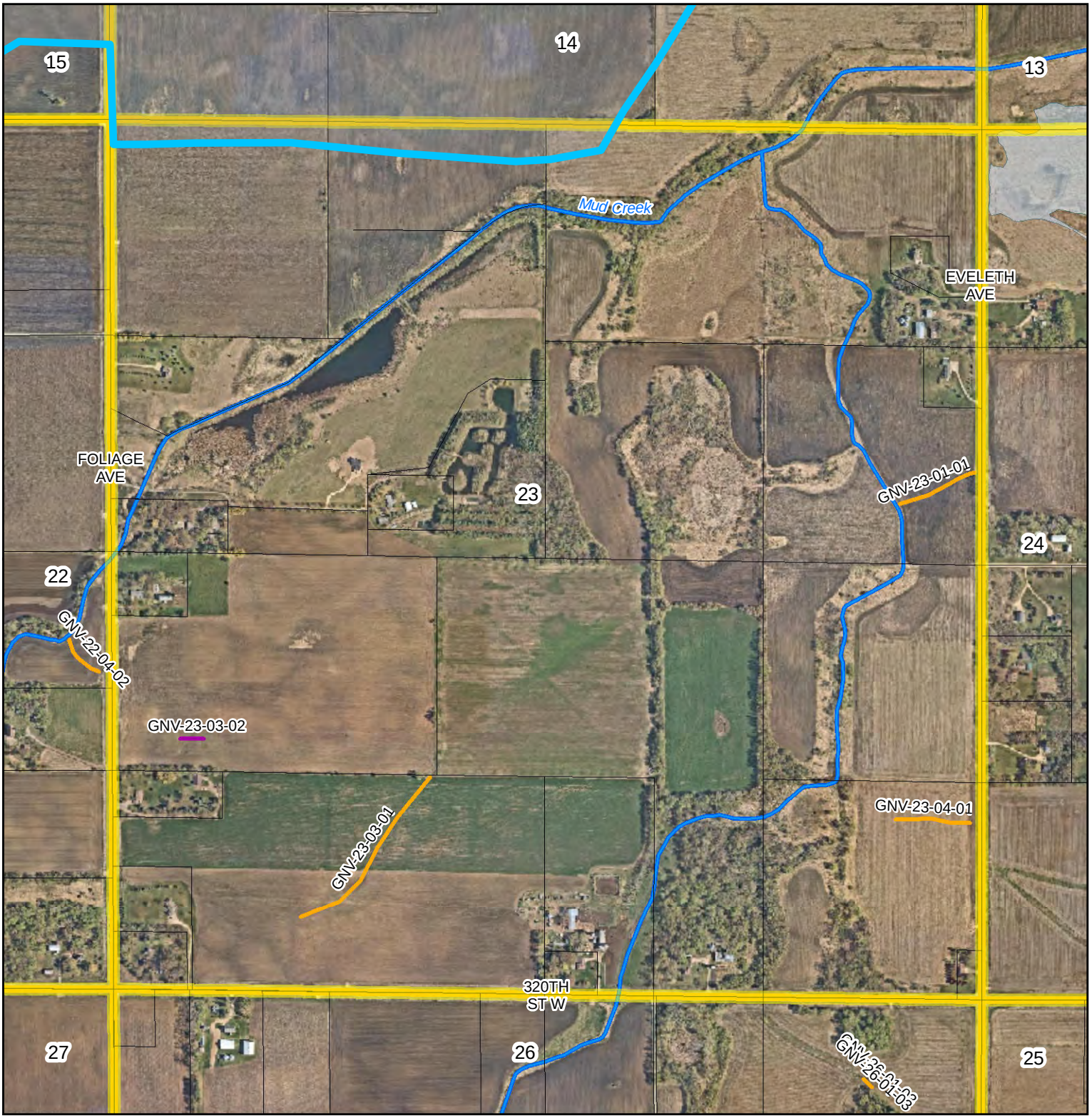
Approximately 631 acres of Section 23 of Greenvale Township are in the Mud Creek Subwatershed. The area primarily consists of agricultural cropland, wetlands, several farmsites and homesites, and some riparian wetlands adjacent to Mud Creek. Mud Creek flows through the northern half of the section. Conventional tillage practices are utilized on the majority of the cropland. Webster clay loam with 0-2% slopes and Glencoe silty clay loam with 0-1% slopes are the predominant soil types.

Land Management Recommendations:

The primary land use within this section is agricultural. Land management practices recommended throughout this section include proper use of cover crops, appropriate nutrient management, conservation crop rotation, and conservation tillage. Although the land management practices were not analyzed for pollutant reduction, it is likely that they have a greater benefit than structural practices within the watershed due to their ability to prevent the transport of sediment and other nutrients.

BMP Cost Benefit Analysis:

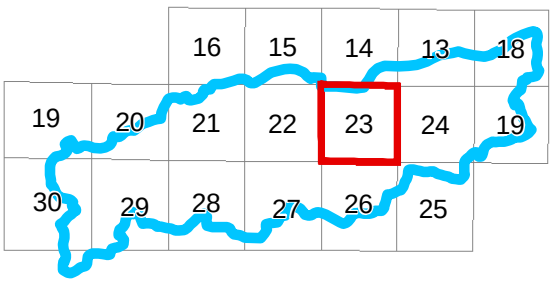
Feature ID (Township-section-1/4-#)	BMP/Project Name	Size	Units	Sediment Reduction (ton/yr)	Estimated Project Cost	Cost/Ton of Sediment Reduction
GNV-23-01-01	412 - Grassed Waterway - simple design	500	Lin. Feet	3.94	$8,620	$219
GNV-23-03-02	638 - Water & Sediment Control Basin (narrow)	1	Each	2.10	$11,120	$530
GNV-23-03-01	412 - Grassed Waterway - simple design	1200	Lin. Feet	2.13	$12,120	$570
GNV-23-04-01	412 - Grassed Waterway - simple design	460	Lin. Feet	0.98	$8,420	$861



Source: (Aerial) Dakota County 2021

Township: Greenvale

Section: 23



Potential Practices

- Stream Stabilization
- Grade Stabilization
- Water and Sediment Control Basin
- Waterway
- Filter Strip / Critical Area Planting
- Wetland Restoration
- Existing SWCD Practices
- Existing SWCD Filter Strips
- Mud Creek Subwatershed

DAKOTA COUNTY SOIL & WATER CONSERVATION DISTRICT

0 400 800 1,600 Feet

N

Greenvale Township, Section 24

Description:

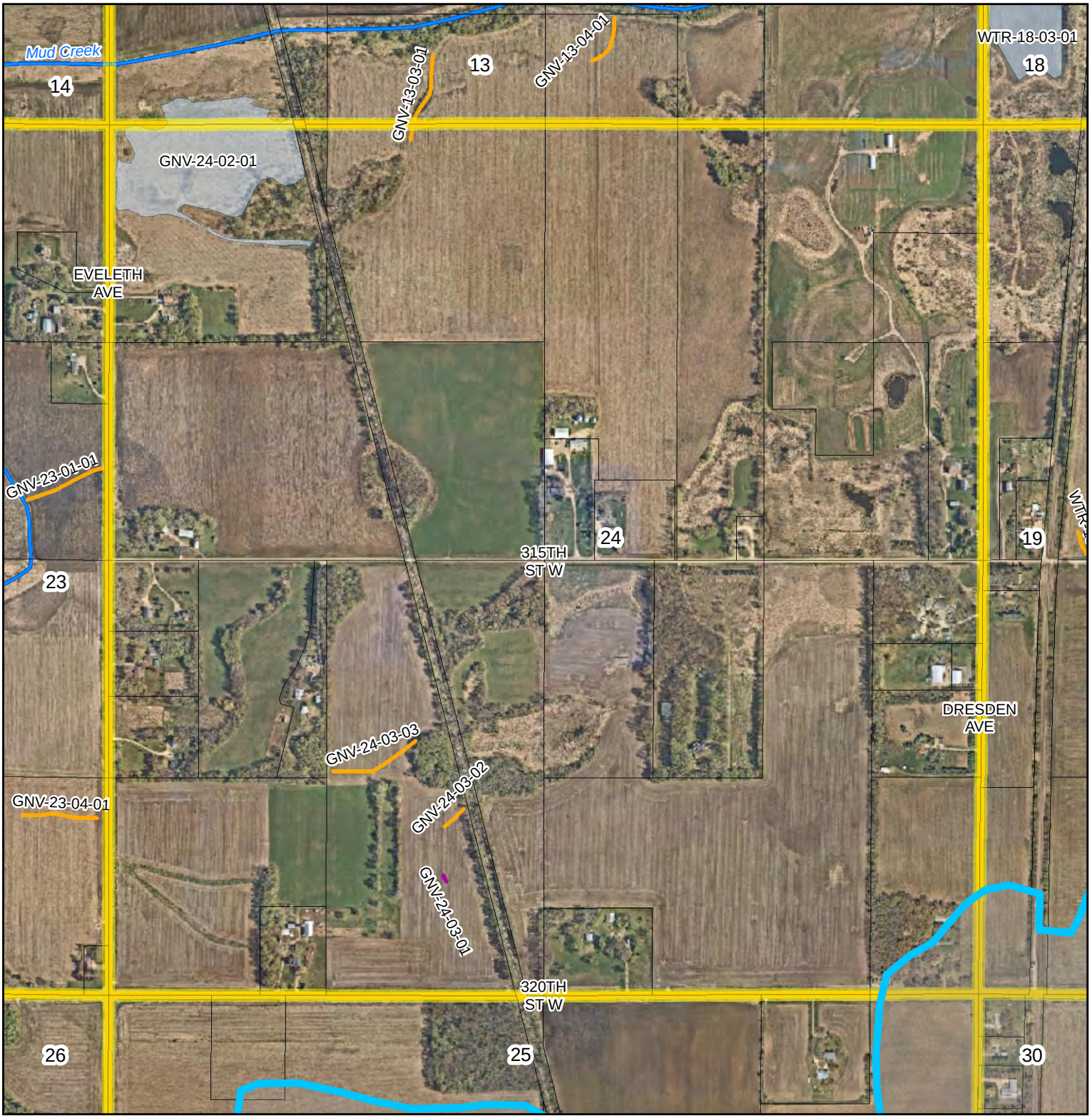
The area of the Mud Creek Subwatershed that lies within Section 24 of Greenvale Township is approximately 640 acres. It consists primarily of agricultural cropland, several homesites, several wetlands, and deciduous woodland. Conventional tillage practices are utilized on the majority of the cropland. Blooming silt loam with 1-6% slopes and Merton silt loam with 1-6% slopes are the predominant soil types.

Land Management Recommendations:

The primary land use within this section is agricultural cropland. Land management practices recommended throughout this section include proper use of cover crops, appropriate nutrient management, conservation crop rotation, and conservation tillage. Although the land management practices were not analyzed for pollutant reduction, it is likely that they have a greater benefit than structural practices within the watershed due to their ability to prevent the transport of sediment and other nutrients.

BMP Cost Benefit Analysis:

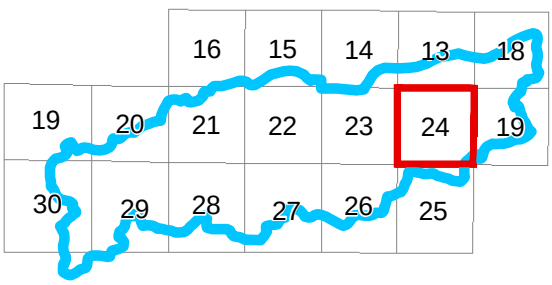
Feature ID (Township-section-1/4-#)	BMP/Project Name	Size	Units	Sediment Reduction (ton/yr)	Estimated Project Cost	Cost/Ton of Sediment Reduction
GNV-24-03-03	412 - Grassed Waterway - simple design	560	Lin. Feet	9.80	$8,920	$91
GNV-24-02-01	657 - Wetland Restoration	14	Acres	80.50	$112,400	$140
GNV-24-03-02	412 - Grassed Waterway - simple design	160	Lin. Feet	1.12	$6,920	$618
GNV-24-03-01	638 - Water & Sediment Control Basin (narrow)	1	Each	1.09	$11,120	$1,017



Source: (Aerial) Dakota County 2021

Township: Greenvale

Section: 24



Potential Practices

- Stream Stabilization
- Grade Stabilization
- Water and Sediment Control Basin
- Waterway
- Filter Strip / Critical Area Planting
- Wetland Restoration
- Existing SWCD Practices
- Existing SWCD Filter Strips
- Mud Creek Subwatershed

DAKOTA COUNTY SOIL & WATER CONSERVATION DISTRICT

0 400 800 1,600 Feet

N

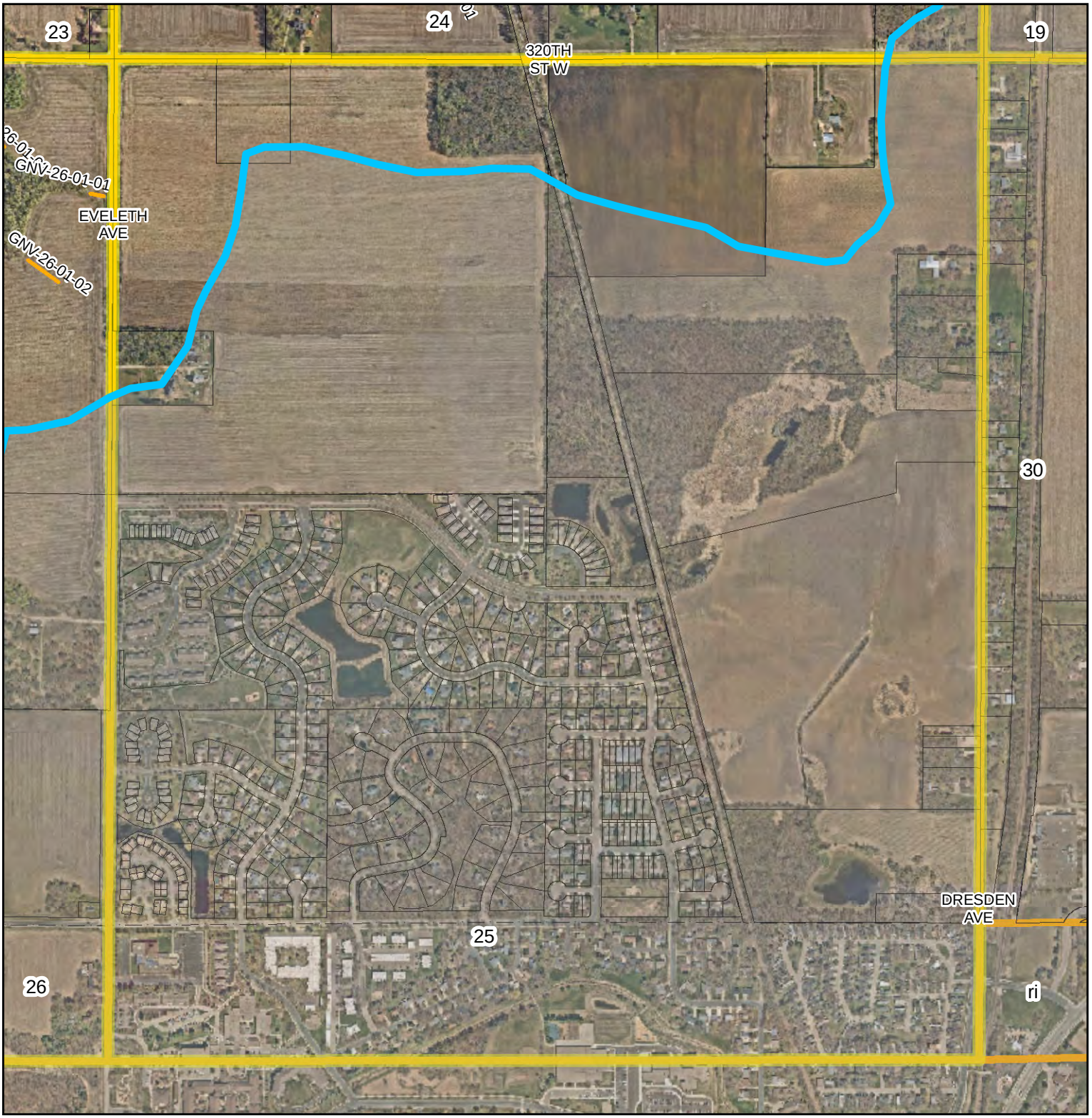
Greenvale Township, Section 25

Description:
The area of the Mud Creek Subwatershed that lies within Section 25 of Greenvale Township is approximately 106 acres. It consists primarily of agricultural cropland with a wetland and a homesite. Conventional tillage practices are utilized on the majority of the cropland. Blooming silt loam with 1-6% slopes and Lester loam with 6-10% slopes are the predominant soil types.

Land Management Recommendations:
The primary land use within this section is agricultural. Land management practices recommended throughout this section include proper use of cover crops, appropriate nutrient management, conservation crop rotation, and conservation tillage. Although the land management practices were not analyzed for pollutant reduction, it is likely that they have a greater benefit than structural practices within the watershed due to their ability to prevent the transport of sediment and other nutrients.

BMP Cost Benefit Analysis:

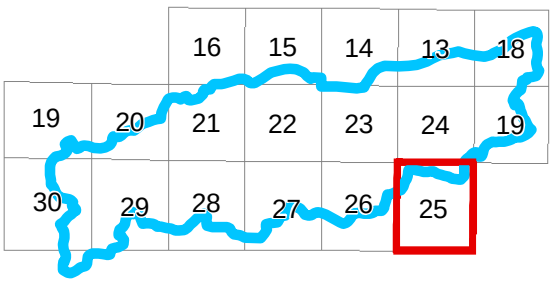
There were no structural practices that ranked high for cost-effectiveness identified in this section. Focus in this section should be on proper land management practices and non-structural best management practices.



Source: (Aerial) Dakota County 2021

Township: Greenvale

Section: 25



Potential Practices

- Stream Stabilization
- Grade Stabilization
- Water and Sediment Control Basin
- Waterway
- Filter Strip / Critical Area Planting
- Wetland Restoration
- Existing SWCD Practices
- Existing SWCD Filter Strips
- Mud Creek Subwatershed

DAKOTA COUNTY SOIL & WATER CONSERVATION DISTRICT

0 400 800 1,600 Feet

Greenvale Township, Section 26

Description:

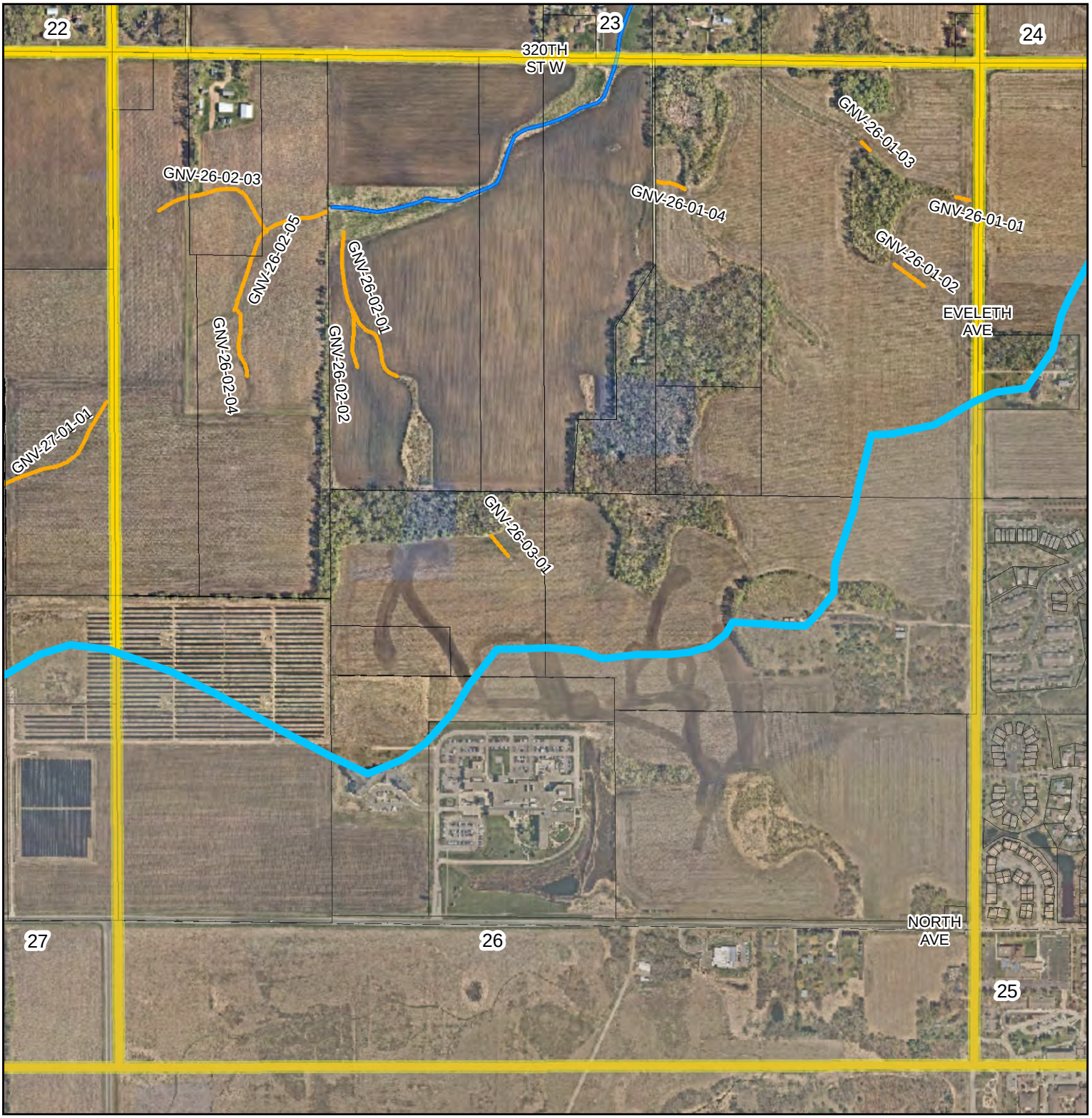
The area of the Mud Creek Subwatershed that lies within Section 26 of Greenvale Township is approximately 429 acres. It consists primarily of agricultural cropland, deciduous woodlands, wetlands, a solar farm, and homesites. Conventional tillage practices are utilized on the majority of the cropland. Lester loam with 6-10% slopes and Glencoe silty clay loam with 0-1% slopes are the predominant soil types.

Land Management Recommendations:

The primary land use within this section is agricultural. Land management practices recommended throughout this section include proper use of cover crops, appropriate nutrient management, conservation crop rotation, and conservation tillage. Although the land management practices were not analyzed for pollutant reduction, it is likely that they have a greater benefit than structural practices within the watershed due to their ability to prevent the transport of sediment and other nutrients.

BMP Cost Benefit Analysis:

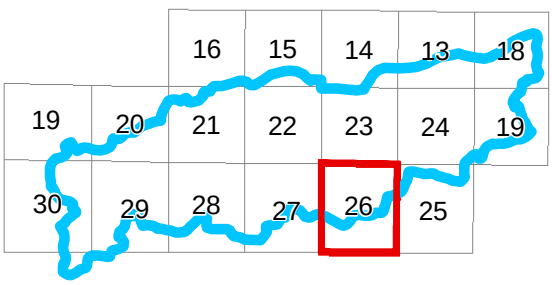
Feature ID (Township-section-1/4-#)	BMP/Project Name	Size	Units	Sediment Reduction (ton/yr)	Estimated Project Cost	Cost/Ton of Sediment Reduction
GNV-26-02-05	412 - Grassed Waterway - simple design	920	Lin. Feet	14.66	$10,720	$73
GNV-26-02-01	412 - Grassed Waterway - simple design	1000	Lin. Feet	12.75	$11,120	$87
GNV-26-02-03	412 - Grassed Waterway - simple design	825	Lin. Feet	11.73	$10,245	$87
GNV-26-02-04	412 - Grassed Waterway - simple design	420	Lin. Feet	7.35	$8,220	$112
GNV-26-02-02	412 - Grassed Waterway - simple design	350	Lin. Feet	3.35	$7,870	$235
GNV-26-01-02	412 - Grassed Waterway - simple design	230	Lin. Feet	2.21	$7,270	$328
GNV-26-01-04	412 - Grassed Waterway - simple design	180	Lin. Feet	1.34	$7,020	$524
GNV-26-01-03	412 - Grassed Waterway - simple design	75	Lin. Feet	0.79	$6,495	$825
GNV-26-03-01	412 - Grassed Waterway - simple design	160	Lin. Feet	0.64	$6,920	$1,085
GNV-26-01-01	412 - Grassed Waterway - simple design	90	Lin. Feet	0.43	$6,570	$1,517



Source: (Aerial) Dakota County 2021

Township: Greenvale

Section: 26



Potential Practices

- Stream Stabilization
- Grade Stabilization
- Water and Sediment Control Basin
- Waterway
- Filter Strip / Critical Area Planting
- Wetland Restoration

Existing SWCD Practices

Existing SWCD Filter Strips

Mud Creek Subwatershed

DAKOTA COUNTY SOIL & WATER CONSERVATION DISTRICT

0 400 800 1,600 Feet

N

Greenvale Township, Section 27

Description:

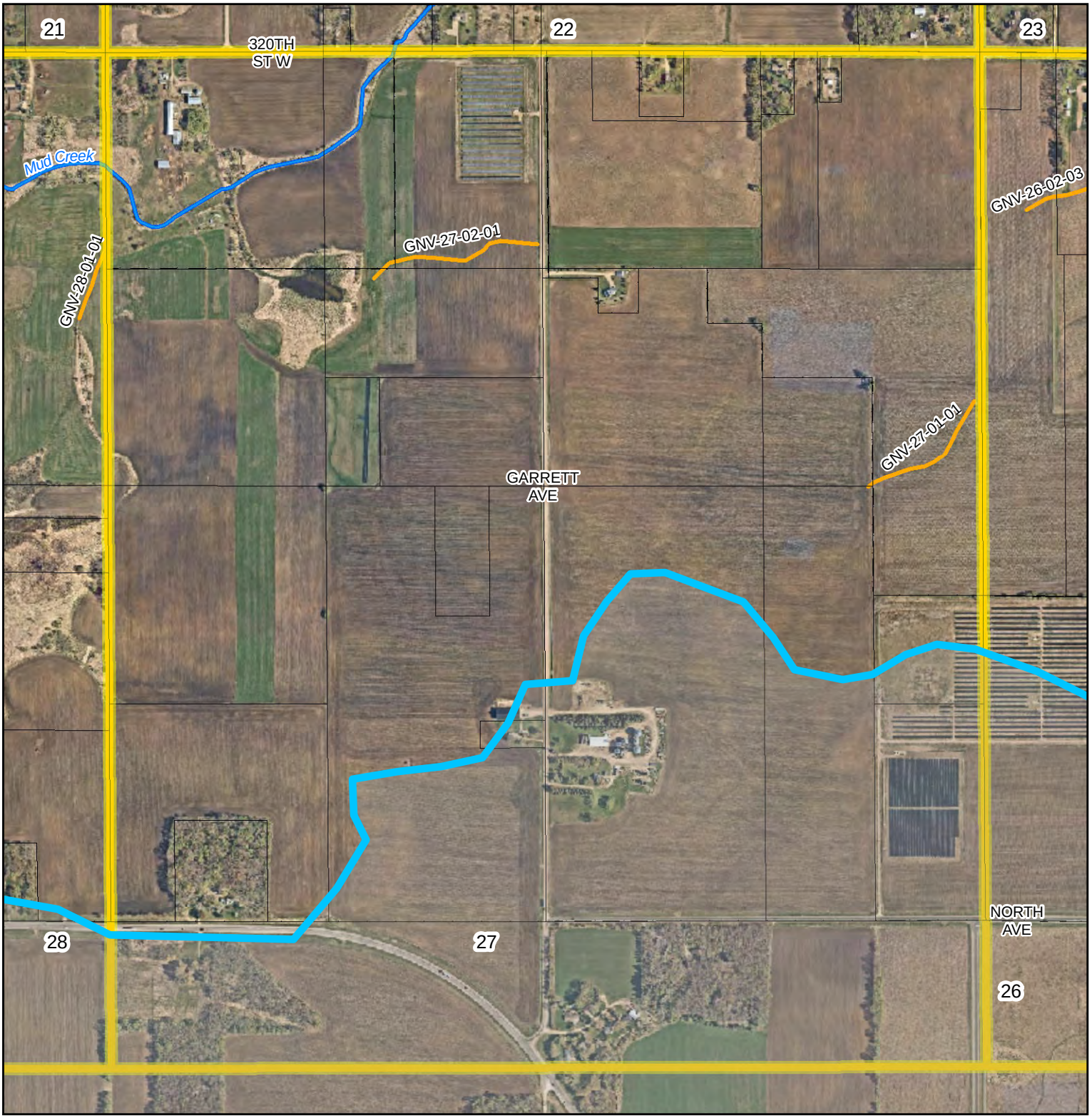
The area of the Mud Creek Subwatershed that lies within Section 27 of Greenvale Township is approximately 513 acres. It consists primarily of agricultural crop land, wetlands along Mud Creek, several homesites, and a solar farm. Conventional tillage practices are utilized on the majority of the cropland. Lester loam with 2-6% slopes and Marshan silty clay loam are the predominant soil types.

Land Management Recommendations:

The primary land use within this section is agricultural. Land management practices recommended throughout this section include proper use of cover crops, appropriate nutrient management, conservation crop rotation, and conservation tillage. Although the land management practices were not analyzed for pollutant reduction, it is likely that they have a greater benefit than structural practices within the watershed due to their ability to prevent the transport of sediment and other nutrients.

BMP Cost Benefit Analysis:

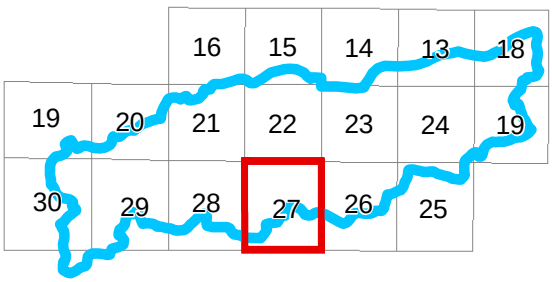
Feature ID (Township-section-1/4-#)	BMP/Project Name	Size	Units	Sediment Reduction (ton/yr)	Estimated Project Cost	Cost/Ton of Sediment Reduction
GNV-27-02-01	412 - Grassed Waterway - simple design	1100	Lin. Feet	9.03	$11,620	$129
GNV-27-01-01	412 - Grassed Waterway - simple design	880	Lin. Feet	3.66	$10,520	$288



Source: (Aerial) Dakota County 2021

Township: Greenvale

Section: 27



Potential Practices

- Stream Stabilization
- Grade Stabilization
- Water and Sediment Control Basin
- Waterway
- Filter Strip / Critical Area Planting
- Wetland Restoration
- Existing SWCD Practices
- Existing SWCD Filter Strips
- Mud Creek Subwatershed

DAKOTA COUNTY SOIL & WATER CONSERVATION DISTRICT

0 400 800 1,600 Feet

N

Greenvale Township, Section 28

Description:

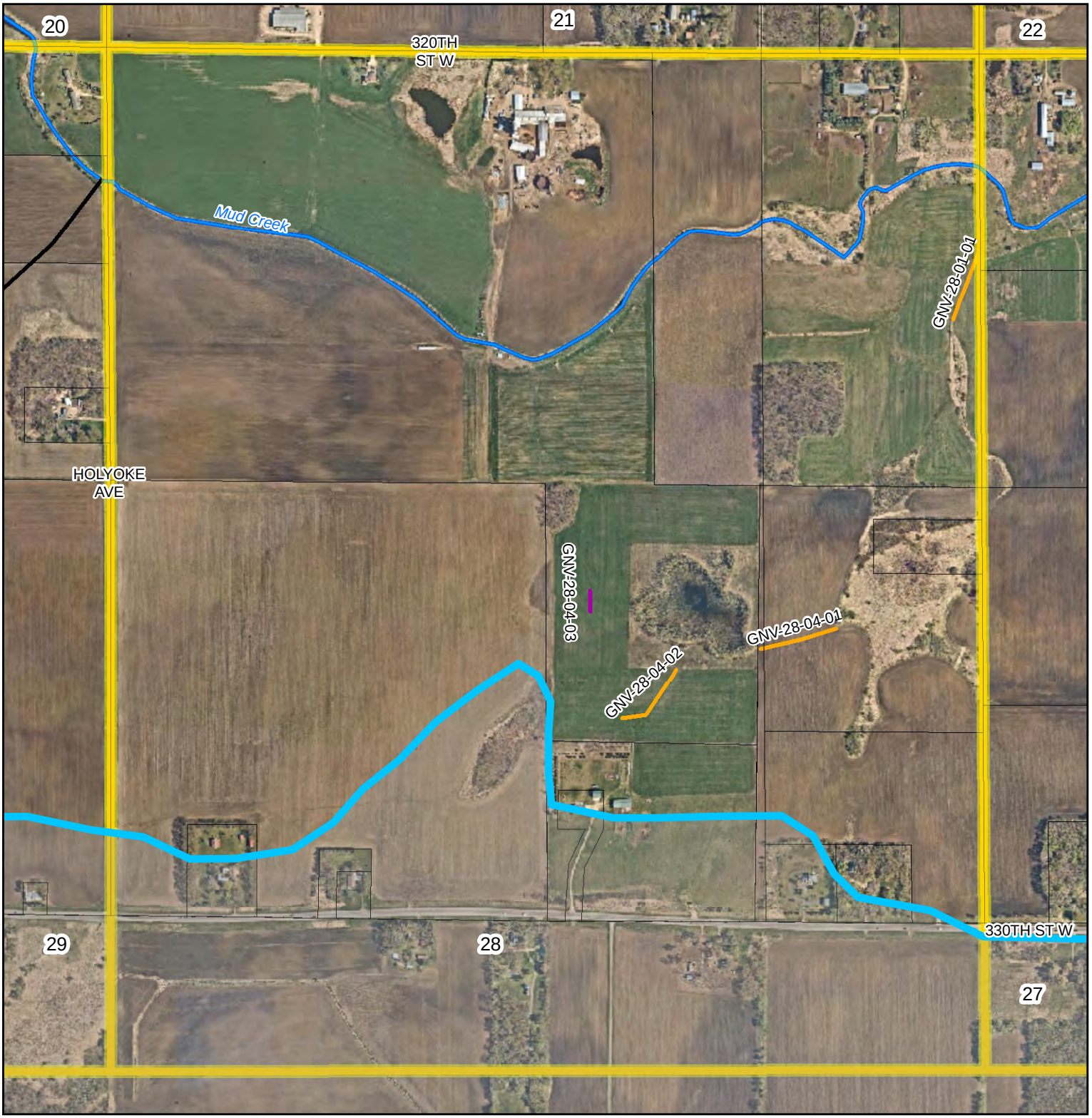
Approximately 570 acres of Section 28 of Greenvale Township are in the Mud Creek Subwatershed. The area primarily consists of agricultural cropland, several wetlands, and multiple farmsites/homesites. Mud Creek runs through the northern portion of the section. Conventional tillage practices are utilized on the majority of the cropland. Lester loam with 2-6% slopes is the predominant soil type.

Land Management Recommendations:

The primary land use within this section is agricultural. Land management practices recommended throughout this section include proper use of cover crops, appropriate nutrient management, conservation crop rotation, and conservation tillage. Although the land management practices were not analyzed for pollutant reduction, it is likely that they have a greater benefit than structural practices within the watershed due to their ability to prevent the transport of sediment and other nutrients.

BMP Cost Benefit Analysis:

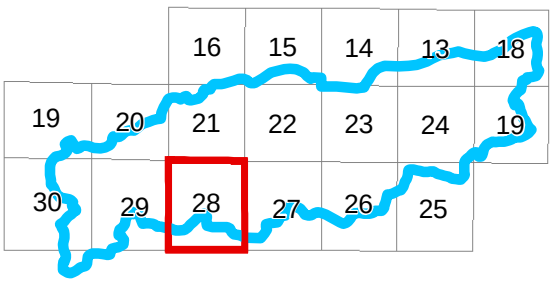
Feature ID (Township-section-1/4-#)	BMP/Project Name	Size	Units	Sediment Reduction (ton/yr)	Estimated Project Cost	Cost/Ton of Sediment Reduction
GNV-28-04-01	412 - Grassed Waterway - simple design	480	Lin. Feet	5.74	$8,520	$148
GNV-28-01-01	412 - Grassed Waterway - simple design	440	Lin. Feet	2.10	$8,320	$396
GNV-28-04-02	412 - Grassed Waterway - simple design	480	Lin. Feet	1.05	$8,520	$811
GNV-28-04-03	638 - Water & Sediment Control Basin (narrow)	1	Each	1.02	$11,120	$1,090



Source: (Aerial) Dakota County 2021

Township: Greenvale

Section: 28



Potential Practices

- Stream Stabilization
- Grade Stabilization
- Water and Sediment Control Basin
- Waterway
- Filter Strip / Critical Area Planting
- Wetland Restoration

Existing SWCD Practices

Existing SWCD Filter Strips

Mud Creek Subwatershed

DAKOTA COUNTY SOIL & WATER CONSERVATION DISTRICT

0 400 800 1,600 Feet

N

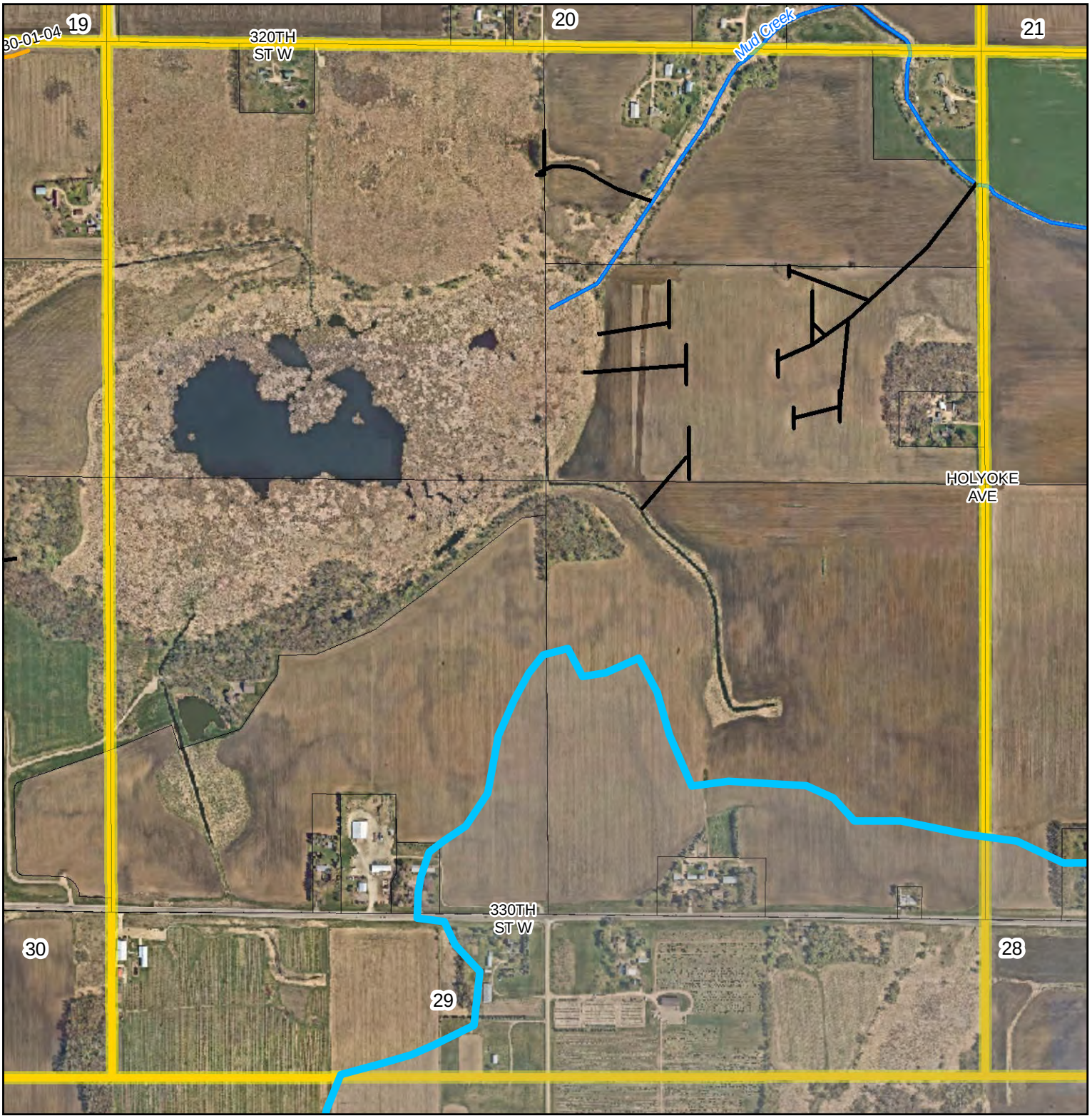
Greenvale Township, Section 29

Description:
Approximately 621 acres of Section 29 of Greenvale Township are in the Mud Creek Subwatershed. The area primarily consists of agricultural cropland, several home/farmsites, wetlands, and a wetland complex in Mud Creek Wildlife Management Area. Conventional tillage practices are utilized on the majority of the cropland. Lester loam with 2-6% slopes are the predominant soil types.

Land Management Recommendations:
The primary land use within this section is agricultural. Land management practices recommended throughout this section include proper use of cover crops, appropriate nutrient management, conservation crop rotation, and conservation tillage. Although the land management practices were not analyzed for pollutant reduction, it is likely that they have a greater benefit than structural practices within the watershed due to their ability to prevent the transport of sediment and other nutrients.

BMP Cost Benefit Analysis:

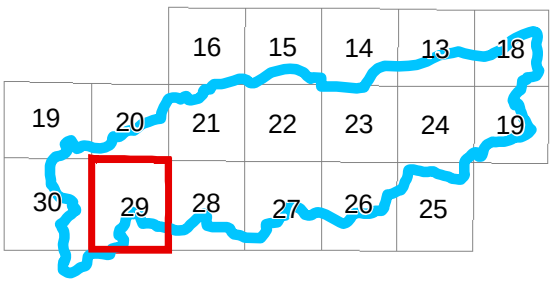
There were no structural practices that ranked high for cost-effectiveness identified in this section. Focus in this section should be on proper land management practices and non-structural best management practices.



Source: (Aerial) Dakota County 2021

Township: Greenvale

Section: 29



Potential Practices

- Stream Stabilization
- Grade Stabilization
- Water and Sediment Control Basin
- Waterway
- Filter Strip / Critical Area Planting
- Wetland Restoration
- Existing SWCD Practices
- Existing SWCD Filter Strips
- Mud Creek Subwatershed

DAKOTA COUNTY SOIL & WATER CONSERVATION DISTRICT

0 400 800 1,600 Feet

Greenvale Township, Section 30

Description:

Approximately 315 acres of Section 30 of Greenvale Township are in the Mud Creek Subwatershed. The area primarily consists of agricultural cropland, wetlands, and several home/farmsites. Conventional tillage practices are utilized on the majority of the cropland. Lester Loam with 1-10% slopes are the predominant soil types.

Land Management Recommendations:

The primary land use within this section is agricultural. Land management practices recommended throughout this section include proper use of cover crops, appropriate nutrient management, conservation crop rotation, and conservation tillage. Although the land management practices were not analyzed for pollutant reduction, it is likely that they have a greater benefit than structural practices within the watershed due to their ability to prevent the transport of sediment and other nutrients.

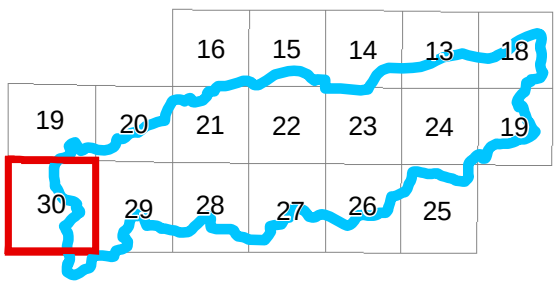
BMP Cost Benefit Analysis:

Feature ID (Township-section-1/4-#)	BMP/Project Name	Size	Units	Sediment Reduction (ton/yr)	Estimated Project Cost	Cost/Ton of Sediment Reduction
GNV-30-01-08	412 - Grassed Waterway - simple design	1300	Lin. Feet	8.40	$12,620	$150
GNV-30-04-01	412 - Grassed Waterway - simple design	720	Lin. Feet	4.21	$9,720	$231
GNV-30-01-07	412 - Grassed Waterway - simple design	480	Lin. Feet	3.40	$8,520	$251
GNV-30-01-05	638 - Water & Sediment Control Basin (narrow)	1	Each	3.85	$11,120	$289
GNV-30-04-02	412 - Grassed Waterway - simple design	240	Lin. Feet	1.91	$7,320	$383
GNV-30-01-06	638 - Water & Sediment Control Basin (narrow)	1	Each	2.91	$11,120	$383
GNV-30-01-01	412 - Grassed Waterway - simple design	370	Lin. Feet	0.64	$7,970	$1,250
GNV-30-01-02	412 - Grassed Waterway - simple design	720	Lin. Feet	0.77	$9,720	$1,271
GNV-30-01-03	412 - Grassed Waterway - simple design	300	Lin. Feet	0.38	$7,620	$2,010
GNV-30-01-04	412 - Grassed Waterway - simple design	240	Lin. Feet	0.34	$7,320	$2,153

Source: (Aerial) Dakota County 2021

Township: Greenvale

Section: 30



Potential Practices

- Stream Stabilization
- Grade Stabilization
- Water and Sediment Control Basin
- Waterway
- Filter Strip / Critical Area Planting
- Wetland Restoration
- Existing SWCD Practices
- Existing SWCD Filter Strips
- Mud Creek Subwatershed

DAKOTA COUNTY SOIL & WATER CONSERVATION DISTRICT

0 400 800 1,600 Feet

N

Waterford Township, Section 18

Description:

Approximately 273 acres of Section 18 of Waterford Township are in the Mud Creek Subwatershed. The area primarily consists of agricultural cropland, wetlands, and home/farmsites. Mud Creek flows through the center of this section and includes sizable wetlands on both sides of the channel. Conventional tillage practices are utilized on the majority of the cropland. Mayer silt loam and Sparta loamy fine sand with 1-6% slopes are the predominant soil types.

Land Management Recommendations:

The primary land use within this section is agricultural. Land management practices recommended throughout this section include proper use of cover crops, appropriate nutrient management, conservation crop rotation, and conservation tillage. Although the land management practices were not analyzed for pollutant reduction, it is likely that they have a greater benefit than structural practices within the watershed due to their ability to prevent the transport of sediment and other nutrients.

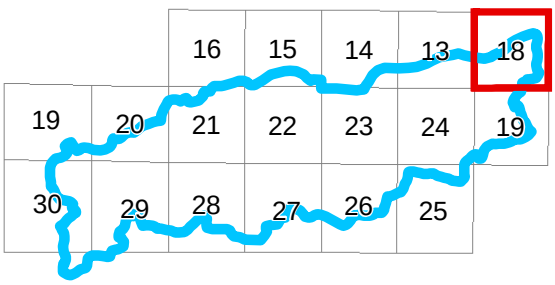
BMP Cost Benefit Analysis:

Feature ID (Township-section-1/4-#)	BMP/Project Name	Size	Units	Sediment Reduction (ton/yr)	Estimated Project Cost	Cost/Ton of Sediment Reduction
WTR-18-04-01	412 - Grassed Waterway - simple design	650	Lin. Feet	17.64	$9,370	$53
WTR-18-03-01	657 - Wetland Restoration	7	Acres	110.00	$63,400	$58
WTR-18-01-01	657 - Wetland Restoration	2	Acres	10.45	$28,400	$272

Source: (Aerial) Dakota County 2021

Township: Waterford

Section: 18



Potential Practices

- Stream Stabilization
- Grade Stabilization
- Water and Sediment Control Basin
- Waterway
- Filter Strip / Critical Area Planting
- Wetland Restoration
- Existing SWCD Practices
- Existing SWCD Filter Strips
- Mud Creek Subwatershed

DAKOTA COUNTY SOIL & WATER CONSERVATION DISTRICT

0 400 800 1,600 Feet

Waterford Township, Section 19

Description:

Approximately 309 acres of Section 19 of Waterford Township are in the Mud Creek Subwatershed. The area primarily consists of agricultural cropland, wetlands, and several home/farmsites. Blooming silt loam with 1-6% slopes is the predominant soil type.

Land Management Recommendations:

The primary land use within this section is agricultural. Land management practices recommended throughout this section include proper use of cover crops, appropriate nutrient management, conservation crop rotation, and conservation tillage. Although the land management practices were not analyzed for pollutant reduction, it is likely that they have a greater benefit than structural practices within the watershed due to their ability to prevent the transport of sediment and other nutrients.

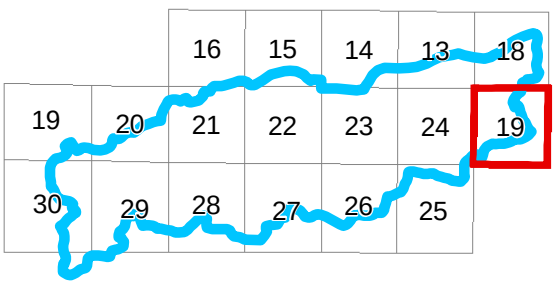
BMP Cost Benefit Analysis:

Feature ID (Township-section-1/4-#)	BMP/Project Name	Size	Units	Sediment Reduction (ton/yr)	Estimated Project Cost	Cost/Ton of Sediment Reduction
WTR-19-02-03	657 - Wetland Restoration	56	Acres	434.35	$406,400	$94
WTR-19-02-01	412 - Grassed Waterway - simple design	340	Lin. Feet	1.08	$7,820	$722
WTR-19-02-02	412 - Grassed Waterway - simple design	150	Lin. Feet	0.48	$6,870	$1,437
WTR-19-03-01	412 - Grassed Waterway - simple design	350	Lin. Feet	0.46	$7,870	$1,693

Source: (Aerial) Dakota County 2021

Township: Waterford

Section: 19



Potential Practices

- Stream Stabilization
- Grade Stabilization
- Water and Sediment Control Basin
- Waterway
- Filter Strip / Critical Area Planting
- Wetland Restoration
- Existing SWCD Practices
- Existing SWCD Filter Strips
- Mud Creek Subwatershed

DAKOTA COUNTY SOIL & WATER CONSERVATION DISTRICT

0 400 800 1,600 Feet

N

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Appendix

Cost estimates were developed based upon the type of BMP and the historical cost of installation and management in Dakota County between 2014 and 2019. The following table provides a breakdown of the estimates used for each BMP:

BMP	Size of BMP (user entered)	Units	Construction Cost per Unit	Design and Project Management	Total BMP Cost (example based on user entered value)
340- Cover Crop	100	Acres	$50	$2,160	**$7,160**
342 - Critical Area Planting (Native Grasses)	10	Acres	$1,500	$2,160	**$17,160**
342- Critical Area Planting (Non Native Grasses)	10	Acres	$500	$2,250	**$7,250**
393- Filter Strip	10	Acres	$1,000	$2,160	**$12,160**
410- Grade Stabilization Structure 0-10ac	1	Each	$12,000	$6,120	**$18,120**
410- Grade Stabilization Structure 10-100ac	1	Each	$25,000	$7,470	**$32,470**
410- Grade Stabilization Structure100-250ac	1	Each	$40,000	$8,820	**$48,820**
410- Grade Stabilization Structure250+ ac	1	Each	$120,000	$14,220	**$134,220**
412- Grassed Waterway - simple design	500	Lin. Ft.	$5.00	$6,120	**$8,620**
412- Grassed Waterway - complex 20' design	500	Lin. Ft.	$6.00	$7,020	**$10,020**
412- Grassed Waterway- complex 30' design	500	Lin. Ft.	$7.00	$7,920	**$11,420**
468 - Lined Waterway	25	Lin. Ft.	$75.00	$6,120	**$7,995**
362 - Diversion	1	Each	$5,000	$5,130	**$10,130**
580- Streambank and Shoreline Protection	500	Sq. Ft.	$125	$8,190	**$70,690**
638-Water & Sediment Control Basin(narrow)	1	Each	$5,000	$6,120	**$11,120**
638-Water & Sediment Control Basin(wide)	1	Each	$10,000	$7,470	**$17,470**
645- Upland Wildlife Habitat Management	10	Acres	$1,500	$5,220	**$20,220**
657- Wetland Restoration	10	Acres	$7,000	$14,400	**$84,400**
658- Wetland Creation	10	Acres	$10,000	$14,400	**$114,400**
659- Wetland Enhancements	10	Acres	$5,000	$8,100	**$58,100**
554- Drainage Water Management (each structure)	1	Each	$2,000	$4,410	**$6,410**
604- Saturated Buffer (40 acres treated)	1	Each	$6,000	$5,400	**$11,400**
605- Denitrifying Bioreactor (40 acres treated)	1	Each	$20,000	$5,850	**$25,850**